ENCYCLOPEDIA
BRITANNICA

THE UNIVERSITY OF CHICAGO

The Encyclopædia Britannica
is published with the editorial advice of the faculties
of The University of Chicago and of a
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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 16

MUSHROOM TO OZONOLYSIS

ENCYCLOPEDIA BRITANNICA, INC.

WILLIAM BENTON, PUBLISHER

CHICAGO · LONDON · TORONTO · GENEVA · SYDNEY

PRINTED IN THE U.S.A.

FOUNDED A.D. 1768

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MUSHROOM TO OZONOLYSIS

MUSHROOM. The well known, edible, umbrella-shaped fungus which is grown for the market and commonly served as a delicacy is called by many people "the mushroom." Botanically it is known as *Agaricus* campestris, or by some authors as *Psalliota* campestris. In the temperate regions of the earth it is often found growing wild, in pastures, lawns, golf courses, etc., where the grass is kept short and the ground is enriched by manure. Restriction of the name mushroom to this fungus alone is not in accordance with the terminology accepted by botanists, nor in most regions does it correspond with popular usage. Hundreds of other umbrella-shaped fungi occur in nature and are to be found in numbers unbelievable to those who have not made a deliberate search for them. These differ from *Agaricus* campestris in minor characters of form, structure, and colour. Many of them are edible, a few are deadly poisonous, others are too tough or unpalatable to serve as food. The botanist calls all of these mushrooms. Such umbrella-shaped fungi in most cases bear on the under side of the expanded upper portion or cap (*pileus*) a number of flat, knife-blade shaped parts (gills) which radiate like the spokes of a wheel from the handle or stalk (stipe) to the margin of the cap. Possession of these radiating gills marks a fungus as a member of the family Agaricaceae, these fungi being commonly called "agarics." Other closely related umbrella-shaped fungi outside this family lack gills. In the Boleti, for example, there may be seen on the under side of the umbrella. myriads of tiny pores which are the mouths of cylindrical tubes, while in members of the family Hydnaceae pendent spines occur instead. Still other related fungi lack the typical umbrella-shape, and show wide variation in form. The coral fungi (Clavariaceae) have the aspect of delicately coloured coral, and may be much branched like a deciduous tree. Others occurring on the sides of stumps, fallen logs, or trees are known as the bracket fungi and have the aspect of little shelves overlapping one above the other. The hundreds of species of all these various sorts of fungi possess, for the most part, a soft texture or flesh and the whole aggregation are commonly termed the "fleshy fungi." The application of the name mushroom to all of them accords with professional and popular usage for the most part. Some people use the term mushroom only for the edible members of this great group, and call those which are not edible toadstools. Although botanists recognize the word toadstool they regard it as synonymous with mushroom and write at times "edible toadstool" or "poisonous mushroom." In general they avoid the term toadstool.

The Agaricaceae, characterized as noted above, by the possession of gills on the under side of the pileus, embrace more than fifty different genera. These constitute five groups differing in the colour of the dust or powder which falls from the gills at maturity. This dust, composed of many thousands of tiny, unicellular spores, which float downward in such quantity as to form a noticeable deposit on the grass or earth beneath the fungus, may be easily caught for examination if a sheet of paper be placed directly beneath the cap. The colour of this spore dust in some genera is white. In others it is pink, purple-brown, rusty brown or black. The group characterized by possession of purple-brown spores contains about ten genera, one of which is Agaricus. The well known mushroom of commerce, *A. campestris*, is only one of a dozen or more species composing this genus. Some genera contain many dozens of species. In any given genus the species all possess in common certain prominent features of form, colour or structure which serve to distinguish them from those of other genera. Within a genus the species differ from one another in more minor characters of the same sort, it being necessary in many cases to take note of microscopic points of dissimilarity. Consideration of the genus Agaricus in this connection will serve to illustrate this situation concretely. All the species of the genus have purple to purple-brown spores, and the gills, which are white when young, change gradually through pink and successive shades of deepening brown as the spores reach maturity over their surface. The ends of the gills nearest the stipe are not attached to it and are not disturbed when the stipe is torn from the pileus. On the under side of the pileus of the young opening umbrella there is a chamois-skinlike membrane stretching from the stipe to the margin of the pileus and hiding the gills from view. A little later this membrane *(veil)* detaches itself from the margin of the pileus and falls to form a ring *(annulus)* around the stipe. In the other genera having purple-brown spores the gills are attached to the stipe and an annulus is lacking. The characters which serve for the identification of the genus Agaricus are thus seen to be few and readily recognized.

In the group of white-spored forms the genus Amanita is very important, because to it belong all the deadly poisonous mushrooms. Though a few of its species are regarded as edible, most of them are definitely dangerous, and some are capable of causing death. It is necessary, therefore, that the characters which separate this genus from others be clearly understood. As an annulus is present and as the gills are free from the stipe, there is a pronounced resemblance in form to Agaricus. However, the spore powder is white, and the gills are never brown. In most species they are white, and remain so even in old specimens. Though a young individual of Agaricus in which the gills are still white may be easily confused with one of Amanita, there is present in the latter an additional structure which, if not overlooked, will serve as a danger signal. While yet in the young more or less globose stage the plant in Amanita is completely enveloped in a definite sheath similar in character to the membrane which forms the annulus. This outer layer of enveloping tissue is called the volva. As the young plant grows and enlarges it bursts this membrane, emerges from it, elongates upward, and opens out into the umbrella shape. In some species of Amanita the entire volva persists thereafter at the base of the plant as a bag or cup surrounding the base of the stipe. This "death-cup" is not well formed in all cases, and even when present may be overlooked by careless individuals who fail to pick the entire plant including its base. Furthermore, in other species of the genus the rupture of the volva occurs equatorially in such a fashion that approximately the whole upper half of it remains attached over the upper surface of the pileus and is carried upward, the portion left at the base being insufficient to form a definite cup. In these cases the part carried up on the surface of the pileus is later broken up there into loosely adherent, flake-like scales by the expansion of the tissue beneath as the pileus opens into the umbrella form and increases in lateral diameter. The presence of such loosely attached, flake-like scales on the pileus should hold a fungus under suspicion until study of its other features proves it to be in fact not an Amanita. Though in many edible species in other genera scales occur on the pileus they are more firmly attached in character, and can be seen to have resulted from cracking or fraying of the tissue of the pileus itself. Specimens suspected of being Amanita should be examined carefully in the young state if possible, for the presence of the volva is then more readily noted. Questionable plants should be discarded.

There have been many well authenticated cases of illness and death from mushroom poisoning. In most of these instances poisonous species of Amanita were undoubtedly involved. However, records of symptoms of poisoning, and even death, exist in cases in which the plants consumed were apparently recognized as edible forms. Such cases have probably arisen from the eating of specimens already in a state of decay. Collectors Should avoid all fungi which are not in a wholly fresh and wholesome condition. Old, wormy or semiputrid ones may well contain poisons similar to those present in rotting vegetables and meats. When poisoning by mushrooms is suspected it can not be too strongly urged that a competent physician be summoned with the least possible delay. The poisonous element is not the same in all species of Amanita. In *A. muscaria,* the fly agaric, it has been considered to be chiefly because of the alkaloid muscarine, but more recent work indicates that it may actually be one of the derivatives of muscarine. Symptoms of poisoning with muscarine usually appear in from one-half to two hours. Vomiting and diarrhoea, pronounced flow of saliva, suppression of the urine, dizziness, derangement of vision and loss of confidence in ability to make ordinary movements are succeeded by drowsiness, stupor, cold sweating and marked weakening of the heart's action. In fatal cases stupor persists for two or three days, and death follows the gradual weakening of the pulse. Treatment for this poison consists chiefly in the prompt removal of the unabsorbed mushroom material from the alimentary canal and the giving of subcutaneous injections of some powerful heart stimulant such as atropine. The poison phallin, present in *A. phalloides* and related species, is albuminous in nature and more deadly than muscarine. Preliminary symptoms of poisoning do not appear, unfortunately, until about ten hours after the mushrooms are eaten. Then severe abdominal pains are associated with cramps in the limbs and convulsions. Weakening of the pulse, vomiting, and extreme diarrhoea are followed by death in two to four days. The fundamental injury to the body is due to direct attack on and rapid dissolution of the blood corpuscles. The undigested mushroom material in the stomach and intestines should be removed as promptly as possible. Though it is usually stated that there is no known antidote for phallin, a report from the Pasteur Institute in Paris records preparation there of an antiphallinic serum which has proved so effective that the French Government requires a supply of it to be kept available for use by physicians.

In picking wild mushrooms for the table it is necessary to avoid not only the extremely poisonous Amanitas, but also the more or less poisonous and distasteful species of other genera. Such forms exist in genera whose other members are in all respects wholesome. Consequently, it is necessary to know the specific identity of every plant eaten. There is no royal road to this knowledge. Careful observation of the details in which one species differs from another, combined with the study of pictures and descriptions in some standard book on mushrooms will enable the amateur student to recognize with certainty at least a few desirable forms. All others should be avoided. One species often differs from another in various minor features of form or colour, and only critical observation will enable the collector to recognize a given species with certainty and assure him that it is not a somewhat similar, perhaps poisonous one.

The tiny spores which fall in countless thousands from the gills of mushrooms, float about in the air currents and are disseminated over a wide area. They are analogous to the seeds of higher plants and function in propagating the species. Each spore is a microscopic, more or less globose or ovoidal, cell, composed of a bit of protoplasm surrounded by a thin wall. Though capable of remaining quiescent for a time, it finally undergoes renewed growth, and if it finds adequate moisture and food in the spot where it has fallen it germinates. The side of the spore bulges outward and forms a cylindrical tube-like outgrowth which gradually lengthens and develops into a system of branching threads. These permeate the elements of the substratum, and are readily visible to the unaided eye as a network of delicate strands, usually white, though in some species of other colours. Strands arising from different spores may merge, and threads as heavy as ordinary twine may result. The tips of these heavy cords at the surface of the substratum in time enlarge into more or less globose bodies, commonly termed buttons. Each button is in fact a young mushroom, and by increase in size and internal differentiation of tissues, the umbrella-like mature plant gradually comes into being. It will be understood then that this umbrella is not the whole plant but merely the above ground fruiting portion of it. The mycelium below ground is the vegetative or feeding portion. In some wild species it occurs in the soil, in others in leaf mould, in rotting wood. or in any other material from which the fungus may obtain its food. The mushrocm of commerce, *Agaricus campestris,* is grown in beds of specially prepared manure to which soil, straw, or other materials are sometimes added. In this mixture the mycelium grows luxuriantly. The grower calls manure in which the mycelium is abundantly present spawn. Old spawn is mixed into the manure in the preparation of new beds, and flakes of spawn or bricks of it are sold. Horse manure has been preferred to other sorts, and the coming of the automobile era has reduced the amount available while increasing its price. Efforts have been made to make use of other materials. Research has shown that the application of urea to mixtures of straw and other composting elements gives satisfactory results. Much more investigation is desirable.

Not uncommonly, commercial mushroom beds are invaded by the mycelium of other species of fungi. In these cases the reduction in the crop necessitates the removal of the infested material, sterilization of the beds, and the use of new spawn.

Like all widely spread and much-cultivated plants, the mushroom of commerce has developed a number of recognized varie-

PHOTOGRAPHED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA BY ALEXANDER H. SMITH

EDIBLE AND INEDIBLE MUSHROOMS

Top row, left to right: Coprinus ***micaceus*** **(Mica** or Inky, cap), edlble. Found around the stumps of shade **trees** in spring and fall. *Cantharellus* ***cibarius*** (Chanterelle) **,** edible, **choice.** Found in areas of open hardwoods in summer. *Pholiota squarrosa,* **edible.** Found on hardwoods and conifers

Second row, left to right: ***Boletinus pictus,*** edlble. Found under white pines, summer and **fall.** *Coprinus* ***comatus*** **(Shaggymane),** edlble, choice. Found **in** waste places. *Armillaria* ***mellea*** (Honey **agaric),** edible. Found on wood or around stumps in the late summer and fall

Third row, Ieft to right: ***Lactarius*** *deliciosus,* edible. Found under conifers in summer and fall. *Lepiota clypeolaria,* not recommended. Found In woods, summer and fall. ***Amanita muscaria*** (Fly **agaric),** poisonous. Found in aspen, pine and spruoe woods in spring and fall

Fourth row, left to right: ***Agaricus silvaticus,*** not **recommended.** Found in conifer woods in the fall. ***Hydnum*** *repandurn,* edible, choice. Found under conifers and hardwoods **in** summer and fall. ***Morchella esculenta*** (Morel), edible, choice. Found **in** orchards and near open hardwoods **in** the spring

Fifth row, left to right: Fistulina hepatica (Beefsteak fungus), edible. Found on hardwood stumps in the fall. ***Clavaria*** *subbotrytis,* edible. Found under conifers. ***Hypomyces lactifluorum,*** edible. Found under hardwoods. **late** summer

MUSIC

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1. Giovanni Pierluigi da Palestrina (1526–94), Italian. 2. Arcangelo Corelli (1653–1713), Italian. 3. Henry Purcell (1659–95), English. 4. Alessandro Scarlatti (1659–1725), Italian. 5. Johann Sebastian Bach (1685–1750), German. 6. George Frederick Handel (1685–1759), German. 7. Joseph Haydn (1732–1809), Austrian. 8. Wolfgang Amadeus Mozart (1756–91), Austrian. 9. Ludwig van Beethoven (1770–1827), German. 10. Franz Peter Schubert (1797–1828), Austrian. 11. Jakob Ludwig Felix Mendelssohn-Bartholdy (1809–1847), German. 12. Frédéric François Chopin (1810–49), Polish. 13. Robert Alexander Schumann (1810–56), German. 14. Richard Wagner (1813–83), German. 15. César Franck (1822–90), French. 16. Johannes Brahms (1833–97), German. 17. Peter Ilich Tschaikovsky (1840–93), Russian. 18. Giacomo Antonio Puccini (1858–1924), Italian. 19. Claude Achille Debussy (1862–1918), French. 20. Richard Strauss (1864–1949), German. 21. Maurice Ravel (1875–1937), French. 22. Igor Stravinsky (1882–), Russian. 23. Sergei Prokofiev (1891–1953), Russian. 24. George Gershwin (1898–1937), U.S. 25. Dmitri Shostakovich (1906–), Russian

ties, and in different regions and under different modes of culture it shows differences as do the various garden plants. There is always the desire to obtain even more attractive or productive varieties. Toward this end research work in various laboratories has been carried on, and pure cultures obtained from single germinating spores have been prepared and tested. Such pure cultures are in some cases maintained under laboratory conditions and made available to the grower on request.

Mushrooms are grown in caves, in abandoned coal mines, in dark cellars, and in specially built mushroom houses. They are not allowed to reach the fully expanded condition, but are harvested in the large button stage while still very firm, and before the discolouring spore dust begins to fall from the gills. They are usually packed neatly in attractive containers. Though they are being grown in increasingly large quantities, they are still expensive and constitute a delicacy rather than a staple article of food. Though nutritious, their food value is not as great as their extremely high protein content would indicate. See **FUNGI**; MOREL; PUFF-BALL; TRUFFLE.

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MUSHROOMS, COOKERY OF. Edible mushrooms contain some nitrogenous food and about 90% water. Eaten with other foods they are of great service in the diet on account of their flavouring properties. It is dangerous to eat mushrooms which have been gathered by anyone who has not studied the different kinds.

Among the most familiar kinds are the common meadow mushroom (*Agaricus* campestris); button (immature) mushrooms employed chiefly for garnishing purposes and as an addition in high-class dishes; and truffles (underground fungi).

To prepare ordinary mushrooms for cooking, pick over and wipe with a flannel dipped in salt. Peel and remove stalks where necessary. The latter may be used for flavouring stews, soups, sauces, etc.

Mushrooms may be grilled (broiled) and served with maître d'hôtel or plain butter, etc.; baked in the oven under glass (or in a shallow dish); stewed in a casserole with other foods, *e.g.*, Italian pastes, rice, or in a well-flavoured sauce; or, they may be used in stuffings for turkey, poultry and game; they are also employed for garnishes in making galantines, etc.

Stewed Mushrooms. — Place the mushrooms in a stewpan with 2 oz. of butter, salt, a squeeze of lemon juice and a blade of mace. When cooked, stir in a white liaison of flour and butter blended together. Stir well and serve either as an entrée, or on toast as a savoury. This dish may be varied by adding other ingredients and may be served as a cream by adding a sauce of cream and beaten-up eggs.

Fried Mushrooms. — These are frequently added as an addition to a mixed grill. Frying should be done in a frying pan and not in a deep pan of fat. It is best to use good margarine or butter.

Grilled Mushrooms. — Large mushrooms should be chosen for grilling. Grease the gridiron before cooking. Place flesh side uppermost on the gridiron.

Stuffed Mushrooms. — Good-sized mushrooms are needed for stuffing. Any well-flavoured forcemeat can be used though certain flavours blend better with mushrooms than others, *e.g.*, game. To stuff, remove the stalks and pile the forcemeat in the centre of each mushroom. Squeeze lemon juice over and cover with buttered paper or place under glass. Bake in the oven for half an hour.

Mushroom Ketchup. — Sprinkle salt freely over large meadow mushrooms and leave them to stand for a few hours, then mash them in a mortar and set aside for 48 hours. Stir from time to time. Press through a colander and place in a pan. Boil up, skim carefully and simmer for an hour. Strain into a pan and leave until the next day. Then strain again leaving the sediment at the bottom of the basin and add one ounce of black peppercorns, a blade of mace, half an ounce of allspice, one quarter of an ounce of ginger and half an eggspoonful of grated lemon rind to each quart of liquor. Boil up and reduce to half the quantity Bottle and store in a dry place.

MUSIC. The Greek *μουσική* (*sc.* *τέχνη*) from which this word is derived was used comprehensively for all the arts of the Nine Muses. Contrasted with *γυμναστική* (gymnastic) it included the culture of the mind as distinguished from that of the body. Thus the singing and setting of lyric poetry formed but a small, if a central, part of a "musical" education which ranged from reading and writing to the sciences of mathematics and astronomy besides all the arts of literature. The philosophers valued music both in the ancient general sense and in our restricted sense, chiefly as an educational element in the formation of character; so that we obtain little light from them on the pure aesthetics of the Greek art of musical sounds.

1 INTRODUCTION

The present article deals mainly with the musical art-forms matured by European civilization since the 14th century. More ancient music is discussed frankly as beyond our power of appreciation except in the light of prehistoric origins. Our Western art of music stands in the unique position that its language has been wholly created by art.

Music owes but little to nature in the form of acoustic science, and still less to the sounds that occur outside works of art. It is already a mature musical art that selects the acoustic facts, just as in painting it is art that determines the selection of optical facts. Wise critics have, since Ruskin's day, abandoned the attempt to settle *a priori* how much of nature an aesthetic system ought to digest; and music differs only in degree from literature and the plastic arts as to independence of nature.

Yet the difference is often important. Perspective existed as a science before it was taken up by painters, and as a human experience before it became a science. The naïve Western spectator has seen enough of it in pictures to make him resent its neglect, whether in modern art or in the masterpieces of China and Japan. In music the nearest analogy to perspective is the system of tonality developed by the great composers from Alessandro Scarlatti to Wagner. (See HARMONY.) Every step in its evolution has been fiercely contested; and even twenty years after the end of Wagner's long career not every responsible musician was ready to admit Wagnerian tonality as a legitimate enlargement of the classical system.

If we set aside language and the organized art of music, the power of distinguishing sensations of sound is no more complex than the power of distinguishing colours. On the other hand sound is the principal medium by which most of the higher animals both express and excite emotion; and hence, though until codified into human speech it does not give any raw material for elaborate human art, it suffices for bird-songs that are as long prior to language as the brilliant colours of skins, feathers and flowers are prior to painting. Again, sound as a warning or a menace is an important means of self-preservation; and it is produced instantly and instinctively.

All this makes musical expression a pre-human phenomenon in the history of life, but is unfavourable to the early development of musical art. Primitive music could mysteriously re-awaken instincts more elemental than any that could ever have been appealed t~ by the deliberate process of drawing on a flat surface a series of lines calculated to remind the eye of the appearance of solid objects in space. But the powers of music remained magical and unintelligible even in the hands of the supreme artists of classical Greece. We may be perfectly sure that if the Greeks had produced a music equivalent to the art of Palestrina, Bach or Beethoven, no difficulty of deciphering would have long prevented us from recovering as much of it as we have recovered of Greek literature. Some enthusiasts for Oriental lore assure us that long ago the Chinese knew all about our harmonic system but abandoned it after they had exhausted it. This need not worry us. The Oriental aristocrat conceals in his politeness a profound contempt for our efforts to patronise his culture; and that contempt is justified when we show such ignorance of our own music as to suppose that a music of similar calibre could have utterly disappeared from a living nation whose most ancient plastic art and literature commands our respect and rewards our study. When we trace the slow and difficult evolution of our harmonic system we cease to wonder that it was not evolved sooner and elsewhere, and we learn to revere the miracle that it was evolved at all.

2. NON-HARMONIC AND GREEK MUSIC

Music before the rise of a harmonic system is of two kinds, the unwritten or extemporaneous, and the recorded or scientific. At the present day the music of races that have not acquired Western harmony often pleases us best when it seems most extemporaneous. Tradition can go far to fix the forms and even the details of a performance that may, without the aid of words or dance, last for hours. With words or dance, music becomes more capable of being fixed by writing; but the first musical problems are as far beyond conscious reasoning as the origins of language. Birds solved them before human beings; and folk-music can show real beauty when the systematic music of its day is arbitrary and uncouth. Moreover, folk-music, together with the present music of barbarous races and Oriental civilization, can give us materials such as anthropology uses in reconstructing the past from its vestiges in the present.

For us the music of ancient Greece is by far the most important branch of musical archaeology. Unfortunately the approach to this most difficult subject has been blocked by lack of co-ordination between scholarship and musicianship; and the ascertained truth is less instructive to the general reader than the history of opinions about it. These opinions begin to be interesting when they are expressed by musicians whose music we can understand. The natural tendency of such musicians was to suppose that Greek music was like their own; and each advance in knowledge is marked by disillusion. The first difficulty presented by ancient Greek writers was sufficiently disconcerting. The Greek terms for "high" and "low" were found to be reversed. Our own meaning seems founded in nature; and science confirms it. Our "high" or "acute" notes demand tense vocal cords and correspond to vibrations of "high" frequency. A great 16th century composer, Costanzo Porta, inferred a mystery here, and argued that the Greeks had mastered the art of a totally invertible polyphony, such as Bach afterwards displayed in two fugues in *Die Kunst der Fuge.* Porta accordingly wrote a 4-part motet *(Vobis datum est cognoscere mysterium)* which could be sung upside down: and his contemporary Vincentino composed 4-part motets in each of the three Greek *genera,* diatonic, chromatic and enharmonic. *(See* Hawkins's *History of Music,* i. 112, *seq.)* They are as good as any other music written on a *priori* principles, and the enharmonic motet may be commended to some of our modern experimenters in quarter-tones. But they represent as much knowledge of Greek music as we possess of the inhabitants of Mars.

The truth must be sought by other methods and by far the most promising is the study and comparison of the present scale of nations, whether barbarous or cultured, who have not come into contact with the classical harmony of the West.

A readable account of musical origins may be found in Parry's *Evolution of the Art of Music.* Following the researches of A. J. Hipkins and A. J. Ellis, Parry illustrates the fact that most of the primitive scales, notably the pentatonic scales prominent in Scottish and Chinese music, are built around the interval of a downward 4th (as from C to G) which was probably the first melodic interval to become fixed in the human mind as being simple enough but not too wide. A scale would begin to form by the accretion of other notes near the bottom of this interval. Now take another 4th with similar accretions below the former, either conjunctly (as G to D below the C–G) or disjunctly (as F–C). The resulting scale will either fill or include an octave, it does not matter which; for the filled octave of the conjunct tetrachord contains in another position the notes of the included octave of the disjunct tetrachords, as can be seen in the combined series C, A, G, E, D, C, A, G. And the octave was recognized from the outset as a limit after which a musical series repeats itself.

The Greeks had three ***genera*** of scale: the diatonic, the chromatic and the enharmonic. Of these the diatonic divides the tetrachord most evenly, as E, D, C, B:A, G, F, E. This gives us our diatonic scale in what Palestrina would call the Phrygian mode. The Greeks found that all its notes could be traversed (as a knight's move can traverse our chessboard) in a series of intervals which they called concords. (They thought of them only as successions, not combinations of sound.) These were the 4th (in the ratio 4:3); the 5th (3:2); and the octave (2:1). (Our own "perfect concords" are in these ratios.) Scales with chromatic tetrachords (E, C♯, C♮, B:A, F♯, F♮, E) could also be traversed by the concordant intervals, but not so easily. The enharmonic tetrachords, which only the most accomplished singers could sing, were beyond the reach of perfect concords; and for us they would need a special notation, as E, C, B′, B ; A, F, E′, E♮; where B′ and E′ signify something like quarter-tones above the B♮ and E♮. Yet this difficult scale was said to be the oldest of all; which seems not unlikely when we observe that it gathers three notes closely to the bottom of the tetrachord, leaving a gap of a major 3rd from the top. Eliminate the quarter-tones, and there remains a pentatonic scale E, C, B:A, F, E, which is more likely to be the earliest filling out of the downward 4th than the scales in which the auxiliary note is a whole tone away. And if this nucleus had the prestige of a mystic antiquity musicians would feel a pious pride in mastering the difficulty of filling it up like the other genera.

If authorities on Greek music would abandon their habit of writing scales and reckoning intervals upwards, their results, whether correct or not, would become much more lucid. For, as Parry points out, it is only our harmonic system which makes us think of scales as normally rising; and when a musician applies the term "cadence" to chords that rise from dominant to tonic he contradicts the literal meaning of the word.

Until the most recent times classical scholars have ruthlessly closed the door upon all hope of further light from the comparison of Greek data with the phenomena of extant non-harmonic folk-song and Oriental scales. If such a comparison is to have any meaning we must assume that the now universal phenomena of modes existed in ancient Greece. Modes, as far as non-harmonic melody is concerned, are various cross-sections of a standard scale. Thus, Scottish music shows very clearly five pentatonic modes. Adding the 8ve to complete the scale, these are, 1. C, A, G, F, D, C; 2. D, C, A, G, F, D; 3. F, D, C, A, G, F; 4. G, F, D, C, A, G; 5. A, G, F, D, C, A. In the article HARMONY the ecclesiastical modes of pure polyphony are given with their fondly-imagined Greek names. Pre-harmonic music without modes is contrary not only to our Western prejudices but to the whole trend of anthropological research. In these circumstances classical scholars, under the guidance of D. B. Monro, crushed all hopes by deciding that the Greeks had no modes at all, but that either their ʽαρμονίαι or their *τονόι* (the terms, whatever they mean, are not synonymous) were mere transpositions of the three genera into various pitches, just as our "keys" are transpositions of our pair of major and minor modes.

When Monro published his *Modes of Ancient Greek Music* in 1894, musicians had learnt too well the lesson that Greek music must not be expected to make sense. They would never dispute a point of classical scholarship; and it did not occur to them that Monro might be just so innocently familiar with modern music as not to realize that he might as well impute high-church tendencies to Alcibiades because of "the splendour of his liturgies" as impute to the ancient Greeks a system of keys related by mere transposition. But musicians only thought that even the most unprejudiced anthropological comparison of extant scales could prevail no more than Macfarren's Victorian assumptions could do in a dispute with Monro. Fortunately in 1916 Mr. G H. Mountford, in a degree thesis, satisfied classical scholars that Monro was in error and that the Greek modes were modes in the universal and proper sense of the term.

Miss Kathleen Schlesinger has found, by experiments with a monochord, a means of producing modes on mathematical principles. Certainly the Greeks did measure musical intervals mathematically on a string; certainly Miss Schlesinger's system is among the very first things that could have happened in that way; and its results produce many phenomena that ought to have occurred in ancient Greek music. There is, for instance, a remarkable passage in Plato's *Republic* (VII., 531) where Socrates gibes at the pedantries of the merely practical musicians who spend hours in arguing whether this and that note are too near to allow another note between them. And Miss Schlesinger's various scales comprise between them notes quite close enough to explain how the practical musician could get into difficulties about what was obvious to the philosopher. Miss Schlesinger has, moreover, tuned a pianoforte on the basis of her theory, and the result is acoustically very interesting. So much then, for a *priori* theory and practical experience. If Miss Schlesinger's results are not Greek they ought to have been.

The other line of approach is through the experience of setting the choruses of Greek tragedy to a modern music which confines itself to a strict representation of the metre and sets strophe and antistrophe to the same melody. The composer should not attempt Greek modes, on whatever theory, or he will achieve nothing better than an effect of singing "We won't go home till morning" on the supertonic of a minor key and with a beat missing. Instead of thus warping his imagination the composer should translate all that modern culture enjoys in Greek poetry into a music that he can enjoy; restricting himself mainly to one note to a syllable and, while making his instrumental accompaniment as beautiful as he likes, straying into no by-paths of musical tone-painting other than the most natural symbolisms. The Greek rhythmic forms prove musically fascinating, and there is full scope for fine melody within them. The strict correspondence of strophe and antistrophe causes difficulties which reveal much. Even a unisonous accompaniment, such as the Greeks had, can glide over a difference of punctuation or indeed a running on of the sense between strophe and antistrophe, as at the end of the enormous first chorus of *Agamemnon;* and the technique of such compromises closely resembles that of Schubert and Brahms in strophic songs, and has the subtlety of Greek simplicity. Aristophanes, in the Frogs, laughs at the interlinear *θραττο θραττο θραττ* (or "plunketyplunk") of the Aeschylean lyre. The passage seems to indicate something more extensive than a merely connective tissue; but exaggeration is not unknown in comedy.

More difficult and therefore still more instructive are the occasional contrasts of sentiment between strophe and antistrophe. In another chorus in *Agamemnon* the pretty ways of a lion-cub are to be sung to the same music as the tale of disaster that befell the man who adopted it when, on growing up, it behaved as might be expected. The highest point of pathos in the first chorus, one of the supreme things in poetry, is the moment where the description of the sacrifice of Iphigeneia turns into a reminiscence of her singing in her father's halls and then runs on into the antistrophe, with the words "The rest I saw not, nor will I tell." After which the same music has to express the pious hope that the queen who now approaches shares the wishes of the chorus for the welfare of the land she holds in trust.

From Plato we learn that musicians degraded themselves by imitating the roaring of lions and the whistling of winds. But what was the Greek criterion for the singing voice? Certainly very different from ours; for Aristotle says that certain high-pitched modes (but what is "high" in this context?) are suited to the voices of old men. An age-limit is the only criterion the heartless modern critic has for the voices of old men. Be this as it may, the safest inference from it is that every educated Greek was expected to sing well as an integral part of the art of speaking well. Perhaps our modern contrast between the singing and the speaking voice did not exist. Nowadays it is not uncommon to find a high soprano speaking normally around the A or G below the treble staff.

(See also ARISTOXENUS; EUCLID; PYTHAGORAS.)

3. HARMONIC ORIGINS

The latent harmonic sense of the Greeks is shown in the fact that their diatonic scale was amenable to the Pythagorean science of harmonic ratios. And we cannot suppose that no notice was taken of the combined sounds resulting from reverberation in halls and caverns, or from striking several strings of the lyre at once. Yet the fact remains that outside the orbit of our own Western music of the last six centuries we know of no harmonic system that has advanced beyond drones below the melody and cymbals (our Authorized Version is right in reading "tinkling cymbal") or bells above it.

Music, as we now understand it, consists in the interaction of three elements as inseparable (but not as interchangeable) as the three dimensions of Newtonian space. The Greeks knew two, rhythm and melody, which are as ancient as human consciousness and evidently have their meaning for some other animals. But non-harmonic melody is a very different thing from melody that implies harmony. (See MELODY exs. 1 and 2 with their discussion.) When we hear an unaccompanied folk-song we involuntarily think of it as the top line of a series of harmonies. If it is really pre-harmonic it will prove unamenable to that interpretation, and then we shall think it quaint. Neither the quaintness nor the harmonic interpretation ever entered into its intention. Life is too short for Western musicians to devote much of it to the violent mental gymnastics of thinking away the harmonic ideas that have made Western music enjoyable throughout five centuries. We may perhaps widen our experience by going back another two centuries; for it was agreed by all the musicians in Vienna that a concert of "Gothic" music was their most interesting musical experience of the year 1928.

In the article HARMONY the main steps are indicated by which mediaeval musicians advanced from doubling melodies in 4ths and 5ths (as the unoccidentalised Japanese are said to be doing now) to an aesthetic system of polyphony that demands complete independence in its melodic threads and forbids consecutive 5ths and 8ves as barbarous. The details of this evolution are abstruse; but two main issues may be mentioned here. Polyphony could not have been established without fixed scales and a repository of known melody for composers to work upon.

The scale was set in order in Graeco-Roman times by Ptolemy the astronomer, who flourished A.D. 130 and from whose time the history of the "ecclesiastical modes" becomes continuously traceable until the records of music are secured by the art of printing,

The necessary repository of melody was supplied by the ancient plain-songs of the church, many of which claimed to have come uncorrupted from the music of Solomon's temple and certainly had a continuous history reaching back to early Christian services in the catacombs of Rome. In A.D. 384 a large body of these "tones" was set in order by St. Ambrose. According to a tradition accepted, after some "historic doubts," by good authorities, St, Gregory revised and enlarged the Ambrosian collection; and the whole corpus of Gregorian music undoubtedly familiarizes Roman Catholics of to-day with a music enormously more ancient in its origin than any harmony. This music forms the principal melodic foundation of Palestrina's polyphony; but by his time it had become corrupted, and we must look to the Solesmes edition of 1904 for the text and method of singing plain-song in the perfection it is held to have attained shortly after the death of St. Gregory. The essential difference between the Ratisbon tradition (which we may loosely call Palestrinian) and that of Solesmes is that the Palestrinians impatiently curtailed the flourishes of the plain-song much as Palestrina did with the Gregorian themes he used in polyphony; whereas the Solesmes method restores the free speech-rhythm which makes the flourishes (or melismata) possible in a rapid delivery. Some of these melismata are very extensive, and the Palestrinians (who gradually developed the modem organist's habit of providing each note of a Gregorian melody with a separate chord) had some excuse for mistaking them for corruptions of style.

The Gregorian tradition did not stand alone. There was an ancient Visigoth (or "Spanish") tradition; and there are the traditions of the Eastern Church. Professor J. J. W. Tillyard has shed much light on Byzantine music (*q.v.*), including a promising opening in the deciphering of the earliest *Neumae,* diacritical signs above the words, supposed to indicate musical notes.

He uses the method of interpreting the past from vestiges of primitive usage in the present. Controversies as to the number of modes, whether 8 or 12, raged till late in the 16th century. The *Dodecachordon* of Glareanus settled the question in favour of twelve, as its name implies. Meanwhile composers developed polyphony by ear and got no help whatever from the theorist. Quite independent of modes and entirely practical was the hexachord scheme (*see* HEXACHORD) developed in the 11th century by Guido of Arezzo (*q.v.*).

The general reader may learn something of the hexachord system very pleasantly from the music-lesson in *The Taming of the Shrew.* Hortensio's gamut says "Gamut am I, the ground of all accord . . . D sol re, one clef [*i.e.,* sign, or key], two notes have I: E la mi: show pity or I die." "Gamut" is a survival of Greek tradition; for the bottom note of the Greek scale was identified with the bass G, and this "ground of all accord" is an octave below the Ut of the hard hexachord. Hence it is Gammaut. D is Sol in the hard hexachord $\left\{\begin{matrix}\text{G}, & \text{A}, & \text{B}, & \text{C}, & \text{D}, & \text{E}\\ \text{Ut} & \text{Re} & \text{Mi} & \text{Fa} & \text{Sol} & \text{La}\end{matrix}\right\}$ and Re in the natural hexachord $\left\{\begin{matrix}\text{C}, & \text{D}, & \text{E}, & \text{F}, & \text{G}, & \text{A}\\ \text{Ut} & \text{Re} & \text{Mi} & \text{Fa} & \text{Sol} & \text{La}\end{matrix}\right\}$. It has two names but only one position or "clef," unlike B which has to be flattened in the soft hexachord (F to D). (Morley writing in 1597, calls A flat the B clef.) E is La in the hard hexachord and Mi in the natural hexachord.

Between Fa of the natural hexachord and Mi of the hard hexachord a dissonant tritone 4th exists. It gave great trouble to mediaeval musicians, who assigned it to the devil. *Mi contra Fa est Diabolus in Musica.*

To the early harmonic and contrapuntal processes alluded to in the article HARMONY some details must be added. The famous unwritten songs of the aristocratic troubadours or *trouvères* of the 12th and 13th centuries undoubtedly set the fashion in melody, and probably set it in the direction of *Sumer is icumen in;* that is to say, in the Ionian mode (that *modus lascivus* that is identical with our major scale) and in a lilting trochaic rhythm

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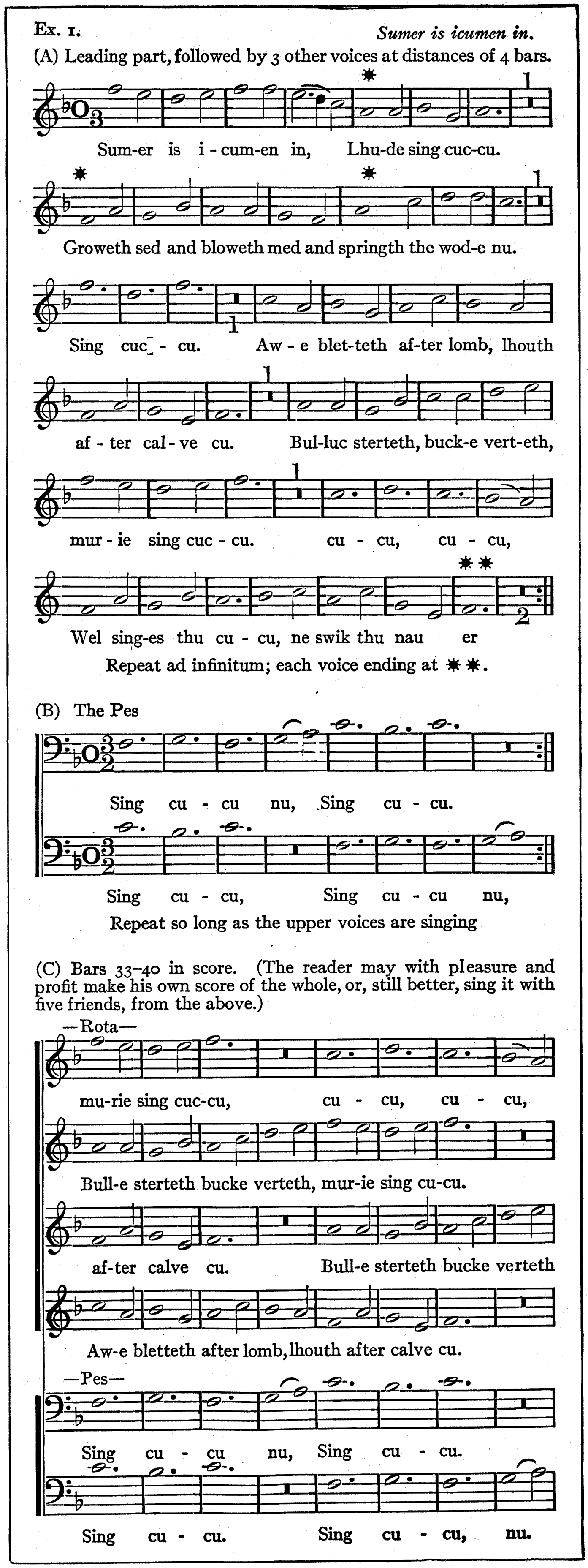
Sumer is icumen in contains no technical feature that has not been found in other compositions of its period, but nothing within two centuries of it achieves either its euphony or its easy handling of canon in four parts on a canonic bass in two. Its consecutive 5ths which sound licentious to us were in its own day the sole justification of the scheme.

It confirms other evidence that the imperfect concords (3rds and 6ths) must have obtained squatter's right in music in spite of theorists; for a very early practice known as ghimel or gymel consisted in singing in 3rds. This is not merely doubling, for the 3rd must oscillate between major and minor according to its position in the scale; and this adjustment requires an advanced harmonic system. When scholars tell us that singing in 3rds was traditional in Britain before the Roman Conquest, we must demur, especially when they tell us (in *Grove's Dictionary of Music and Musicians,* 3rd edition) that we must not expect to find written records of "so simple a process." Similarly we must not expect to find ancient Greek written records of so simple a process as steam locomotion. Still, let us not be unduly sceptical as to the extent to which popular licence and unrecorded extemporisation could advance beyond all the theoretic lore that scribes will record.

The troubadours disdained both the practice of accompaniment (which they left to their servants) and the art of scientific or written music. Not until the time and work of Adam de la Hale, surnamed the Hunchback of Arras (*c.* 1230–1288) can we trace the development of the troubadour into the learned musician. Nearly a century later, when literature is unbending from its universal Latin and becoming truly universal by becoming vernacular, we find the poet Machault, who stands with Petrarca among Chaucer's masters in the technique of verse, producing music that marks a technical advance discoverable by grim toil of expert analysis. But so far we may pardonably dismiss all such



archaic work (except *Sumer is icumen in)* with Burney's sly comment on the earliest piece of recorded music known to him: "It is not of such excellence as to make us greatly regret the loss of such music; though the disposition of those who were pleased by it may have been a great blessing to them." When music is too archaic or inaccessible to give us aesthetic data more may be learned from the disposition of those who were pleased by it than from its recorded technical data.

Before the middle of the 15th century music had passed forever out of the stage at which anything need be known about a composer other than his music. As early as 1437 an Englishman, John Dunstable. had acquired a European reputation. The golden age of the 16th century had no use for archaic music, and Morley in his *Plaine* and *Easie Introduction to Practickall Musicke* quotes Dunstable much as we might now quote Bach if all Bach's works were lost except for traces of contemporary hostile criticisms and awe-inspired laudations. To call Dunstable the "inventor of counterpoint" is no better than to call Cadmus the inventor of the alphabet. But he is the earliest composer whose polyphony is in direct line with that of the golden age; for Dufay, the first important master of the Netherlands, where the true polyphonic tradition was for long thought to have originated, is known to have died in 1474, 21 years after Dunstable. And when Walker, in his *History of English Music,* praises a motet by Dunstable for its distinction of style, he is describing permanently intelligible aesthetic values. By the end of the 1jth century counterpoint was substantially fixed. Practice was still imperfect and aims were uncertain, but skill was increasing, and in the 16th century we leave archaic music behind.

4. THE GOLDEN AGE

From this point onward the history of music is best studied in the masterpieces of the art. Each period has its own art forms. Articles relevant to the golden age are COUNTERPOINT; INSTRUMENTATION; MADRIGAL; MASS; MOTET; with biographies on ANIMUCCIA, GIOVANNI; ARCADELT, JAKOB; BATESON, THOMAS; BENNET, JOHN; BULL, JOHN; BYRD, WILLIAM; DESPRÈS, JOSQUIN; ECCARD, JOHANN ; FARRANT, RICHARD; FESTA, CONSTANZO ; GABRIELI; GIBBONS, ORLANDO; GUERRERO, FRANCISCO; HANDL, JAKOB; HASLER, HANS; ISAAC, HEINRICH; LASSO (LASSUS), ORLANDO; MARENZIO, LUCA; MORLEY, THOMAS; OBRECHT, JAKOB; OKEGHEM, JOANNES; PALESTRINA, GIOVANNI PIERLUIGI DA; SWEELINCK, JAN PIETER; TALLIS, THOMAS; TAVERNER. JOHN; VICTORIA, TOMAS LUIS DE; WEELKES, THOMAS; WILBYE, JOHN.

The external history of music is not so easily brought into true relation with the art as popular legends would have it. Everybody is familiar with the story of the drying up of polyphony in the foolish ingenuities of Flemish contrapuntists until, at the behest of the Council of Trent, Palestrina wrote the *Missa Papae Marcelli* in a pure and simple style which convinced the authorities that polyphonic music could be devout. Undoubtedly there was a great deal of barren ingenuity in the work of the lesser Flemish masters, and Obrecht himself had written masses in which the liturgical text is drowned beneath five other texts which each voice sings to other plain chants and themes of old songs.

The secular tunes thus freely introduced were not always sung as *canti fermi* too slow to be recognized. Recognition sometimes even led to the singing of the original words.

One old song, *L'homme armé,* became the string round which every possible ingenuity crystallized in the composition of the Mass. There is no reason to doubt that the state of church music both deserved and received the serious attention of the Council of Trent.

On the other hand, not all Flemish music was silly, and many of the quaintest "canonic" devices were really nothing but harmless cryptography applied to music that was composed on purely artistic lines. Burney discovered this when, with his usual flair for good illustrations, he quoted some dry ingenuities from Okeghem (or Okenheim) and followed them by the wonderful *Deploration de Jehan Okenheim* by that master's great pupil Josquin Desprès, who is the first unmistakably great composer and who has been well named "the Chaucer of music." No listener can fail to recognize, from anything like a competent performance, the spontaneous beauty and poetic depth of this music, throughout which, while the other voices sing an elegy in French, the tenor intones in Latin the plain chant of the Requiem beginning on a note a semitone lower than the liturgical pitch, and continuing in the wailing melodic mode thus produced. Burney had the wit to see that the "canon" *ung demiton plus bas* did not mean that some other part was to answer the tenor in canon, but was merely the "rule" for reading the cryptogram, the tenor being written at the normal pitch.

Many Flemish devices are well calculated to give coherence or climax to a large composition. One voice may wander up and down the scale with a single figure and a single motto text while the other voices tell their whole story in polyphony. For instance, declaim the words *Miserere mei Deus* in monotone rising one step just for the first syllable of *Deus.* Start on the fundamental note of the scale, and at intervals repeat the phrase a step higher each time. After reaching the fifth degree go down again. Josquin's *Miserere* is a setting of the whole 51st Psalm, woven round a tenor part entitled *Vagans* and constructed on this plan. It is one of the first mature masterpieces in the history of music. Palestrina's art is too subtle for rigid Flemish devices; but once, in one of his finest motets, *Tribularer si nescirem,* he uses Josquin's *Miserere* burden in exactly Josquin's way. Lasso is thoroughly Flemish in both sacred and secular music, and in a motet on the resurrection of Lazarus he makes a soprano *Vagans* cry *Lazare, veni foras* from the beginning of the narrative until the chorus reaches these words and joins in with them in triumphant polyphony.

One must not, then, be misled by the ecclesiastical tradition that condemns Flemish music wholesale. In any case the concern of the church authorities was liturgical rather than artistic. The bishops would have been for the most part glad enough to see church music restricted to the note-against-note style of Palestrina's litanies, *Stabat Mater, Improperia* and last book of *Lamentations.* A very sublime style it is, and Tallis's responses, in their authentic form, are a noble illustration of it. But, as Jeppesen *(The Style of Palestrina and the Dissonance)* has clearly shown, Palestrina's *Missa Papae Marcelli* shows special signs of being a deliberate demonstration that a high degree of polyphony can be reconciled with clear choral delivery of the words. Certainly the ecclesiastical authorities did not long succeed in preventing the use of secular themes in church music.

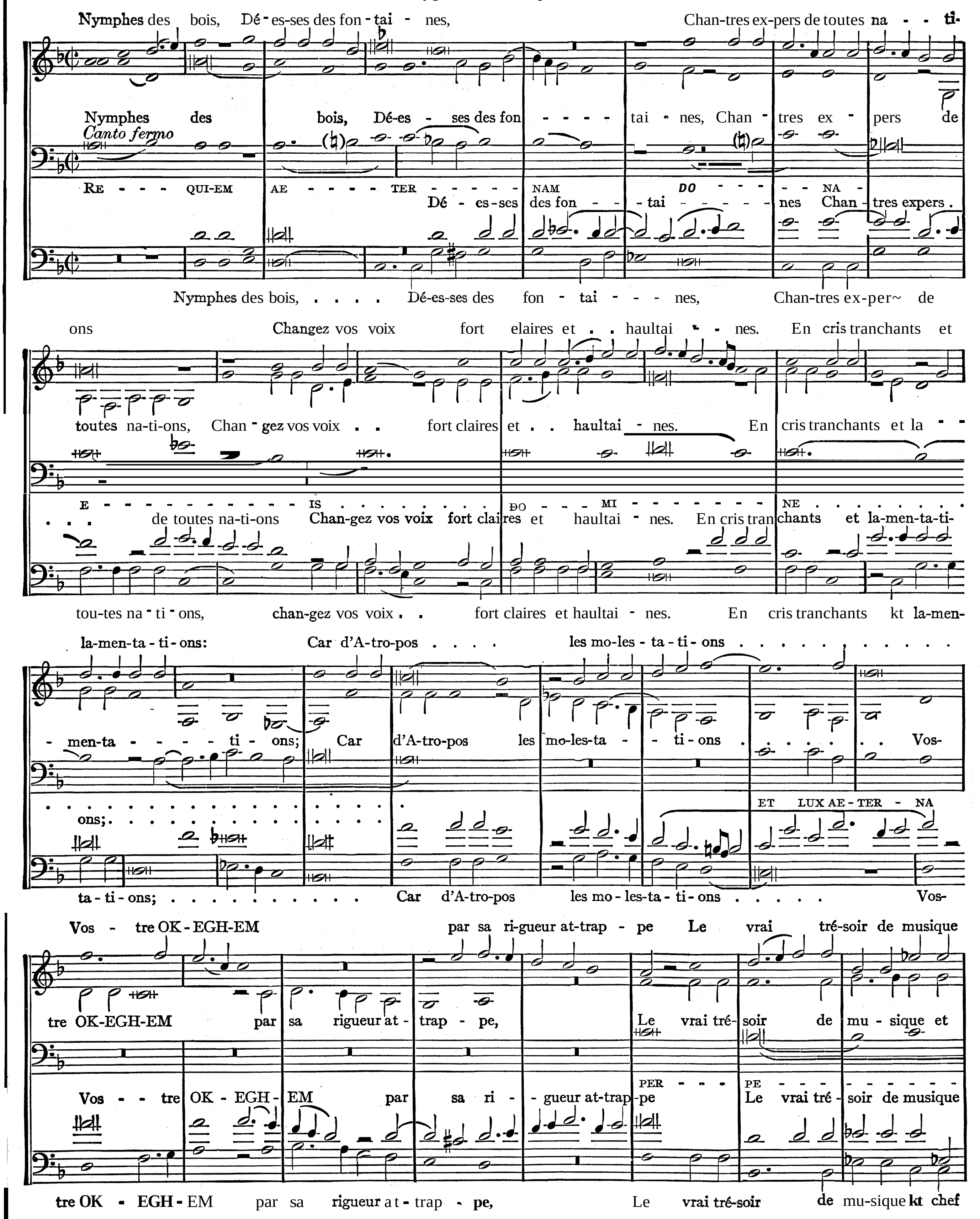
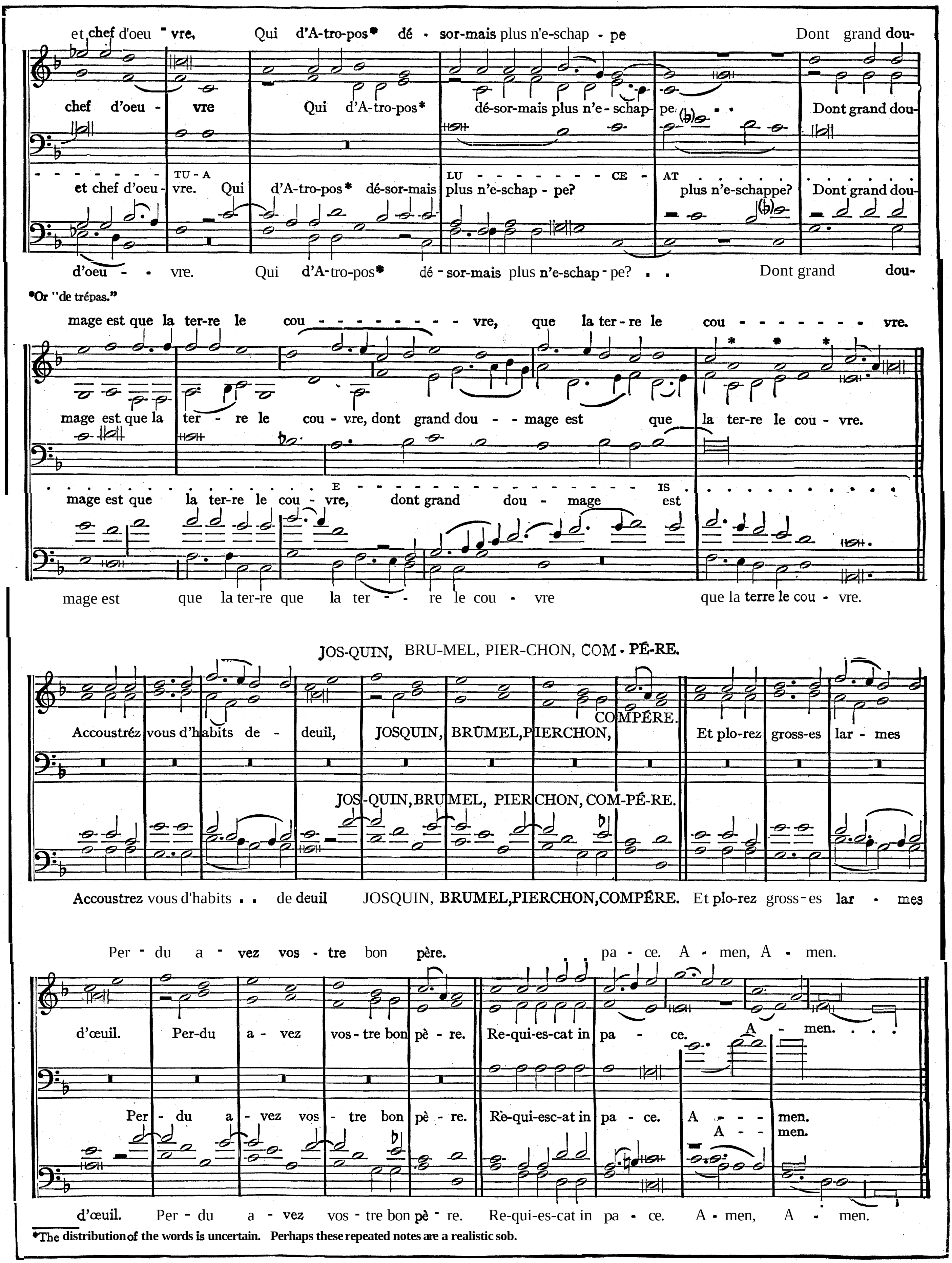
Many great musicians of today have a musical culture which ignores the golden age; and a knowledge of Palestrina is still considered, as it was in the days of Bach and of Beethoven, rather an out-of-the-way specialty. This is like a culture based on Latin and sceptical of Greek; good as far as it goes, but limited and cocksure like an 18th-century gentleman's artistic impressions of the grand tour. An illustration of the most perfect style of the golden age is appended to the article MOTET.

5. THE MONODIC REVOLUTION AND ITS RESULTS

Until Palestrina's art attained its height, the path of progress in music for the best part of two centuries was that of purity. It was not the free and bold spirits but the idlers and dullards who broke rules and disliked contrapuntal forms. The Hispano-Roman style of Victoria and Palestrina was not everything. It was not secular (though Palestrina's madrigals make him as supreme in that form as in church music), and it was not, like the glorious English polyphony, experimental or racy of the soil. But it was metropolitan, and the boldest of the Tudor composers would have been no such fool as not to hold it supreme. But even before the death of Palestrina a new music was groping toward the light; the path of progress for this music was no more that of purity than the path of omelette making is that of the conservation of eggshells.

Eve's apple was not more fatal to man's earthly paradise than the rise of instrumental music and dramatic solo declamation was to the hope of continuing the golden age of music into the 17th century. The revolution did not consist in this detail or that. To

Ex. 2. *La Déploration de Jehan Okenheim,* for soprano, male alto, two tenors and bass
(Barred according to the main rhythms.)
Phrygian mode transposed.

by JOSQUIN DES PRÉS

*The distribution of the words is uncertain. Perhaps these repeated notes are a realistic sob.

say that Monteverdi '(invented" the dominant 7th, or that anyone else invented it, or that any such invention could revolutionize music, is like saying that Shakespeare revolutionized drama by inventing strange oaths. The important point is not the technical names of the details but their meaning. When Lasso was young some experiments in chromatic music had been made by Cipriano de Rore, and were eagerly imitated by Lasso. But what is Lasso's object in being the first person to write such an out-of-the-way note as A♯? Simply to express the words *"novum melos."* Very different from such intellectual playthings is the purpose of the powerful discords of Monteverdi's madrigal *Cruda Amarilli* and of the monodic lament of Ariadne which drew tears from the spectators of his opera *Arianna.*

The article MONTEVERDI contains further remarks on his importance and on his coincidence in place and time with the creators of the violin. *(See* also OPERA.) The Palestrina style henceforth became the rightful privilege only of those composers who, either having mastered it before monody arose, or, like Orlando Gibbons (1583–1625), living in regions too remote for it to penetrate, could still compose polyphonically from impulse and not from asceticism. Orlando Gibbons did, in fact, try some monodic experiments which are poor enough.

An impulsively eclectic composer is another matter; and in uncouth, illogical Germany a giant such as Schiitz could almost fill the century before the birth of Bach and Handel, with a life's work ranging from the pure polyphony of his Venetian master Gabrieli to the exploitation of all his "astute friend" *(scharfsinniger Frezmd)* Monteverdi's new principles in most gigantic efforts in mixed vocal and instrumental polyphony. From Schiitz we can extract no such system as that which makes Monteverdi a favourite subject in musical history; but in Schutz's chaos the elements may at any moment come together in some strange work of art that fits into no historical or technical scheme but speaks clearly to us through its o n coherence. Schutz's "astute friend" always knows what he is doing and whither his work is leading; but, except in a madrigal here and there, which was not his proper business, he does not produce a convincing work of art so often as Schiitz who seems to have no proper business at all. It is to the astute, logical Italians that we must look for the progress and consolidation of musical art in general during the 17th century; but we must not let the enthusiasm of historians make us think that such a century of progress was a period of great music. The historians themselves are apt to neglect the intrinsic values of the 17th century compositions and to estimate them merely for their tendency towards something that was to take convincing shape later. The early 17th century was, in fact, musically not unlike what we have so far experienced of the 20th; the eyes of musicians and music-lovers were at the ends of the earth prophesying Wagner, when all that the whole century could finally achieve was the *da capo* form of aria.

Monteverdi and his fellow monodists had, in no mood of caprice, moved in the one direction that was universally important for music; yet their formless declamation soon palled, and its method survived only by becoming codified into the formulas of recitative, which are happy idealizations of Italian speech-cadence, and which survive as dramatic idioms in all music even at the present day. The "invention" of recitative has been ascribed to this or that monodist, with as little room for dispute as when we ascribe the invention of clothes to Adam and Eve. Any vocal music which, whether from inability or from disinclination, avoids organizing symmetrical melody, will be called recitative. When Wagner was still a subject of controversy, critics on both sides used to say that *Das Rheingold* was all recitative.

Two tendencies converged to make music become formal after the '(first fine careless rapture" of monody was spent. First, the dramatic stage, with baroque scenery in magnificent development as early as 1667, in Cesti's *Porno d'Oro,* greatly encouraged the ballet; so that when serious musicians cultivated the stage they also cultivated dance-music. This, however, was less important than the rise of the violin Monteverdi had alreadv understood its importance; and one symptom of the decadence of polyphony had been the growing habit of solo-singers to sing the top parts of madrigals with all manner of ridiculous flourishes. Persons less legendary than King Cole felt the fascination of the "tweedle-dee" of the fiddle; the great Dutch polyphonist Sweelinck (q *v.)* used to adorn his organ works with passages of *imitatio violinistica;* and the last quarter of the 17th century saw the brilliant work of Biber with his queer abnormal violin-tunings, and the sober classical *sonate da chiesa* and *sonate da camera* of Corelli *(q v.).* Artistically as well as morally this development of the violin was healthier than that of the voice, wherein coloratura singing tended to become an acrobatic monstrosity though it had first been regarded as a means of emotional expression. A talent for the violin was no danger to a boy; but a beautiful voice put a boy in deadly peril in an age when all the great opera-singers were *castrati.* Even Haydn had a narrow escape in his youth.

And yet there is, on the whole, more beauty than decadence in the vast mass of solo vocal music produced between 1630 and 1760. That period takes us from the advent of mature instruments and instrumentalized music to a time beyond the death of Handei. Except for the device of the ground-bass *(see* VARIATIONS) the first form that emerged from chaos organized itself on a method of balance between a solo voice and a group of instruments, together with a development of melodic form by means of a firmly-estabhshed classical key-system. The result was the classical aria, one of the most effective art-forms ever reduced to the capacity of normal musicians It entirely destroyed the dramatic character of opera for a whole century; but this has been lamented with unnecessary vehemence. With the exception of the early monodic works and of Purcell's *Dido and Aeneas,* opera before Gluck is not an art-form at all; it is merely a name for the spectacular conditions under which the 18th century public could he induced to listen to a string of thirty arias by one compoier uho could either handle no other forms or find no listeners for them *(See* ARIA.) Other art-forms developed in the 17th century for use in the 18th are discussed under CANTATA, CONCERTO, OPERA, ORATORIO. SONATA, SONATA FORMS. and SUITE. Matters of style and texture are discussed in CHAMBER MUSIC, HARMONY and INSTRUMENTATION. The articles on monodic composers include CACCINI, CAVALIERI, CESTI, PERI and MONTEVERDI, besides BANCHIERI who wrote against Monteverdi's earlier works with well-grounded demonstrations of their subversive effect on pure polyphony. The survival of polyphony in grimy and pompous decadence is represented by Pitoni, and later and more as a renascence by LOTTI. Early violin music is represented by BIBER and CORELLI.

The short career of PURCELL (*q.v.*) ends twenty years after the death of Schütz and ten years after the birth of Bach and Handel. Almost any random quotation from Purcell might be by a composer of the calibre of Bach or Handel. Purcell is one of the greatest contrapuntists that ever lived; one of the greatest inventors of themes; one of the greatest masters of declamation; and a completely mature master of early orchestration. And his fellows in the English music of the Restoration. Pelham Humfrey, Child and Blow were no mean spirits. Burney devotes an entire plate in his *History of Music* to examples of "Dr. Blow's crudities"; and later historians need look no farther afield for examples of intelligent prophesy. But the Restoration music lacks one thing; and that is power of composition. Purcell, in small dance-forms and short lyrics, is unsurpassable. But his only chance of getting through a sustained movement is when he writes on a ground-bass. In this fascinating forlorn hope of English music we see the fruit of nearly a century of bold endeavour ripening a generation too soon. Parry ascribes the patchiness of Purcell to the subtle humour of Charles II. in sending his best chorister to learn from Lully, the master of the French ballet-opera, how to write English church music. But Lully is not patchy, and Purcell's music is a crazy-quilt, purple with foreshadowing~of the music of the future.

6. BACH, HANDEL AND THE NEAPOLITAN SCHOOL

If all music between 1685 and 1759 were annihilated except the work of Bach and Handel, the ordinary music-lover would miss nothing but a large collection of decorative and decorous violin music and a still larger collection of arias; and to most of these favourite *gemme d'antichità* the mid-19th century editor has contributed much of their lusciousness. For us the age of Bach and Handel is the age of nobody else in music. But the contemporaries of Bach and Handel thought of Handel as a fashionable opera-writer who with advancing years developed choral music as a pious fad; while nobody thought of Bach except people within coaching-range of Saxony where Bach was known as a wonderful organist and an impracticably deep scholar. The polyphony of Bach and Handel stands almost alone in an age when polyphony was utterly unfashionable. It was inculcated as a staple subject in musical education; but to carry it into mature art was to discuss Latin grammar in the drawing-room. The opportunities and the difficulties of early symphonic orchestration alike arose from the neglect of polyphony after 1750. Apart from Bach and Handel, that neglect can be traced much further back; and it characterized musical connoisseurship much later; so that Burney could say of Philipp Emanuel Bach that wherever he got his beautiful and natural style from it was not from his father, for that eminent organist, though profoundly versed in all devices of canon and fugue, was so fond of crowding all the harmony he could into both hands that he must inevitably have lost melodic grace.

The vast and accurately-perfected aesthetic system of Bach and the improvisatorial opportunist eclecticism of Handel are discussed in the articles on those masters, and also under the headings of CANTATA. CONCERTO, COUNTERPOINT, FUGUE, HARMONY, INSTRUMENTATION, ORATORIO, SONATA FORMS and SUITE. But, while this information covers the aesthetic values of the period, it tells us little of its historic trend. We must not look for light from the "spirit of the age" as shown in its politics or even in its religious history. Palestrina writes, from habit and preference, a devout music which neither Luther nor the Council of Trent could blame as representing the spirit of the age; and Bach achieves the ideal Lutheran music while Voltaire is at the court of Frederick the Great.

The music that pleased the contemporaries of Bach and Handel was that which continued. not too elaborately, the Neapolitan tradition founded by Alessandro Scarlatti. Lully (an Italian by birth) took his tradition to France, and transformed Italian opera by encouraging the French taste for the ballet. Rameau, greatest of classical French composers and epoch-making theorist, carried on the Lully tradition in opera, and joined forces with the exquisite school of clavecinistes, whose leader, Couperin, was admired and imitated by Bach in his suite-forms. Italian violin music and concertos in the Neapolitan style were produced by composers who were also great players. The enormous industry of Bach and Handel was nothing unusual. Arias could be written as easily as letters, and distributed by thirties in operas. Oratorios and church music, though less fashionable, were more highly organized, mainly because they kept choral music in being.

And thus the Neapolitan tradition of choral music passes straight into the polyphony of Mozart, quite independently of Handel and wholly ignoring Sebastian Bach, of whom Mozart knew not a note until he was grown up. Meanwhile cultured Europe was unvexed by doubts as to who were the immortals. The Handel-Bononcini rivalry had been little more than a nine-days' wonder. Six years after Handel's death, the seven-year old Mozart in London dedicated his violin-sonatas to Queen Charlotte in the hope that under Her Majesty's protection "je deviendrai immortel comme Haendel et Hasse." Graun would probably have been the third name of European repute; and Telemann, the most voluminous composer of his voluminous day, was a great figure in his own country. As for Bach—everybody in London knew Mr J. C. Bach, of the Bach and Abel concerts, and report said that his father had been a great musical scholar.

Behind the dignified musical history, but not (like Sebastian Bach) aloof from it, vital forces were at work in comic music-drama. This was admitted by way of *intermezzi* between the acts of serious operas. One of these intermezzi, La *Serva Padrona* by Pergolesi (known in the 19th century by his conventional *Stabat Mater* for two-part female chorus) not only broke from its moorings, like many other intermezzi, but found its way to Paris where it created a furore of popular success and precious disputation dividing musical Paris into *Buffonnistes* and *Anti-buffonnistes.* Except for the untimely blossom of English opera in the hands of Purcell in the previous century this is the only moment at which opera after Monteverdi and before Gluck (with all respect to Rameau) becomes a genuine art-form instead of a concert on the stage.

Biographical articles dealing with the following named composers who belong to this period: the violin writers CORELLI, GEMINIANI and TARTINI: the clavier writers COUPERIN and D. SCARLATTI (the Paganini of the harpsichord and a most unclassical son of the founder of classical tonality) ; the opera writers (which meant the all-round musicians) DURANTE (Francesco), GALUPPI (who certainly never wrote Browning's "sixths diminished, sigh on sigh"!), LEO (Leonardo), PERGOLESI and SCARLATTI (Alessandro). RAMEAU is equally important in three capacities as a master of French opera, a livelier master of instrumental music, and an epoch-making theorist. German beginnings of serious and comic music-drama were sumptuously inaugurated at Hamburg by KEISER (*q.v.*) whose influence is traceable in Handel's first opera *Almira.*

7. THE RISE OF DRAMATIC MUSIC AND THE SONATA STYLE

The fashionable distaste for polyphony was a mere negative force in the early 18th century. The positive force was, as in the monodic revolution a hundred and fifty years earlier, an impulse towards drama. Unlike the monodists who, when they rejected polyphony had no power of composition beyond the single musical sentence, the 18th century musicians could easily cover ten minutes with a well-balanced form; and the problem of making such forms dramatic was no longer confined to the monodist's problem of making them rhetorical. On the contrary, the rhetoric had to be demolished; for the action of drama is not the action of rhetoric.

The distaste for polyphony was no unfavourable condition for the rise of dramatic music; it was the inverse aspect of a growing sense of contrast in various textures cheap and valueless in themselves. The rest of the story is told in the articles, INSTRUMENTATION, HARMONY, OPERA, SONATA FORMS, and GLUCK, BEETHOVEN, HAYDN, MOZART.

It is inadequate to call Gluck a "reformer" of opera. Music itself was not dramatic before Gluck made it so. Hence it is a mistake to separate Gluck's "reform" from the whole process of the development of the sonata style. Lastly, we miss the whole meaning of that style unless we realize that as soon as it arose the purely instrumental music became more dramatic than any drama. At the same time it also became more powerfully architectural than any earlier music. The art comprised in the works of Haydn, Mozart, and Beethoven constitutes one unbroken aesthetic system, more universal in emotional range than any art since Shakespeare, and as perfectly balanced as the arts of ancient Greece. Until the end of the 19th century it would have seemed a paradox to maintain that Beethoven's work belonged to the same aesthetic system as Haydn's and Mozart's; for critics were slow to escape from the habit of estimating works of art by the face-value of their subjects and the dignity of their language And the language of Haydn and Mozart corresponds with that of the comedy of manners, while Beethoven is the most tragic composer that ever lived. Nevertheless the huge expansion which music underwent at Beethoven's hands was no revolution, and the popular idea of Beethoven as a revolutionary artist is based on two errors; first, the commonplace habit of seeking parallels between the works of genius and the personal eccentricities of their authors; and, secondly, the inadequacy of orthodox doctrine on musical forms. This inadequacy results from the fact that the doctrines are contemporaneous with the compositions and are accordingly hostile to all but the easiest conventions. A proper grammar of a classical art requires something of the attitude of the unjustly-despised Byzantine scholars who sacrificed aesthetic pleasures in humble devotion to the task of securing the texts. It is when the languages are dead that they live for ever and suffer no corruption.

We need not expect scholarship in the orthodoxies that were current as to musical forms used in the lifetime of the classics themselves. (See FUGUE for a demonstration of the irrelevance of traditional doctrine on that art-form.) Still more impertinent is our orthodoxy on sonata-forms. It ignores the differences between Haydn and Mozart which are as radical as any innovation Beethoven introduced; and, having thus cut away all ground for appreciating Beethoven, treats him as the central symphonic classic, and also as a stupendous revolutionary. This result is correct as far as it goes: central classics can be stupendous revolutionaries. But correct pious opinions are the healthier for facts that can give us a right to them; and the beginning of the 19th century was unfortunately the beginning of an age of humbug in musical education. (See CHERUBINI, who, however, has other claims to our respect.) One consequence is that many a musical revolt purports to revolt against the classics when its nearest contact with classical forms has been the perky generalizations of textbooks by writers who regarded the great masters as dangerous, and who deduced their rules from the uniform procedures of lesser composers. Now these procedures were often derived from one or two popular works by the greatest men: thus Beethoven himself produced one model sonata (op. 22)—if its "first subject" had only been long enough. And if Mozart's great C major quartet had not such a subversive introduction it might (and did) serve as a jelly-mould for all the quartets of Spohr. Take another jelly-mould from Spohr, and you have classical tradition.

But now comes the fundamental difficulty in all attempts to distinguish the classical from the pseudo-classical. Every individual work must be judged on its own merits. No generalizations are trustworthy. Many movements by Mozart are as alike as peas. But, being alive, they are not as alike as buttons. With Mozart and Haydn the individuality of each work is all-important for the critic, and if he neglects this all that he says about the common form is superficial. On the other hand, the materials of Beethoven's work developed so rapidly that he seems to be driven to invent a new technique for almost each composition. Hence the external differences become obvious; and unless the critic penetrates to the common form he is lost.

With the symphonic classics we enter the period when these considerations become important; for there is no gulf between that period and our own. No musical art known to Haydn has suffered, like the art of Bach, a period of total eclipse; nor, on the other hand has it had preserved a character that Haydn could have understood. Not much light is shed on Haydn and Mozart by calling them court composers, and little more on Beethoven by calling him a child of the French Revolution. In an age of court patronage Bach the theologian had been inspired to write warlike music not more by ancestral memories than by scriptural texts of war in Heaven. Mozart and Haydn were restive in the service of courts and their musical language was that of the comedy of manners when it was not racy of the soil. In Paris, where musicians might be expected to know most about the French Revolution, the modest, lovable Etienne Méhul (famous for the biblical opera Joseph) produced his prettiest comic operetta Le *Jeune* Sage et le Vieux Fou in the year of the Terror; and on French music the immediate effect of these tremendous days was the rise of a new type of sentimental opera concerning the hair-breadth escapes and sufferings of the political prisoner rescued by the heroic wife. Hence Cherubini's Les Deux Journkes (The Water-Carrier) and Beethoven's Fidelio. Genius is the wind that bloweth where it listeth. In Bach's day Beethoven would have been musical interpreter of the Apocalypse; and in this 20th century Bach would be something like Dr. Schweitzer.

When we contemplate the impassable gulf that separates Bach's art not only from Haydn's and Mozart's but from the apparently more kindred spirit of Beethoven, we find it hard to realize that contemporaries were unaware of any catastrophic development. In the case of choral music a little study shows us that its forms and language remained Neapolitan. Haydn's and Mozart's masses are flamboyant Neapolitan music; and Michael Haydn, who was merely decorative as an instrumental composer, was rightly thought by his brother to be the better man at church music Again we regard Philipp Emanuel Bach as bridging the gulf between his father's and the new art; but Philipp Emanuel was writing quite mature sonatas in the year of his father's B minor Mass and his last set of sonatas was produced in the year of Mozart's Don Giovanni. Clementi, born in the year after Bach's death, was an infant prodigy of eight when Handel died; he had developed an extraordinarily massive and genuine pianoforte technique (more powerful than beautiful) when he encountered Mozart in a musical tournament, and he survived Weber, Beethoven and Schubert. Nothing can be gained by a further attempt to summarize this "Viennese" period. We may call it the period of the sonata and of Mozartean comic and French romantic opera. More particular information is given in the following technical and categorical articles: HARMONY (on Key-relations); INSTRUMENTATION; MELODY; OPERA; ORATORIO; OVERTURE; RONDO; SCHERZO; SONATA FORMS; SYMPHONY; VARIATIONS, and the biographies ABEL (K. F.); BACH (K. P. E.); BEETHOVEN; BENDA; BOCCHERINI; CHERUBINI; CLEMENTI; DITTERSDORF: DUSSEK; GLUCK; HAYDN (F. J.); MOZART; PICCINNI; SCHUBERT; SPOHR; WEBER (C. M. F. E. VON).

8. THE ROMANTIC PERIOD

With the romantic period comes the development of lyric music in the forms of songs and short pianoforte pieces. Schubert, Weber, Spohr, Mendelssohn and Schumann would be the romantic composers in this sense, and many contemporaries would have added Cherubini to the list, for they thought of him not as the martinet who directed the Paris Conservatoire but as the composer of Les Deux *Journées*. Romanticism was thrilling and classicism was cold.

But this list traverses another sense of the term which opposes the romantic to the classical. The classical is in this connection identified with both formalism and mastery. Mendelssohn and Spohr chose romantic subjects to no purpose; their mastery was unromantically slick (there is no other word for it) and Spohr's forms were more thoroughly ascertained than anybody else's except those of Mozart's brilliant pupil, J. N. Hummel. Mendelssohn's forms were free; but he never got into difficulties, so how could anybody recognise his freedom? Philipp Emanuel Bach's vein of sentimental rhetoric was not only typically romantic but enabled him to write some genuinely lyrical songs. J. Schobert is another romantic writer who influenced Mozart at an impressionable time of his boyhood. Every thrilling modulation in Beethoven's music was romantic, and so were the double-bass passages at the beginning of Cherubini's overture to Les Deux Journkes.

But the facts are more interesting than this generalization. Mastery is not the line of cleavage that ranges Spohr and Mendelssohn on the one side and Schubert, Schumann and Chopin on the other. Beethoven's later tonality and polyphony had made music ready for lyric forms which he himself adumbrated in a few of his bagatelles for pianoforte and some sporadic good things in his songs. Mendelssohn and Spohr took up song-writing and produced in that line masterpieces for the drawing-room. We ought not to despise the drawing-room. Schubert became the supreme master of song, and Schumann achieved greatness there as in his pianoforte lyrics; but you might as well think of Keats and Shelley as writers for the drawing-room.

Another line of cleavage separates Schubert from Schumann and Chopin as fundamentally as it separates him from Mendelssohn and Spohr. When Schumann and Chopin handle the large classical forms they show obvious weaknesses. Schumann makes an effective new artificial sonata form out of his stiff antithetic epigrammatic style, as a man might construct a landscape in mosaic. Chopin merely shows that he has taken the sonata forms uncritically from Hummel, though the first two movements of the B flat minor sonata are almost as happy in their classical form as the Ballades are in Chopin's unique way. But Schubert's large forms have only the weaknesses of youth, and their positive qualities and tendencies set him above all schools and indicate that if he had lived we should not so readily have closed a historic chapter with Beethoven. The mastery that Schubert lacks is not anything that Spohr could have supplied. Younger composers with new worlds to conquer could with some truth accuse Spohr of playing with classical forms as one might play chess; but they could never have so accused the Schubert that died young or the Schubert that might have reached old age.

We do not know what Mendelssohn might have achieved if he had lived longer. His influence on the musicians he knew personally was wholly stimulating and good. But he too, seemed able to play chess with symphonies, oratorios and songs with and without words, while other composers were grappling in their music with real life, perhaps confined to one narrow art-medium like Chopin, or, like Schumann, deserting lyrics for larger forms or some artificial hypothesis, or, like young Berlioz, kicking right and left against all teaching and all criticism while dreaming new wonders of orchestral sound, and correctly dreaming the practical means to them also.

Meanwhile a greater than Berlioz was arising, a dreamer of new sense as well as of sound. Mendelssohn and Schumann saw only the beginning of Wagner's development, and could not feel very sure that this voluble and stormy reformer of music-drama was really likely to achieve anything better than the tinsel of the astute Meyerbeer who dominated the world of cosmopolitan opera. The early style of Wagner is inaeed an alloy of many metals besides iron and potter's clay; but even in the 'forties his work marks the eclipse of the first romantic period and the dawn of another and greater epoch.

The art-forms peculiar to the Romantic period have no definite names, though composers began to use many literary titles, such as Ballade, Romance (already used by Mozart for slow movements in sonata-form), Nocturne and the like. Dance-rhythms, especially those of Poland, were brought into prominence in the pianoforte music of Chopin. Mendelssohn's invention of the song without words was very successful, but the notion is too facile to lead far, or always, even in Mendelssohn's hands, to justify its existence. Fantastic titles, used in the 18th century by the French clavecinistes, assumed great prominence in the pianoforte works of Schumann who created a new type of long connected cycles of epigrammatic little pieces. The articles PROGRAMME MUSIC and SONG concern this period vitally. Relevant biographical articles are CHOPIN, MENDELSSOHN, SCHUBERT, SCHUMANN, SPOHR, WEBER; while the crowd of pianoforte composers whose brilliance on that instrument obstructed all wider musical prospects, include the respectable HUMMEL, the less respectable STEIBELT and the Irish writer of beautiful pre-Chopin nocturnes, FIELD (John).

9. THE WAGNERIAN DEVELOPMENT AND THE RENASCENCE OF CLASSICAL FORM

Wagner formulated his principles of music-drama long before he matured his musical style. It is impossible to understand the musical history of the second half of the 19th century until we frankly admit that the composers of instrumental music saw in Wagner not only the subversive operatic theorist and erotic dramatist but the composer who was popular because of the salvation-army religiosity of the end of the Tannhauser overture and the downright vulgarity of the entr'acte before Act III in *Lohengrin.* His theories and methods might be controversial, but these lapses never were.

Strange to say, Wagner received something like recognition from the doyen of classical champions, Spohr, whose attitude to Beethoven had been merely condescending, but who saw in Der Fliegende Hollander and *Tannhäuser* interesting, if faulty, works which well deserved painstaking production at his theatre at Cassel. Schumann too, after joining in the general hostility towards *Tannhäuser,* frankly recanted and praised its many noble features. Personally he and Wagner did not get on so well; he found Wagner too talkative and Wagner found that Schumann had nothing to say. Later on when Wagner was in exile, *Lohengrin* found a powerful champion in Liszt at Weimar.

Liszt presented another problem to sober musicians. Wagner himself at first saw nothing in Liszt but the virtuoso who, when asked for music, would give you a fantasia on Robert *le* Diable. On the other hand, persons who became bitterly hostile to all the musical tendencies that Liszt fostered went out of their way to declare that no such wonderful interpretations and technique as Liszt's pianoforte playing had ever before been heard on any instrument or orchestra. All Liszt's gestures were superb, from his monumental immobility at the pianoforte to his princely and often really self-sacrificing generosity to other musicians. And at the age of 37 he made the most superb of all his gestures in giving up playing in public. And so the one incontrovertible power of his art became a legend and his actual activity became the championship of unorthodox artists. He took to composing on a more. ambitious scale than that of the marvellous pianoforte virtuoso; and became himself the leader of a new development of romantic music. Although he took little pleasure in counterpoint he had none of Berlioz's clumsiness in harmonic texture; and his orchestration, in which his first efforts had the secret assistance of Raff, was always brilliant and novel, though it never caught the Berliozian fire or plumbed the Wagnerian deeps. Liszt realised no more than Berlioz the true musical purport of the new ideas which his symphonic poems and Berlioz's symphonic-dramatic phantasmagorias were putticg forward under all kinds of literary and pictorial names. While the new romantic composers purported to be devoting instrumental music to the illustration of literature (see PROGRAMME MUSIC) they were really struggling with a new musical time-scale.

As we have already seen in the present article and in the discussion of HARMONY, musical history may be traced in terms of the time-limit over which the listener's memory is brought into play. In the 16th century that limit is from accent to accent; by the end of the 17th century it ran from phrase to phrase. The great architectural forms of Bach could stretch it easily to six minutes, and, in extreme cases to ten. The rise of the dramatic sonata style did not greatly enlarge the time-scale; for there are few well-constructed sonata-movements that exceed a quarter of an hour, though on no smaller scale could Beethoven have prepared the famous harmonic collision that gave such offence in the first movement of the Eroica symphony. Now this ten-minute time-scale obviously compelled musicians to handle the action of an opera by means of conventions. (*See* OPERA.) It is less obvious that it also produced a similarly conventional artifice in the relation of sonata-forms to their emotional content. A design may complete itself in ten minutes while raising emotional issues that cannot be dealt with in less than forty. And so the sonata-forms are grouped in from two to four (rarely more) movements as artificially as the musical sections of classical operas. Wagner's enormous achievement in music-drama consisted essentially in giving music the same time-scale as that of the drama. As with all first solutions of an art-problem he achieved an extreme case, for his drama became cosmically slow. But from *Das Rheingold* onwards every Wagnerian opening instantly, and without any introductory gestures, lays down the lines of its vast time-scale, to the utter bewilderment of his contemporaries who continued to expect Das *Rheingold* to show its pattern on Beethoven's time-scale, just as Beethoven's contemporaries had heard seven pianissimo bars on the chord of E flat, not as that vaulted vacancy appears in the middle of the andante of the C minor symphony, but as it would have sounded if it were intruded into an andante by Mozart.

Nobody else before Richard Strauss achieved Wagner's mastery of his new time-scale; and few, if any, of his contemporaries, whether hostile or friendly to him, realized its existence. Liszt was trying, in his symphonic poems, to make a music that filled its half-hour or forty minutes continuously; but his first effort of the kind, *Ce qu'on entend sur la montagne,* spends the first twenty of its forty minutes in a series of introductions, and the remaining twenty in retracing the series backwards. And his more successful efforts, such as *Orpheus* and *Les Préludes,* are either essentially lyric or not on the new time-scale at all. He never achieved so effective a symphonic poem as Schubert had already long ago unwittingly produced in the "Wanderer" fantasia. Musicians who might not have been repelled by new doctrines of musical form found Liszt's style even more demi-mondaine than that of the early works of Wagner; nor did Liszt show any tendency to purify it. Moreover he rivalled Meyerbeer in the efficiency of his press-bureau by which he made propaganda, often in his own fluent French, more generously for others than for himself

Meanwhile another musical development was arising, conscious of its continuity with the past, and, like Judaism as defined by Matthew Arnold. tinged with emotion in the morality of its aesthetic principles. Joachim, as great an interpreter on the violin as Liszt on the pianoforte, at first found in Liszt a congenial friend, until he saw his compositions. These horrified him, and the horror completed an estrangement already begun by his dislike of the atmosphere of Liszt's press-bureau. He and his younger friend Brahms were united not only in general musical taste but in personal devotion to the heroic widow of Schumann, who, after her husband's tragic and lingering death, was bringing up a large family on the proceeds of her concerts. These three artists soon came to regard the musical atmosphere of Weimar, where the *Lisztianer* gathered around their master, as unhealthy. In the correspondence and mutual criticism of Brahms and Joachim the word *Lisztisch* became synonymous with "devilish"; and indeed it is true that any characteristic Lisztian and many Wagnerian idioms would have a disgusting effect if intruded into Brahms's music. To-day we can be wise after the event and find matter for regret in the drastic out-spokenness of Joachim and Brahms which elevated matters of taste into questions of artistic honour. If Liszt could have been contented with *sachlich* criticism on definable issues of technique without requiring attestations of sympathy and enjoyment, and if Joachim could have resolved matters of taste into questions of artistic proportion, the neo-classical and neo-romantic musicians would have joined forces instead of condemning each other. Similar economies might be effected in nature if lions could be converted to vegetarianism.

The controversy was unequal, in two compensating ways. Wagner had a tremendous, if acrid, fluency in prose and did not care where his vitriol might alight. Moreover, Wagnerian and Lisztian music was much easier to write about, whether in attack ordefence, than music which had no literary aspect. Brahms, like Wagner, needed and found friends who adored his music, but he hated the idea of a press-bureau and snubbed anybody whose compliments aroused the least suspicion of flattery. These drawbacks had their own compensation. It might be difficult to write as interestingly about Brahms as about Wagner; but Wagner, whether in exile or enthroned at Bayreuth, had Wagnerian music-drama as his whole province, while Brahms reigned over the whole of the rest of music, instrumental, choral and lyric. If criticism came to persecution, on the whole the neo-classics had the worst of it; for Brahms had no equals since Joachim gave up composition, and the position of a champion of classical forms was easily confused with that of a persecutor of the prophets of progress. As a matter of fact, Brahms was no anti-Wagnerian and was annoyed when his friends bracketed Wagner with Liszt.

But, apart from the clash of flying inkpots, the recognition of Brahms was assured by two facts; first the propaganda of his work not by words but by consummate and authoritative performance, and second, the very fact that his music required an experienced love of music for its understanding A man might become an enthusiastic Wagnerian or even a well-equipped conductor of Wagner's music and be as the brutes that perish about symphonic orchestration, choral music, chamber-music, songs and all pianoforte music except Chopin. But it was long before any musician could venture to tackle Brahms's music on any basis except that of the most comprehensive musical culture and technique. Brahms lived long enough to become worshipped unintelligently; and after his death (in 1897) the reaction was more evident than the fashionable worship had been. There are signs that the reaction is over by now.

The Wagnerians felt deeply that their propaganda was incomplete for lack of a master of purely symphonic music. This they found in Bruckner (*q.v.*). Brahms was appalled by the clumsiness of Bruckner's forms, and the most official Wagnerians admitted the frequent lapses of their symphonic master. On the other hand Bruckner's Nibelungen-tetralogy openings to his symphonies obviously dwarfed the terse themes of Brahms. By the time Brahms and Bruckner had come into their own, the public had long lost all sense of form in its appetite for bleeding gobbets of musical butcher's-meat hacked from the living body of Wagnerian music-drama and served up in concert rooms as *Waldweben, Karfreitagszauber* and *Walkürenritt* After this it was pedantry to quarrel with any symphonic composer's form so long as his openings were vast enough. Brahms was no pedant; obvious weakness of form and style did not deter him from being the first to recognize Dvořák (*q.v.*); and he was drastic in his rebuff of anybody who thought to flatter him by talking against Wagner.

The song-writer Hugo Wolf (1860–1903) became recognized too late to be made use of as a lyric-pawn in the Wagner-Bruckner party politics of music As far as his theory of song can be summarized, it consists in the application of Wagnerian declamation to lyric poetry. If his practice were not better than this essentially prose theory of verse-rhythm (*see* RHYTHM) and the perky censorship of classical musical declamation that goes with it, Hugo Wolf's art would not have survived his short and ailing life. But it is deeper than the theories on which it is supposed to rest and its apparent revolt from lyric melody only partly conceals a powerfully organized lyric form, and does not at all conceal a great gift of characterisation.

10. NON-GERMAN MUSIC OF THE 19TH CENTURY

While these great issues were being debated in Germany, the music of other countries was awakening from long sleep or outgrowing infancy and provinciality. France had, since Rameau, been remarkably content to have its music dominated by foreigners Before Rameau, French opera was established by the Italian Lully. After Rameau it was reformed by the German Gluck. Early 19th century French classicism was dominated by the Italian Cherubini. Another Italian, Rossini, was in the prime of his life absorbed by Paris; and the result was *Guillaume Tell*, with its rich orchestration and grandiose forms. But the crown of French opera was imposed on it by the German Jew Meyerbeer. The pretensions of the native French composers were more modest, except for the volcanic eruptions of that typical Gascon Berlioz. The popularity of Gounod (1818–1893) rested on the same misunderstanding of the meaning of art as the vogue of Doré in the capacity of an illustrator of the Bible. *Faust* was a success. Another development, more improvisatorial, uncertain of its style, but fundamentally sincere, was initiated by the Belgian, César Franck (1822–1890) (*q.v.*). From him, and not from the more prolific and facile Saint-Saens, originated the main stream of modern French music. His style had too much affinity with Liszt to please the musicians who continued to regard Liszt as the author of all modern musical evil; but he achieved mastery in a wide range of forms all his own and he never wrote for effect.

In Italy music after Rossini aas long contented to imitate the things in which Rossini was imitable. These were the mechanical cultivation of *bel canto* and the use of a full orchestra to support the voice in a thick unison of the melodic instruments, with a brassy dance-rhythm in the rest, and the big drum and cymbals to mark the rhythm. The genuine melodic inventiveness of Bellini and Donizetti did little to improve the other categories of the art; but in Verdi (1813–1901) a new genius was arising together with the Risorgimento. In *Rigoletto*, *Il Trovatore* and *La Traviata* Verdi's dramatic sincerity triumphs over the defects of a musical texture which still clung to traditional squalor, though strokes of genius occurred unpredictably in the orchestration of many passages. In *Aïda* the style silences all cavil; and in *Otello* (written at the age of 74) and *Falstaff* (written at the age of 80) Verdi created a new kind of opera, Wagnerian in its perfect continuity and dramatic movement, but utterly independent of Wagner's style and method.

Bold prophets in Beethoven's time had been heard to say that a great musical future was in store for Russia. The fulfilment of this prophecy was long delayed, for when Rubinstein averred that Michael Glinka (1803–1857) was the equal or the superior of Haydn and Mozart he expressed an opinion which could have occurred only to a Russian, and then only as a patriotic paradox. Rubinstein himself achieved only a weak cosmopolitanism in his voluminous compositions, though his pianoforte playing remained, for all its waywardness, till near the end of the century, as the most monumental power of interpretation on that instrument since Liszt. The first composer to make a genuinely Russian music recognized over the whole civilized world was Tschaikovsky (1840–1893) whose symphonies were held by some critics to have eclipsed those of Brahms. This was the eclipse of drama by melodrama. The true merits of Tschaikovsky were eclipsed by the rising reputation of his less immediately successful contemporaries. Moussorgsky (1835–1881) had the posthumous fortune to have his two great operas *Boris Godunov* and *Khovantschina* revised by Rimsky-Korsakov (1844–1908) the most brilliant contemporary master of pure orchestral colour and texture. This was unquestionably good fortune in so far as it speeded these unconventional works on their way into the wide world; but something like indignation accompanied the later study of Moussorgsky's original scores, with the discovery that besides altering clumsinesses Rimsky-Korsakov constantly meddled with features in his friend's style that were far beyond his comprehension.

The 19th century was over before any musician on the continent could be persuaded that there were composers in England. Schumann had repeated St. Gregory's pun about Angles and angels when he hailed Sterndale Bennett as "ein englischer Componist"; but the trials of English musical life dried Bennett up. All who knew and loved him denied hotly that his music reflected Mendelssohn's; and perhaps, to-day, a leisurely study of it might vindicate his independence. Macfarren (1813–1887), who succeeded Bennett in his educational offices, was a widely-cultured musician whose influence for good was frustrated by his violent conservatism which co-existed with a fatal readiness to be led by faddists. The renascence of English music began in the work of Parry (1848–1918) and Stanford (1852–1924). They put an end to the provincial absurdities of British oratorio tradition, and consistently set great literature in a way that revealed to contemporary poets that the antithesis between musical and general culture was false.

They also had wide and deep influence as teachers of composition.

Still, recognition of English music on the continent was rare and capricious. Englishmen wrote church music for the stage, stage music for the church, organ music for the orchestra, and, as far as they had any orchestral ideas at all, orchestral music for the organ. The one famous English composer who could be understood on the continent as saying intelligible things in fit terms, was Sullivan, with his Savoy operas. And his serious colleagues and critics urged him with owlish solemnity to produce no more light masterpieces but to go on with his serious and luscious Golden Legends and Martyrs of Antioch and generally to consummate the final merging of English music into "The Lost Chord." We may thankfully hope that that chord is now lost for ever; but the Savoy operas live, and might, without delay to their popularity, have risen to the position of great music if Sullivan had had enough steadfast love of music to finish those parts of his work to which the public did not listen; if for example, he had provided his operas with better orchestral introductions than the perfunctory pot-pourris of their favourite tunes which he calls overtures and which are quite as long as artistically-decent overtures would have been.

It is customary to explain the failure of all but the most recent British music by saying that the native art was crushed by the ponderous genius of Handel. It is a great pity that the united ponderosity of Handel and the middle-weight Mendelssohn could not avail to dam the output of oratorios by composers who might have become good song-writers or even acquired some knowledge of orchestration beyond that of choral accompaniment. The complaint of foreign domination is nonsense. No nation has had its music so long and so completely dominated by foreigners as France; and French music has always remained exclusively French and has made thoroughly French artists of the foreigners who dominated it. The traces of foreign influence on English music have always been the echoes of individual phrases or mannerisms.

While Englishmen echoed, as fashions changed, Mendelssohn, Brahms and Debussy, they learned no technical lessons from them. Such mechanical echoes show no foreign domination, but are the best proof of an inveterate provincialism and the kind of ignorant and irritable independence that goes with it. Since music ceased to be an integral part of an Englishman's culture (about the time of William and Mary) their musicians, as a rule, began its serious study far too late. The language of music cannot be begun at the age of 19 like courses in law or medicine. Their universities have played a considerable part in shaping British musical destinies; but a mighty Oxford treads on the tongue of the encyclopaedist who would pursue this topic.

(D. F. T.)

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11. MUSIC OF THE 20th CENTURY

It has often been said that the 20th century witnessed as drastic a musical revolution as that of any period in history. The attitude of the public as well as the internal evidence of the music clearly showed a definite rupture with the immediate past. At first the radical new departures aroused indignant audiences just beginning to enjoy the colourful richness of the late romantic composers like Richard Strauss and Nicolas Rimsky-Korsakov and resulted in many violent demonstrations. Critics raved; composers explained; sides were taken; and societies were formed to propagate what was then called "ultramodern" music.

But even if this were not sufficient proof, a comparison of any brief portion of Arnold Schonberg's *Pierrot Lunaire* (1912) or of Igor Stravinsky's *Le Sacre du printemps* (1913) with any previous music would reveal at once how extreme the break with the past was. Yet these and other radical new works could not be easily dismissed as the misguided experiments of a few isolated eccentrics, because their novel methods soon attracted more and more followers among musicians and the public. When the nazi and soviet states in the 1930s and 1940s began to legislate against those using the newer styles, it became clear that the modernists were to be reckoned with. By mid-century, the importance of the revolution had to be admitted by almost every musician; for not a single composer had appeared since about 1920 who could write convincingly enough in the older style to win recognition. The only important late romanticists still greatly respected during this time were those like Richard Strauss (1864–1949), Sergei Rachmaninoff (1873–1943) and Johan Julius Sibelius (1865–1957), who had become known earlier.

There were many attempts to summarize the distinguishing marks of the new music. Most of these efforts were made by adherents of one or the other of two main factions that began to take shape around 1930: the neoclassicists, who followed the lead indicated by the later works of Igor Stravinsky (1882–), and the atonalists, who followed Arnold Schonberg (1874–1951). Since many intelligent articles were written by the composers and their followers discussing these two points of view, both were very influential; but besides these two schools, there were a great number of independents harder to deal with in critical estimates because of their avoidance of doctrinaire attitudes. The case of Béla Bartók (1881–1945), whose music did not receive the recognition accorded his more discussed contemporaries until after his death, is a rather typical example of the fate of a composer not belonging to a pressure group who preferred to let his music alone speak for him. Five years after his death, Bartok was generally regarded as superior in many ways to almost every other composer of his time.

In spite of their doctrinaire tendencies, the neoclassicists and the atonalists represented the opposite poles between which much music of the first half of the century lay; and the undeniable mastery of Stravinsky and Schonberg lent their points of view considerable weight. Because both dwelt so much on the importance of musical technique, they had often been dismissed as "formalists" concerned only with pure form devoid of musical expression. Indeed, the neoclassicists were particularly condemned for their insistence on "objectivity," but this objectivity was really a way of achieving artistic dignity and distinction by maintaining an aesthetic distance from the emotions portrayed. It was similar to the type of representation of feelings used in the baroque era, and this attitude distinguished modern neoclassicism from that of Brahms, which was truly romantic in its direct expression of dynamic emotions. True to classical precepts, the new group adhered to the representation of centrally important human feelings seen through the restless rhythmic and harmonic tension of modern technique. This double exposure of past and present inevitably suggested a commentary of one period on the other with comic or, more often, with nostalgic overtones. This school began to decline in influence around 1945.

The atonalists, on the other hand, were concerned with intensifying and compressing direct expression to the utmost. They continued the romantic psychology of dynamic emotions but focused it on the most subjective and unusual states of mind, related to the tormented, neurotic violence of the German expressionist theatre and painting. Their weird, fantastic and personal realm found its expression in a strict musical technique that was claimed to be a summation of all the devices of previous music, combining the formal methods of preromantic styles and the psychology of romantic music with the new techniques of the 20th century.

Most of the independents reflected a concern with elaborate musical techniques and with the avoidance of large-scale, opulent, romantic rhetoric. There was also a group of followers of the "populist" composers of soviet Russia who were under official pressure to avoid these "formalist" methods. These used a kind of romantic style drastically simplified, yet with certain contrapuntal and harmonic devices similar to the neoclassicists. Their works, particularly those by Sergei Prokofiev (1891–1953) after he returned to soviet Russia in 1934 and Dmitri Shostakovich (1906–), often met with great acclaim for their very real musical values, but few of them outlasted their first flush of success.

Technically, composers of the first half of the 20th century seemed to have been mainly occupied in breaking up the relationships between the various elements of musical discourse and in reintegrating them on a level of greater freedom. The rhythmic aspect of a work often had a comparatively independent life of its own, not emphasizing the harmonic changes or the melodic flow. Harmonies were often used for their sonorous and expressive qualities and not to underline the melody. This freedom was usually ordered by new kinds of self-imposed formal and stylistic restrictions. The neoclassicists favoured strict mechanical regularity of pulse while employing great liberty in the irregular distribution of accents and in all the other elements; the atonalists adhered to a strict system of ordering the tones of a composition, allowing the greatest licence in other directions.

Each element within its own domain was freed from previous limitations in order to bring out its particular expressive qualities. Rhythm became highly irregular, using either assymetrical groupings of rather rapid regular pulsations or sought the other extreme of expressive rubato. Two main ideas were current about melody. One, accepting the classical use of a pronounced and definite melodic line, emphasized its rhythmic aspect by reiterations or escaped into the free development of motives like that of Gregorian chant. The other idea, derived from Claude Debussy's melodies of harmonies and Schonberg's "melodies of tone-colour," renounced the clear definition of melodic outline, treating the total sound effect of any moment as a unit to be connected to other units as single tones are in a melodic line.

In harmony, any simultaneous grouping of tones was considered acceptable provided it gave the desired qualities of tension and expression. The movement from one chord to the next usually obscured or negated classical usages, dissonances not being prepared or resolved. When music had a tonal feeling, this was more a result of melodic emphasis on tonal centres than of functional harmonic activity.

Whether new music invented new "open" forms or adapted old "closed" ones to new needs, it was permeated by the principle of continual variation replacing the classical devices of literal or sequential repetition. The older symmetry of balancing sections was eliminated in favour of drastic shortenings and lengthenings to preserve the greater tension of the assymetrical rhythmic basis. Texture became predominantly contrapuntal with a freedom of relation between voices that sometimes recalled the heterophonic practices of primitive or Balinese music and more often the linear counterpoint of the middle ages. The orchestra was dissociated into sharply defined groups of colours in order to bring out the contrapuntal and linear nature of the music; the individual instruments mere often treated as soloists as in chamber music.

Perhaps the most striking general aesthetic and technical feature of the period was a new attitude toward stylization. Obviously works of music had been stylized in every period, but previous composers usually drew upon the general practices of their time for the devices used to give each work its special stamp. From 1860 on, the commonly accepted methods of the immediate past began to disintegrate rapidly. Wilhelm Richard Wagner, Hugo Wolf, Modest Petrovich Mussorgsky and others added many novel features, and by the end of the century the impressionist composers Claude Debussy (1862–1918) and Maurice Ravel (1875–1937) had stretched the use of older harmonies to the point where they no longer fulfilled their former functional capacities of pushing toward cadences and employed them as separate sonorities much as blotches of colour were used in impressionist paintings. Debussy in his later works consciously strove for a more fluid style that dispensed with classical rhythmic and melodic procedures achieving a technique that resembles the "stream of consciousness" of contemporary literature. At about the same time. Alexander Scriabin (1871–1915) invented new chords to express his sensual mysticism, and Erik Satie (1866–1925) and Ferruccio Busoni (1866–1924) were demonstrating in very different ways the "objective" attitude in their works.

Around 1908 there was an outburst of musical primitivism and expressionism that paralleled the postimpressionist reaction in painting against the tenuous world of the impressionists. From this time until about 192 j, each new composer strove to invent his oan vocabulary of melodies, harmonies and rhythms, as well as his own grammatical rules. Each went in search of new materials and new ways of joining them, and each work provided an opportunity of carrying some technical, stylistic or aesthetic idea to its extreme limit. For a while such stylistic relativism seemed to point toward complete anarchy. It looked as if there were going to be almost as many styles as there were works written. In Stravinsky's works, for instance, the vehement barbaric ritualism of *Le Sacre du printemps* (1913) gave way to the dryly humorous pathos of *L'Histoire du soldat* (1917) with its deliberate distortions of café music. This in turn led to a whole series of works related to styles ranging from Bach to Tschaikovsky and, in 1948, to an austere setting of the Mass using bits of musical Gothic. All of these works were done with such imagination, fantasy and authority that they furnished cues for one group of followers after another.

Similar but not so drastic changes went on within the very individual styles of Bartók and Schonberg, as each passed in his own way through a period of classicism.

This desire for total stylization can be seen as shaping the background of the entire first half of the 20th century, often with sensational results as in the works of Edgar Varèse (1885–) or of Anton Webern (1883–1945), which extended stylization to the limits of unusualness, or in the later works of Erik Satie and in those of Virgil Thomson (1896–), which carried it to the opposite extreme of simplification.

Against this experimental background, however, several marked trends began to form which gave the years between 1925 and 1940 a certain unity. Around the time when Schonberg wrote his first works using the 12-tone technique in 1924, when Stravinsky had gone back to Bach in his *Piano Concerto* (1923–24) and when Bartók had finished his most experimental works, the *Piano Sonata* (1926) and the *Third String Quartet* (1927), the directions became defined. Composers felt that the previous inventions needed to be explored. At this time a number of excellent neoclassicists appeared: Sergei Prokofiev before he returned to soviet Russia, Darius Milhaud (1892–), Francis Poulenc (1899–), George Auric (1899–), who followed the new aesthetic using elements of their native French popular, folk and art music, while Arthur Honegger (1892–1955) combined this idea with a dramatic violence that brought him close to the romantic style. In Germany, where Busoni had prepared the way, Paul Hindemith (1895–) turned from romanticism in his clear-sounding, objective, contrapuntal style and treated chromatic elements in a new motoristic, vigorously rhythmic way derived from the neoclassic approach. His series of outstanding works revealed a growing preoccupation with the styles of the Renaissance and middle ages. In the United States, Walter Piston (1894–) and Roger Sessions (1896–) produced important and skilful uorks in this style. Shunning romantic attitudes, they regarded themselves as returning to the ideals of craftsmanship of earlier times. Many wrote teaching pieces and music for amateurs and other kinds of *gebrauchsmusik* (music for use) in their own idioms.

The other important rallying point, atonalism, for a time eclipsed by the success of the neoclassicists, was also related to the earlier techniques, particularly of the Renaissance. Schönberg and his followers, Alban Berg (1885–1935) and Anton Webern, developed a rigorous system usually called the 12-tone or dodecaphonic technique which they applied to their subsequent works. By this an entire composition is organized around a chosen order of the 12 tones of the chromatic scale, sometimes transposed, inverted or read in retrograde motion (backward). No tone can return unless separated by the other intermediate 11 tones, thus ensuring an equal distribution of emphasis on all 12. This was intended to obviate the classical feeling of tonality. The chosen "row" of 12 tones forms the basis of all melodies, counterpoints and harmonies in a given work, and its application immediately gives stylistic and motivic unity. Alban Berg's amazing feat of composing a full-length opera, *Lulu,* on one tone row revealed the enormous possibility of variety within the system, borne out by the numerous and varied works of Schonberg and Webern. Berg's music, surprisingly enough, is also quite clearly romantic in its feeling, while Schonberg's is more austere and Webern's fancifully aphoristic. Around 1940, many composers like the former neoclassicist, Ernst Křenek (1900–), and the young Italian, Luigi Dallapiccola (1904–), began to use this system as did many others in most important musical centres. It also had an indirect influence on Bartók and on the Americans, Sessions and Wallingford Riegger (1885–1961).

A mature form of nationalism that aimed at expressing the national spirit of a country in music abstracted from its folk origins emerged in almost every country during these years. The outstanding exponents of this trend were: Bartók and Zoltán Kodály (1882–) in Hungary; Manuel de Falla (1876–1946) in Spain; Ralph Vaughan Williams (1872–1958) and Gustav Holst (1874–1934) in England; Bohuslav Martinu (1890–1959) in Czechoslovakia; Gian Francesco Malipiero (1882–) in Italy; Heitor Villa-Lobos (1887–1959) in Brazil; Carlos Chávez (1899–) and Silvestre Revueltas (1899–1940) in Mexico; and Roy Harris (1898–), Aaron Copland (1900–), Douglas Moore (1893–) and the independent experimenter, Charles Ives (1874–1954), in the United States. Since all of these and many more applied in some measure the principles of stylization mentioned above, their works present a most varied character.

For sensitivity to stylistic difference~had been very strongly developed as musicians came to know recordings of folk, primitive and oriental music, as well as pre-18th century music as it was occasionally performed under the supervision of musicologists intent on reviving the original music with its original style of interpretation. This expanded cultural and historical horizon, as was seen above, contributed new stylistic and aesthetic ideas to many 20th-century composers, some of whom, such as Bartók, Hindemith and Křenek, were musicologists themselves.

It is beyond the scope of this article to discuss in detail the psychological and sociological background of modern music. One characteristic feature deserves mention, however—the role of the societies which were formed in almost every occidental country to encourage and propagate the new music. Many composers took a determined stand against the banalities of the contemporary popular mass culture and relied on the understanding and support of such intelligent and progressive groups of musicians and music lovers to serve as intermediaries between them and the broad musical public. This reaction against the widespread public trend toward cultural uniformity (which in the musical world showed itself in the standardization of the repertoire) led many musicians to the cultivation of pronounced individuality of style. It also led them to uphold the integrity and dignity of modern art by assuming more meaningful attitudes toward artistic expression and toward contemporary life than were possible in popular entertainments or in the general run of concerts devoted to the repetition of familiar masterpieces. Hence modern music was often misunderstood by the general musical public, while the societies which supported modern music were able to distinguish its importance. The faith of these societies over the years was amply justified by the remarkable works which they brought to light and championed.

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MUSIC, TEACHING OF. Music is concerned with three types of individuals—composers. performers and listeners. The basic training of all three is related, since none can function fully without an understanding of musical structure. Hence the teaching of music is essentially the development of musicianship—that is. the sum of individual aptitudes. insights and skills in respect to music. Musicianship consists of both intuitive and rational responses, and the teacher's responsibility is to develop the latter through all available means according to the student's individual needs and capabilities. Musicianship is based primarily upon a grasp of how composers use their materials, and hence the greatest teacher of music. either technically or aesthetically, is music itself. But, as Franz Joseph Hapdn said, "The educated ear is the sole authority," and this simple fact is the basis of the teaching of music in terms of musicianship.

Listening, as the primary type of musical activity, is transmuted into specific skills through singing, playing, analyzing, writing and creating music. These avenues of learning all have a common goal—musical insight, which is promoted by their integration. Specifically, this means that the student learns the structure of music through the simultaneous study of written and keyboard harmony, music reading. ear training, analysis and creative writing. All are of equal importance, and all contribute to "the educated ear." These, then, are the basic principles of the teaching of music: the development of musicianship through the study of music literature based upon aural perception and promoted through related and integrated skills. The teaching of these skills may be summarized thus:

Listening is a mental activity dependent only in a general sense on physical hearing. Hence "ear training" should be regarded as directed listening for all rather than as a separate skill for the select few. It may be either oral or written, and its precision will depend upon the maturity of the student and the end in view. The first aural reactions will be general in character: the recognition of register, tones of the tonic chord, consonance and dissonance. These generalities will gradually be refined to specific reactions: chord quality, inversions, form and rhythmic, melodic and harmonic complexities, paralleling the development of other skills. In general, the musical passages used should be presented as a unit, not as separate rhythmic, melodic or harmonic drills, even though each of these factors may be recognized individually. Three specialized types of dictation should be noted: (1) corrective listening—the recognition of differences between the music as printed and as performed when the instructor deliberately introduces alterations; (2) contrapuntal listening—notation of simple two-voice counterpoint; and (3) analytic listening—recognition and notation of formal design, using letters for various parts and arbitrary symbols for cadences.

Writing is one aspect of musical literacy and as such is an essential skill. In the beginning. notation is best learned directly from the analysis of familiar melodies, not as an isolated body of facts unrelated to musical experience. When the elements of notation are learned: the study of harmony is begun, and scale structure, key signatures, intervals and chords are explained as the need arises from the music examined. Four-part harmony is approached gradually through one-, two-, and three-voice writing and simple piano accompaniments. Chords are best taught in the order of their use in music literature rather than in the order of their structure; *i.e.,* triads! their inversions, seventh chords, etc. Musical usage implies the early introduction of nonchord tones and modulations. Figured bass assumes less importance, though its principles should be clearly understood. Counterpoint is studied stylistically through the vocal and instrumental idioms of Giovanni Pierluigi da Palestrina and Johann Sebastian Bach respectively. The traditional approach, strict or academic counterpoint, is less desirable, as its musical values occur unrestricted in Palestrina's style.

Keyboard Harmony makes abstract knowledge concrete. It includes melody harmonization, transposition, improvisation, modulation, score reading, harmonic reductions, keyboard dictation and playing by ear. From the beginning all students should have some keyboard experience, limited only by their technical facility. Two advanced specialized types of keyboard instruction should be noted: (1) the teaching of transposition through the use of movable clefs and (2) keyboard analysis of piano literature for interpretive purposes.

Music Reading, as the other aspect of musical literacy, is equally important. The immediate purpose of music reading or "sight singing" is dual: to read music silently and to reproduce it vocally. The training of the inner ear takes precedence, because vocal reproduction is the echo of the sound conceived mentally. Hearing precedes singing. All systems for developing a sense of pitch relationship are only means to that end and should be abandoned when it is achieved. The oldest system, solfeggio and its modification, tonic sol-fa, associated the first syllable of each line of a medieval hymn to John the Baptist with one of the six degrees of the Guidonian hexachord (*q.v.*). Its long use is due as much to tradition as to the success of the system. However, it is open to criticism on both psychological and pedagogical grounds. In America, three other systems are found: (1) the use of numbers or letters, or both, for scale pitches, (2) the development through rote singing and melodic analysis of a strong sense of tonality without the use of specific pitch names and (3) the supplementary use of a simple flutelike instrument to solve physical or psychological problems. Without evaluating these various methods, it is clear that they all are only teaching devices to aid in vocal discrimination. The whole problem of music reading is complex and includes many psychological and musical factors. The solution requires a thorough study similar to that done in the field of language. Certainly it is known that one of the essential principles is phrase-wise rather than note-wise reading, and, in general, emphasis on the musical rather than the technical elements involved.

Analysis is an understanding of the total organization of music. Its objective is the explanation of musical structure in such a way that insight results. It includes awareness of all harmonic, contrapuntal, formal and stylistic elements. In a sense, all musical activity is dependent upon either conscious or intuitive analysis, and for this reason it should permeate all levels of instruction. Even a child can understand, in his own terms, the organization of music that he performs. In harmonic analysis it is desirable to stress essential progressions rather than details; *e.g.*, chromatic embellishing chords or diatonic extensions, which can be fitted later into the general pattern. Contrapuntal analysis, especially of the baroque period, is of particular value to pianists, organists or choirmasters.

The analysis of form, or the sequence of musical ideas, is also essential for musicianship and yet is frequently neglected. The first principle of teaching form is to explain the structure in simple language understood by the student. Second, analysis must be applicable to the student's needs and relative to his experience. Third, it should be both aural and visual, though analysis by ear is a much more musical and realistic approach. Both can be combined by reading the music while listening to its performance.

Creative Writing is one of the best means for the promotion of musical insights. Creativity is universal and should be used from the outset according to individual capacity. Begin by setting short poems to music without accompaniment, or by writing free instrumental melodies, and parallel later study by composition in the small-song forms. Students, even with a meagre background, can express themselves acceptably when musical rather than technical problems are stressed. The objective is musical growth through doing, and this can be achieved on all levels.

These six skills, then, as the basis of musicianship, should be so taught as to meet the individual needs of composers, performers and listeners.

Trends.—At mid-20th century, some specific trends in music teaching were: (1) emphasis on musicianship as the goal, achieved through the study of musical literature. This implied a consideration of style as a factor of structure and consequently as a basis of judgment; *e.g.*, the different attitude toward parallel fifths in various periods. Another implication was the stress on musical rather than technical values, the recognition of general principles rather than of specific rules. Thus, if the trained ear was to be the only arbiter, a passage could not be poor musically but correct theoretically. This involved the question of taste—also an essential element of musicianship. (2) Use and integration of all avenues of learning discussed above, rather than the traditional emphasis on reading and writing. This meant that ear training, keyboard harmony, analysis and creative writing were also treated as integral and integrative factors in the development of musicianship.

General trends in the teaching of music were: (1) belief in the social and democratic values of music, and of its vital role in the well-rounded curriculum at all levels of instruction, as shown by the expanding instrumental and vocal programs in primary and secondary schools, and colleges. (2) Use of audiovisual aids enlarged and improved tremendously the techniques of both group and individual study through the use of radio, records and scores for the exploration of musical literature in accordance with the principles outlined above. (3) Growth of the adult education movement increased both the number and type of music students. Instruction of these amateur groups emphasized the cultural rather than the technical aspects of music, unless the latter were required for individual needs. (4) Remarkable development of musicology, especially in America, where outstanding European authorities had settled from 1914 onward, thereby stimulating its study.

(H. A. My.)

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UNITED STATES

Music received slight attention in the days of the American colonists. For the improvement of church music, manuals of instruction in singing were prepared early in the 18th century by two Massachusetts ministers, the Rev. John Tufts and the Rev. Thomas Walter. These books and their successors provided the text material for the "singing schools" and "musical conventions" which for years represented the chief activity in music study.

The first well-organized effort to provide a more complete musical education was the Boston Academy of Music founded by Lowell Mason in 1833. The first college recognition of music was the engagement of an instructor of music at Oberlin college, Oberlin, O., in 1838. From about 1840 a considerable number of Americans went abroad to study music, chiefly in Germany. These pioneers, home again and reinforced by many foreigners, were leaders in the marked advance of their profession, especially after the Civil War. The first comprehensive music schools were the Oberlin conservatory (1865), which in 1867 became the first college music department, and the New England conservatory (Boston, Mass., 1867). Then followed the Cincinnati conservatory (Cincinnati, O., 1867), Chicago Musical college (Chicago, Ill., 1867), Peabody conservatory (Baltimore, Md., 1868), College of Music in Cincinnati (1878), American conservatory (Chicago, Ill., 1886) and many others.

Reporting in 1908 on a study of such schools and departments of music, the bureau of education declared that their widely varying curricula in many instances were so much given to the vocational aspects of music that music was separated from general educational thought. Data in Randall Thompson's College *Music* (1935) were indicative, however, of academically well-based curricula, though varied in extent and other respects, at Oberlin by 1865, Harvard by 1870, and Smith, Vassar, Wellesley, Yale, Columbia and the Universities of Michigan and Oregon between then and the turn of the century. The Music Teachers National association (1876), comprised of teachers and, later, composers, conductors, musicologists, editors, critics, music librarians and publishers, became increasingly a disseminator of broadly educational ideas as to music teaching. Also directly effective in the improvement of many music schools and departments was the National Association of Schools of Music, founded in 1924 to develop uniform standards for granting degrees and other credentials. Efforts were made in some states to set standards for the work of private music teachers, but with only partial success.

Four music schools with large endowments became especially competent to give the highest professional training, often through scholarships. The oldest, the Institute of Musical Art of New York, was founded in 1904 and in 1926 became affiliated with the Juilliard School of Music as its undergraduate school. The large bequest of Augustus D. Juilliard (1919) for musical education led to founding in 1924 of the above-named graduate school for students of unusual talent. The Eastman School of Music (1919), a department of the University of Rochester (N.Y.), was endowed with $12,000,000 by George Eastman, and the Curtis Institute of Music in Philadelphia (Pa., 1924) with more than $12,000,000 by Mrs. Edward W. Bok. Sharing the Boston Symphony orchestra's ideal setting at Tanglewood was the Berkshire Music centre, established by Serge Koussevitzky in 1940 in connection with the Berkshire festivals. Two classes of students were admitted to this great summer centre: those capable of profiting by the best professional training for careers as orchestra or solo players, singers, conductors or composers; and "students, teachers and others . . . seeking to enrich their capacities for lifelong enjoyment." Tanglewood was given to the orchestra in 1936 by Mrs. Andrew H. Hepburn and Mary A. Tappan. A bounty of another kind was the settling in the United States of many more of the world's finest musicians and teachers shortly before and during the period of World War II.

Public school music education in the United States began with Lowell Mason's work in the Boston public schools in 1837, an example followed promptly in Buffalo, N.Y., Pittsburgh, Pa., Louisville, Ky., Cincinnati, O., San Francisco, Calif., and other communities. The Music Educators National conference was founded in 1907 by school music supervisors. Largely through that organization, with its affiliated regional, state and local associations, research council, active committees on every phase of the work, and its journal and other publications, the teaching of music in schools had by the mid-century become almost everywhere a cherished indispensable. The brief summer schools for music teachers of the early days were succeeded by special four-year curricula and graduate courses at state and other universities and some conservatories. There were still many school systems with very little or poor music instruction, some with none, but many high schools had developed excellent performing groups and music courses, while guided listening, rhythmics, class instrumental instruction and playing groups as well as singing had become common in elementary schools. Two of the greatest events for music teachers in the first half of the 20th century were the amazingly good performance of the *Eroica* symphony by a large national high school orchestra at the Music Educators National conference in Detroit, Mich., in 1926 and the superb performance of great music by a Flint (Mich.) high school *a cappella* choir at the Chicago meeting of that conference in 1928. The challenge of these revelations was felt throughout the nation.

The first music textbooks, by Lowell Mason (1841) and Charles Aiken (about 1850), were for grammar grades and high school and were derived from those of the "singing schools." The *National Music Course* (Luther W. Mason, 1870) was the first to provide distinctively for all grades. It was used widely in the U.S., and a translation published in Leipzig was used in German schools; but by 1880 its abundance of songs and the teaching of music reading mainly through them came under suspicion of not helping directly enough toward mastery of the printed page. Moreover, where accepted as a regular part of school work, music had now to prove not its appeal and human value, but that it could be taught efficiently by the grade teacher. The *Normal Music Course* (1883) gave answer in a relentlessly logical succession of exercises and songs. This won many adherents, but its use gradually revealed that mastery of details of scale and rhythm, won apart from music, was of little use in reading music. By mid-20th century 16 other complete music courses had been published and widely adopted, all using the song approach to musical learning, but many with large quantities of inane songs. The trend, however, was toward using many folk songs and other vital music and toward greater dependence, as to method, on the musicalness, judgment and skill of the teacher.

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MUSICAL-BOX. The modern musical-box is an elaboration of the elegant toy musical snuffbox in vogue during the 18th century. The notes or musical sounds are produced by the vibration of steel teeth or springs cut in a comb or flat plate of steel, reinforced by the harmonics generated in the solid steel back of the comb. The teeth are acted upon and musical vibrations produced by the revolution of a brass cylinder studded with projecting pins, which, as they move round, raise and release the proper teeth at due intervals according to the nature of the music. The revolving motion of the cylinder is effected by a spring and clockwork, and the rate is governed by a fly regulator.

MUSICAL COMEDY. Until the end of the 19th century, the term musical comedy was one of many used to describe any stage piece of a comic nature to which music was either integral or incidental. By the second part of the 20th century, the term defined a particular form of dramatic and musical entertainment which had virtually taken the lead in modern theatre forms. Within the loose usage of the previous century, an *opera buffa* such as Mozart's *Le Nozze di Figaro* could be called a musical comedy; at the opposite extreme, the term was also applied to the popular U.S. farces staged by Edward Harrigan and Tony Hart in the late 19th and early 20th century, on the strength of their interpolated songs and ballads. A specific application of the term to a genre of stage piece in which popular songs. dances and production ensembles are festooned upon a farcical plot was first made in the early 1890s by George Edwardes, manager of the Gaiety theatre in London, who called his production of *A Gaiety Girl* musical comedy to distinguish it from his previous burlesques. These musical comedies were brought from the Gaiety to the United States. where they formed the basis for the entertainment that has since persisted.

Musical comedy, as it bad been known in 20th-century U.S. and English theatres, differs from comic opera and operettas in that it adheres to a more vernacular style in its music, dances, lyrics and dialogues. It differs from variety or vaudeville—to which it is indebted for many of its elements of song, dance and humour—in its possession of a plot, however minimal, and also as a rule in the elaborateness of its physical production. It differs from the revue largely in its use of a plot; the mainstays of that medium—satire. parody and topical thrusts—are also used in musical comedy. U.S. musical comedy, as it came into being just before the beginning of the 20th century, developed through a fusion of the elements of six earlier types of musical entertainment—extravaganza, pantomime, variety. burlesque, farce-comedy (in the special sense the term acquired in the 1870s) and European comic opera. The extravaganza (in France, the *féerie*) was originally an imaginative spectacle leaning upon the devices of ballet; *The Black Crook* by Charles M. Barres (1866) was a celebrated example in the United States.

After French romantic ballet dropped out of favour, almost any spectacular piece using elaborate machinery for the production of illusions was called extravaganza. Pantomime, still popular in England, was a short-lived importation in the U.S., disappearing in the 1870s. Variety served as a proving ground for performers who later graduated into musical comedy; many songs and dance routines (including those from blackface minstrel shows) became the stock in trade of musical comedy.

Burlesque, still true to its name, was taken to the United States in 1868 by Lydia Thompson of London and was given a homely U.S. showing by Edward E. Rice in *Evangeline* (1874). Among the distinguishing marks of burlesque in the 19th century were its girls in tights, playing so-called male roles, its comedians with baggy pants and red noses and its coarse humour. Farce-comedy derived from the work of the Roman comic dramatist Plautus, with its metric recitations accompanied by the flute (*tibia*), became in the middle of the 1870s, a vernacular form of entertainment popular in England. The Vokes family of England and an American troupe called Salsbury's Troubadours introduced the notion of hanging variety specialties upon a slender thread of plot. These shows stood in contrast to English and Viennese comic opera and Offenbach's French *opéra bouffe*, which at best constituted a more aristocratic form produced by better craftsmen.

Borrowing from all these sources and adding a native drive and ingenuity, U.S. musical comedy began to develop. In the second decade of the 20th century, ballroom dancing and the ragtime of Irving Berlin moved musical comedy out of the world of imaginary Balkan principalities into the present. As the impact of the new continental inventions in staging, led by Max Reinhardt and Josef Urban, invaded the theatre, the artistic level of musical comedy rose considerably.

In the depression years of the 1930s, political satire *per se* appeared; *Of Thee I Sing* by George S. Kaufman, Morrie Ryskind and Ira and George Gershwin, became the first piece of this kind to win the Pulitzer prize (1931). In the late 1930s and early 1940s such choreographers as George Balanchine and Agnes De Mille won for the dance a serious participation in the story telling of the musical comedy form. Music and the lyric theatre took on more importance; the combined efforts of score, scenery, ballet, costumes and play were taken seriously.

From a series of "intimate" musical comedies initiated by Jerome Kern, Guy Bolton and P. G. Wodehouse with *Very Good, Eddie* (at the Princess theatre in New York in 1915), the musical theatre gradually took on believable plot construction and characterization which grew into such dramatically superior works as *Lady in the Dark* by Moss Hart and Kurt Weill (1941) and *South Pacific* by Richard Rodgers and Oscar Hammerstein II (1949). As the musical field was enriched by such serious and even tragic "musical plays" as Gian-Carlo Menotti's *The Consul* (1950) and *The Saint of Bleecker Street* (1954), a change took place in more popular entertainment. The use of plays by such dramatic authors as Eugene O'Neill, Sidney Howard and George Bernard Shaw became great popular successes in musical comedy form, as *New Girl in Town* by George Abbott and Bob Merrill (1954), *Most Happy Fella* by Frank Loesser (1955) and My *Fair Lady* by Alan Jay Lerner and Frederick Loewe (1955). (R. N. LE.)

MUSICAL INSTRUMENTS, a general term used to designate instruments used for producing sound. The sound produced is generally that of musical notes with definite pitch. Each note (though there are exceptions, such as the pure tone of single frequency produced by a tuning fork and the primary tones of electronic musical instruments) normally consists of a complex of harmonic frequencies or overtones, varying in their number and relative strength according to the type of instrument and the intensity with which it is sounded. The sound is analyzed by the ear and so recognized as a musical note having the tone-quality characteristic of the instrument in question. By attentive listening it is often possible to distinguish several of the overtones individually—especially in notes of deep pitch—while scientific examination, *e.g.*, by oscilloscope and mathematical analysis of the wave-form shown thereon, makes possible a precise graphic demonstration of the "tonal spectra" of different notes throughout an instrument's range. With some musical instruments, such as bells and tuned drums, in which the sound-producing vibration is complex compared with that of the stretched string of stringed instruments and the air column of wind instruments, the pitch of a note may be less easy to perceive owing to the presence in it of inharmonic or dissonant frequencies. With others no definite pitch is perceived, the sound being that of a clash, knock or rustle of wholly dissonant constitution and employed to mark rhythms or points of musical structure. Occasionally the primary purpose of such an instrument may be nonmusical; *e.g.*, a pair of spoons, which exemplifies an improvised musical instrument. Also, the purpose of the sound of an instrument may be nonmusical in the strict sense, as when it is employed for signaling, *e g.*, many whistles, or in ritual without musical context. Sound-producing instruments with such nonmusical purposes are so closely linked both typologically and genealogically with those used in music-making that all are included under the one conventional term, musical instruments. Their historical and ethnological study is called organology.

Chronological Evolution of Instruments.— The chronology of Curt Sachs *(Geist und Werden der Musikinstrumente,* 1929) is the foundation of modern study. The earliest instruments were used for marking rhythm. Initially a dancer beat his body, stamped and clapped; then a piece of wood, sometimes placed over a hollow in the ground, was used to amplify the sound of stamping, while sticks, spears or boomerangs were clashed, and strings of rattles were worn on the body to give sound to otherwise silent rhythmic movements. Familiar survivors of this stage of development in the western world include the jingle bells worn on the legs of morris dancers and the rumba claves (rhythm sticks). In the next stage, still a very early one, appeared many primitive instruments which show magic connotations, by which the sounds produced from natural substances by the hand or breath of man are used for communication with the spirit world in rites of every kind. These include seed-gourd rattles; scrapers, in which the sound is produced from a serrated or corrugated surface; the bull-roarer, a piece of wood whirled on a cord to spin and thereby produce a roaring vibration of the free air; and whistles made from bones. Excavations of Magdalenian sites in Europe (representing a final stage of Upper Paleolithic culture) have yielded archaeological examples of all the last three. Many simple instruments still keep their ritual use in European folklore, as, for example, willow whistles, horns, pottery flutes, and rattles and knockers sounded at various feasts of the year; the ratchet rattle swung at football matches may be placed on the fringe of these. Others have lost such associations and may be regarded as purely rhythmic instruments, as, for instance. the rumba maracas (gourd rattle) and guiro (scraper), or have degenerated into signaling instruments or toys.

A little later than the early rattles and flutes are the first "trumpets," as, for instance, conch shells, and hollow branches, such as the Australian dijeridoo. Their most primitive use is simply as voice disguisers in the utterance of spells and commands; the trumpet at this stage is not actually a true sound producer but a "pseudo musical instrument," like a kazoo or a megaphone. The first drums are placed by Sachs among the early Neolithic strata (though "friction drums," from which a roaring sound is produced by rubbing a stick or cord attached to the centre of the drum-skin, are later; the Spanish *zambomba* is a well-known surviving European species). At this stage, too, appear various instruments on which two or more contrasted pitches are deliberately obtained, like the "slit drum." a log partially hollowed out through a slit-like incision, the two edges of which give different pitches when struck (whereby in West Africa speech-tone patterns are reproduced and messages transmitted); kindred forms include the orchestral wood block. which gives but one sound, and the "temple blocks" (Chinese "wooden fish"), each sounding a different pitch. "Stamping tubes" are large bamboos pounded on a log and often tuned to chosen notes. Neolithic flutes, generally of cane, may give several notes. either as natural harmonics, or through finger-holes, or by being combined as Panpipes.

By this stage primitive stringed instruments had appeared, notably the widespread "musical bow." which may be either an ordinary hunting bow or one specially constructed; among its playing techniques, one is to hold one end of the bow to the mouth and, by altering the mouth cavity so that it acts as a selective resonator, to make melodies from the string's natural harmonics, tapping the string with a stick. The same acoustic principle is employed in playing the Jew's harp, widely distributed as a primitive instrument with a vibrating tongue of bamboo, though in Europe of metal; the melody of the mouth-resonated harmonics has to be listened for above the noisier droning of the deep-pitched fundamental frequency. In another instrument of Neolithic cultures, a slither of bark is separated from a bamboo stem except at the ends, and raised from the stem by bridges to provide a "string"; several such canes may be placed beside each other. or several "strings" may be cut in one thick bamboo, *e.g.*, the *valiha* of Madagascar, making various types of primitive zither. Generally, the greater the tuneful and tunable possibilities of a primitive instrument, the smaller are its ritualistic connotations, and primitive stringed instruments, also xylophones (which occur first among higher Neolithic cultures) and the African metal-tongued *sansa,* are played mainly for their music in recreation and entertainment rather than at rituals.

The native civilizations of America developed no stringed instruments, relying upon rattles, drums, flutes and trumpets (notably conches). In the ancient civilizations of the middle east, on the other hand, stringed instruments had risen very early to that leading position in music which they have since maintained in high civilization. Most modern authorities postulate the musical bow as progenitor of the arcuate (bow-shaped) harp (c. 3000 B.C.) and long-necked lute (*c.* 2000 B.C.). The middle east also knew clappers, sistra (metal rattles), drums, flutes (mainly pastoral), aulos (reed pipe) and cymbals and metal trumpets. Many of these are mentioned in the Old Testament, though some of their names in the Authorized (King James) Version are misleading: the "harp" was actually a lyre and the "psaltery" was a harp. Just before the Christian era, the organ, the first keyboard instrument, was invented, it is believed, in Alexandria. At the other end of the old world, ancient China, provided with drums, many other percussion instruments and flutes, developed its first stringed instruments from the primitive zither; the Japanese koto is their best-known modern descendant. Among wind instruments, China evolved the free-reed mouth organ, a parent of the harmonica (*q.v.*). In early medieval Europe a notable development, possibly from central Asia, was the fiddle, allowing the production of a sustained sound on a stringed instrument by bowing.

For details of ancient and modern western instruments, *see* ORCHESTRA; PERCUSSION INSTRUMENTS; STRINGED MUSICAL INSTRUMENTS; WIND INSTRUMENTS; ELECTRONIC MUSICAL INSTRUMENTS; and articles on individual instruments. *See* also AFRICAN MUSIC; CHINESE MUSIC; JAPANESE MUSIC.

Classification of Instruments.— Musical instruments do not fall naturally into any single comprehensive taxonomic scheme, and their many physical cross-relationships make it very difficult to devise a useful classification consistently based upon straightforward criteria. Yet some scheme is required, and for the broad study of instruments (from over the entire world and back into prehistory) the familiar grouping of strings, wind and percussion has been superseded by a scheme introduced by V. C. Mahillon in 1888 (though Indian music had long observed its essence) by which instruments are grouped primarily according to the nature of the material which is regarded as producing the sound in the first instance. Hence percussion instruments are divided into (I) idiophones, in which sound is produced from hard substances not previously stretched in any way (bells, cymbals, xylophones, etc.); and (II) membranophones, producing sound from a stretched skin (drums). Stringed instruments are termed (III) chordophones. Wind instruments come under (IV) aerophones, and it will be noted that the definition does not specify blowing; it requires that the sound be regarded as being produced in the first place from a vibrating mass of air. (A fifth group, electrophones, may be appended to include instruments in which sound is produced electronically.) In the main groups, the acoustic chain of events, as seen by the scheme, may be illustrated by a few examples, as is shown in Table I.

TABLE I.—*Stages in the Acoustic Chain of Events*

Instrument	A	B	C	D
Gong	Arm movement	Impact of stick	Vibration of *metal*	—
Violin	Arm movement	Impulses from resined horse-hair bow	Vibration of *string*	Resonation by air contained in body of instrument
Clarinet	Breath stream	Impulses from pressure changes at vibrating reed	Vibration of *air column*	—

It must be stressed that the only object in thus equating the events which take place in such entirely different acoustical systems as these is to establish a basis for classification. Even so, there are a number of "borderline" cases, especially between idiophones and aerophones, *e.g.,* the free-reed instruments, and the plucked reeds (Jew's harp, musical box, sansa), and authorities still disagree about where these should be placed in the scheme. A. Schaefiner's discussion of such cases is of special value (see *Bibliography*). For defining subdivisions within the main groups, the sound-generating actions are referred to (*see* columns A, B, Table I), except that with stringed instruments this leads to so distorted a picture in terms of musical practice and history, that arrangement according to structure is preferable. The examples cited in the following table are chosen from past and present western music, except for certain primitive types and unique oriental types.

TABLE II.—*Classification of Certain Instruments*

I. Idiophones

Method	Wood or other organic material	Metal or other inorganic material
Struck	Percussion boards, xylophone	Triangle, glockenspiel, vibraphone, celesta
	Stamping tubes, slit drum	Tubular bells, gongs, steel drums, bells
Struck together	Rhythm sticks, castanets	Cymbals
Shaken	Rattles	Jingle bells, sistrum
Scraped	Guiro, ratchet rattle	Washboard
Rubbed	New Ireland "rubbed wood"	Glass harmonica
Plucked	Primitive versions of the Jew's harp	Jew's harp, African sansa, musical box

II. Membranophones

Struck	Drums: bowl drums—pottery drums, timpani; *tubular drums*—side bass, tabor, bongos; *frame drums*—tambourine;
	"Roller" (a leather cylinder, China)
Shaken	Rattle-drum (Tibet)
Rubbed	Friction drums
Plucked	Indian gobi-yantra drone

III. Chordophones

Ground harps (rattan rope)	Beaten
Musical bows	Plucked, beaten, or, in Hottentot *gura,* blown
Zithers (strings run from end to end of resonator)	Open-string: plucked—psaltery, harpsichord; beaten—dulcimer, pianoforte; wind-blown—aeolian harp
	Stopped-string: plucked—Austrian zither, mountain dulcimer; bowed—bowed zither.
Lyres (strings run over resonator to crossbar)	Plucked—ancient and African lyres; bowed—Welsh crowd
Lutes (strings run over resonator and along "neck" where they may be stopped)	Plucked—lute, guitar, cittern; bowed—violin, viol, tromba marina; bowed by wheel—hurdy-gurdy
Harps (strings leave resonator at angle in plane vertical to soundboard)	Plucked—arcuate or angular *frame:* ancient and non-western harps; triangular *frame:* western harps; with neck and bridge: African harp-lute

IV. Aerophones

Flutes (no mechanical vibrator)	*Artificial air-slit:* (tubular) whistles flageolets, recorder; (globular) bird whistles, ocarina
	Lip-formed air-slit: (tubular) side-blown—transverse flutes; end-blown—*kaval,* Panpipes, notched flute; (globular) gourd flutes
Trumpets (vibrating lips, coupled to air column)	Conch, animal horn, tusk, wood (alpenhorn): end-blown or side-blown; with finger holes—cornet, serpent
	Metal: mainly cylindrical bore—trumpet (natural, keyed, valved), trombone (slide, valved); *narrow-taper* bore—French horn, posthorn, cornet; *wide-taper* bore—bugle, ophicleide (keyed), Flugelhorn, alto and tenor horns. tubas (valved)
Reed instruments (vibrating reed coupled to air column)	Cylindrical bore: (single reed) reed pipes, clarinet; (double reed) anlos, crumhorn, rackett; (free reed) free-reed pipe of southeast Asia
	Taper bore: (single reed) saxophone, tarogato; (double reed) shawm, oboe, bassoon
Free aerophones	Without reed—bull-roarer, siren; band-reed—grass squeakers; free *reed*—bark or fish scale placed in mouth, mouth organs, accordion, toy trumpets

BIBLIOGRAPHY.—F. W. Galpin, *Old English Instruments of Music* (1910); Karl Geiringer, *Musical Instruments* (1943); Curt Sachs, *The History of Musical Instruments* (1940), which contains a full bibliography for further reference. Concerning classification *see* E. von Hornbostel and C. Sachs, "Systematik der Musik instrumente," in Z. *Ethn.,* xlvi, p. 553 (a full expansion of Mahillon's scheme) (1914); André Schaeffner, *Origine des instruments de musique,* p. 371, also especially p. 225 ff. (1936); Jaap Kunst, *Ethnomusicology,* 3rd ed., p. 55 (a review of the whole subject) (1959). (A. C. BA.)

MUSICAL NOTATION, a graphic method of representing sounds to the ear through the medium of the eye. It is probable that the earliest attempts at notation were made by the Hindus and Chinese, from whom the principle was transferred to Greece. The exact nature of the Greek notation is a subject of dispute, different explanations assigning 1680, 1620, 990, or 138 signs to their alphabetical method of delineation. To Anicus Manlius Severinus Boethius we owe the certainty that the Greek notation was not adopted by the Latins, although it is not certain whether he was the first to apply the 15 letters of the Roman alphabet to the scale of sounds included within the two octaves, or whether he was only the first to make record of that application.

Indications of a scheme of notation based, not on the alphabet, but on the use of dashes, hooks, curves, dots and strokes are found to exist as early as the 6th century, while specimens in illustration of this different method do not appear until the 8th. The origin of these signs, known as neumes (*q.v.*) (*νεύματα*, or nods) is the full stop (*punctus*), the comma (virga), and the mound or undulating line (*clivus*), the first indicating a short sound, the second a long sound, and the third a group of two notes. The musical intervals were suggested by the distance of these signs from the words of the text. The variety of neumes employed at different times, and the fluctuations due to handwriting, have made them extremely difficult to decipher. In the 10th century a marked advance is shown by the use of a red line traced horizontally above the text to give the singer a fixed note (F = fa), thus helping him to approximate the intervals. To this was added a second line in yellow (for C = ut), and finally a staff arose from the further addition of two black lines over these.

A variety of experiments resulted in the assignment of the four-lined staff to sacred music and of the five-lined staff to secular music. The yellow and red colours were replaced by the use of the letters F and C (fa and ut) on the lines. This use of letters to indicate clef is forestalled in a manuscript of Guido of Arezzo's Micrologus, dating from the 12th century, in which is the famous hymn to St. John, printed with neumes on a staff of three lines (see GUIDO OF AREZZO and HEXACHORD). The use of letters for indicating clefs has survived to the present day, our clef signatures being modified forms of the letters C, F and G, which have passed through a multitude of shapes.

Before the 12th century there is no trace of a measured notation; *i.e.*, of a numerical time division separating the component parts of a piece of music. It was at the time of Franco of Cologne that measured music took its rise, together with the black notation in place of neumes, which disappeared altogether by the end of the 14th century. In the black notation, which led to the modern system, the square note with a tail (▜) is the long sound; the square note without a tail (■) is the breve; and the lozenge shape (♦) is the semibreve. In a later development there were added the double long ▀▌ and the minim (♦). The breve, according to Franco of Cologne, was the unit of measure.

The development of a fixed time division was further continued by Philippe de Vitry. It has been noted with well-founded astonishment that at this period double time (*i.e.*, two to the bar) was unknown, but only triple time which was regarded as "perfect"— "because it hath its name from the Blessed Trinity which is pure and true perfection." Vitry championed the rights of imperfect time and invented signs to distinguish the two. The perfect circle O represented the perfect or triple time; the half circle C the imperfect or double-time. This C has survived in modern notation to indicate four-time, which is twice double-time; when crossed ¢ it means double-time. The method of dividing into perfect and imperfect was described as prolation. The addition of a point to the circle or semicircle (⊙ ⋶) indicated major prolation; its absence, minor prolation. The substitution of white for black notation began with the first year of the 14th century and was fully established in the 15th century.

It has already been shown how the earlier form of alphabetical notation was gradually superseded by one based on the attempt to represent the relative height and depth of sounds graphically. The alphabetical nomenclature, however, became inextricably associated with the graphic system. The two conceptions reinforced each other; and from the hexachordal scale, endowed with the solmization of ut, re, mi, fa, sol, la—which was a device for identifying notes by their names when talked of, rather than by their positions when seen on a page of music—arose the use of what are now known as accidentals (*q.v.*).

Of these it may here be said that the flat had originated from the necessity of sinking the B of the scale in order to form a hexachord on the note F in such a way as to cause the semitone to fall in the right place—which in the case of all hexachords was between the third and fourth notes. This softened B was written in a rounded form thus: ♭ (rotundurn), while the original B remained square thus: ♮ (*quadrum*). The original conception of the sharp was to cross or lattice the square B, by which it was shown that it was neither to be softened nor to remain unchanged. The flat, which originated in the 10th century, appears to have been of far earlier date than the sharp, the invention of which has been ascribed to Josquin Des Près (1450–1521). The B-sharp was called B cancellaturn, the cross being formed thus ✕.

The use of key signatures constructed out of these signs of sharp and flat was of comparatively late introduction. The key signature states at the beginning of a piece of music the sharps and flats which it contains within the scale in which it is written. It is a device to avoid repeating the sign of sharp and flat with every fresh occasion of their occurring. The double ♭♭ and the double sharp χ are conventions of a much later date, called into existence by the demands of modern music, while the sign of the natural (♮) is the outcome of the original B quadration or square B♮. See TONIC SOL-FA; see also references under "Musical Notation" in the Index volume.

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MUSICAL SOCIETIES AND INSTITUTIONS. Medieval and Renaissance Societies.—Societies in Europe formed to promote the performance of music consisted originally of performers with common secular or religious ideals. Among the most ancient associations for the performance of secular music were the Welsh Eisteddfod (*q.v.*), the French guilds of troubadours of about the 11th century (which organized competitions called the Puy) and the German guilds of Meistersinger (*q.v.*) which flourished from the 14th to the 16th centuries. Medieval associations for the performance of sacred music were the Compagnia de Gonfalone (Rome, 1264) and the Confrérie de la Passion (Paris, 1402). In the Renaissance, academies were founded in Italy and later in France for the encouragement of music and poetry. The principal Italian academies associated with music were in Florence, founded by Lorenzo the Magnificent in 1480, Venice (Accademia Pellegrina, 1550) and Bologna (Accademia dei Filomusi, 1615).

The Camerata (Florence, 1594) led to the production in 1597 of O. Rinuccini's Dafne, a music-drama on the lines of Greek tragedy with music by J. Peri and J. Corsi, and to the establishment in Italy of opera (*q.v.*). The chief French institutions of this kind were the Académie de poésie et de musique, founded by J. A. Baïf in 1570, associated with secular music, and the Académie de Musique (1671) associated with opera. In London opera was promoted by the Royal Academy of Music (1720), not to be confused with the institution of this name founded in 1822.

Early Concert Societies.—In the 17th and 18th centuries the institution of the Collegium Musicum, deriving from an earlier institution, the Convivia Musica, was associated with universities in Germany and Switzerland. Its purpose was to organize public concerts (see CONCERT). The Collegium Musicum at Prague dates from before 1616, and the Gesellschaft auf dem Musiksaal was founded at Ziirich in 1613. G. P. Telemann was associated with the Collegium Musicum at Hamburg at the beginning of the 18th century, and other towns where there were such institutions were Halle, Berlin and Leipzig. Early concert societies in London were the Academy of Ancient Music (1710), the Castle society (1724), the Catch club (1761), the Anacreontic society (1766), the Concerts of Ancient Music (1776, later known as the King's concerts), the Professional concerts (1783) and the Caecilia society (1785). The Edinburgh Musical society was founded about 1725.

In Paris the most important 18th-century concert-giving society was Le Concert Spirituel founded by A. D. Philidor in 1725 for the performance of sacred works, later enlarging its scope to include secular works. Its rival, the Concerts des amateurs, was founded in 1770. In Vienna the Tonkiinstler-Societat (1771, renamed in 1862 the Haydn-Verein) was the main concert organization. Developing the activities of the Collegium Musicum, the Gemandhauskonzerte were founded at Leipzig in 1781. Choral music was fostered at Berlin by the foundation of the Singakademie (1791). Other concert societies were founded at Copenhagen (1744), Bergen (1765), Stockholm (1771) and at Åbo, Finland (1790). In the United States the St. Cecilia society was founded at Charleston, S.C. (1762) and the Musical society at Stoughton, Mass. (1786).

19th-Century Concert Societies — The Museums-Gesellschaft was founded at Frankfurt in 1808, the Musikakademie in Munich (1811) and the Philharmonische-Gesellschaft in Berlin (1826). The Gesellschaft der Musikfreunde was founded in Vienna in 1812 and led to the establishment there of the conservatory in 1821. The Singakademie was founded in Vienna in 1858.

In Paris the main concert organizations were the Société des Concerts du Conservatoire (1828), the Société Sainte-Cécile (1849), the Société Philharmonique founded by Berlioz (1850) and the Société des jeunes artistes du Conservatoire (1851). In London the Philharmonic society (1813, from 1912 the Royal Philharmonic society) was the principal concert organization, followed by the New Philharmonic society (1852) and the Halle society in Manchester (1857). The amateur choirs that sprang up in England brought the formation of the Sacred Harmonic society (1832), the Choral Harmonists' society (1833), the Royal Choral society (1871) and the Bach choir (1875). In Italy the Società Musicale Romana and the Societi Orchestrale Romana (both 1874) were followed by the Societi dei Concerti (Turin, 1877).

In the United States the Handel and Haydn society (Boston, 1815) gave early performances of choral music. In instrumental music the Philharmonic Society of New York (1842) was the leading institution. The Oratorio Society of New York was founded in 1873, and the New York Symphony society in 1878. Other concert societies were formed at Stockholm (1820), Amsterdam (1829), Copenhagen (1836), Prague (1862), Brussels (1865), Oslo (1871) and St. Petersburg (1873). In Australia the Royal Sydney Philharmonic society was founded in 1850. Many of these societies, which greatly developed with the wider interest in instrumental music, flourished into the 20th century, and similar societies were established in provincial towns.

Schools and Academies. — With the growth of concert music, schools, hitherto private or ecclesiastical institutions, were established for the public in the principal centres. In London the Royal Academy of Music was founded in 1822, the Trinity College of Music in 1872, the National Training School of Music in 1873 (becoming in 1883 the Royal College of Music) and the Guildhall School of Music in 1880. The Royal Irish Academy of Music was founded in 1848 and the Royal Scottish Academy of Music in 1885. The Metropolitan College of Music was founded in New York (1887, becoming in 1900 the American Institute of Applied Music). The Canadian Academy of Music was founded in Toronto in 1911. Taking the name, conservatory (*q.v.*) from the French school founded in Paris (1795), the Boston Conservatory of Music was founded in 1867 and the Elder Conservatory in Adelaide, Aust., in 1898.

Historical Societies. — About the middle of the 19th century scholars began to publish editions of earlier composers and societies were formed to study and perform the work of particular composers. In England the Handel society was formed in 1843, the Bach society in 1849, and the Purcell society in 1876. In Germany the Mozartstiftung was founded at Frankfurt in 1838, becoming in 1951 the Deutsche Mozart-Gesellschaft. The Bach-Gesellschaft was founded in 1850, the Handel-Gesellschaft in 1856, and other societies in Germany and Austria were formed to study the works of Wagner (1883), Beethoven (1889) and Brahms (1904). The Société Frederic Chopin was formed in Paris (1911) and the Beethoven association in New York (1918).

National and International Societies. — The rise of musical nationalism about the middle of the 19th century led to societies that promoted the performance of national music such as the Russian Music society (St. Petersburg, 1859), the Société Nationale de Musique (Paris, 1871), followed by the Société Independante (1909), the British Music society (1918) and the Society for the Publication of American Music (1919). Later, international societies were formed to deal with scientific, economic, social and religious problems connected with music. The main international societies devoted to musicological research were the Internationale Musikgesellschaft (Leipzig, 1899) and the Internationale Gesellschaft für Musikwissenschaft (Basel, 1927). In 1926 The Confédération Internationale d'auteurs et compositeurs was established in Paris to protect authors' and composers' copyrights. The Performing Rights society in England and the American Society of Composers, Authors and Publishers (ASCAP) in the U.S. are among the many national organizations affiliated to it. The International Society for Contemporary Music was founded in 1922, the Société Internationale des amis de la musique française (1928), the International Folk Music council in 1947 and the International Council for Music, organized by UNESCO, in 1949. The Fédération Internationale des Jeunesses Musicales (1947) co-ordinated the activities of educational concerts, and an international society for music education was founded in Brussels (1953). The Association internationale des Bibliothèques musicales (1951) began the publication of an international index of source materials. An international society for the promotion of Catholic church music was founded at Frankfurt in 1929.

20th-Century Societies. — The mechanical reproduction of music by phonograph and radio, as well as educational and aesthetic matters, were among the main concerns in the first half of the 20th century of both amateur and professional bodies. Among 20th-century societies devoted to the wider diffusion of music in England were the National Federation of Gramophone societies (1936), the Committee for the Promotion of New Music (1943), the Exploratory Concert society (1947) and the National Federation of Music societies (1935), founded with the support of the professional musicians' organization, the Incorporated Society of Musicians (1882). Interest in older music was encouraged by the Plainsong and Medieval Music society (1888), the Chamber Music association (1934), the Society of Recorder Players (1937), the Renaissance society (1944) and the Viola da Gamba society (1948). The English Folk Dance society (1911, becoming in 1932 the English Folk Dance and Song society), the Society for the Advancement of Musical Education (1935), the Workers' Music association (1936) and the Society of Young Musicians (1936) were devoted to the broad popularization of music. Musicological research was published by the Royal Musical association (1874) and research on old instruments was promoted by the Galpin society (1946).

In the U.S. the Society of Friends of Music (1913) sponsored performances of lesser-knomn works, and the League of Composers (1923) the interests of contemporary music. Chamber music was encouraged by the American Society of Ancient Instruments (1927), the Chamber Music Society of America (1933), the New Friends of Music (1936) and the Haydn society (1949). The National Music council (1940) was concerned with both professional and cultural aspects of musical life. The Music Library association was founded in 1931 and the American Musicological society in 1934.

In the Argentine, 20th-century music was encouraged by the Grupo Renovación (1929) and chamber music by the Sociedad Argentina de Musica da Camera. Cultural movements were promoted in Brazil by the Academia Brasileira de Musica (1945) and U.S. and Latin-American musical interests by the Instituto Interamericano de Musica (Montevideo. 1932).

In Canada the Federation of Canadian Music festivals organized widespread activities, and the Composers. Authors and Publishers

Association of Canada gave awards and scholarships to composers. The Canadian Music council (1949) promoted a broad interest in musical affairs. In Australia contemporary music was fostered by the Guild of Australian Composers (1935), chamber music by the Musica Viva society (1946) and professional interests by the National Council of Music associations (1932). The Elizabethan Theatre trust (1954) promoted opera throughout Australia.

(E. LR.)

MUSIC HALL AND VARIETY are related forms of popular entertainment which stem from the taproom concerts given in city taverns in England during the 18th and 19th centuries. Sadler's Wells was typical of the many refreshment houses enlivened by song and dance. Gradually a stage was provided for paid singers, the most popular being comic, and the audience was seated at tables; liquor sales paid the expenses.

To discourage these entertainments. parliament passed an act (1751) which required every such pleasure haunt to obtain a magistrate's licence, but the measure had the contrary effect: the larger taverns lived up to their new dignity by employing musicians and scenery and the smaller did without the licence by forming harmonic clubs. Profits from the licensed premises led to the building of variety theatres of increasing size and glitter with elaborate scenic effects. In the early 19th century the unlicensed "musick" houses evaded the licensing laws by changing into "burletta" houses; *i.e.,* theatres where plays had to include by law a certain number of songs (see BURLESQUE). "Saloon" then became the name for any place of popular entertainment, while "music hall" meant a concert hall and "variety" was an evening of mixed plays.

In Victorian times the rapid increase of urban populations intensified the demand for song. Publicans adapted the adjoining building to their premises as the music hall, thus giving it the significance it has had ever since. The first was reputedly at the Canterbury arms. Lambeth, where Charles Morton, the publican known as the "father of the halls," liked the music to be operatic and the comedians to wear smart clothes; the doorway survived a bomb of World War II and displayed its date of 1852 with an inscription referring to the act of 1751. At the same time Sam Collins, a chimney sweep who appeared as an Irish singer, founded Collins's music hall by Islington green. The humour of the halls concentrated on the hardships of life and caricatured weddings, funerals, seaside holidays, large families, wash day and other trials; yet, space was found in the protracted programs for ballads of domestic tragedy and patriotic heroism. Some outstanding performers were Marie Lloyd, Dan Leno, Vesta Tilley, Harry Champion, G. H. Chirgwin, Eugene Stratton, "Little Tich" (Harry Relph) and George Robey.

There was a change in 1891 when Albert Chevalier, an actor from a fashionable theatre, broke away from taproom humour to express a side of street life at the Pavilion which gave him the name of the "costers' laureate," in his songs of courtship and one of old age, "My Old Dutch." The idyllic strain persisted until Harry Lauder sang as a Highland lover with a hint of poetry. Will Fyffe, apart from his famous "Glasgow belongs tae me," sang of the sea, moors and mountains.

When the sale of liquor during performances was no longer permitted, the comedians still dominated the halls but had a diminishing place among the many amusements which kept variety true to its name. As the 20th century advanced, the music halls were dwarfed by palaces of variety on an even larger scale than the Empire and the Alhambra. Just as Sadler's Wells had advertised, 100 years earlier, the spectacle of real water and pony races, so the Hippodrome now displayed aquatic dramas and the Coliseum representations of the Derby and chariot races in ancient Rome. None of these lasted long, but other ambitious plans kept variety prosperous after the real music hall had been killed by the competition of the cheap cinema.

Such celebrities as Sarah Bernhardt, Sir George Alexander and Sir Herbert Tree put on one-act plays or the last acts of plays; eminent musicians such as Mascagni and Henry Wood gave performances with their orchestras; Diaghilev and his ballet, at the height of its fame, appeared in 1918 at the Coliseum in a bill which included comedians and jugglers.

Yet the excitement caused by actors or dancers never exceeded the enthusiasm aroused by the popular singers of the 1920s who showed how this fame had been intensified by the phonograph. Nora Bayes, who was the first to make this trend noticeable, received a welcome when she appeared at the Palladium such as a diva of grand opera might have envied. Sophie Tucker was her successor, but Gracie Fields, fresh from a touring revue called "Mr. Tower of London," proved that Lancashire could produce a favourite equal to those of New York. Also in the 1920s the craze for dance music was started by Paul Whiteman's band; it was continued by more than 12 others, headed by those of Jack Hylton and Jack Payne.

The advent of "talking films" caused variety theatres throughout. the United Kingdom to be turned into cinemas. Among the schemes invented to keep comedians employed were a mixture of films and songs called cine-variety and attempts to keep theatres open from noon to midnight with nonstop variety. These were short-lived, with the exception of the Windmill theatre near Piccadilly Circus, London, which remained open throughout World War II and afterwards. The most remarkable experiment in entertainment during the 1930s and 1940s was the creation of the Crazy Gang (Bud Flanagan, Nervo and Knox, Naughton and Gold) who, at the Palladium and later at the Victoria Palace, restored elementary humour to favour.

The influence of radio was of fluctuating importance to music hall and variety: broadcast programs of "turns" were difficult because few comedians could survive the continual strain of composing new material. Audiences once preferred old favourites in song; television set the pace for frequent change.

Oddities of the licensing laws in Great Britain permit cabaret to be performed before an audience who are seated at tables and who consume food and strong drink which cannot be served in the auditorium of a theatre. Consequently the old music hall of Gatti's-under-the-Arches, at Charing Cross, London, run on Victorian music hall lines, became a club and the Hippodrome, while retaining its stage for revue, became a restaurant. In Europe cabaret often means a music hall while "music hall" usually means variety. See also VAUDEVILLE.

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MUSIC PRINTING. Printed music originated soon after the invention of typography and 1465 is given as the earliest date of any record of its existence. At first the method was only used for printing the staves in red ink from a woodcut, the notes being written in by hand. Later the staves and notes were engraved separately on wood blocks and printed respectively in red and black. Then followed the practice of cutting both the staves and notes on one block for printing in black. There are no records of music being printed from separate characters before 1473 when a theological work by a German printer named Gerson mas issued containing five notes of music evidently so printed. This may be regarded as the foundation of music printing.

In 1482 William Caxton, the first English printer, published a work entitled *Polychronicon,* in which there are a few notes of music, though apparently filled in to the printed stave lines by hand. Wynkyn de Worde, who succeeded Caxton, reprinted this work in 1495, introducing both the notes and stave lines by type characters, so that he must be given the credit of being the first English printer of music from movable type. The *Mainz Psalter* of 1490 contained typeprinted music. In 1500 Ottaviano Petrucci, in Venice, produced music with the staves and notes printed from type by separate operations.

Thenceforward the system of printing the stave lines separately fell into disuse. Pierre Attaignant, in Paris (1529), was the first to print the words of songs under the notes. In 1530 music began to be printed in England with type similar to that used by Petrucci, and it was done in two printings, but in 1539 a London printer named Gough issued music from type characters with the staves and notes printed at one impression. In 1550 Richard Grafton printed in London the *Booke of Common Praier noted*, the musical part being executed in type with red stave lines. Printing from type then became general and by 1700 it had assumed the appearance of present day music.

Music printed from plates dates from 1525, when Pierre Hautin, a French engraver, cut punches for the notes and stamped them into metal plates, which were finished by engraving. This style of work became general in England and continued to hold the field until about 1710, when music printed from punched plates began to appear.

Lithographic music printing dates from 1799, being first applied by Alois Senefelder, the inventor of lithography, who drew the music direct on stone, or on transfer paper.

Typographical music printing recovered its position with the production of better music type by the English letter founders and came largely into use for hymnals, song books, and other musical works for which large editions in a cheap form are required. (W. Gam.; X.)

MUSIL, ROBERT, Edler von (1880–1942), German writer renowned for his unfinished *Der Mann ohne Eigenschaften*, one of the most significant novels of the 20th century. Born at Klagenfurt, Nov. 6, 1880, he studied engineering and philosophy and obtained a doctorate degree for his work on Ernst Mach (1908). After working in the Austrian war office he went to Berlin in 1922 where he lived as an independent writer. From 1933 to 1938 he lived in Vienna, then in Geneva, where he died April 15, 1942.

Der Mann ohne Eigenschaften was published in three volumes (1930, 1933, 1943); a more complete version came out in 1952, the last part, however, was an unscholarly compilation from unpublished papers. There is an English translation, *The Man Without Qualities* (1953–60). This monumental novel is an ironic analysis of the ills of the age, an unmasking of false attitudes of mind and an attempt to apply scientific precision of thought to social and spiritual experiences; Musil also explores a way of life for his hero who seeks to live without pretense. His style is translucent and often resembles a scientific mode of writing, but leaves room for expression of emotion. His method of presentation shows the influence of Marcel Proust and James Joyce.

Other works include *Die Verirrungen des Zögling Törless* (1906; Eng. trans. *Young Törless,* 1955), a novel; *Der Schwärmer* (1921) and *Vinzenz oder die Freundin bedeutender Männer* (1924), dramas; and *Drei Frauen* (1924), prose tales. (H. S. R.)

MUSK, the name originally given to a perfume obtained from the strong-smelling substance secreted in a gland by the musk deer (*q.v.*), and hence applied to other animals, and also to plants, possessing a similar odour. The variety which appears in commerce is a secretion of the musk deer; but the odour is also emitted by the musk ox and muskrat of India and Europe, by the musk duck (*Biziura lobata*) of West Australia, the musk shrew, the musk beetle (*Calichroma moschata*), the alligator of Central America, and others.

To obtain the perfume from the musk deer the animal is killed and the gland completely removed, and dried, either in the sun, on a hot stone, or by immersion in hot oil. It appears in commerce as "musk in pod," *i.e.,* the glands are entire, or as "musk in grain," in which the perfume has been extracted from its receptacle. Three kinds are recognized: (1) Tongking, Chinese or Tibetan, imported from China, the most valued; (2) Assam or Nepal, less valuable; and (3) Karbardin or Russian (Siberian), imported from central Asia by way of Russia, the least valuable and hardly admitting of adulteration. The Tongking musk is exported in small, gaudily decorated caddies with tin or lead linings, wherein the perfume is sealed down.

Good musk is of a dark purplish colour, dry, smooth and unctuous to the touch, and bitter in taste. It dissolves in boiling water to the extent of about one-half; alcohol takes up one-third of the substance, and ether and chloroform dissolve still less. A grain of musk will distinctly scent millions of cubic feet of air without any appreciable loss of weight, and its scent is not only more penetrating but more persistent than that of any other known substance. In addition to its odoriferous principle, it contains ammonia, cholesterin, fatty matter, a bitter resinous substance, and other animal principles. As a material in perfumery it is of the first importance, its powerful and enduring odour giving strength and permanency to the vegetable essences.

Artificial musk is a synthetic product, having a similar odour to natural musk. It was obtained by Baur in 1888 by condensing toluene with isobutyl bromide in the presence of aluminum chloride, and nitrating the product. It is a symtrinitro- Ψ-butyl toluene. Many preparations have been made, and the odour seems to depend upon the symmetry of the three nitro groups.

Musk in botany is *Mimulus moschatus.* (*See* Mimulus.) The musk orchis is *Herminium monorchis;* musk mallow, *Malva moschata;* muskmelon, *Cucumis melo;* musk thistle, *Carduus nutans.*

MUSK DEER (*Moschus moschiferus*), an aberrant deer, presenting many peculiar characteristics (*see* Deer). There are no antlers, but in lieu of such weapons, the upper canine teeth of the male form projecting tusks. About 20 in. high at the shoulder, the musk deer possesses long limbs, and there is a great development of the lateral pair of hoofs. The ears are large and the tail rudimentary. The grayish-brown hair is long, coarse, and brittle. This animal inhabits the forests of the Himalayas as far west as Gilgit, always at great elevations and preferring thickets of birch, juniper, and rhododendrons. It extends into Tibet, Siberia and northwestern China. In habits the musk deer is solitary! shy and nocturnal, but very active; it feeds on moss, grass and leaves. The deer takes its name from the secretion of a sac, about the size of an orange, beneath the skin of the abdomen, opening in front of the preputial aperture. This contains a dark brown substance of the consistency of "moist gingerbread." It is only present in the male (*see* Musk). A race, the southern musk deer (*M.* m. *sifanicus*), inhabits eastern China, distinguished by its longer. black ears.

MUSKEGON, a city of western Michigan, U.S., a port of entry and seat of Muskegon county, is on Muskegon lake and Lake Michigan. 38 mi. N.W. of Grand Rapids. The largest port on the eastern shore of Lake Michigan, with an excellent landlocked harbour protected by a breakwater. it is served by all-year car-ferry and steamship lines to Milwaukee. In 1960 the population of the city was 46,485 and of the Muskegon-Muskegon Heights standard metropolitan statistical area (Muskegon county) 149,-943. (For comparative population figures for the two cities. which adjoin each other, *see* table in Michigan: *Population.)*

The city benefited greatly from gifts of Charles H. Hackley (1837–1905), lumberman–philanthropist. totaling about $8,500,-000 and consisting of a $2,000,000 endowment to the public schools: buildings. equipment and endowments of a manual training school, public library. art gallery. stadium and hospital; and a public square with numerous statues. The city also has a public junior commercial college opened in 1926 and a historical museum.

A trading-post was established on the site of the city in 1812 by Jean Francois Recollet and the first sawmill was erected in 1837. The town was laid out in 1849. incorporated as a village in 1861 and as a city in 1869; the name is derived from the Ottawa *Mus-Kee-Go* and the Chippewa *Mas-Ki-Ki-Gon,* both of which mean "river-with-marshes." The lumber industry reached its peak in 1887. with a cut of 700,000.000 bd.ft. The population then was about 24.000 but with the depletion of the forests it dwindled. Renewed prosperity began about 1900 when the city's wealthy citizens financed new manufacturing. With more than 200 manufacturing establishments. Muskegon's principal products are automotive! military and aircraft engines, piston rings and other automobile parts, office furniture and equipment. refrigerators, bowling and billiard equipment, gray iron. steel, brass and aluminum castings. boats, electric cranes and hoists. and wire products. Points of interest include an old Indian burial ground and the grave of the abolitionist Jonathan Walker, immortalized in Whittier's poem "The Branded Hand." (E. K. W.)

MUSKELLUNGE (Muskie): *see* Pike.

MUSKET, a term generally applied to all smoothbore infantry small arms before the universal adoption of rifled firearms about the middle of the 19th century. The original musket evolved during the third yuarter of the 16th century in the Spanish army, then the foremost military system of Europe. Following the wars betneen Spain and France in Italy, the trend toward solidarity in infantry tactics led to the demand for a heavier firearm than the arquebus (*q.v.*). A solution was found in a weapon that was in effect an enlarged arquebus, since the matchlock firing principle remained unchanged.

The musket, like the arquebus, was loaded by pouring coarse powder donn the barrel, then ramming home a lead ball and a wad of rag. A pull of the trigger brought the serpentine, with its length of burning slow-match. into contact with the fine powder in a pan that the musketeer uncovered by hand. The resulting flash of the powder in the pan passed through the touchhole and discharged the piece. Not much accuracy could be expected of the musket. Reloading was such a complicated process that two soldiers were assigned to the clumsy weapon. The adoption of a portable iron fork, serving as a rest, made it possible to bring into the field a firearm 5½ ft. in length, weighing 15 lb. and firing a ball as heavy as 2 oz. with an effective range from 150 to 200 yd.

Musketeers and pikemen—the "shot and pike" of the 16th century—were drawn up in a phalangial formation, many ranks in depth. for the purpose of mutual protection. Reloading was such a slow process that the musketeers of the front rank retired to the rear for that function and gradually moved forward until their turn came to fire again.

Improvements in the musket during the Thirty Years' War made it possible to reduce the weight and discard the iron fork. Late in the 17th century the matchlock mas replaced by the flintlock, known in France as the fusil. But the term musketry survived into the 20th century on occasion to denote infantry fire with rifles. See also SMALL ARMS, MILITARY. (LN. MS.)

MUSKMELON, a frost-tender annual trailing vine of the family Cucurbitaceae, grown for its edible fruits. The botanical name is *Cucumis melo.* The leaves are three to five inches across, coarse, hairy to rough, nearly round to slightly heart shaped, three to seven angled with angles rounded, and with margins wavy. Its flowers are yellow, five-lobed, wheel shaped, about one inch across; they occur at the nodes, usually singly, on short peduncles. Generally the plant bears male flowers and female flowers; some plants bear male and perfect flowers. The male flowers, which appear first, are easily distinguished by the absence of tne small undeveloped fruit subtending the corolla. Fruits are very diverse. ranging in neight from two to nine pounds; in shape they vary from slightly oblate through globular to oval and long tapered; in surface features they are regular to broadly sutured to wrinkled, and from smooth to heavily netted; in flesh colour they are from pale green to orange; in odour and flavour from very slight to strongly "musky"; harvest time is from 85 to 125 days after planting.

Cantaloupe is sometimes loosely used in referring to the fruit of any variety of muskmelon; it properly applies, in the United States, only to small (two to four pound), round to oval, heavily-netted, highly perishable varieties. All varieties of muskmelon belong to the same species and intercross freely. When grown for production of seed for planting, varieties must be separated by a quarter of a mile or more; they are insect pollinated. Muskmelons will not cross with cucumber, squash, pumpkin or watermelon. As muskmelons of the highly perishable type approach maturity a separation layer develops where the stem joins the fruit. When a crack is visible completely around the stem at this point the fruit has its maximum sugar content and is ready for harvest. At this "full slip" stage slight pressure will remove the stem cleanly. leaving no broken tissue of stem or fruit. Muskmelons of the "winter" or long-keeping type such as honeydew, Persian and casaba do not develop this separation layer until after they are ripe, so are harvested by cutting the stems. Proper harvest stage of the ninter type is detected by rind colour, which must be judged according to variety. After harvest muskmelons will become softer but not noticeably sweeter.

The muskmelon originated in Iran and the Transcaucasia. Northern Pakistan. Kashmir and Afghanistan constitute a secondary centre of development. The ancient Egyptians probably grew it and the ancient Greeks and Romans definitely did. It was introduced into China about the beginning of the Christian era. It is now grown in the warmer parts of the temperate zones and less humid parts of the tropics the worldwaround. In the cooler parts of the temperate zones it can be gro n only under glass.

Muskmelons grow well on many kinds of soil but they need high fertility and ample soil moisture. Usually seeds are planted directly in the field or garden; sometimes plants are started under protection and transplanted to the field after danger of frost is past. Early field plantings may be protected by paper covers over the plants, and by windbreaks of brush and paper. Plants usually are spaced about two feet apart in rows five to six feet apart or in "hills" five by five feet apart.

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MUSKMELON (CUCUMIS MELO)

In the U.S. muskmelons are grown commercially in more than 25 states; California, Arizona, Texas and Colorado account for about two-thirds of the acreage and three-fourths of the production of the country. (V. R. B.)

MUSKOGEE, a city of northeast Oklahoma, U.S., 50 mi. S.E. of Tulsa is situated near the confluence of the Verdigris, Grand and Arkansas rivers; the seat of Muskogee county. Incorporated in 1898, the city adopted a council-manager form of government in 1920. In Muskogee are located the U.S Indian agency for the Five Civilized Tribes, regional offices and a hospital of the U.S. veterans administration, the Oklahoma School for the Blind, Bacone College for Indians and the Oklahoma Free State fair.

Founded in 1872 as a townsite on the first railroad built into Indian territory and named for the Muskogee (Creek) Indians, Muskogee soon became the administrative centre for the Five Civilized Tribes. The Commission to the Five Civilized Tribes, which dissolved tribal landholdings in preparation for Oklahoma statehood, maintained headquarters there. Originally the city served an agricultural and oil region but in modern times the economy was diversified including processing and manufacturing of rocket and missile fuel, rare metals, glass products, clothing, steel and iron, boxes, canned goods, meat and milk products and tire repair materials.

For comparative population figures see table in OKLAHOMA: *Population.* (J. D. MO.)

MUSKOGIAN INDIANS. This group constituted one of the larger speech stocks of native North America, and was typical of and dominant in the southeastern area of aboriginal culture, comprising the region from the Gulf of Mexico to Tennessee, and from the Carolinas to Louisiana. The Muskogian family comprised a series of divisions: (1) Apalachee; (2) Hitchiti, Apalachicola, etc ; (3) Alabama, Koasati, etc.; (4) Choctaw, Chickasaw, Mobile, Pensacola, etc.; (5) Tuskegee; (6) Cusabo, Yamasee and other tribes of the Georgia coast; (7) Miskogi proper. The latter formed the bulk of what was later the Creek confederacy, in nhich the Hitchiti and other groups were included. The Natchez and Taensa of the loner Mississippi seem to be a remote Muskogian offshoot; the Calusa and other south Floridian tribes may be.

Since the middle of the 18th century the historically important tribes have been the Choctaw, Chickasaw and Creek, plus a branch of the latter, the Seminole. With the non-Muskogian Cherokee, these make up the "five civilized tribes," which for three-quarters of a century, until 1906, maintained quasi-autonomous governments in Indian territory (Oklahoma), where they had removed under the pressure of American settlement.

Ethnographically the Muskogian or Southeastern culture province included, besides the groups listed, the Chitimacha and Tunica of the lower Mississippi, the Iroquoian Cherokee, the Timucua of central Florida and, in the lower region of Georgia and Carolina, the Yuchi, the Algonkin Shawnee and various eastern Siouan tribes. All these groups were agricultural, planting maize, pumpkins, beans, cane-millet, tobacco, sometimes Jerusalem artichokes, and sunflowers. They gathered hickory nuts and wild fruits, hunted deer and, in the west, bison, and stored nut oil and bear fat. The settlements were straggling; the "town" contained a square, on which were public and religious buildings; "villages" were often outlying. The towns were autonomous and essentially constituted tribes. They united into confederacies, directed by councils; such confederacies might break up and recombine. The most successful, like those of the Creek and Choctaw, grew in population during the colonial period, largely through absorption of smaller or scattered groups. The tribes were divided into matrilineal, totemic clans; chieftainship and office were hereditary, probably in the lineage within the clan. The Natchez and some other groups had superimposed a peculiar class or caste system. Chieis in these cases were carried in litters, enthroned on raised seats or in arbours, and accompanied in death by sacrificial followers. All the tribes were warlike and in chronic but shifting embroilment with others. They took scalps and slowly tortured prisoners to death in a frame or tied to a post in the town square. Often there was a distinction between civil and military chiefs; the towns entitled to offices of one or the other kind in a confederacy were known as peace and war, that is, white or red.

Economic life was undeveloped as compared with the fairly well organized socio-political institutions. Houses were of logs or poles, wattled, chinked or plastered with mud, the roof of thatch. Bark or thatch houses were also built. Exposed settlements were palisaded, or log forts erected. Pottery was unpainted, basketry of cane splints; simple weaving was done in bark fibres and bison hair, but the principal clothing besides mantles was breech clouts for men and apron skirts for women. Many tribes deformed their heads. There was little property, almost no treasure: and limited trade before the corning of the whites. Ritual was also simple. The most important ceremony was the busk or green-corn festival, a first-fruits and new-fire rite. Purification by emetics was a common religious observance. There was little that could be called art. Most tribes had a migration legend.

The Muskogian-Southeastern culture extended with variations north into the Ohio valley to the prehistoric moundbuilders, and northeast to the tribes of Iroquois lineage; it was represented in pallid form among many of the Xlgonkian groups as far as New England and the Great Lakes. The total Muskogian population was about 50,000. At the time of discovery, there may have been 7,000 Creeks (increased to 20,000 by 1832), 3.500 Chickasaw, 15,000 Choctaw, 5,000 Xpalachee, perhaps 5,000 Mobile. The first three of these tribes survive in increased numbers, but much mixed with whites and Negroes.

See also Indian, North Americas; Central and North American Languages; and the articles on individual tribes: Apalachee; Choctaw; Chickasaw; Creek; Natchez; etc.

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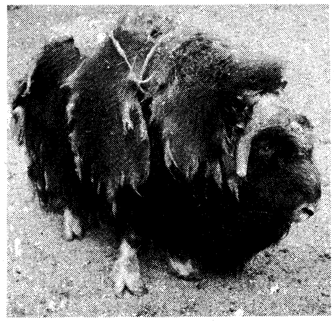
MUSK OX, a shaggy-haired arctic American ruminant (*Ovibos moschatus*) of the cattle family (Rovidae: *q.v.*). it is not a true ox (subfamily Bovinae) but belongs rather to the goat-sheep subfamily (Caprinae), and in general appearance resembles somewhat a very hairy domestic bull. It is closely related to the takin of Asia. The musky odour from which it takes its name does not come from a special gland as in so many other musk-producing mammals.

The bull musk ox stands about 5 ft. at the shoulder; the cow is somewhat smaller. Horns, present in both sexes, are borne on a large almost "neckless" head. In old males the sometimes two-foot-long horns meet by broad bases at the mid-line of the brow and proceed laterally, dip downward at the sides of the head and then curve upward. Females and young have smaller horns with a space between the bases. The striking external fezture of this animal is the coat of long, dark bronn hair, reaching nearly to the feet, concealing the short tail and nearly covering the small ears. Shorter hair covers the face, and is shortest on the space between the nostrils and upper lip. Underneath the shaggy coat is a thick wool, shed in summer. The legs are stout and short with hoofs that are rounded in varying degrees, depending on the subspecies.



W. SUSCHITZKY

MUSK OX (OVIBOS MOSCHATUS)

Musk oxen often travel in herds numbering 20 to 30 individuals. They are not aggressive animals, but when attacked the band forms a circle, the larger oxen presenting a formidable front of horns on the outer rim. This defense is very effective against arctic wolves and dogs. Musk oxen feed chiefly on grass, but also eat other low-growing vegetation including lichens, willows, etc. Some authorities, considering musk oxen as arctic cattle—with excellent milk production, valuable wool and good meat—are urging their domestication in suitable places. After a gestation period of 9 months the female gives birth to one young in late May or early June.

In the Pleistocene epoch (about 1,000,000 years ago) musk oxen were circumpolar in distribution, inhabiting Siberia, Germany, France, England and even parts of the southeastern Cnited States. Today they are confined to arctic America, from about latitude 64 to the Arctic ocean and from a short distance east oi the Mackenzie river delta to Greenland, including some of the arctic islands of Canada. Since the advent of firearms in the Arctic; the range of musk oxen is thought to be even further restricted. In 1929 a group of musk oxen was shipped from Greenland to Fairbanks, Alaska; this herd, now living on Nunivak Island in the Bering sea, was intended to be used to restock arctic Alaska. (O. J. M.)

MUSKRAT (Musquash), a large ratlike semiaquatic rodent (*Ondatra zibethicus*) of the family Cricetidae, subfamily Microtinae. The subfamily also includes the voles, meadow mice and lemmings. Muskrats occur over almost all of North America excluding the treeless tundra. They have been introduced in Europe and are becoming widespread there. The muskrat measures about 12 in. long and has an almost naked, scaly, laterally compressed tail somewhat shorter than the compact and heavy body. The eyes are small and the rounded ears project barely beyond the fur. The five-toed hind feet, partially webbed and fringed with stiff bristles, are an aid in swimming. The body is dark brown or somewhat paler; the feet, usually black. A dense, soft underfur is heavily overlaid with long, glossy, stiff guard hairs. Because of their availability, beauty and durability, muskrat pelts are a basic commodity of the fur industry. The yield in North America exceeds in value that of any other fur. The musky secretion that gives the animal its name issues from musk sacs. Muskrats live in poorly constructed reed and rush mounds, or lodges, in

JOHN H. GERARD

MUSKRAT (ONDATRA ZIBETHICUS)

marshes, shallow lakes and streams. The lodge, in a bank or on a reed and mud island. is entered through an underwater opening. Food consists of a wide variety of sedges. reeds, roots — mostly of aquatic plants — and occasional fresh-water mussels. crayfish, salamanders and fish. Feeding customarily takes place at special feeding sites, usually a flat rock or island of cut reeds. One to 11 young are produced once or twice a year, depending on the locality.

(K. R KN.)

MUSK SHREW, the common name for small insectivores (*q.v.*) of the genus *Crocidura,* characterized by a powerful. musky odour. Because they frequent human habitations — in Africa and the warmer parts of Europe and Asia — they are often called house shrews. Their habits are like those of other shrews; they are voracious, sometimes vicious, alternately extremely active and completely inactive in frequent and swift succession. *See* also SHREW.

MUSLIM: *see* ISLAM.

MUSLIM-IBN AL-HAJJAJ (full name, MUSLIM IBN AL-HAJJAJ ABU'L HUSAIN AL-QUSHAIRI AL-NAISABURI) (*c.* A.D. 820–875), Arabian scholar, was one of the chief authorities on the apostolic tradition, the *Hadith* (*q.v.*), in which accounts of the sayings and deeds of the prophet Mohammed were collected. He was born *c.* 820 at Naisabur, northeast Persia, and died in 8i5 at Nasrabad near Naisabur. He traveled widely! and his great work, the *Sahih* ("The Genuine")? is said to have been compiled from about 300,000 traditions collected throughout the middle east. It has been unanimously acclaimed as authoritative and is generally ranked next to al-Bukhari's work. He was careful to give a full account of the *isnads* (links in the chain of transmission) for each tradition and to record textual variations. Muslim defended al-Bukhari's contention that the words of the Koran were the creation of an inspired prophet and not a transcript of eternal divine law. (F'U. R.)

MUSLIN, a plain-woven cotton fabric made in various weights from very sheer to coarse, heavy sheetings.

The better qualities are fine and smooth in texture, woven from evenly spun warps and wefts. They are given a soft finish, bleached or piece dyed and sometimes patterned in the loom or printed. The coarser varieties are often of irregular yarns and textures, bleached, unbleached or piece-dyed and generally sized in the finishing. Varieties of muslin are known under such names as book, mull, swiss, sheeting, etc.

The name is derived from the city of Mosul in Mesopotamia (Iraq), where the material was first made. Early Indian muslins were handwoven of extremely fine handspun yarns and were very costly. They were imported into Europe in the 17th century and later manufactured in Paisley and Glasgow in Scotland and in many of the English factories. (M. DA.)

MUSSEL, the name given to certain aquatic bivalve mollusks of the class Lamellibranchia. In its most regular usage, it is applied to the marine Mytilidae, of which the edible mussel. *Mytilus edulis,* is the most familiar example, and to the fresh-water genus *Anodonta*. The marine mussels (*Mytilus, Modiolaria, Modiolus*) belong to the suborder Mytilacea of the order Filibranchia. The edible mussel, *Mytilus edulis,* has a wide distribution. It is found on both sides of the Atlantic and in the Mediterranean, and on the eastern Atlantic seaboard its range extends as far south as Rio de Oro, in Morocco. Its habitat is toward low-tide mark, where it lives attached to rocks or on consolidated shingle or sandbanks. It is usually found in large numbers. mussel beds sometimes covering several acres and containing millions of individuals.

The Mytilidae have an inequilateral shell. the apex or umbo appearing to be displaced to one end when compared with that of a cockle. for example. This is due to the imperfect development of the anterior end of the shell. The foot is provided with a byssus, a bunch of hairs secreted in a glandular cavity of the foot. From this cavity the hairs are extruded and harden on contact with the sea water, forming a means of attaching the mussel to a rock or stone. This fixation is not, however, permanent; the animal can discard the byssus and anchor itself afresh in a new situation, Such a means of anchorage and the faculty of occasionally changing position are highly important in animals which live, as the Mytilidae do, in the tidal zone, where gales tend to shift the sand or shingle on which they live, and where the animal is liable to be swept away from its feeding ground or buried beneath the debris of the shore.

The edible mussel, *Mytilus edulis,* is of considerable economic importance as human food (though it is not eaten to any great extent in the United States) and as bait for edible fishes. It is considered of fair size for eating when it is two inches long, a size attained three years after the young mussel settles down. Under favourable conditions it will attain a much greater size. The degree of salinity of the water has a considerable effect on the size of the shell. For example, those mussels which live in the comparatively fresh water of the Baltic sea are often a quarter or one-fifth the size of the North sea forms. Nevertheless, it seems to thrive best in water having a salinity lower than that of normal sea water. In Great Britain the chief mussel beds are in Morecambe bay (Lancashire) and in the Wash.

There are many genera in the family Mytilidae, which has a wide distribution. They include *Modiolaria, Lithophapa* (the date mussel), which bores into rock, *Modiolus* and *Crenella.*

The fresh-water mussels, or clams, are members of the family Unionidae (order Eulamellibranchia) and include the genera *Anodonta, Unio, Quadrula, Lampsilis, Margaritana,* etc. They are mainly found in ponds, lakes and quiet rivers and streams. They burrow in the soft mud of the bottom and, living thus in more tranquil conditions than the sea mussels, have a byssus only in the juvenile stage.

The developmental history of these mussels is unique among mollusks. In the female the ripe eggs are emitted from the ovaries and pass to the gills, where they are fertilized by sperm brought in water currents. The fertilized eggs attach to gill elements and begin their development. In a short time the eggs become minute larvae (glochidia), which are equipped with two valves. After the larvae are shed into the water they sink to the bottom or are distributed by water currents. The next stage is parasitic on fish. Hooked glochidia attach to the soft parts of a fish, and hookless types clamp onto the gill filaments of a fish. The parasitic larvae feed and grow by absorbing nourishment from the host fish. In time the young mollusk releases its hold and drops to the bottom to take up its free-living existence.

The members of the genus *Unio* and its near allies are of considerable economic importance in the United States, where they are cultivated for the pearly shell used in button making. At one time the pearls obtained from mussels were widely sought in Europe, but this industry declined after the introduction of the oriental pearls of Ceylon, etc. At times the glochidial stage causes considerable losses of young fish in fish hatcheries.

More detailed information on habits, structure and function will be found in specific articles BIVALVE and MOLLUSCA; *see* also references under "Lamellibranchia," "Bivalve" and "Mussel" in the Index volume. (G. C. R.; X.)

MUSSELBURGH, a small burgh of illidlothian, Scot., 6 mi. E. of Edinburgh. Pop. (1961) 17,273. The burgh, which lies on the south shore of the Firth of Forth, is intersected by the Esk and embraces the village of Fisherrow on the left bank of the river. The "burgh" in Musselburgh means "bank." While preserving most of the ancient features of its High street, the town, with its fine beach and golf course, has become a suburb of Edinburgh. Loretto school occupies the site of the chapel of Our Lady of Loretto, which was founded in 1534 by Thomas Duthie, a hermit from Mt. Sinai: and was the favourite shrine of Mary of Guise. The 1st earl of Hertford destroyed it in 1544, and after it was rebuilt the Reformers demolished it again, some of its stones being used in erecting the tolbooth. The school also owns Pinkie house, a Jacobean mansion with a fine fountain, formerly a seat of the abbot of Dunfermline, but transformed in 1613 by Lord Seton. The painted gallery, with an elaborate ceiling, was used as a hospital after the battle of Pinkie (1 mi. southeast) in 1547, and Prince Charles Edward slept in it after the battle of Prestonpans (1745). Near the tolbooth stands the market cross. A 16th-century stone bridge crosses the Esk. and Roman remains have been found near it. Foundations of a 2nd-century Roman fort, similar to those along the Antonine wall, as well as other Roman remains have been found at Inveresk. The chief bridge. which carries the high road from Edinburgh to Berwick, was built by John Rennie in 1807.

The principal industries include the making of wire ropes, paper. twine and nets; there is also brewing and market gardening. Fishery is confined to Fisherrow where there is a harbour. Race meetings are held on the links. At Carberry hill hlary surrendered to the lords of the congregation in 1567, the spot being still known as Queen Mary's mount The burgh has a famous July festival. "The Riding of the Marches of the Commonty," celebrated every 21 years. A celebration of this ceremony took place in 1935. In September is an annual event called the "Fisherman's walk."

MUSSET, ALFRED DE [Louis Charles Alfred] (1810–1857), French poet, playwright and novelist, was born on Dec. 11. 1810 in a house in the middle of old Paris, near the Hôtel Cluny. In the summer of 1827 he won the second prize (at the Collège Henri IV.) by an essay on "The Origin of our Feelings." He took up law and medicine but could endure no profession. He was taken by Paul Foucher to Victor Hugo's house, where he met Alfred de Vigny, Prosper Mérimée, Charles Nodier, Sainte-Beuve, and others. His first original volume, *Contes d'Espagne et d'Italie* (1829), had an immediate success, provoked bitter opposition, and produced many unworthy imitations. This volume contained a fantastic parody in verse on certain productions of the romantic school. This was the famous "Ballade à la lune" with its recurring comparison of the moon shining above a steeple to the dot over an i. It was, to Musset's delight, taken seriously.

In December 1830 Musset was just twenty years old, and was already conscious of that curious double existence within him so frequently symbolized in his plays—in Octave and Célio for instance (in *Les Caprices de Marianne*), who also stand for the two camps, the men of matter and the men of feeling—which he has elsewhere described as characteristic of his generation. At this date his *Nuit vénitienne* was produced by Harel, manager of the Odiron. It failed and Musset was disgusted with the theatre.

Musset now belonged, in a not very whole-hearted fashion, to the "Cirnacle," but the connection came to an end in 1832. In 1833 he published the volume called *Un Spectacle dans un fauteuil,* and was asked to contribute to the *Revue des deux mondes.* In this he published, in April 1833, *André del Sarto,* and he followed this six weeks later with *Les Caprices de Marianne.* The latter play has perhaps more of the Shakespearian quality—the quality of artfully mingling the terrible, the grotesque, and the high comedy tones—which exists more or less in all Musset's long and more serious plays, than is found in any other of these. Its brilliant dialogue and swiftness of action give it superficially the character of comedy, but throughout there runs the sense of fate.

In 1833 the *Revue* published *Rolla,* a symptom of the *maladie du siècle.* Rolla, for all the strain which is not to be denied of Wertherism, has yet a decided individuality. The poem was written at the beginning of Musset's *liaison* with George Sand. and in December 1833 Musset started on the unfortunate journey to Italy. It is well known that the rupture of what was for a time a most passionate attachment had a disastrous effect upon Musset, who was absolutely and completely struck down by the blow. But it was not so well known until Paul de Musset pointed it out that the passion expressed in the *Nuit de dkcembre,* written about twelve months after the journey to Italy, referred not to George Sand but to another and quite a different woman. As fiction, the story is told in the two volumes called respectively *Elle et lui* by George Sand, and *Lui et elle* by Paul de Musset.

During Musset's absence in Italy *Fantasio* was published in the *Revue, Lorenzaccio* is said to have been written at Venice, and not long after his return On *ne badine pas avec l'amour* was written and published in the *Revue.* In 1835 he produced *Lucie, La Nuit de mai, La Quenouille de Barberine, Le Chandelier, La Loi sur la presse, La Nuit de dkcembre,* and *La Confession d'un enfant du siècle,* wherein is contained what is probably a true account of Musset's relations with George Sand. To 1836 belong the *Nuit d'août,* the *Lettre à Lamartine,* the *Stances à la Malibran,* the comedy *Il ne faut jurer de rien,* and the beginning of the brilliant letters of Dupuis and Cotonet on romanticism. *Il ne faut jurer de rien* is as typical of Musset's comedy work as is *Les Caprices de Marianne* of the work in which a terrible fatality underlies the brilliant dialogue and keen polished characterization. In 1837 was published *Un Caprice,* which afterwards found its way to the Paris stage by a curious road. Mme. Allan-Despréaux, the actress, heard of it in St. Petersburg as a Russian piece. On asking for a French translation of the play she received the volume *Comédies et proverbes* reprinted from the *Revue des deux mondes.* In 1837 appeared also some of the *Nouvelles.* In 1839 Musset began a romance called *Le Poète déchu,* of which the existing fragments are full of passion and insight.

In 1840 Musset passed through a period of feeling that the public did not recognize his genius—as, indeed, they did not—and wrote a very short but very striking series of reflections headed with the words "A trente ans," which Paul de Musset published in his *Life.* In 1841 there came out in the *Revue de Paris* Musset's "Le Rhin allemand," an answer to Becker's poem which appeared in the *Revue des deux mondes.* This fine war-song made a great deal of noise, and brought to the poet quantities of challenges from German officers. Between this date and 1845 he wrote comparatively little. In the last named year the charming "proverbe" *Il feut q'une porte soit ouverte ou fermée* appeared. In 1847 *Un Caprice* was produced at the *Théâtre Français.* The word "rebonsoir" shocked some of the old school. But the success of the piece was immediate. In 1848 *Il ne faut jurer de rien* was played at the Théâtre Français and the *Chandelier* at the Théâtre Historique. Between this date and 1851 *Bettine* was produced and *Carmosine* written. The poet died on May 2, 1857

Alfred de Musset now holds the place which Sainte-Beuve first accorded, then denied, and then again accorded to him—as a poet of the first rank. He had genius, though not genius of that strongest kind which its possessor can always keep in check. His own character worked both for and against his success as a writer. He inspired a strong personal affection in his contemporaries. His very weakness and his own consciousness of it produced such beautiful work as, to take one instance, the *Nuit d'octobre.* His *Nouvelles* are extraordinarily brilliant; his poems are charged with passion, fancy and fine satiric power; in his plays he hit upon a method of his own, in which no one has dared or availed to follow him with any closeness. He was one of the first, most original, and in the end most successful of the first-rate writers included in the phrase "the 1830 period." The wilder side of his life has probably been exaggerated; and his brother Paul de Musset has given in his *Biographie* a striking testimony to the finer side of his character. In the later years of his life Musset was elected, not without opposition, a member of the French Academy. Besides the works above referred to, the *Nouvelles et contes* and the *Oeuvres posthumes,* in which there is much of interest concerning the great tragic actress Rachel, should be specially mentioned. (W. H. Po.; X.)

The biography of Alfred de Musset by his brother Paul, partial as it naturally is, is of great value. Alfred de Musset has afforded matter for many appreciations, and among these in English may be mentioned the sketch (1890) of C. F. Oliphant and the essay (1855) of F. T. Palgrave. *See* also the monograph by Arvède Barine (Madame Vincens) in the "Grands écrivains francais" series. Musset's correspondence with George Sand was published intact for the first time in 1904.

See M. Donnay, *Alfred de Musset* (1914); C. Maurras, *Les Amants de Venise: George Sand et Musset* (1916), pp. 316; E. Moroncini, *A. de Musset e l'Italia* (Milan, 1921), pp. 228.

MUSSOLINI, BENITO (1883–1945), Italian politician and journalist, was born July 29, 1883, at Dovia, in the commune of Predappio (province of Forli). His father, Alessandro Mussolini, was a blacksmith of antireligious and vaguely socialist opinions. His mother, Rosa Maltoni, was a school tezcher of strong character. Young Mussolini was named Benito after Benito Juarez, the Mexican revolutionary leader. Benito Mussolini was sent by his mother to the Salesian school of Faenza. The boy showed there a vivid intelligence and an insubordinate temper. Later he went to the normal school at Forlimpopoli and qualified as a school teacher at 18, obtaining an appointment at Gualtieri (province of Reggio Emilia).

The Leftist Period—As a youth Mussolini was interested in the Italian revolutionary movement which was then a mixture of socialist, republican, syndicalist and anarchist tendencies. Looking for a better career than teaching in elementary schools, he went to Switzerland, where he earned a precarious livelihood, sometimes by manual work of various kinds, while engaging in revolutionary and atheistic propaganda. After having been expelled from various cantons, he was finally expelled from the confederation. On returning to Italy he performed his military service in the Bersaglieri (light infantry). Back in his native Romagna, Mussolini became an active member of the socialist movement. On one occasion he was arrested, condemned to ten days' imprisonment and placed under police surveillance.

At the end of 1908 Mussolini went to Trento (then belonging to the Austrian empire) to join the staff of local Italian socialist newspapers. At first he worked with *L'Avvenire,* then with the Popolo. The latter was edited by Cesare Battisti, an Italian irredentist patriot, always ready to fight the Vienna government. (Rattisti was hanged by the Austrians in 1916.) The association with Battisti inspired Mussolini with nationalistic ideas and after publishing an irredentist article, he was arrested and expelled from Austria. In Trento hfussolini became acquainted with the newest German irrationalistic and pessimistic philosophy, particularly that of Friedrich Wilhelm Nietzsche, which strengthened his conviction that violence is the fundamental element of social .transformation.

On his experiences Mussolini published an essay "The Trentino Seen by a Socialist" in La *Voce.* While in Trento Mussolini had published an anticlerical novel Claudia Particella, *the* Mistress of the Cardinal.

In 1910 Mussolini was appointed secretary of the section in Forli of the Italian Socialist party and edited La Lotta di Classe, a small paper in which he developed the idea that "Socialism is war and in war woe to those who have humanitarian feelings." More than with orthodox hlarxism, he sympathized with the revolutionary theories of two Frenchmen: the insurrectionist Louis Auguste Blanqui and the syndicalist George Sorel.

When Giovanni Giolitti's government decided upon the military occupation of the then Turkish province in Africa, Tripolitania, Mussolini was among the more vehement opponents. He said that class war was wanted and not imperialistic wars, that the aim of the Socialists could not be a vast Italy, but should be an Italy "cultivated, rich and free." On Sept. 25–27, 1911, having led the workers of Forli in a movement of resistance to war, he was arrested and condemned to five months' imprisonment. At the next congress of the Socialist party in Reggio nell' Emilia (1912), the left wing obtained the majority, the reformist leaders Leonida Bissolati and Ivanoe Bonomi were expelled and Mussolini's position as a leader of the leftist majority was recognized. On Dec. 1, 1912 he was made editor of the *Avanti,* the official organ of the party. His closest collaborator was then the famous Russian revolutionary, Angelica Balabanoff. Under Mussolini's editorship the circulation rose considerably. His vigorous editorials, written in a synthetic, hammering style, and his support of the "Red week" of June 1914 in the Marches and in Romagna gave him considerable popularity. In the *Avanti* and in the review Utopia—founded by him in 1913—Mussolini stated that the Italian nation needed a "bath of blood," after which the revolutionaries would be able to take power. Mussolini then published another anticlerical book: Jan *Huss, the Truthful* (Rome, 1913). In that period Mussolini met Rachele Guidi who later became his wife. Of humble origin and possessing a good deal of common sense, Rachele Mussolini led a retired life. She bore her husband six children, of whom the best known was Edda, the eldest daughter, who married Galeazzo Ciano.

World War I.—When World War I broke out, Mussolini advocated at first a policy of absolute neutrality. In the *Avanti* he threatened the government with a proletarian uprising in case Italy intervened on the side of Austria and Germany, the powers to which the Italian government was bound by an alliance. After seeing many of his syndicalist friends (among them Filippo Corridoni) take the democratic interventionist side, he began to hesitate. The able diplomacy of the French ambassador Camille Barrère, who gave considerable help to many Italian interventionist groups, and the intermediary activity of his French Socialist friend Marcel Cachin (later a leader of the French Communist party) decided Mussolini to range himself on the side of the Allies.

Mussolini was obliged to leave the editorship of the *Avanti.* On Oct. 25, 1914 the Socialist congress at Milan refused to accept his justification that war would promote social revolution in Italy, and Mussolini left the Socialist party. On Nov. 15, 1914 first appeared the new daily paper of Mussolini, *Il* Popolo d'ltalia, a Socialist daily. (The paper bore two watchwords: "Who has iron, has bread" of Blanqui and "The revolution is an idea plus bayonets" of Napoleon.) Mussolini openly advocated Italy's entry into the war. He explained that if Italy would help the western democratic powers win the war, "more liberty would exist in Europe and the proletariat would have better opportunities to develop its class capacities; on the contrary, if the Prussian reaction triumphs over Europe the level of human civilization would be lowered."

A small number of Socialists followed Mussolini to the Popolo *d'Italia.* The most valuable of them were Sandro Giuliani and Cesare Sarfatti. Together with them and several young republican interventionists, young Mussolini founded the Fasci *d'* Azione *Rivoluzionaria,* which made strong war propaganda. At a great meeting of the Fasci in Milan, on Jan. 25, 1915, Mussolini advocated war not only against Austria, but principally against Germany. For his violent speaking, Mussolini was arrested in April 1915. A few days later he was slightly wounded in a duel with the pacifist Socialist leader Claudio Treves. Summarizing his policy, Mussolini stated on May 15 that either the king would take Italy into the war or there would be a republican revolution. War was declared on May 24. In Sept. 1915 Mussolini was called up and served as a private in the Bersaglieri. On Feb. 23, 1917, while exercising, he was wounded by the explosion of a hand grenade. He spent many months in the hospital and on recovery returned to the editorship of the Popolo *d'Italia.* He wrote a graphic account of his experiences in his *Diario* di Guerra. In the last years of the war he changed the subtitle of his Popolo *d'Italia* to "Organ of the Combatants and of the Producers" and engaged in an active campaign against the Socialist party, which continued to advocate a pacifist policy.

Fascism.—Thanks to the help of wealthy people who feared a bolshevik revolution, and of ex-service men dissatisfied with peace conditions, Mussolini was able to found on March 23, 1919, at Milan. a new political movement under the name of Fasci di Combattimento. The program, adopted on Llussolini's suggestion, asked for a constituent assembly, the abolition of the senate and the recognition of workers' and technicians' control in the factories. Concerning foreign policy, hlussolini said that the League of Nations could be accepted only on condition that the claims of poor nations (like Italy) against the wealthy ones would be taken into consideration.

At first Mussolini tried to acquire the sympathies of the trade unions and to remove them from the influence of the Socialist party. He was not successful. At the elections of 1919 he stood as a fascist candidate for Milan and secured only a few votes. A few days later Francesco Saverio Nitti had him arrested on a charge of "plotting against the security of the state," but he was soon liberated. Meanwhile, Gabriele d'Annunzio had occupied Fiume. Mussolini supported him in the Popolo *d'Italia* and in public meetings. "D'Annunzio," he said on August 5, 1920. "is the only man who has dared to revolt against the plutocracy of Versailles." But when, in Dec. 1920, Giovanni Giolitti settled *manu militari* the question of Fiume, hfussolini refused to give armed support to d'Annunzio. He maintained that the moment had not yet arrived for a direct attack against Italy's liberal regime.

The Conquest of Power.—The social upheaval caused by the war and by the problems of the post-war period reached its climax in Italy in autumn 1920 with the seizure of some factories in northern Italy by metallurgical workers. Mussolini at first supported the movement. He tried to get in touch uith its leaders and offered a common front of direct action against the industrialists, the government and the extremist or bolshevik wing of the workers' movement. Mussolini's offer was rejected. Largely as a result of the wise policy of the government and in exchange of small concessions, the workers surrendered the control of the factories to the owners. The public interpreted this move as a failure of the revolutionary socialist movement. But the panic caused by the revolutionary threat remained and Mussolini decided to exploit the fear and desire for revenge then prevalent in large sections of the Italian nation, in order to achieve the destruction of the liberal parliamentarian regime of Italy. The Fasci received ample funds from many people, chiefly industrialists and landowners. Armed squads (*Squadre d'Azione*) were organized to destroy the political and economic organizations of the Socialists, whose capacity to resist was greatly hampered by their own divisions. The premier, Giolitti, ignored the fundamental principle that in no case can the state surrender to private organizations the obligation of maintaining order. He tolerated the actions of Mussolini's followers believing that it was good policy to let the fascists quell the Socialist revolutionary threat. His successor, Bonomi, actually ordered the armed forces to support the fascists. Blinded by hatred and fear of socialism, various Italian liberal groups and the Catholic democratic party (together with the Socialists. the most important political element in Italy at that time) observed a neutrality favourable to the fascists.

From the end of 1920 on. the fascist squads attacked and destroyed the organizations of the Socialists, the communists, the republicans, etc. Hundreds of people were killed. New fascist groups mere formed everywhere. In May 1921 Mussolini and 35 other fascists mere elected. In Nov. 1921 at the congress of Rome, fascism was organized into a political party. Mussolini was already known to his follouers as I1 Duce (the leader). During 1922 the Trade Union council, the Socialist party and the Railwaymen's union tried to stem the tide by declaring a general strike. The strike was broken by the fascist armed squads. To secure support of the army and important conservative groups, at a fascist gathering at Udine on Sept. 29, Mussolini renounced his former republican convictions. A fascist convention at Naples, on Oct 24, 1922. provided the pretext for the concentration of armed squads from all over the country for a march on the capital *(see* ITALY: *History)*. Mussolini went from Naples to Milan, near the Swiss border, and left the direction of the "march" to a quadrumvirate of his closest friends (Italo Balbo, Michele Bianchi. De Bono and C. M De Vecchi). Practically no opposition was met from the civilian and military state authorities.

The Facta cabinet decided unwillingly to proclaim a state of emergency but the king refused to give his approval. Facta resigned and after a futile attempt on the part of the liberal-nationalist Antonio Salandra to form a coalition government. the king entrusted to Mussolini the task of forming the new cabinet.

The Fascist Government. — The first cabinet formed by Mussolini (Oct. 31, 1922) included several non-fascists, but Mussolini kept for himself every decision on vital questions. Later all non-fascists were eliminated.

There was a period when seven portfolios were in the hands of Mussolini himself. As years went by the quality of Mussolini's cabinet deteriorated. He eliminated all those who showed inclination for independence or had acquired a popular personal following and surrounded himself with more or less insignificant "yes men."

A convinced enemy of all democratic forms of government and particularly of the parliamentarian one, Mussolini devised a number of measures with the aim of concentrating all power in his hands. On Jan. 12, 1923 he created the Grand Council of Fascism, whose members he appointed and which was transformed later into one of the most important organs of the state. On Feb. 1, 1923 the fascist armed squads were officially militarized in the *Milizia Volontaria Fascista per la Sicurezza Nazionale,* and provided Mussolini with a large personal army. The murder of a leading member of the Socialist party, Giacomo Matteotti (June 10, 1924), made Mussolini's position extremely difficult for a while, but the opposition parties confined themselves to passive resistance only (the Aventino) and the king, after some hesitation. decided to support Mussolini, who was able once more to take the political initiative.

In 1925 (Dec. 24) and 1926 (July 31) Mussolini introduced laws which gave him a special position as prime minister. and the right to exercise — as head of the executive — legislative and judicial prerogatives. This meant the end in Italy of the classical "division of powers." In 1926 (Nov. 6) all opposition activity (parties, press. meetings) was definitely prohibited. After 25 years of a varied political career and seven years as the leader of fascism. Mussolini realized his dream of becoming the absolute ruler of his country. In 1928 (May 17 and Sept. 2) a new electoral law was also approved. The fascist political, syndical and cultural associations — through their leaders who were all appointed by Mussolini—were asked to present candidates among whom the Great council (also appointed by the Duce) chose those who were to be nominated. The electors had only the right to accept or reject the whole list. New elections took place on this basis in 1929 and 1934.

For the purpose of bringing Italian economic life under the control of the executive, according to the leitmotiv "for the fascist all is in the state, nothing exists outside the state." Mussolini created the so-called *Corporazioni* in 1930 (March 20) and definitely organized them in 1934 (Feb. 5). The 22 *Corporazioni* were all presided over by Mussolini. In 1938 (Oct. 8) even the fascist parliament was abolished and replaced with the assembly of the *Corporazioni,* which met for the first time on March 23. 1939, The members of the assembly were all appointed by the government and even the formality of popular approval, maintained in the reform of 1928, was dispensed with.

Important reforms concerned Italy's judicial organization. The old codes were abolished and new ones, inspired by fascist principles, enforced. The judicial power was deprived of its autonomy. Also the structure of the fascist party was transformed At first it included important groups more loyal to other fascist leaders than to Mussolini. Under the secretaryship of Augusto Turati and of Achille Starace, the influence of various leaders was eliminated and their clienteles dissolved. The Duce emerged as the only man in control of the party. Mussolini granted special powers to the police which became the most important organ of the Italian fascist state. The chief of police was probably the only man who could see Mussolini whenever he wished. For many years the police was probably the most efficient of all fascist organizations. Its task was not an easy one because the opposition went underground but never surrendered. To the opposition were due numerous attempts against Mussolini's life, the organization of secret political parties, the publication of clandestine newspapers, acts of sabotage, etc.

Foreign Policy.——Violently opposed to ideas of human solidarity and of lasting peace, Mussolini's aim, after he seized power. in the international field was to take advantage of every possible situation to achieve Italy's territorial expansion. He first tried his hand as a conqueror in 1923, when he sent an expedition against the Greek island of Corfu. Pressure from the western democracies obliged him to retreat. Mussolini played for a long time on the differences among the principal European powers, in order to obtain concessions for Italy in Europe and in Africa. From France, Italy had obtained a rectification of colonial boundaries in 1919. Further territories were given up as a result of an agreement between Laval and Mussolini in Jan. 1935. In 1925 England surrendered Jubaland in East Africa and a few oases on the Libyan-Egyptian border. By helping the Albanian Ahmed Zog to seize power in Albania, Mussolini was able to establish an Italian protectorate over that region in 1927. (Albania was definitely occupied in April 1939.)

The Duce's imperial aspirations took definite shape at the time of the world depression of 1929–32. Mussolini was convinced that, as a result of economic crisis and social upheavals, the democratic powers were bound to collapse, that they were not in a position to defend the independence of the small states and would put up little fight for their colonial empires. Three regions exercised a particular fascination over Mussolini's imperial dreams: the Mediterranean, the Balkan-Danubian countries and the northeastern section of Africa. To acquire the control of the Mediterranean, Mussolini strengthened the Italian navy. intervened in Spain (1936–39) and subsidized all kinds of anti-French and anti-British movements in the Mediterranean countries controlled by these powers. But when the crucial moment arrived in World War II to achieve his ambitions, Mussolini found himself obliged to ask Germany's help and to open the Mediterranean to German influence.

As a result of internal divisions and fear of Germany. the Austrian republic under Engelbert Dollfuss and Kurt von Schuschnigg accepted an Italian protectorate. Hungary and Bulgaria drew close to Italy as Mussolini had decided to support their revisionist claims The Croat separatists were supported by Mussolini, who wanted to weaken Yugoslavia as much as possible. But Germany's rise in power under Hitler soon destroyed nhat Mussolini had been able to achieve. Austria was annexed to the *Reich*, Hungary and Bulgaria fell under German control. From the dismemberment of Yugoslavia in *1941*, Mussolini received one-third of Slovenia, Dalmatia and a precarious protectorate over Croatia.

To acquire new territories in Africa, Mussolini began war preparations in the autumn of *1934* against Abyssinia and attacked, with overnhelming military forces, on Oct. *3, 1935*. The League of Nations decided on economic sanctions against the fascist war (they lasted from Kov. *18, 1935* to July *15, 1936*). hlussolini carried on, counting on the divisions between the powers belonging to the League and on the unwillingness of the democratic nations to go to war The Italian army occupied Addis Ababa, Abyssinia's capital, on hlay *5. 1936*. On May *9, 1936* Mussolini nominated the Italian king emperor of Ethiopia. Hatred against western liberalism and territorial ambitions brought him close to the nazis. In *1936* he opened negotiations with Germany and when Count Ciano visited Berlin (Sept.–Oct. *1936*) a secret agreement was reached. In the following years hlussolini went to Berlin. Hitler visited him in Rome and they met several times at the German-Italian frontier. In March *1938* he accepted Austria's annexation by Germany. In September of the same year—at the Munich conference—he helped Hitler to achieve a diplomatic success and the practical annexation of Czechoslovakia. On May *22, 1939* an Italian-German military alliance was concluded. At the beginning of World War II Mussolini proclaimed a policy of non-belligerency but on June *10, 1940*, declared war on France and Great Britain at the moment he thought Germany had certainly won the war. Italy's subsequent military debacles are described in WORLD WAR II; they led finally to his downfall on July *25, 1943*, after the Fascist Grand council, led by Count Dino Grandi, had repudiated his leadership by a vote of *19* to *7*. The king "accepted" Mussolini's resignation and appointed Marshal Pietro Badoglio to succeed him. Il Duce was placed in protective custody, but on Sept. *12, 1943*. the Germans announced he had been rescued by nazi paratroopers at a place later identified as a hotel on Gran Sasso mountain in the Abruzzi. The Germans then set up a "republican fascist party" with Mussolini as its titular head. In April *1945*. when the war in Europe was nearing an end. he and his party were apprehended by Italian Partisans outside the Italian village of Dongo, near Como, where, after "trial" they nere executed on the 28th.

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(M. W. S ; X.)

MUSSOORIE (properly MASURI), a health resort in Dehra Dun district, Uttar Pradesh, India, about *6,600* ft. above sea level. Population *(1951) 7,133*, rising to *20.000* in the hot season. The town. which is *18* mi, by road north of the railhead at Dehra Dun, stands on a ridge of one of the lower Himalayas, amid beautiful mountain scenery. It is one of the chief summer resorts for residents in the plains of Cttar Prsdesh. Mussoorie practically forms one station with Landaur, *7,362* ft. above sea level. Northwestward *(22* mi.) on the road to Simla, is the cantonment of Chakrata, *7.300* ft. The climate makes hlussoorie suitable for numerous schools, including St. George's college, the Oak Grove school of the Northern railway, and several Anglican and Roman Catholic institutions. together with a cathedral of the latter faith. The first brewery in India was established there in 1850. The town has botanical gardens, and is the summer headquarters of the Indian government trigonometrical survey

MUSSORGSKY, MODEST PETROVICH (1839–1881), Russian composer, was born at Karevo, Pskov government. March *21, 1839* The son of a landowner. he was sent to the army cadet school in St. Petersburg at *13*, and at *17* entered the Preobrazhensky regiment. He became seriously interested in music in 1857, when he met Aleksandr Dargomyzhski, César Cui and Mili Balakirev (*qq.v.*). The following year he began to study systematically under Balakirev. who mas only three years older. From the age of *19* Mussorgsky suffered intermittently from a nervous disorder, and before entering the civil service in *1863* led the life of a dilettante, playing the piano in society and beginning various compositions, an opera based on Gustave Flaubert's *Salammbô* and others remaining unfinished. What drove him to earn his living was the liberation of the serfs in *1861*, with which he was politically in sympathy, but which impoverished him as a member of a landed family. His first mature songs date from 1864. He was artistically influenced by Michael Glinka, who had died in *1857*, but whose sister he met in *1866*, and Nicolas Rimsky-Korsakov (*q.v.*), whom he had first known in *1861*. Although Rimsky-Korsakov was five years younger and at first as amateurish as any of the circle, he acquired a more solid technical equipment than hlussorgsky ever achieved and. far less of a spontaneous and natural genius though he was, gained a kind of artistic ascendancy over him. The two shared lodgings from 1871 until Rimsky-Korsakov's marriage. This association mas to bear questionable fruit after hlussorgsky's death, when his friend undertook to edit the finished and unfinished works left by the composer who, though faultily trained, was by far the most important figure among the five who formed the group known as *moguchaya kuchka* (the mighty handful) including these two, Balakirev, Xleksandr Borodin and Cui.

In *1868* Mussorgsky, who by that time had written more than half of his many songs, began an opera based on Nikolai Gogol's *The Marriage*, but abandoned it in favour of another, *Boris Godunov*, based on Aleksandr Pushkin's drama and N. M. Karamzin's Russian history. The first version was finished in 1869, but was at least twice revised by the composer, the second time at the behest of the Imperial opera, which refused to produce the work without a love episode, but at last performed it on Feb. *8, 1874*. Yet another version appeared after Mussorgsky's death, drastically altered and "corrected" by Rimsky-Korsakov, and this held the stage until the earlier versions were tried during the 20th century and judged superior by many authorities. They certainly far better represent Mussorgsky's art, which includes some characteristic crudities more interesting and attractive than any editorial polish. The next two operas, *Khovanshchina* (1872–80) and *Sorochintsy Fair* (1874–80), both remained unfinished. Drunkenness laid hold of Mussorgsky more and more disastrously and made him incapable of sustained work. He still wrote many remarkable songs, however, including the cycles *Sunless* (1874) and *Songs and Dances of Death* (1875–77), as well as the vivid piano suite *Pictures From an Exhibition (1874)*. He died in misery at a military hospital in St. Petersburg, March *28. 1881*.

Mussorgsky survives as a great composer on few works *Boris Godunov* is recognized as an opera nonetheless great for being in some ways defective. and many of the songs. which shon his great gift of outlining human character, are among the most striking and memorable ever written. Mussorgsky had neither the copiousness nor the assured craftsmanship of Tschaikovsky. but ranks with him as a great composer, representing at its best the national side of music in Russia as Tschaikovsky stands for its cosmopolitan aspect.

See M. D. Calvocoressi, "Mussorgsky," *Master Musicians .Series* (1946). (E. W. BM.)

MUSTAFA KEMAL ATATÜRK (1881–1938), Turkish soldier and statesman, was born in Salonika, Greece; his father, a customs officer who afterward entered the timber trade, died when Mustafa was a small child. At the military preparatory school he proved to be an exceptional student, especially in mathematics. His teacher in mathematics, who was also named Mustafa, gave him the distinctive surname of Kemal (Arabic, perfection), as a tribute to his ability. He did not receive the name Atatiirk till 1934, when family names were introduced in Turkey by law.

In 1904 he was gazetted lieutenant, but arrested on the same day and. after examination, banished to Damascus, Syr. There. after observing the deplorable condition into which the civil and military organization of the empire had fallen, he founded in 1905 the secret political society Vatan (Fatherland). From Damascus he was transferred to Jaffa. whence he made his way secretly to Salonika to organize a similar political movement in the European provinces. The association which he founded at Salonika was afterward affiliated with the Union and Progress society. The Constantinople government again ordered his arrest; but he escaped and the government presently forgot him. In 1907 he was promoted and sent to Salonika, where he resumed his revolutionary activities.

When the revolution of 1908 re-established the constitution of 1876, Mustafa Kemal found himself in serious disagreement with the leaders of the victorious Union and Progress party. In consequence he abandoned politics for the time and turned his whole energy into his military career, in which he advanced rapidly. In 1911 he went to Tripoli incognito to take part in the war against Italy. There he was promoted to major. The first Balkan War was over before he could return; but in July 1913, during the second Balkan War, he was appointed chief of staff to the newly organized army corps on the Gallipoli peninsula, where he made a detailed firsthand study of the problem of defending the Dardanelles. After the restoration of peace he was appointed military attaché at Sofia and held this post until the autumn of 1914.

Mustafa Kemal believed that Turkey had entered the war prematurely and that Germany was doomed to eventual defeat. Possibly for this reason his desire to return to active service was not encouraged; but on his insistence he was appointed commander of the forces at Rodosto, Turk., and afterward (in 1915) at the Dardanelles. He inspired the defense of the straits against the British attack—this, when the Turkish high command had lost hope. Mustafa Kemal was then sent to the Caucasus. where he was promoted to the rank of pasha and recovered Bitlis and Mush from the Russians. In 1917 he was posted to the Hejaz.

At this time Germany's intervention in the internal affairs of Turkey had reached its height, and Mustafa Kemal Pasha put himself at the head of the opposition to it. He sent in a succession of reports adverse to the Baghdad expedition, which he thought would end in another disaster, and when his advice was ignored he resigned. In 1918 he yielded to Sultan Mehmed and accepted command of the 7th army corps in Palestine but all chance of taking the offensive, or even averting disaster, had then disappeared.

When the Turkish government negotiated the armistice of Mudros (Oct. 30, 1918), Mustafa Kemal was opposed to the policy of complete surrender and, after the signature of the armistice, retired to Constantinople. The Greek landing at Smyrna on May 16, 1919, which reawakened the Turkish nation, and his appointment by the Ottoman government in Constantinople as inspector of the 9th army corps in northeastern Anatolia gave him his chance. Mustafa Kemal meant to create a nucleus of national resistance against the partition of the country and therefore accepted with alacrity the position oifered him by the unsuspecting government. As soon as he landed at Samsun he began to organize his new movement locally at Amasia, Tokat and Sivas and to correspond secretly with other parts of the country. The sultan's government, too late, recalled him to Constantinople, but he went on instead to Erzerum and sent in his resignation. He next convened two congresses. one at Erzerum in July, the other at Sivas in Sept. 1919. Both congresses endorsed his program of fighting for national existence to the bitter end, and relations betueen the capital and the interior of Anatolia were broken. All the efforts of the Constantinople government and the Allied powers to frustrate Mustafa Kemal's activities simply strengthened his conviction. On April 23, 1920, he gathered at Angora the nationalist members of the late parliament who had escaped from Constantinople and was unanimously elected president of this new national assembly.

During the two and one-half years which followed Mustafa Kemal's military ability, intellect and oratory carried his countrymen through their ordeal. During the summer campaign of 1921, which was the supreme crisis of the Graeco-Turkish War, the Angora assembly appointed him generalissimo of the Turkish forces, with unlimited power; and he took personal charge at the front during the 22 days' and nights' fighting of the battle of the Sakaria, which brought him the rank of field marshal and the traditional title of Ghazi (the victorious). The destruction of the Greek army, the peace settlement at Lausanne, Switz., the abolition of the sultanate, the declaration of the republic and the abolition of the caliphate were the direct work of Mustafa Kemal. On Oct. 29, 1923, when the republic was proclaimed, the national assembly unanimously elected him president, an office to which he was re-elected on Nov. 1, 1927, on May 4, 1931 and finally on March 2, 1935. He died on Nov. 10, 1938, and was succeeded as president by Ismet Inonii (*q.v.*).

Atatürk was the builder of a modern Turkish nation, the reformer of all Turkish life. Under his strong guidance the legacy of the mediaeval and oriental Ottoman empire was discarded and the country turned into a modern progressive secularized republic which could keep abreast of all human progress and take a constructive place at the side of other nations. Though Atatürk, in view of the general backwardness of the country, could accomplish his aim only by dictatorial methods, he remained faithful to the progressive and liberal ideas of his youth. He emancipated the Turkish women, established complete equality of all citizens, introduced universal education and became an educator to democratic forms of life. The democratic constitution of the republic was jealously guarded; Atatürk regarded his dictatorship as a temporary institution for strengthening the foundations of liberal democracy in a population not prepared for it.

In foreign affairs Atatürk resolutely abandoned all dreams of expansion or of military glory, so dear to other nationalist dictatorships. He taught the Turks the virtue of moderation in their aspirations and even succeeded in making a lasting peace with the Greeks, with whom the Turks had fought bitterly for many centuries and whom he had defeated shortly before.

The firm friendship with Greece allowed Turkey to become the leader in an effort to secure a lasting peace by collective agreements with its neighbours: the Balkan pact which united Turkey with Greece, Yugoslavia and Rumania; and the Near Eastern pact which united it with Iran, Afghanistan and Iraq. Atatürk also maintained close and friendly relations with the U.S.S.R., which had helped Turkey throw off the conditions of the peace of Sèvres. He also led Turkey to join the League of Nations and to make peace with the former enemy nations, Great Britain and France.

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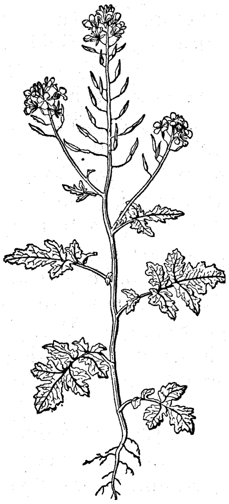
(A. J. T.; H. Ko.; X.)

MUSTANG, the wild or semiwild horse of the prairies of North America, the descendant of the horses imported by the Spaniards after the conquest in the 16th century (see HORSE).

MUSTARD is a name applied to a family of plants (Cruciferae) in which each flower has four petals forming a cross if viewed from above: to various species in several genera of the family; to the leaves of these species when used as greens; and to the pulverized seeds of several species. Both white mustard (*Sinapis alba*) and black mustard (Brassica *nigra*) originated in the Mediterranean region or Middle East, have been cultivated for 2,000 years or more, and have spread almost throughout the temperate regions of the world. Mustard plants were mentioned frequently in biblical. Greek. and Roman writings. Mustard seed was used medicinaily by Hippocrates and probably earlier. Indian mustard (*Brassica juncea*) possibly originated in Africa, but if so, it reached Asia at an early date, where it is extensively cultivated. Wild mustard plants were biennial, but selection has developed annual strains: the only types cultivated.

Mustard is raised for the leaves, to be used as greens, and for the seeds which yield oils and are used as a condiment. To produce greens the plants are grown during the spring or fall, for only basal leaves from fast-growing plants are suitable as pot herbs. Seeds are sown at two- to five-inch intervals in rows two feet apart, or broadcast. Seed-producing plants are grown in summer when flowering occurs early and few leaves appear. Both types of culture are practised in Asia, Europe and North America, and California, Montana and Kentucky lead in production in the United States. Black mustard is a weed in parts of Britain. in California and in some other areas. The plants may attain heights of 10 to 16 ft. Other species of *Brassica* and Sinapis are less aggressive weeds than the black mustard and are troublesome locally only. Mustard is used occasionally as a cover crop. for stock feed, as a green manure in orchards or prior to planting crops that grow best in mid-summer.



BY COURTESY OF THE NATURAL HISTORY MUSEUM

WHITE MUSTARD (B. HIRTA), SHOWING FLOWERS AND FRUITS (SILIQUAE)

Mustard seeds contain a fixed oil that is present in amounts of 30% to 35% and is extracted by the cold press method. This oil is edible, but is used mainly as an illuminant, for making soap and rubber substitutes, in the manufacture of leather and woolen goods, for quenching steel plates and for other technical purposes. A second. very different oil, is obtained by grinding the seeds and treating the flour with water to cause a chemical action between an enzyme and a glucoside, producing an oil not present, as such, in the tissues of the plant. In black mustard the enzyme myrosin acts on a glucoside, sinigrin, to produce a volatile, very irritating oil which was the mustard gas of World War I. In white mustard the same enzyme acts on a different glucoside, sinalbin, to produce a nonvolatile oil that is a powerful rubefacient, but less irritating than the oil from black mustard, and is used in mustard plasters. Such plasters (*Emplastrum sinapis* in the U.S. Pharmacopoeia) contain mustard mixed with one .to four parts of flour to control the irritating qualities.

Many species of Cruciferae have similar systems of enzymes and glucosides in the seeds, and to a lesser degree, in the leaves. The enzyme is destroyed by boiling. so greens made from B. juncea are boiled twice, the first water being discarded to reduce the "bite."

Table mustard made from the seeds of black mustard is preferred on the continent of Europe, while that made from white mustard in England. In the Cnited States the condiment is usually made with a mixture of these two seeds, with a small quantity of B. juncea seed blended with the others in some grades. The sharpness of the condiment may be toned down by adding starch or flour: vinegar or wine, and certain other spices. Mustard. either dry or moist. soon loses its potency owing to oxidation unless it is hermetically sealed. When eaten it stimulates salivary secretions and peristaltic action in the stomach.

See I. H. Burkill, A Dictionary of the Economic *Products* of the Malay Peninsula (1935); A. F. Hill, Economic Botany, 2nd ed. (1952).

(I. L. W.)

MUSTARD GAS, the name given to β, β'-dichlorodiethyl sulphide, one of the most effective toxic agents used during World War I. This substance is not easily destroyed by weathering; at ordinary temperatures, it is a liquid which evaporates only slowly. It therefore tends to persist for days or weeks in any area where it has been released. This property largely governs its tactical use. Inhalation of a sufficient quantity of mustard-gas vapour causes pulmonary inflammation. When the vapour or (more particularly) droplets of the liquid come in contact with the skin, severe blisters and burns are produced (vesicant effect). Of these two methods, the second is more important for military purposes. In World War I mustard gas caused many temporary casualties but few permanent injuries and still fewer deaths. See CHEMICAL WARFARE.

MUSTARD OILS, a general term applied to the esters (q v.) of isothiocyanic acid. The name arises from the fact that allyl isothiocyanate occurs in. and forms the principal component of, the oil obtained by distilling black mustard seeds (Sinapis nigra). These seeds contain a glucoside (see GLYCOSIDES, NATURAL) termed potassium myronate which undergoes a fermentative change due to an enzyme (*q.v.*), myrosin, also present in the seeds. Allyl mustard oil (allyl isothiocyanate). $C_3H_5.N:C:S$, is a colourless liquid sparingly soluble in water and boiling at 151° C.; it has a sharp pungent odour and produces blisters on the skin, whence the efficacy of the mustard poultice as a counterirritant. It can be prepared synthetically by heating allyl bromide, $CH_2:CH.-CH_2Br$, with potassium thiocyanate. The odour and taste of mustard (*q.v.*) are due to this substance. The analogues of allyl isothiocyanate are readily prepared by the action of carbon bisulfide on primary amines, when alkyl dithiocarbamates are formed which on distillation with mercuric chloride yield the corresponding mustard oils. These compounds are colourless liquids with pungent irritating odours. This general reaction proceeds so smoothly that it is employed as a distinctive test for primary amines. See AMINES.

MUTANABBI, AL- (ABU AL-TAYYIB AHMAD IBN HUSAYN) (915–965), regarded by many Arab critics as the greatest Arab poet of Islamic times, was born at Kufah of poor and obscure parentage. He gave early signs of poetic talent and became a professional poet. This meant that he had to attach himself to a succession of rich patrons willing to support him in return for poems extolling their merits. His debut was made among the bourgeoisie and minor officials of Syria and Palestine. His career was interrupted by a curious incident of which little is known in detail: in 932 he joined a heretical revolutionary movement staged by a section of the nomad tribes of the Syrian desert and is alleged to have declared himself as the "prophet" of the movement. It was from this that he gained the cognomen of al-bfutanabbi. "the claimant to prophethood." The revolt failed, and he spent two years in prison, thereafter resuming his profession. The peak of his career was reached when, in 948, he attached himself to the brilliant and versatile Hamdanid prince of northern Syria. Sayf-al-Dawlah. For the first time, al-Mutanabbi had a patron whom he could admire. But the association lasted only nine years, and the latter part of it was clouded nith intrigues and jealousies. which culminated in al-Mutanabbi's leaving Syria for Egypt, then under the rule of a rival princely family, the Ikhshidids. The ruler, however. was a puppet and actual power rested in the hands of the Negro eunuch Kafur, to whom al-Mutanabbi attached himself. Such patronage was wounding to his pride, and he soon transferred himself to the protection of Abu Shuja' Fatik, another prominent member of the Ikhshidid court. The latter died in 961. and the poet's position was then one of extreme danger; he had bitterly offended Kafur, both by deserting his patronage and by writing scurrilous satirical poems against him, and was forced to flee secretly. He returned to Iraq and after four years of wandering in an unsuccessful search for another patron was killed by bandits during a journey.

Ancient Arabic poetry had been characterized both by a rich and varied vocabulary and by a freshness and spontaneity resulting from an intimate acquaintance with the Bedouin environment with which the poems dealt. In the urban civilization which grew up in the 8th century, poets who clung to the ancient models were forced either to replace this freshness by literary artifice or to retain spontaneity by writing on intimate and personal themes in a simple, everyday language. Abu Tammam and Buhturi (*qq.v*), belonged to the former school and al-Mutanabbi followed them. Hence his poetry is ornately rhetorical; yet he handles this "Augustan" style with consummate skill and artistry, and greatly influenced Arabic poetry until the 19th century. His collected poems (edited by 'Abd-al-Wahhab with introduction and notes, 1944) are mainly panegyric. but contain some occasional odes (*e.g.,* laments and satires) of high quality.

See R. Blachère, *Un podte arabe du IV^e siècle de l'Hégire, Abou-Tayyib al-Motannabi* (1935). (A. F. L. B.)

MUTATION: see VARIATION: Experimental; HEREDITY; EVOLUTION, ORGANIC.

MUTILATIONS AND DEFORMATIONS. In every part of the world, both in civilized as well as uncivilized communities some form of mutilation of the human body is found; but the widest variety of mutilations as well as the most severe occur among the more primitive peoples.

Early historians and writers, long before the Christian era, show that in those days such mutilations as tattooing and circumcision, as well as skull deformation, were well known. Some form of mutilation was probably practised from earliest prehistoric times. On the cave walls of France and Spain, where Aurignacian and Magdalenian man painted the mammoth, elephant and woolly rhinoceros during the closing phases of the last Ice Age, are painted hands which indicate the removal of one or more finger joints, a practice still common in South Africa, India and elsewhere. The reason for this mutilation on the part of prehistoric man can only be conjectured by analogy with these modern primitive peoples. The Wellcome Historical Medical museum in London has a skeleton of an early man from a prehistoric grave at Gebel Moya in the Sudan. Found close to the jaw is a stone stud exactly similar to the lip studs worn by modern Nilotic peoples. Other evidence may be found in folk tales, early paintings and carvings and by a careful interpretation of objects found in the graves. The motives behind mutilation may be classified as. tribal convention; adornment; initiation ceremonial; religion; punishment; and health.

Skin. — Tattooing consists of puncturing the skin in the pattern desired and rubbing in colouring material so that the pattern is indelibly fixed. In New Zealand the Maoris brought tattooing to a very high art, and the intricate patterns with which they adorned their faces were executed with exquisite workmanship and taste. In China, Borneo. India and other parts of the Far East tattooing is prevalent, and it was introduced into Europe chiefly by sailors. Arms, legs, body and face are all considered suitable surfaces for decoration. Modern tattooing saloons exist in London and in many of the bigger seaports. True tattooing, but of a less lasting nature, is occasionally found in parts of Africa, and must not be confused with scarification.

Scarification. — This consists of cutting deep marks into the skin and rubbing in charcoal and other irritant material to keep open the wound which eventually is allowed to heal but which leaves a deep scar. Sometimes the wound is so treated that a shiny keloid instead of a flat scar results. Scarification occurs all over Africa for reasons as numerous as they are different. Very frequently small scars are made on the face which serve as tribal and clan marks. Often elaborate patterns are worked out on the chest for purely personal adornment; these are especially good on the West Coast. Sometimes the object of the operation is semimagical, women of many African tribes being scarified on the abdomen during pregnancy. At other times, scarification is merely the result of surgical treatment and is the consequence of rather crude cupping methods followed by the application of an irritant powder. In Australia the aborigines scarify their arms and chests, which often show great black keloids representing many years of patient work, the wound being opened up from time to time and fresh irritants applied.

Hair. — Depilation by some means or other has been practised by primitive peoples for hundreds of years, while all modern civilized peoples still continue to remove unwanted hair by various methods. One of the widely accepted modern methods employs electrolysis as a means for removal of adventitious growth of hair. One of the commonest primitive methods of hair removal is by plucking out each individual hair by its root, every time it grows. By starting at an early age the time comes when the hair on the parts so treated could be grown only sparsely even if desired. Depilation by plucking is common all over Africa and in many parts of the east and Oceania. The areas so treated are more especially the face and pubic regions, and chest and under the arms. Some individuals even go to the length of removing all body hair.

Shaving of the face, as well as of the scalp, is a common practice among primitive people, and may be carried out with such instruments as a piece of broken glass, or a special iron blade. It is usually done dry, without the use of water or lather. Depilation by singeing, as well as by the use of ointments occasionally occurs.

Removal of the hair is usually a tribal custom, as hairy people are despised and often unable to find a mate.

Head. — There are few if any parts of the world where some portions of the head and face entirely escape mutilation, but the most commonly maltreated are the ears, nose, lips and teeth. Skull deformation may be the result of deliberate intention, or of chance. In some tribes, especially in America every individual was intentionally treated as a child with the direct view of reducing the skull to a certain shape. In other cases, as in parts of Africa, deformation is the unintentional result of the local methods of carrying water pots or loads on the head. Young children, especially girls, start such work long before the skull is properly developed and the result is a definite and fairly uniform deformation. Skull deformation occurs in nearly every part of the world, though commonest in the Americas and least common, if at all existent, in Australia. Intentional deformation is carried out from various motives, sometimes a long pointed head, sometimes a flat depressed head being the shape required. Various methods are employed, commonest of which are by bandaging, and by tying the child's head to a flat board fixed to the occipital region.

Ears. — These are pierced to carry earrings all the world over, indeed very few, primitive or civilised peoples, leave the ears totally unmutilated, though the Andamanese, Bushmen and true Baganda are reported as doing so. Both the ear lobes, as well as the cartilage round the top of the ear, are commonly pierced. This is usually done during childhood and a small piece of wood is inserted into the wound which is then left to heal. Later this plug is removed and a larger one inserted, the process being continued until the required size of hole is obtained by reason of this continual stretching. In many countries both sexes treat their ears in this way, while in others it is confined to one or other sex. The greatest distensions are to be found in Borneo and East Africa. In both these places lobes are often seen so stretched that they hang down to the shoulder, with holes so large that it would be possible to pass a closed fist through them. In all these ear mutilations adornment is the end in view. Large carved wooden plugs, carved stone ornaments, metal rings and fibre and paper rolls, all are used as earrings, while to-day even earthenware jam pots and circular cigarette tins are popular in some parts of Africa.

In some tribes such as the Kikuyu, a husband if displeased with his wife breaks the lobe of her ear with his hands.

Nose. — The nose is often mutilated for purposes of personal adornment especially in India, and the East, as well as in New Guinea and Polynesia, S. America, Australia and in parts of Africa. Nose ornaments also signify social rank. Sometimes it is the alae, and sometimes the septum which is perforated. Often only a small hole is made through the septum from which a gold ring or other jewel is suspended; at other times the hole in the septum is big enough for a finger to be passed through. Elsewhere one, and occasionally both, nostrils are pierced and distended to carry coloured studs, sometimes of unbelievable size, as among the Makonde of Portuguese East Africa. Nose ornaments are more common with women than men, but in New Guinea and especially among the Tugeri and the Solomon Islanders, the men wear great pointed sticks, or sometimes the tusks of wild pig through holes in the nose.

Lips. — In several parts of Africa, especially in the Congo, the south east Tanganyika Territory, and the upper reaches of the Nile, and among the Botocudo of S. America enormous plates and plugs are inserted in hugely distended holes, cut in the upper and lower lips. The lip studs and pins of the Nilotic peoples of Uganda, Kenya Colony and the Sudan are usually small and made of ivory, rock crystal or stone, and are inserted through the upper and lower lips or both. Other lip mutilations include pricking and rubbing with irritant to cause them to swell. This is done in parts of West Africa.

Teeth. — Over the greater part of Africa, as well as in Australia, New Guinea and elsewhere, it is a common practice to remove one or more front teeth in the upper or lower or both jaws Sometimes the ceremonial knocking out of the teeth accompanies initiation and is a test of ability to bear excruciating pain unflinching; sometimes it is simply a matter of custom; sometimes it serves as a tribal mark, while yet another reason given is the fear of lock-jaw. The removal of the teeth is in this case a precaution which would enable the patient to be fed if the disease were contracted.

Another common practice in Africa, found also in Southern India, is the filing or chipping of teeth to serve either as a tribal mark or as an initiation step, or for both purposes. The Akamba and certain Congo peoples file their incisors to sharp points, and for some unknown reason this was considered by early travellers as a sign of cannibalism — a most erroneous view. The Eskimo file the teeth to make them shorter and less like those of dogs and in south and central Africa the incisors are filed to all sorts of shapes and patterns as described by Dr. G. Turner in the *Transvaal Medical Journal* for 1911

The Dyaks of Borneo and other people in the East, occasionally drilled holes in the teeth, into which plugs of gold were driven to serve as ornament. This method of adornment was also used in ancient Mexico, precious stones being inlaid in the teeth.

Tongue, Cheeks **and** Neck. — Among the Bateso of East Africa a hole is sometimes bored through the tongue and a brass ring bearing one or two beads is inserted. The cutting out of the tongue was once a legal penalty in Europe, and has only recently been forbidden in some parts of Africa.

The Aleutian Islanders bored a hole through each cheek through which seal's whiskers were stuck. Feathers are put through holes in the cheek in parts of S. America.

The *Padang* of the South Shan States deform the necks of their womenfolk by making them wear — from early childhood onwards —high metal collars whose length is gradually increased; this eventually produces such elongation and dislocation of the neck that if the collars were removed the wearers would not be able to hold up their heads.

Eyes **and** Body. — Putting out eyes as a punishment for various crimes has existed at different times all over the world — Europe included. Priests and worshippers of certain eastern cults still gash and cut themselves with knives as did the priests of Baal in olden times. In parts of Africa it was once a practice to cut off the breasts of an unfaithful wife.

Limbs. — In former times both in England, and Europe generally, amputation of one or more limbs was a common punishment for crime *(see* Pike's *History of Crime in England,* 1893), and this method has also been suppressed in parts of Africa.

For purposes other than punishment and medical necessity, amputation consists chiefly of cutting off the finger joints. especially the little finger. In south Africa this was either done as mourning or as a magical preventive measure in the case of a child born to a mother whose last baby aas stillborn. In southern India grandmothers used (in some castes) to have to cut off one joint for each grandson born to them.

There is too the former Chinese bandaging of girl children's feet to prevent their development.

MUTIS, JOSÉ CELESTINO (1732–1808), Spanish naturalist noted for his studies of the plants of Colombia and for his part in the early history of quinine, was born at Cadiz on April 6, 1732. He took his degree at Seville university and afterward studied medicine at Madrid, where for a time he lectured in anatomy. His preference, however, was for the study of mathematics and natural science. especially botany. He became one of the first Spanish disciples of Linnaeus. Attracted by the wide and fruitful fields of study which South America then afforded, Mutis sailed in 1760 for New Granada (Colombia).

There he occupied himself collecting and describing plants from the lowlands and from the higher Andean regions. but that he did not neglect medicine is shown by his appointment as king's physician in the viceroyship. He spent much time on sanitary problems, including the establishment of proper cemeteries, the prevention of smallpox and the reduction of malaria. He put into general use many South American herbs, the properties of which he had studied, among them ipecacuanha (ipecac), guaco and Peruvian balsam. Some of these, such as the cinnamon laurel of the Andes, he made known in Europe.

Mutis' favourite study, however, was quinine, which he investigated from every angle from the distribution of the different species of cinchona down to experiments in the curative properties of the drug. Having been presented with some samples of bark and a drawing of the tree, he sent them to Linnaeus (1764). His *El Arcano de la quina* was published in 1793. Later studies were published in the *Papel periodico* and, after his death, by his nephew Sinforoso Mutis, who completed and arranged his notes on the subject (1828).

His work probably had much to do with making possible the colonization of malaria-infested regions. It attracted the attention of the king, who created the Royal Botanical expedition of New Granada and placed Mutis at its head. With 18 of his best students, Mutis carried out a systematic survey in which material was collected for the monumental *Flora de Bogotá ó de Nueva Granada* which he planned in 13 folio volumes.

Only the first volumes of this intended work were arranged at his death. For the remainder he left manuscripts, notes, illustrations and sketches in such profusion that only someone knowing his schemes of arrangement could have finished the work. Among these botanical riches were 6,480 illustrations, admirable in precision and colour, which were intended for an atlas volume. This material, amounting to more than 4,000 folios of loose manuscripts, and his collection of more than 20,000 plants were sent after his death to the botanical garden at Madrid, where they are preserved.

For 18 years Mutis carried on a correspondence with Linnaeus, much of which was published in *A Selection of the Correspondence of Linnaeus* (1821). He furnished many specimens of plants which the Swedish naturalist described, including additional material from which Linnaeus' son perfected the generic description of cinchona. Linnaeus the younger named in Mutis' honour the beautiful genus *Mutisia,* of the family Compositae, comprising about 50 species of plants found in South America. Mutis died at Bogotá on Sept. 11. 1808.

MUTTON: *see* LAMB AND MUTTON.

MUTTONBIRD: *see* SHEARWATER.

MUTTRA (officially, and anciently, MATHURA), a city and district in the Agra division of Uttar Pradesh, India. The city is on the right bank of the Jumna, 30 mi. above Agra; pop. (1961) 125,808. In the 6th century B.C. it was the capital of the Saurasenas. Fa Hien *(c.* A.D. 400) refers to it as a centre of Buddhism; but his successor Hsuan Tsang *(c.* 650) is forced to record a Brahmanical revival. It was sacked by Mahmud of Ghazni in 1017–18; about 1500 Sultan Sikandar Lodi destroyed all the Hindu shrines, temples and images; and in 1636 Shah Jahan appointed a governor expressly to "stamp out idolatry." In 1669–70 Aurangzeb visited the city and continued the work of destruction. Muttra was again captured and plundered by Ahmad Shah with 25.000 Afghan cavalry in 1757.

The town is still a great centre of Hindu devotion, and temples and bathing stairs line the river bank. The majority are modern, but the mosque of Aurangzeb, on a lofty site, dates from 1669. Most of the public buildings are of white stone, handsomely carved. The city is the seat of two colleges of Agra university and of the Curzon museum of antiquities. Cotton, paper and pilgrims' charms are the chief manufactures.

MUTTRA DISTRICT (area 1,467 sq.mi.; pop., 1961, 1,070,572) consists of an irregular strip of territory on both sides of the Jumna. The eastern half consists of a rich upland plain, abundantly irrigated by wells, rivers and canals, while the western part, though rich in mythological association and antiquarian remains, is comparatively unfavoured by nature. The principal crops are millet, pulse, cotton, wheat, barley and sugar cane. The eastern half is watered by the navigable Agra canal and the western half by branches of the Ganges canal. The central part of Muttra district is one of the most sacred spots in Hindu mythology. The district within a circuit measuring about 170 mi. around Gokul and Brindaban nas called Braj-Mandal and had many associations of earliest Aryan times. There Krishna and his brother Balarama fed their cattle: and numerous relics of antiquity in the tonns of Muttra, Gobardhan. Gokul. Mahaban and Brindaban attest the sanctity of this holy tract. After the invasion of Mahmud of Ghazni the city fell into insignificance until the reign of Akbar; thenceforward its history merges in that of the Jats of Bharatpur, until it again acquired separate identity under Suraj Mal in the mid-18th century. The whole of Muttra passed to British rule in 1804.

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MUTUAL ECONOMIC ASSISTANCE, COUNCIL OF, an organization established in Moscow, U.S.S.R. in Jan. 1949 to centralize arrangements for trade, credit and technical assistance between the Soviet Union and the other members of the Sino-Soviet bloc. Before its establishment, foreign trade, apart from reparation payments to the Soviet Union from the defeated countries of eastern Europe, mas conducted under one-year agreements on a bilateral basis that specified fixed quantities of goods to be imported and exported. Prices were expressed in the United States dollars at existing prices. No credits were provided. and the accounts nere expected to be balanced each three months. This system was regarded as inadequate since there was no assurance that necessary imports would in fact be supplied or surplus exports bought.

After Jan. 1949 and especially after the ruble revaluation of Feb. 1950 this system was altered The new Council of Economic Mutual Assistance (CEMA) permitted longer-run national planning through the exchange of lists of minimum import needs and export availabilities; the conclusion of long-term trade agreements for periods up to five years; and the conclusion of bilateral investment agreements and technical-assistance contracts. Particular co-operation was effected in transportation where agreements provided for the exchange of rolling stock.

Credits from the Soviet Union under the CEMA arrangements nere arranged to finance trade imbalances and specific investment projects. such as factories to be built with Soviet equipment and possibly by Soviet technicians. The standard credit arrangement was said to run for 12 years. bear $2\frac{1}{2}\%$ interest and call for repayment in commodities (possibly those produced by the factory) or in the money of the borroner. The amounts of such credits were difficult to determine. A totaling of specific announced credits amounted in 19j6 to $850,000,000 for eastern Europe and at least $430,000,000 for Communist China. A statement by N. Khrushchev in 1956 set the total at $5,500,000,000. A 1958 estimate by the west German finance ministry was $7,000,000,000. These last tno figures may have included some considerable volume of military credits. All figures were derived by converting rubles into dollars at the official exchange rate fixed in 1950—four rubles to the dollar. This rate could substantially overstate the purchasing power of the ruble outside the Soviet bloc.

No estimate was possible of the extent to which this unknown amount of credits represented net assistance by the Soviet Union to the other members of the bloc, because of the unknown amount of reparations from the satellites to the Soviet Union, especially from Germany. After the disturbances in 1956, however, it was clear that the rate of Soviet assistance increased.

The nest German finance ministry indicated that aid by Communist China increased sharply after the middle of the 1950s. Credits, loans and gifts were said to have amounted to $190 000,000 in 1955, $170,000,000 in 1956 and $215,000,000 in 1957. The last figure consisted of $85,000,000 each for North Korea and North Vietnam. nith smaller amounts for Outer Mongolia, Sepal and Hungary.

For a discussion of Soviet aid to countries outside the Sino-Soviet bloc. *see* FOREIGN AID PROGRAMS

The volume of trade among the countries of the Sino-Soviet bloc conducted under CEMA was difficult to estimate. Including east Germany and Communist China. total trade of the bloc may have amounted to $12.500,000,000 in 1952. Of this sum. $9,400,000,000, or 75%, was believed to represent intra-bloc trade. Bloc trade with the outside world mas more readily approximated. and was believed to have declined from $2,000,000,000 (of "free world" exports) in 1947 to $1,388,000,000 in 1953, under the impact of the strategic trade control system. After 1953 it expanded again, as the system was relaxed, and reached $3,086,000,000 in 1957.

See Nicolas Spulber, *The Economics of Communist Eastern Europe* (1957), especially ch. 11. For a discussion of the trade of the Soviet bloc with nonbloc countries including underdeveloped nations, *see* the reports to the congress under the Mutual Defense Assistance Control act of 1951 (Battle bill), especially the eighth report for the last half of 1955 (*C.* P. K.)

MUTUAL SECURITY PROGRAM, the name by which U.S. foreign aid programs became officially known in 1951. The concept of U.S. economic aid to Europe exemplified by the Marshall plan (European Recovery program) was applied to non-Euroocan areas. as well as to Eurooe. and combined with U.S.-aided technical assistance programs and programs of mutual military defense and defense support in the Mutual Security act of Oct. 10, 1951 and succeeding mutual security acts. A Mutual Security agency (MSA) was established as the successor of the Economic Cooperation administration (ECA). which had administered the Marshall plan. In 1953 MSA was superseded by the Foreign Operations adininistration (FOA) and in 19jj by the International Cooperation administration (ICA). See FOREIGN AID PROGRAMS.

MUWASHSHAH, an Arabic poetical genre in strophic form (in contrast to classical Arabic poetry in which a poem has one single rhyme recurring at the end of each line); it is said to have been invented in Spain by a poet from Cabra who lived *c.* 900. The fundamental scheme is seen in the following example, and its translation:

Nasimu'l-rawdi fah (A) fa-qumu nashrahu (B)

A-la qum ya ghulam (c)
Adir ka'sa'l-mudam (c)
Mada sirfu'l-zulam (c)
Wa-kafuru'l-sabah (A) ilayna yujlabu (B)

Silu mazja'l-khumur (d)
Bi-salsali'l-thughur (d)
Fa-ma sirru'l-surur (d)
Sima ka'sati rah (A) wa-riqin ya'dhubu (B)

The garden scents the air; (A) Awake and drink, my friend; (B)

Awaken boy, I say, (c)
And pass the cup this way; (c)
Darkness is gone, and day, (c)
Shining and camphor-fair, (A) To us doth perfume send. (B)

Come, mix the ruby sips (d)
With nectar of the lips. (d)
While time for ever slips (d)
Away, what joys are there (A) But these, before the end? (B)

The usual number of strophes is five. The rhyme scheme can be complicated by introducing internal rhymes (*e.g.,* ABCABC defdefdefABCABC, etc.). The poems are written in classical Arabic and their subjects are those of classical Arabic poetry, such as panegyric, love. wine. The second part of the last strophe (called *kharja* or *markaz*) is usually written in vernacular Arabic or in the Spanish "Mozarabic" dialect; it is normally put into the mouth of a girl and expresses her longing for her absent lover. These verses—the earliest examples of lyric poetry in a Romance language—make it probable that the inventors of the *muwashshah* were partly inspired by some kind of oral Romance poetry. Most of the Arabic *muwashshahs* from Spain are from the 11th and 12th centuries. From the 12th century onward the genre also spread to north Africa and the east. Jewish poets of Spain also wrote *muwashshahs* in Hebrew, with *kharjas* in Arabic and Spanish.

See M. Hartmann, *Das arabische Strophengedicht. I: Das Muwassah* (1897); S. M. Stern, *Les chansons mozarabes* (1953). (*S.* M. SN.)

MUYBRIDGE, EADWEARD (EDWARD JAMES MUGGERIDGE) (1830–1904), British photographer and pioneer in motion photography, was born at Kingston-on-Thames, April 9, 1830. He emigrated to the U.S. in 1852 and was engaged in business until 1860. when he joined the U.S. coast and geodetic survey as a photographer. In 1872 he made a series of photographs which proved that at one point in its stride a galloping horse has all four feet off the ground. His major work, published in 1887, was *Animal Locomotion: an Electro-photographic Investigation of Consecutive Phases of Animal Movements, 1872–1885,* 11 vol., containing 781 photoengravings.

Muybridge also developed the zoopraxiscope. a forerunner of the modern motion-picture projector. Photographs were mounted on a disk which when rapidly rotated recaptured the original motion of the subjectsand cast the enlarged images upon a screen.

Muybridge returned to Kingston-on-Thames in 1900 and died there May 8, 1904.

MUZAFFARGARH, a municipality, *tehsil* and district of Bahawalpur division, West Pakistan. The town (pop.. 1951, 11,271) is near the right bank of the Chenab, 20 mi. S.W. of Multan. Its fort and mosque were built by Nawab Muzaffar Khan in 1794–96.

MUZAFFARGARH TEHSIL had a population in 1951 of 234.856.

MUZAFFARGARH DISTRICT (area 5.601 sq.mi.; pop.! 1951, 751,-250) occupies the dagger-shaped southern end of the Sind-Sagar *doob* between the Indus and Chenab rivers. The northern half of the district is an arid plateau. the *thal,* in the cold months the grazing ground of the camel herds belonging to Afghan *povindah* merchants. Elsewhere in the district wheat. pulse, rice and indigo are cultivated. Irrigation is effected from the two rivers.

MUZAFFARPUR, a town and district in the Tirhut division of Bihar, India. The town, which is the divisional headquarters, is on the right bank of the Little Gandak river, about 36 mi. N.N.E. of Patna. Pop. (1951) 73,594. The town is well laid out along tn-o lakes and is an important trade centre. being on the Patna-Nepal route. Four colleges in the town are connected with Patna and Bihar universities. Muzaffarpur is the headquarters of the Behar Light Horse.

MUZAFFARPUR DISTRICT (area 3,018 sq.mi.; pop., 1951, 3,520,-739) is a plain watered by the Great Gandak, Baghmati and Little Gandak rivers and their tributaries; it is dotted with mango groves and clumps of bamboo. It is closely cultivated, rice being the main crop. The indigo industry, almost extinguished by the coming of the synthetic dye, was largely replaced by sugar.

Excavations revealed the remains of buildings of *c.* A.D. 300; hundreds of seals of the 4th or 5th century A.D. also have been found. At Kolhua, 3 mi. N.W. of Muzaffarpur, is a pillar crowned by a lion, set up by the emperor Asoka to mark a stage of his journey to Nepal in 249 B.C.

MWERU (or MOERU), a large lake of eastern central Africa. It lies 3,010 ft. above the sea, in a western branch of the great Tanganyika rift valley. The lake is about 75 mi. long by about 27 mi. in breadth, and is roughly rectangular. It is cut a little south of its centre by 9° S. Mweru, first visited in 1798 by F. de Lacerda. was reached by Livingstone in 1867, but its western shore was first explored in 1890 by Sir Alfred Sharpe, who two years later circumnavigated the lake. The eastern shores belong to Northern Rhodesia, the western to the Belgian Congo. There is one large island! Kilwa, in the southern part of the lake.

MYCENAE, one of the most ancient cities of Greece. The citadel on the summit is triangular with sides facing north, south-east and south-west. Part of the south-eastern wall and the palace within have been undermined by the torrent which bounds the lower town on the east. For the artistic significance of the various graves and building remains scattered among the groups of houses forming the lower town, *see* AEGEAN CIVILIZATION. Mycenae is a natural rock citadel standing in the north corner of the Argive plain flanked to north and south by deep ravines. It watched the hills, controlled the plain, and was the key to the road from the Gulf of Argos to the Gulf of Corinth which afforded the shortest route from Crete to central Greece.

The hill is roughly triangular with the apex pointing south and is defended by massive cyclopean walls. At the northwest angle is the Lion Gate surmounted by the famous limestone relief of two confronted lions ten feet high. The gate itself is about ten feet square and with its approaches is built of ashlar masonry in hard conglomerate. In the north wall is a smaller but similar gate and near it lies a secret underground cistern fed by the Perseian spring and approached by a subterranean passage from inside the walls. The extreme northeast angle is a later addition to strengthen this important point and to provide a sally port. Within the Lion Gate lies the Grave Circle enclosing the Royal Graves found by Schliemann and by it are ruined houses and storehouses. From the gate an inclined roadway leads to the summit crowned by the palace. This was built at different periods, but the ruins now visible belong in the main to the last great age of Mycenae. At the northwest angle was a columned entrance porch, and a throne room, a shrine, a bathroom, and a room with store jars have been found. On the south a wide staircase with two flights ascends to a spacious court. To the east a porch and vestibule open into the great hall *(megaron)* in the centre of which is a large circular hearth covered with painted stucco and surrounded by four column bases. The walls and floors of the *megaron,* court and vestibule were covered with painted stucco and there are plentiful remains of frescoes which adorned other rooms at different periods. West of the court a staircase led to the upper stories and to its north ran two parallel corridors giving access to other rooms at higher levels.

From the citadel a narrow ridge runs westwards so that its backbone forms the natural approach to the Lion Gate. Here are three of the beehive tombs (the Tomb of Aegisthus, the Lion Tomb, and the Tomb of Clytaemestra) and also the north wall of the Hellenistic lower town and the ruins of its gymnasium and theatre. At its west end a wider and longer ridge runs due south. Its northern end was included in the Hellenistic lower town and somewhere along it must have run the prehistoric road. On its east side stands the Treasury of Atreus, the largest beehive tomb, and on its west another, and all about are rock cut chamber tombs. Below its southern extremity the ravine which runs from the south side of the citadel was spanned by a prehistoric bridge on the road leading southeast towards the Argive Heraeum and Tiryns. Sub. sidiary ridges running westwards to the plain are also honeycombed with tombs among which are four more beehive tombs. On one ridge, Kalkani, traces of early Bronze Age occupation have come to light, and in the hollows are two ancient wells. On the peak of Hagios Elias which overlooks Mycenae to the north stands a small fort of the later part of the Third Bronze Age which clearly served as a signal station, for thence the whole plain can be surveyed from Asine to Argos with the passes towards Arcadia, Nemea and Cleonae and the Acrocorinthus itself can be seen. A system of built roads radiates through the hills from Mycenae and they and the signal station emphasize its strategic and political importance.

Argolis was inhabited in the Neolithic age by a branch of the race that occupied central and northern Greece. No settlement of this period has yet been found at Mycenae, whose history begins with the Bronze Age. Then the citadel was occupied by the bronze using folk of the Early Aegean period who seem to have come into Greece from the islands and southwest Asia Minor. There is no clue to the language of the neolithic race, but the Bronze Age people probably spoke a non-Hellenic tongue and brought into Greece the place names which end in -nthos, -assos, or -ene. Among these is Mykene, a heroine mentioned by Homer whose name is to Mykenai as Athene is to Athenai. It is hard to estimate either the date of the Bronze Age settlement, which probably existed before the third millennium *B.c.,* or its size, for ceramic remains, though frequent, are much disturbed by later buildings. With the beginning of the Middle Aegean period soon after 2200 *B.C.* a new racial element of unknown origin entered Greece. Its presence is marked by a class of pottery called Minyan Ware which has several varieties. The plentifulness of this and of a matt painted fabric, developed from the Early Bronze Age pottery at Mycenae, shows that the city prospered under this new impulse. As Minyan ware is practically unknown in Crete, though common in the islands, relations between Crete and Mycenae cannot have been intimate, and so the latter's expansion would have been mainly independent of Crete. Throughout the Middle Bronze Age, on the hillside where the Grave Circle and Lion Gate were afterwards built, a cemetery had been in use, as this was the nearest spot where the rock was soft enough for simple cist graves of the type usual at the period. Among them in one special area larger and deeper graves were hewn out to contain the remains of the princes, the famous Shaft Graves, the treasures of which, excavated by Schliemann, first revealed the great prehistoric civilisation of Greece. The earliest, the Sixth, contains some objects from Crete, but the bulk of its pottery is unmistakably indigenous.

This Shaft Grave Dynasty rose to power about 1600 B.C. almost coinciding with the establishment of the 18th Dynasty in Egypt and the renaissance of Knossos after its destruction towards the end of the Middle Bronze Age. Slight signs of Cretan influence appear shortly before, but now at the beginning of the Late Bronze Age Cretan fashions and art were largely adopted at Mycenae. Three explanations are possible: (1) that Cretans now conquered the mainland and displacing the native population colonized a large portion; (2) that Mycenaean kings, strong on land and sea, successfully raided Crete, bringing home rich treasures and craftsmen as slaves; (3) that the kings of Mycenae grew powerful and rich, entered into relations with Crete and absorbed its culture. The first view seems least probable because for one reason Cretan pottery of the date of the alleged conquest is extremely rare at Mycenae where local fabrics still continued. Which of the other two is more correct time alone can show. The "Crétoiserie" of the Shaft Grave kings can be compared to the European *Chinoiserie* of the early 18th century, which was not the result of a Chinese conquest of Europe. These kings undoubtedly resided on the summit of the citadel where there are traces of a "palace" underlying the later palace. No signs of a circuit wall have yet been found and in any case it would not have had the area of the later enceinte. Still the richness of the royal graves and of private tombs of the period shows that a high standard of civilisation had been reached. This was not due entirely to the adoption of the Cretan culture, but to the fact that the newcomers of the Middle Bronze Age, who may well have spoken Greek, were themselves keen, energetic, and well advanced in things material, and needed only the contact with Crete to develop artistically as well.

Towards the close of the 16th century B.C. a change in royal burials indicates a new dynasty, which laid its princes in stone built beehive tombs from 25 to 50 feet in height and diameter. Nine such tombs exist at Mycenae. Their architecture displays gradual advance in technical matters, the use and cutting of materials and the handling of the problems of stresses and weights, so that they fall by progressive development into three groups of three tombs each. The first group belongs to the later 16th and to the early 15th century B.C. and the second group to the later 15th century. The earlier tombs were smaller, the construction primitive, the material inferior, the stone unshaped, and stresses not understood. The second group is larger and better built, the stone was hewn but not sawn, and a relieving triangle over the lintel was employed. In the two first groups the finest are the Tomb of Aegisthus and the Lion Tomb which last was closed with a door and threshold instead of rude stone walling. The first Beehive Tomb kings must have lived in the citadel but, apart from signs of their activity in the palace area, no other building can be definitely assigned to this date. The standard of culture was the same and there was intercourse with the islands, Crete and Egypt. The private tombs show that comfort was extending and the rather simple rock cut tombs of the 16th century now developed into spacious chambers with wide entrances.

After 1400 B.C. when Knossos fell and Egypt decayed under the last Amenhoteps, Mycenae, which had been rapidly developing since the end of the Middle Bronze Age, now took first place. Greek traditions, Homer's picture of Agamemnon as suzerain of the princes who sailed against Troy, and its mighty ruins, all bear witness to its greatness. Under the aegis of Mycenae ruled by the later kings of the Beehive Tomb Dynasty the Minoan-Mycenaean culture spread throughout the Eastern Mediterranean, and echoes of this are found in Homer. To this great age the majority of the amazing buildings at Mycenae belong. The palace was reconstructed on a large and sumptuous scale, the cyclopean walls of the citadel were built with the Lion Gate. Within the walls rose storehouses and residences for the civil and military officers of the court, and for their guards and servants. The royal Shaft Graves with part of the old cemetery were enclosed within the enceinte and the space round them was levelled, ringed with standing slabs, and made into a sacred area for the worship of the dead princes.

These later kings of the Beehive Tomb Dynasty to whose energy and ability the greatness of Mycenae seems so largely due, were buried in the last group of Beehive Tombs, the Treasury of Atreus, the Tomb of Clytaemestra, and the Tomb of Genii. These are naturally the best in construction, plan and size, and are built throughout of hard stone, mainly sawn. Each had a door, and a threshold constructed on a wedge principle. The understanding of stresses and of the means to counteract them shows that their architects profiting by earlier experiments perfected their methods and materials, so that two of these tombs still stand almost intact. The Treasury of Atreus is structurally so like the Lion Gate and the palace that it is possible that the royal builder of the two latter prepared the former as his tomb. The same style occurs in the walls and palace at Tiryns which are contemporary. The civilian population of Mycenae must have lived in undefended settlements on the neighbouring hills and the many cemeteries of this date divide into local groups suggesting separate communities. The tombs are carefully hewn in the rock with long narrow entrance passages and were furnished with objects in pottery, bronze, glass, ivory and gold, which show that the culture of Mycenae at its zenith even if less artistic displays wonderful technical ability. During the 14th and 13th centuries B.C. at Mycenae not only were crafts such as the potter's intensively and skilfully practised, but also professions such as those of engineers and architects, for the cyclopean walls and great domes like the Treasury of Atreus imply structural genius.

Troy according to tradition was taken early in the 12th century. Then, as the use of iron spread, the Iron Age began and as the contemporary Egyptian records say "the Isles were restless." This was the age of the Dorian Migration. Then Mycenae fell and the palace and houses were burnt. The walls, however, were not destroyed and as such a stronghold could not be left untenanted Mycenae was inhabited during the early Iron Age, but was of small importance as Dorian Argos usurped her place. As a small city state it preserved its independence and a Doric temple of Athena who ousted the local heroine Mykene arose early in the sixth century upon the ruins of the palace of the Bronze Age kings. Some sculptures from this temple survive. The débris among the ruins proves Mycenae's continuous existence, through the geometric, orientalising and archaic periods of Greek art down to the Persian Wars. Then Mycenae sent her small contingent to join in resisting Xerxes' invasion. Her men fought at Plataea in 479 B.C. and the name Μυκανῆς can still be read on the serpent column from Delphi now in the Hippodrome at Constantinople. Argive jealousy, however, could not forgive and in 470 B.C. when Sparta was in difficulties an Argive army besieged Mycenae. The citadel was starved out, its walls and buildings were overthrown and the site laid waste.

In 235 B.C. the Argive tyrant Aristippos was murdered at Mycenae which like other small towns dependent on Argos was probably reoccupied by the Argive tyrants of the third century B.C. during their struggles with the Achaean League. The walls of the citadel were repaired and part of the hillside on the south was walled in to make a lower town. In this lay a small theatre directly above the Tomb of Clytaemestra and by it was a gymnasium. The Doric temple, which the Argives had perhaps spared in 470 B.C., still stood on the summit of the citadel. Inscriptions dating probably from 194 B.C. and referring to Mycenae's relations with Argos and Nabis of Sparta give some details of its government. After Argos was freed from Nabis Mycenae vanishes from history and Pausanias in the second century A.D. makes no mention of inhabitation. A few remains of the Roman period have been found so it cannot have been entirely deserted, but the depopulation of Greece must have affecred Mycenae and a few inhabitants among ruins so famous would give every impression of desolation. Soon after it must have been completely deserted, for there are no traces of Byzantine or later occupation.

The site of Mycenae was never forgotten as Pausanias who saw the Lion gate shows and when Greece began to be revisited by travellers from western Europe it became a place of pilgrimage. Excavations were begun by Schliemann who made soundings in 1873. but conducted his epoch-making campaign in 1876 when he found the royal Shaft graves. Stamatakes followed from 1877 to 1879 when he found the sixth Shaft grave and cleared the Treasury of Atreus. From 1886 to 1902 Tsountas in a fruitful series of excavations cleared several houses, and found the palace, three beehive tombs and a large number of private tombs. Rodenwaldt did valuable work on the frescoes in the palace between 1912 and 1914. From 1920 to 1923 Wace excavated here for the British school at Athens, when many tombs were found and new and important results were obtained from the Grave circle, the Beehive tombs and the palace.

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MYCETOZOA or **MYXOMYCETES.** The lower members of the plant and animal kingdoms approach each other so closely that it is often difficult to decide to which they belong. Among such organisms are the remarkable Mycetozoa. Literally the term means "fungus-animals," and rhe synonym preferred by botanists is Myxomycetes or "slime moulds," the latter being a common designation for the assemblage. While students have disagreed as to the types embraced by the name Mycetozoa, all are agreed that the rather homogenous assemblage known as the Myxogastres must be included. Indeed, since the beginning of the 20th century the tendency has been to limit the definition of the Mycetozoa to the point where it is customary to use, as does this article, either Mycetozoa, Myxomycetes, or slime moulds as synonyms for the stricter designation, Myxogastres.

The Plasmodium. — The stage in the life cycle of the Mycetozoa which has commanded most attention begins by the sexual fusion of microscopic gametes. Nuclear division commences in the amoebalike zygote, but unlike true amoebae the zygote does not split following nuclear division. Thus, with repeated nuclear divisions there is formed a creeping, jellylike plasmodium of no fixed shape, containing many nuclei. As the plasmodium grows, the amoeboid creeping is no longer feasible by the extension of a pseudopod into which the mass of protoplasm flows or which pulls the rest after it; the diffusion of oxygen to the interior, the excretion of waste and the intake of nutrients impose conditions which a rather compact amoeba can no longer meet.

Therefore. the plasmodium becomes thin and sheetlike, broken into interconnecting strands of protoplasm, and assumes a fanlike shape. The plasmodium, by the time it is easily visible to the unaided eye, has already achieved the characteristic fanlike appearance; and the fan both grossly and microscopically has distinguishable regions. The front comprises a broadly curved sheet of protoplasm, usually with a raised anterior border. Just posterior the sheet is thinner, and microscopic examination shows that it is formed of gelled protoplasm crossed by anastomosing strands of liquid protoplasm in active streaming motion. Toward the rear the sheet begins to break up into strands until the trailing end of the plasmodium is fdrmed of a few strands, or frequently a single strand, of protoplasm.

The vivid protoplasmic streaming shown by the Mycetozoa has excited the curiosity of naturalists since it was first observed. In the strand5 of the plasmodium it is somewhat rhythmic, the flow being first in the general direction of the front, then slowing, coming to a full stop and reversing. The forward creeping of the plasmodium is at least in part because of the accumulation of protoplasm at the front by forward streaming. The reverse streaming does not last for so long a period as the forward flow and presumably has the function of depositing waste to the rear.

While because of its mass a large plasmodium may not change shape as rapidly as an amoeba, the shape is by no means constant. A plasmodium may reverse its direction of creeping either by turning around or by simple reversal of the main protoplasmic flow, in which case the former rear now becomes a broadly fan-shaped front. At times small secondary fans are formed which may be later resorbed, or not infrequently may finally separate from the parent. The fan shape is typical only of plasmodia on a smooth substrate in the laboratory or on the surfaces of logs, leaves and other vegetable debris. For these plasmodia which live within decsyiag wood the fan shape is obviously impossible, and the plasmodium is a loosely flung network through fissures, within vessels and along the tunnels of boring insects.

If a strand of a vigorous plasmodium is severed, there is an immediate welling out of the fluid endoplasm which may continue until a drop the size of a pea or larger is formed. Almost immediately there is gelation of the endoplasm at the surface which continues toward the interior, and in a few minutes the entire drop becomes a soft but firm mass. If placed on a new substrate, -it forms a small plasmodium; if left in place, it is resorbed in a matter of hours.

Simultaneously with the injury, the strand usually gels for some distance on either side of the cut, so that further flow does not occur until the interior reverts to its former fluid state. The fluid-gel reversal also occurs naturally. The flowing protoplasm of a channel may come to rest and gel, while adjacent protoplasm will become fluid and begin to flow, thus creating a new channel.

Although mycetozoan plasmodia, because of their often great size, have been used frequently for studies on the physiology of undifferentiated and primitive protoplasm, the protoplasm is neither particularly primitive, undifferentiated nor more resistant to abuse than the protoplasm of more conventional cells. Rough mechanical treatment may kill part or all of the plasmodium; it may be overwhelmed by bacterial contamination; and the protoplasm of some forms is sensitive to lack of oxygen and to excessive wetting.

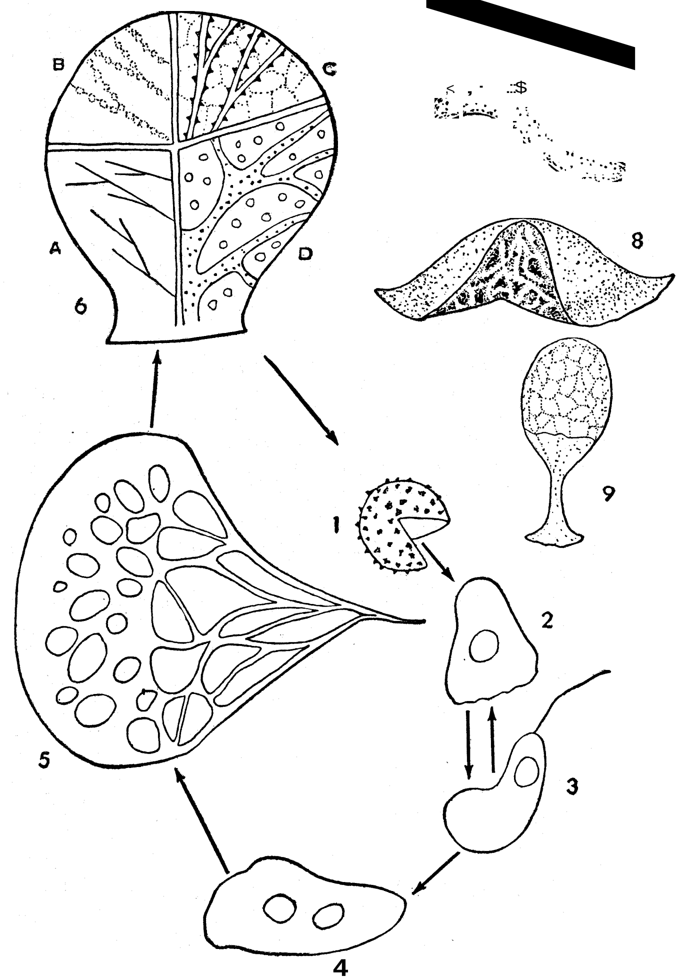
Most of the Mycetozoa are terrestrial forms which spend their vegetative existence creeping in and among damp, decaying leaves, twigs and logs. Nutrition and safety are aided by tactic behaviour — the oriented response to external conditions, such as light, moisture and food.

Negative chemotaxis is exhibited in the laboratory by movement away from stale to fresh substrates and by the avoidance of certain bacterial colonies. Positive chemotaxis is often dramatically shown toward other bacteria or fungi, as when the plasmodium of *Physarum polycephalum* envelops and digests a large mushroom down to an unrecognizable slimy mass within a day after first contact has been established.

Plasmodia from the field are often seen to be crowded with fungus spores, woody particles and other debris indicating an animal-like ingestion of particles, some of which might have nutritive value. But other data indicated that the chief mode of nutrition was saprophytic, the absorption of the dissolved products of decaying organic matter.

In 1939 it was shown that plasmodia could partially digest vegetable substrates but could not grow indefinitely upon them alone. Micro-organisms were also necessary, and indeed plasmodia could grow indefinitely solely by ingesting various killed or living bacteria or yeasts, thus making it probable that the chief mode of nutrition is animal-like.

Life History. — The plasmodium does not always remain in a fluid state of differentiation, but under ill-defined conditions it generally seeks an elevated place for fruit formation. The details of fruiting body formation differ from group to group, but usually the plasmodium breaks up into small globules which become invested with pellicles which dry into the peridium. The globules may remain sessile on the substrate or be elevated on stalks while within the sporangium the protoplasm forms tubular vacuoles, the walls of which become lined with secreted material forming a branched or network system which hardens into the capillitium. Further successive division of the protoplasm results in separa-



FIGS. 1—9.— LIFE CYCLE AND TYPES OF FRUITING BODIES IN MYCETOZOA

All figures highly diagrammatic; figs. 1–4, magnified approximately 1,000 ×; 6, 7 and 9, approximately 12 ×; 5 and 8, approximately life size. Fig. 1. — Emptied spore case from which myxameba (fig. 2) has escaped. Fig. 3.— Swimming stage (gamete) which may revert back to myxameba or fuse in pairs. Fig. 4.—Fused gametes, flagellae retracted, nuclei unfused. Fusion of nuclei and growth of zygote produces plasmodium, fig. 5. Fig. 6.—Sessile fruiting body showing stages of development: A, formation of strain lines in protoplasm which develop into chains of vacuoles; B, C, coalescence of vacuoles to form system of hollow tubes; protoplasm is cleaving into blocks from which spores are formed; D, mature fruit, granule-filled capillitium with a few spores in the meshes. Fig. 7.—Plasmodiocarp. Fig. 8.— Aethalium as in *Fuligo septica*, cut open to show black spore masses and interlacing walls of the separate, imperfect sporangia. Fig. 9.—Stiped fruiting body of *Arcyria*, showing the expanded capillitial network

tion of each nucleus with its surrounding protoplasm as a spore. Investment of the spore with a firm wall and drying of the sporangium releases the dry, microscopic spore for dissemination by wind. In some genera such as *Arcyvia* and *Trichia* the capillitium plays an active role in spore dispersal. With the drying of the fructification, the peridium is burst by the elastic capillitium, spores being scattered by the sudden expansion of the capillitium and by the constant twisting of its threads with changes in the moisture content of the surrounding air.

On attaining a suitable wet environment, the spore absorbs water, nuclear division occurs and the spore wall is either ruptured or partly dissolved to release two or more swarm cells or, more frequently, an amoeboid mass which soon divides into uninucleate swarm-cells. The swarm cell of the Mycetozoa has two interchangeable phases, an amoeboid, creeping stage, in which it crawls over the substrate ingesting bacteria and other particles, and a swimming stage, in which it is comma-shaped with a flagellum projecting from the anterior, tapering end.

Since 1911 there is agreement that the swarm cells are sexual cells or gametes; prior to that time it was thought that the plasmodium was formed either by nonsexual fusion of swarmers or that nuclear fusion took place before germination of the spore. It is probable that such early concepts and some later disagree-

ments may be because of the difference in plasmodial behaviour de-
pendent either on species or on conditions of formation.
The coalescence of groups of swarm cells probably results in nuclear pairing and fusion within the young plasmodium at a later period, while pairing of gametes may result either in immediate or delayed nuclear fusion. With fusion of the gametes, retraction of flagella and nuclear fusion, the plasmodium is initiated as previously described.

There are alternative resting conditions which, unlike spore formation, do not result in propagation. The swarm cell—on fouling of the medium, starvation or desiccation—may surround itself with a smooth cyst wall to await the return of favourable circumstances. Under similar circumstances the plasmodium may form a sclerotium. Microscopic examination shows that the plasmodium has divided into numerous cells, which may contain from 1 to more than 20 nuclei each. These sclerotia retain their viability when dry, viability having been recorded up to 20 years, though 3 years is the usual limit. On being moistened, the cyst walls are dissolved, the contents of the cysts coalesce and the plasmodium resumes vegetative activity.

Extent of the Group.—Approximately 500 species of Mycetozoa are known. Identification of genus and species is based on the fruit, for the plasmodia are usually very similar in appearance and of inconstant colour, the prevailing colours being yellow, orange and buff to watery white. In all genera except *Ceratiomyxa* the spores are obviously borne within fruiting bodies. In *Ceratiomyxa* the fructifications are apparently composed of pillars or ridges, with the spores borne individually on minute stalks. The researches of H. C. Gilbert, however, indicate that the so-called spores are sporangia reduced to the extreme degree where each contains one spore.

Diagnosis of family, genus and species is made, in order of importance, on the colour of the spores, the existence of a capillitium, the presence or absence of calcium carbonate granules in the sporangium wall and in the capillitium, the type of fruit and the often beautiful sculpturing of the capillitium and of the spore walls. The fruits are of several types. The individual sporangia may be sessile on the substrate or on a thin horny sheet, the hypothallus, or raised on a stalk. Some species fruit without breaking up into individual sporangia, the fructifications, called plasmodiocarps, resembling more or less completely the strands of the plasmodium. The aethalium is a type of fructification consisting of fused individual sporangia or of plasmodiocarps. In some cases the walls of the separate sporangia comprising the aethalium may be reduced to threadlike remnants resembling the capillitium and known as a pseudocapillitium.

Field observations and laboratory cultivation indicate that fructifications derived from a single plasmodium may vary greatly in type, depending on external conditions at the time of sporangium formation. Thus, the author has found the well-known *Physarum polycephalum* fruiting as plasmodiocarps and as sessile sporangia as well as the typically stalked forms with convoluted sporangia.

Other Groups Sometimes Included with the Mycetozoa.—The Acrasieae (or Sorophoreae) constitute a remarkable group of organisms which engage in communal encystment. The vegetative stage is passed as small individual amoebae indistinguishable from the many other small amoebae which inhabit the soil and decaying vegetable matter. The vegetative period is also the period of reproduction by fission, a sexual cycle not being established for the group. At the completion of the vegetative period the amoebae creep toward a common centre, the converging streams of their closely packed cells recalling the strands of a plasmodium; and therefore this stage is known as a pseudoplasmodium. The pseudoplasmodium becomes more compact, and in the lower forms all the individual amoebae encyst, to be scattered by wind or rain as a prelude to excystment and commencement of the vegetative stage. In the higher forms, such as *Polysphondylium* and *Dictyostelium*, the cells comprising the pseudoplasmodium become differentiated, some of them being sacrificed to form the vacuolated, polygonal cells of the stalk and branches (sorophores), on which are borne the heads of cysts (sori). In the highly developed *Dictyostelium discoideum* the entire pseudoplasmodium migrates as a unit before fructification. For an account of this remarkable group the reader is referred to the papers of Kenneth Raper.

The Labyrinthulae is a group very imperfectly known and with certainty containing only the type genus, *Labyrinthula,* whose species are all parasites of aquatic plants, one being the cause of an economically important disease of eel grass *(Zostera marina).* The characteristic structure of *Labyrinthula* is the net-plasmodium, which unlike the true plasmodium of the Myxomycetes, shows only partial fusion of the individual cells. The spindle-shaped bodies are connected to each other by a network of slender extensions along which they move with relation to each other. Prior to 1929 it was generally believed that these strands were pseudopodial extensions, but work since that date indicates that they may be nonliving tubes or threads along which the spindles glide. The life cycle is still very obscure, only vegetative division and cyst-formation having been observed.

The Plasmodiophoreae in some respects approach most closely the Mycetozoa in life cycle and in morphology. The vegetative state is a plasmodium, parasitic in higher plants, which eventually breaks up into spores. On being freed from the host, and on germination, these spores produce anteriorly flagellate swarm cells which gain access to the host through the root hairs.. There is little agreement on the details of the life cycle, but there is reasonable agreement that these swarm cells are gametes, and on fusion initiate the plasmodium either immediately or after an intermediate stage.

Relationships. — Forming, as they do, small fruiting bodies resembling those of the higher fungi, it is understandable that for a very long time the Mycetozoa were supposed to be a division of the Gasteromycetes, hence the name Myxogastres. Not until the classical work of Heinrich Anton de Bary was it made clear that these forms were not to be grouped with the highly specialized puff balls, but instead were related to very primitive forms resembling both plants and animals.

In some respects the Mycetozoa resemble the lowest fungi— the chytrids, some of which may spend a large part of the life cycle without a firm cell wall. In other respects, they recall strongly the amoeboid-flagellate line with its borderline members such as the flagellate amoeba, *Mastigamoeba.* A. Pascher has described the chlorophyll-bearing counterparts of the Mycetozoa, Labyrinthulae and of *Mastigamoeba,* and it is well recognized that any line drawn across the flagellates to separate plants from animals is an arbitrary one. While close relationship with the amoeboid-flagellate line is very likely, the Mycetozoa probably form an evolutionary blind alley of their own.

As to the relationships between the Mycetozoa as defined here, and the Plasmodiophorae, Acrasieae, Labyrinthulae and other curious forms such as *Vampyrella* and Proteomyxa, too little is known of the life history to group these forms together with any certainty, or else increased knowledge has widened the gulf between the Mycetozoa and some divisions formerly included with them, such as the Acrasieae.

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MYCOLOGY is the science of fungi (Greek *myco,* "a mushroam." *logy,* "discourse"), and is dealt with in the article Fungi.

MYCORHIZA (Mycorrhiza), a word used to describe several types of partnership between a fungus and the roots of a higher plant. The term mycorhiza, derived as a compound of the Greek terms for "fungus" and "root." also designates the composite organs formed by the fungus and the host plant. and has been extended to include organs in which the component of the higher plant is a rhizome (underground stem) or thallus (undifferentiated plant body) rather than a root. Such growths are common on the roots of trees and many other plants. Since the organs of the host plant are unharmed, although modified in structure, and root growth may be stimulated. these associations are considered symbiotic or mutually helpful.

The roots of land plants live in soil. competing therein for water and nutrients with a crowded population of microorganisms. This population varies greatly in density depending on the various components of which the soil is composed, and great densities of colonization occur in the immediate environs of living roots. The soil surrounding the roots is called the rhizosphere and in this region, and on the surfaces of roots themselves, populations of fungi. differing in number and kind from the general soil population, are present. Many of the organisms of the root region are specialized in nutritional requirements and have important effects on their hosts in respect to their potential to cause or inhibit disease or to affect the availability of nutrients.

Many species of land plants enter into an even closer association with certain fungi in which they form composite organs of root and fungal tissues. This phenomenon was comparatiyely well known, especially to foresters, when in 1885 the German botanist A. B. Frank coined the name mycorhiza for the fungus root organs of forest trees, especially oak, beech, hornbeam and other members of the Cupuliferae and certain conifers, to register his view that these constituted an organ of importance in nutrition. He put forward the hypothesis, based on observations and experiment. that in woodland conditions certain trees normally were infected by fungi that formed mycorhizae with their roots. Later he and others described analogous associations of fungi with roots and absorbing organs of many other plants and distinguished various other kinds of mycorhiza. Robert Hartig and other botanists took the view that these fungal infections were of a parasitic nature and it was not until the end of the 19th century that mycorhizal associations were accepted as a natural and healthy condition of many plants.

Distribution. — Mycorhizae are formed by liverworts, ferns. club mosses and conifers and by flowering plants of most families. Analogous associations, the lichens, are formed between algae and fungi. Mycorhizae are constantly formed in certain groups of seed plants (*e.g.,* Orchidaceae. Ericales) and are invariably developed by saprophytic species lacking chlorophyll. Fungal infections, similar histologically to living examples of certain mycorhizae. have been observed in fossils such as the Psilophytales from the Devonian period and the Cordaitales from the Carboniferous period. The widespread occurrence of mycorhizae in living and fossil plants and their universal presence in diverse saprophytes are arguments supporting the view that infections of this kind are of selective value to the host plants.

Structure of **Mycorhizae.**—It is still convenient to recognize two main types of mycorhizal structure and to use the descriptive names given to these by Frank. The ectotrophic types are specially characteristic of many forest trees in which the fungal mycelium completely invests the tips and younger portions of the root with a sheath of compact fungal tissue. From the sheath. hyphal branches penetrate between the cortical cells to form a network but rarely penetrate into the cells themselves. The endotrophic types of infection are more variable than the ectotrophic types and are characterized by the absence of a fungal sheath although there may be in some a profuse development of extraradical mycelium. The hyphae or branching threads penetrate the cortex of the root, usually entering the cells where they form coils or branched haustoria. In the majority of endotrophic infections the hyphae at some stage disintegrate or are digested within the host cells, liberating soluble products that presumably become available to the host.

Ectotrophic mycorhizae are to a great degree uniform in structure regardless of the species of host plant. Their main variability lies in the extent of penetration of the cells of the host and in the thickness of development of the sheath. Some, in which the cells are heavily penetrated, have been called ectendotrophic mycorhizae; others. in which the fungus appears to give rise to slight parasitic symptoms, have been called pseudomycorhizae. These variations seem to be due to the species of fungus involved and to conditions of growth.

By contrast, endotrophic mycorhizae do not comprise a single natural kind of mycorhiza. That found in the Orchidaceae, some Gentianaceae and in certain liverworts, for instance, differs markedly from that of Ericaceae, although in both the fungal hyphae are septate and form coils within the cells. Again, plants belonging to many other Angiosperm families such as Gramineae, Leguminosae and Rosaceae, to conifers such as cypress and yew and to certain groups of liverworts and ferns form mycorhiza with fungi lacking septa (walls) in their hyphae which form large branched haustoria and swollen vesicules in their cells. In the ensuing paragraphs a few important kinds of mycorhiza will be described.

Mycorhiza of Trees.—The ectotrophic mycorhiza of forest trees is easily recognized. Each rootlet is enveloped in a sheath of fungal tissue, branches from which penetrate on the one hand into the cortex and on the other into the soil. In most species the infected roots are aggregated into racemose systems of short rootlets borne upon long mother roots of more normal appearance. These mother roots are, however, normally infected in some way, either by a network of hyphae in the cortical cells or by a superficial fungal sheath. The young short branches consequently become infected as they grow out through the cortical tissues of the mother root. The mycorhizal rootlets of pines differ from those of other trees in being forked rather than racemosely branched.

Many of the characteristic fungi of forests have been isolated into pure culture and some have been shown experimentally to form mycorhizae with trees. These belong mainly to Hymenomycetes or toadstool fungi, of which genera like Boletus, *Russula,* Tricholoma and Lactarius include many mycorhizal species. Some Gasteromycetes (puffball fungi) such as *Rhizopogon* are mycorhizal, as are a few Ascomycetes. By cultural experiments 50–100 species have been shown to be capable of forming mycorhizae with forest trees and these show variable specificity. For instance, Boletus *elegans* is known to form mycorhizae only with larch, whereas Cenococcum graniforme forms them with numerous and varied tree species.

Elias Melin and his colleagues in Sweden demonstrated that most of these mycorhizal fungi have characteristic nutritional requirements. They usually are dependent upon a supply of simple carbohydrates, vitamins and growth factors. Although in this respect there is considerable variation among them, their development on root surfaces is to some degree explicable by their nutritional characteristics. Some produce as end products of their metabolism substances with auxinlike properties that can affect the pattern of root growth and this affords a partial explanation of the characteristic form and structure of mycorhizal rootlets.

Although totally uninfected individuals of mycotrophic trees are probably never found in nature, the intensity of mycorhizal infection varies, especially in seedlings. Such variation has its explanation in the nutritional status of the host plant. Adequate or excessive supply of nutrients in the soil tends to confer resistance on the host, whereas deficiency or lack of balance in one or more nutrients predisposes the host to infection. At the same time infection occurs abundantly only on plants with excess of carbohydrates in their root systems. Hence plants grown in low light intensity or in normal light intensity with high nutrient supplies are deficient in mycorhizal development. This complex interaction of carbohydrate status and mineral nutrient status upon susceptibility of hosts to infection, which was first shown by E. Björkman, has not been fully explained. Reasons have been sought in the change in nature or quantity of substances secreted by the roots of host plants. Similarly, the effects of auxinlike secretion of mycorhizal fungi have been shown to give a partial explanation of the change of histological pattern in the cells of the host roots. Both these problems are being actively investigated by research workers.

By contrast with those on natural sites, it has been observed that plantations of exotic trees, especially conifers, in areas far removed from their normal habitat sometimes fail to produce mycorhizae when first planted. Such plantations often fail to develop normally but sometimes recover after inoculation with suitable mycorhizal fungi. In controlled experiments, where inoculation has been done with pure cultures, it was shown that mycorhizal plants grow faster and absorb nitrogen, phosphorus, potassium and other nutrients at a faster rate from poor soils than do uninfected control plants. It was concluded that mycorhizal root systems are able to extract nutrients more rapidly from deficient soil than uninfected systems and that they pass these nutrients on to the host plant.

In some degree the explanation of these results is to be found in the effect of mycorhizal infection upon the form of the root system, for the fungus appears to stimulate root growth and to prolong the life of the feeding roots. In addition it was shown, using isotopically labeled nutrients, that the hyphae connecting mycorhizae with the soil may absorb and pass substances to the host and that the sheath tissues themselves are capable of a greater rate of absorption of some nutrients than are uninfected roots. Mycorhizal roots accumulate rapidly great quantities of some nutrients into their sheath tissues and this may be translocated to the host under suitable conditions.

Root systems equipped with ectotrophic mycorhizal rootlets are nutrient-absorbing organs of great efficiency that can compete with other soil inhabitants and confer a selective advantage on their host plants.

The ectotrophic mycorhizal habit, characteristic of forest dominants in the temperate regions of the northern hemisphere, is also found in southern hemisphere trees such as renantheroid Eucalypts.

Mycorhiza in Ericaceae and Related Families.—In the northern hemisphere certain members of the family Ericaceae, *e.g.,* heaths (Erica *spp.*), ling or heather (Calluna) and cranberry and bilberry (Vaccinium) and Empetraceae, *e.g.,* crowberry (*Empetrum*), are constant features of the vegetation of acid humus soils—moorland and woodland—on which they often dominate large areas almost to the exclusion of other plants. In the southern hemisphere, Epacridaceae have a somewhat similar habit.

The mycorhiza of these plants is of the endotrophic type with certain characteristic features, in some respects showing points of resemblance with that of trees. The young roots are of small diameter and the outermost layer of cells forms a definite mycorhizal zone. In favourable soil conditions practically every cell in this layer is filled with a densely branched complex of fungal hyphae from which strands of mycelium extend outward into the soil. The growth of the mycelium on the outside of the roots is usually profuse and in some species, *e.g.,* arbutus, may resemble the sheath of ectotrophic mycorhizae. In the cells the hyphal complexes are subject to digestion and the resulting products appear to be absorbed by the host cells.

There has been some disagreement between research workers who have investigated the mycorhiza in Ericaceae. Some described a cyclic symbiosis in which all the organs of the host plant were infected by fungal hyphae so that the seed coat became infected before seed dispersal and the seedlings became infected early in germination. Normal germination and growth failed if infection did not take place. But the evidence against this view of mycorhiza in the Ericaceae is stronger than that for it, since asymbiotic germination of many species has been brought about in sterile natural substrates and great difficulty is experienced in obtaining evidence for fungal infection of stems, leaves and floral parts.

At one time the mycorhizal fungi of Ericaceae were believed to belong to the imperfect genus *Phoma,* which may be capable of fixing atmospheric nitrogen. This is questionable since several fungi other than *Phoma* produce typical mycorhizae with many ericaceous species. Many commonly held opinions concerning the functioning of this mycorhiza probably are of doubtful validity.

Work after 1955 on the *Pernettya* genus of evergreen shrubs further emphasized the similarity of the mycorhizae of Ericaceae with that of forest trees. In respect to both the factors affecting intensity of infection and the rate of salt absorption from deficient soils, similarities with ectotrophic mycorhizae are apparent.

Mycorhiza of Orchids.—The mycorhiza of orchids is endotrophic and the mycelium is widely distributed throughout the cortex of the root. or in rootless forms: in the chlorophyll-free tissues of the absorbing organs. Two contrasted types of cell usually are observable: "host" cells containing active hyphae and "digestion" cells in which hyphal digestion or disintegration occurs. In the former the mycelium fills the cells with skeins or "pelotons" of characteristic appearance and is believed to extract nutrients from the host. In the digestion cells the contents of the hyphae are released to the cells.

The French botanist Noel Bernard and the German botanist Hans Burgeff were responsible for important researches on orchid mycorhiza. Fungi mere isolated into pure culture from the roots and shomn, by back inoculation into sterile seedlings, to be capable of mycorhiza formation. Many of these fungi belong to the imperfect genus *Rhizoctonia,* of which some species are known to be dangerous parasites and others weak root-inhabiting parasites. *Rhizoctonia solani* is a parasite of many plants but also forms mycorhiza with at least one orchid. Certain mycorhizal *Rhizoctonia* species, including *R. solani,* are capable of forming basidiomycete fructifications in some conditions and may be referred to the genus *Corticium.* Basidiomycetes in perfect state such as species of *Fontes, Xerotus* and *Armillaria* form mycorhiza with saprophytic orchids. The majority of these fungi have the ability to utilize as carbon sources many resistant substances of soil and plant material; many utilize cellulose and some lignin also. In this respect the fungi of orchid mycorhiza are contrasted with those of ectotrophic mycorhiza.

The minute seeds of *Orchidaceae* usually do not germinate in natural substrates unless they become infected by appropriate fungi. They may. as L. Knudson first showed, be stimulated to germination in aseptic culture if given appropriate conditions. Research upon the conditions required for aseptic germination indicates that the provision of soluble carbohydrate is all that is needed in some cases. but more often the seed is unable to synthesize some essentials. For instance, many orchid seeds require nicotinic acid or nicotinamide (precursor of the enzyme cocarboxylase) before germination proceeds.

After germination the tiny orchid seedling grows saprophytically, usually for a period of years, before producing organs above ground. Hence, even those species that become self-supporting in respect to carbon compounds as adults are saprophytic and dependent on fungal activity in youth The mechanism whereby the fungi of orchids improve the supply of carbon compounds to their hosts is not fully understood It is however, probable that the hyphae in the substrate absorb carbonaceous substances and conduct them into the host where they are released by both direct secretion and digestion

Mycorhizal infection similar to that of orchids is found in many other plants. including some of the *Gentianaceae* (gentian family) and some liverworts. including Cryptothallus, the only saprophytic member of the group

Mycorhiza of Common Crop Plants.—By far the commonest type of inycorhiza is that in which the fungi concerned are of the class Phycomycetes with aseptate hyphae. In these endotrophic mycorhizae the main hyphae may either grow betaeen the cells of the cortex of the host or be completely intercellular. In both cases specialized lateral branches of small diameter are formed that ramify dichotomously in the cells to form complex haustorial organs called arbuscules. In addition the main hyphae may also form large swellings or vesicules in or between the cells. In many cases the fungal hyphae are also present in the soil on or around the roots and the extraradical vesicules may be formed. In spite of the presence of profuse mycelium in the soil around many of these mycorhizae great difficulty has been experienced in culturing the fungi and so in learning anything of their physiological properties.

The roots of plants infected with vesicular-arbuscular mycorhiza are often little modified in form or structure. Indeed the majority of common angiosperm crop plants, *e* g., Gramineae (grasses and cereals) and Leguminosae (clover, peas. beans, etc.) are infected in this way as also are Rosaceae (roses, apples, pears. peaches, strawberry. etc.). Among the conifers this form of mycorhiza is common in all families except Pinaceae. so that many forest dominants, *e.g.,* cypresses. redwoods, yew. etc.. are infected. Many ferns, club mosses and liverworts also have this mycorhiza. w

As yet there is no conclusive evidence that mycorhizal infection of this type has any marked effect on the growth of the host plant. Experiments have been impeded because of the difficulty of isolating the fungi into pure culture. After 1950 two lines of research gave promise of providing results. On the one hand it was sho n that a species of *Endogone* can produce mycorhizae of this type with many Rosaceae. On the other hand the phycomycetous parasite *Pythium ultimum* was isolated from mycorhizae of wild garlic and is said to be capable of forming mycorhizae with various plants when back inoculated. These lines of investigation may lead to fuller understanding of the commonest type of mycorhiza.

See also FUNGI: *Nutrition and Functions;* SYMBIOSIS.

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MYELITIS, from the Greek word meaning marrow. is used in medicine in accordance with the significance of the root and ending to mean an inflammation of the marrow of the bone as osteomyelitis or of the spinal cord as in poliomyelitis. A large number of descriptive adjectives are used to describe more accurately the various types of disorders involving the spinal cord. *See* BONE, DISEASES AND INJURIES OF; NERVOUS SYSTEM; SPINAL CORD, etc. (F. L. X.)

MYERS, FREDERIC WILLIAM HENRY (1843–1901), English poet and essayist. son of Frederic Myers. was born at Keswick. Cumberland, on Feb. 6. 1843, and educated at Cheltenham and Trinity college. Cambridge; where he was appointed classical lecturer in 1865. He had no love for teaching, which he soon discontinued, but he took up his permanent abode at Cambridge in 1872, when he became a school inspector under the education department. He published poems, for instance *St. Paul,* but is more likely to be remembered by his *Essays, Classical and Modern* (2 vol., 1883). The essay on Vergil, by far the best thing he ever wrote. represents the matured enthusiasm of a student and a disciple to whom the exquisite artificiality and refined culture of Vergil's method were profoundly congenial. In 1882 Myers led a small band of explorers (including Henry Sidgwick and Richard Hodgson. Edmund Gurney and F. Podmore), who founded the Society for Psychical Research. He was the mouthpiece of the society, and steered a middle course between extremes. He helped to revise the cumbrous mass of *Proceedings,* the chief concrete results being the two volumes of *Phantasms of the Living* (1886). His *Human Personality and Its Survival of Bodily Death* (2 vol.. 1903) was described by William James as "the first attempt to consider the phenomena of hallucination, hypnotism, automatism. double personality and mediumship. as connected parts of one whole subject." Also there was *Science and a Future Life* (1893). Myers died at Rome on Jan. 17, 1901, but was buried in his native soil at Keswick.

MYLIUS-ERICHSEN, LUDWIG (1872–1907), Danish explorer, was born at Viborg, Jutland, on Jan. 15, 1872 He made two notable expeditions to Greenland in 1902–04 and 1906–08. The first of these yielded much valuable ethnographical information; the second provided increased geographical knowledge of the eastern coast. He died in Nov. 1907, with two companions, on a sledge journey during his second expedition.

MYLODON, type of family of large ground sloths characteristic of the new world. *Paramylodon,* from the Pleistocene of North America, was the size of a rhinoceros. It had short stout limbs, terminated by feet with five digits. The inner digits bore strong clams, but the outer were clawless. The head was long: with a blunt muzzle. Front teeth were lacking. but the jaws were set with large prismatic cheek teeth, five above and four below on each side. The teeth became progressively large posteriorly and the last molar was two or three lobed. *Mylodon,* as shown by specimens from a cave off the Straits of Magellan, possessed a skin studded with bony ossicles and covered with a heavy coarse brown hair.

Sloths of the family Mylodontidae ranged from Patagonia to Canada. Several genera are known from the Pleistocene of South America. Lestodon has the front pair of teeth enlarged as tusks and a flaring, bell-shaped muzzle. *Scelidotherium* is characterized by an elongate skull and narrow body. The toes are reduced and specialized. The ancestry of the family can be traced back into the Miocene, and possibly the Oligocene, in Patagonia. Early genera are less specialized than their descendants and more clearly point to relationships with tree sloths, armadillos and anteaters.

(W. D. M.; E. C. O.)

MYLONITE, in petrology, a rock which has been crushed and ground down by earth movement and at the same time rendered compact by pressure. Mylonites are fine grained, sometimes even flinty in appearance, and often banded in parallel fashion with stripes of varying composition. The great majority are quartzose rocks, such as quartzite and quartz-schist; but in almost any type of rock mylonitic structure may be developed. Gneisses of various kinds, hornblende-schists, chlorite-schists and limestones are not infrequently found in belts of mylonitic rock. The process of crushing by which mylonites are formed is known also as "granulitization" and "cataclasis," and mylonites are often described as granulites, though the two terms are not strictly equivalent in all their applications.

Mylonites occur in regions where there have been intense earth movements. Thrust planes and great reversed faults are often bounded by rocks which have all been crushed to fine slabby mylonites that split readily along planes parallel to the direction in which movement has taken place. These "crush belts" may be only a few feet or several hundred yards broad. The movements have probably taken place slowly without great rise of temperature, and hence the rocks have not recrystallized to any extent.

MYMENSINGH, a municipality and district in the Dacca division of East Pakistan. The town (formerly known as Nasirabad) is on an old channel of the Brahmaputra, 70 mi. N. of Dacca, with which it is connected by a line of the isolated metre-gauge system of the Eastern Bengal railway. Pop. (1951) 44,527; of the surrounding administrative subdivision 1.522,48j. It has been noted for the manufacture of glass bangles.

MYMENSINGH DISTRICT occupies a part of the alluvial valley of the Brahmaputra east of the main channel (called there the Jamuna). Area 6.230 sq.mi.; pop. (1951) 5,797,521. For the most part level and open, it is covered with cultivated fields. The Madhupur jungle, partly covered with red ferruginous clay, extends from the north of Dacca district into the heart of Mymensingh; its average height is about 60 ft. above the level of the surrounding country, and nowhere exceeds 100 ft. On the west is an alluvial plain watered by the Jamuna; the eastern area of the district is fertilized by the Surma and Meghna. the old Brahmaputra and other streams, and contains extensive marshes. which are under water for eight months of the year and are grazing grounds for cattle for the other four months. On the southern border the Susang hills rise. The Jamuna forms the western boundary for 94 mi.; during the rainy season it expands in many places to 5 or 6 mi. in breadth. The Brahmaputra formerly flowed through Mymensingh till it joined the Meghna a little below Bhairab Bazar, but in the late 18th and early 19th centuries the formation of sand bars in the upper course diverted it into the Jamuna. The rainfall is heavy, the mean annual at Mymensingh being 91.48 in.

The staple crop is rice, followed by jute, which is an important cash crop. Cottage industries such as hand weaving and brassworking are carried on in the district. The two colleges of Dacca university concerned with training primary teachers and women teachers are in Mymensingh town; the university has also affiliated two other colleges in the town and nine elsewhere in the district.

MYNAH, the name given to several birds of the starling family (Sturnidae). The Indian house mynah (Acridotheres *tristis*) is a well-known bird in the east and has been introduced into Australia and New Zealand. Somewhat larger than a thrush, with brown plumage, except for a black head and white on the wings and tail, the house mynah is easily domesticated and will learn to talk.

The true talking mynah (Grecula religiose) is, however, a very different bird. See GRACKLE.

MYRA (mod. DEMBRE), an ancient town of Lycia situated a short distance inland between the Myrus and Andracus rivers. Its early history is obscure. St. Paul touched Myra on his last journey westward, and changed into "a ship of Alexandria sailing into Italy." In the 3rd century St. Nicholas, of Patara, was its bishop. Theodosius II made Myra the Byzantine capital of Lycia, and as such it was besieged and taken by Harun al-Rashid in 808. The town seems shortly afterward to have decayed. A small Turkish village occupied the plain at the foot of the acropolis, and a little Greek monastery lay about a mile westward by the church of St. Nicholas. The latter formed the nucleus of modern Dembre. The western scarp of the acropolis has been sculptured into a number of sepulchres imitating wooden houses with pillared façades, some of which have pediment reliefs and inscriptions in Lycian. The theatre lies at the foot of this cliff and is partly excavated out of it, partly built. The church of St. Nicholas lies out in the plain, at the western end of Dernbre. Its floor is far below the present level of the plain, and for some time the church was half filled with earth. There are also extensive ruins of Andriaca, the port of Myra, about 3 mi. W., containing churches, baths and a great grain store: inscribed with Hadrian's name. They lie along the course of the Xndraki river; whose navigable estuary is still fringed with ruined quays.

MYRIAPODA. A group of terrestrial Arthropoda. comprising the Chilopoda (centipedes, *q.v.*), Diplopoda (millipedes, *q.v.*), Pauropoda and Symphyla (*qq.v.*). The name was originally used by Pierre Latreille (1796) to embrace the centipedes and millipedes. which, with certain Crustacea, he ranked as an order under the Insecta. Subsequently William Leach (1814) restricted the term to the centipedes and millipedes, raising the group to the rank of a class, of equal status with insects and Crustacea, the Pauropoda and Symphyla being incorporated much later.

After 1893 a classification of Myriapoda into Progoneata and Opisthogoneata was widely adopted among zoologists. the Progoneata (comprising Diplopoda, Pauropoda and Symphyla) having the reproductive opening near the anterior end of the trunk, while in the Opisthogoneata (comprising the Chilopoda) it is located at its hinder end.

The classification is held to imply the independent descent of the two groups from a common ancestor with multiple reproductive openings, any resemblance being therefore of a fortuitous and superficial character. The remarkable anatomical characters of the Symphyla seem, however, altogether to invalidate this classification, for, as shown by A. D. Imms (1936) and O. W. Tiegs (1940), they are surely closely related to the Insecta, even though the latter are opisthogoneate.

The Myriapoda are, indeed. by no means an unnatural assemblage of animals. A. Sedgwick, who shared this view, defined them as follows: "Tracheates with numerous and similar pedigerous segments, with one pair of antennae followed by a pair of palpless mandibles, with regularly and segmentally arranged tracheal stigmata, and with malpighian tubules. The young are. with a few exceptions. not provided with the full complement of segments at hatching" (from A. Sedgwick, *Student's Teat-Book of Zoology,* by permission of The Macmillan Company. publishers). Many of these characters. he points out, are also found in Onychophora (*q.v.*) and insects. and he is led to conclude that "the classes Insecta, Onychophora and Myriapoda are the survival of a once great and continuous group of land Arthropods, a large number of which have become extinct, leaving two groups. Insecta and Onychophora. each fairly compact and showing little variety of organization. and one, the Myriapoda, loose and heterogeneous, and with considerable gaps between the orders."

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MYRICA is considered by many authors as the only genus of the Myricaceae family. while some others accord generic rank to the three subgenera (*Myrica, Gale* and *Comptonia*) as distinct from *Myrica.* About 40 species. with only one under *Comptonia,* are widely distributed throughout the world. Well-known representatives are the sweet fern (*C. perigrina*), sweet gale (*M. gale*) and wax myrtle (*M. cevijera*). *See* SWEET GALE; WAX MYRTLE. (J. M. BL.)

MYRISTICACEAE, the nutmeg (*q.v.*) family, comprising 18 genera and 300 species. all tropical and especially numerous in Asia. They are trees or shrubs with evergreen leaves.

MYRIVELES. STRATES (STRATIS MIRIVILIS) (1892–), Greek novelist. whose best-known work is his "war trilogy": the *Zoe en Tapho* ("Life in the Tomb"; 1930); the *Daskala me ta Chrysa Matia* ("The Teacher With the Golden Eyes": 1932); and the *Panagia Gorgona* ("The Mermaid Virgin": 1955). Born in Lesbos in 1892. he firrt appeared as a writer in 191j with a book of short stories. *To Kokkino Biblio* ("The Scarlet Book"), but it was in 1932 that he captured the public imagination. with his *Zoe en Tapho.* This is a series of war impressions from the Macedonian front. where the author fought in World War I. It was followed by the *Daskala ntc ta Chrysa Matia,* in many respects a maturer novel. which starts with the Asia Minor campaign of 1921–22 and continues in the island of Lesbos. The *Panagia Gorgona* tells of the life of a group of Greek refugees from Asia Minor who settled in Lesbos. Myriveles also wrote several shorter novels and short stories; a lively travel book on Greece. *Apo ten Hellada* (1954); and a few poems and prose poems. His style is forceful and he has a fine mastery of language. Occasionally. however. the dialect and the lyrical elements in his prose are excessive. He is at his best in descriptions of natural scenery. (CE. A. T.)

MYRMIDON. in Homer. one of the inhabitants of Phthiotis in Thessaly of 'ancient Greece. According to post-Homeric legends their original home was Aegina, from which they crossed over to Thessaly with Peleus, but the converse view is now more generally accepted. Their name is derived from a supposed ancestor. son of Zeus and Eurymedusa. who n-as wooed by the god in the form of an ant: or from the repeopling or' Aegina (when all its inhabitants had died of the plague) n-ith ants changed into men by Zeus at the prayer of Aeacus, king of the island. As the fierce and devoted followers of Xchilles. their name came to be used in modern times to mean subordinates who carry out orders implacably.

MYROBAEANS, the name given to the astringent iruits of several species of *Terminalia*, largely used in India for dyeing and tanning and exported for the same purpose. They are large deciduous trees of the family Combretaceae. The chief kinds are the chebulic or black myrohalnn. from *Terminalia chebula*, which is smooth. and the belleric. from *T. bellerica,* n-hich is five angled and covered with grayish don-n. There is also *Prunus cerasifera,* known as myrobalan and widely employed as stock for cherries.

MYRRH, a gum resin (*see* RESINS), highly esteemed by the ancients as an unguent and perfume, used for incense in temples and also in embalming: it was one of the gifts offered by the Magi. True myrrh is the product of *Commiphora myrrha,* a small tree of the family Burseraceae that gron-s in eastern Africa and Arabia, but the name is also applied to gum resins obtained from other species of *Commiphora.* Bisabol or bissabol. from *Commiphora kataf,* resembles true myrrh in appearance. but has a disagreeable taste and is scarcely bitter. It is used in China. mixed with food. and given to cows to improve the quality and increase the quantity of milk. When mixed with lime as a size it imparts a gloss to walls. Opaque bdellium. produced by C. *playfairii,* when shaken with water forms a slight hut permanent lather. It is known as *meena harma* in Bombay, and was formerly used there for the expulsion of the guinea worm. African bdellium is from *C. africana,* and like opaque bdellium lacks the white streaks which are characteristic of myrrh and bisabol: both are acrid. but have little bitterness or aroma. Indian bdellium. probably identical with the Indian drug gugal obtained from *C. mukul* and *C. pubescens,* is of a dark reddish colour, has an acrid taste and an odour like cedarwood and softens in the hand.

As met in commerce true myrrh occurs in pieces of irregular size and shape. from one-half inch to two or three inches in diameter. and of a reddish-brown colour. The transverse fracture has a resinous appearance with white streaks: the flavour is bitter and aromatic and the odour characteristic. It consists of a mixture of resin. gum and essential oil. the resin being present to the extent of 25% to 40%, with $2\frac{1}{2}$% to 8% of the oil. myrrhol. to which the odour is due.

MYRTACEAE, the myrtle or eucalyptus family. dicotyledonous trees and shrubs found in all the warmer parts of the world. especially in Australia and tropical America. There are

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SCARLET FLOWERING GUM (EUCALYPTUS FICIFOLIA)

about 90 genera and approximately 2.800 species. all with oil glands in the evergreen leaves. Several species yield useful timber. and *Eucalyptus* also gives oil: *Eugenia,* cloves; etc. Some have edible fruits. as *Pisidium* (guava'). *Rhodomyrtus* (hill gooseberry). various species of *Syzygium* and *Eugenia,* and *Feijoa* (pineapple guava). *Pimenta officinalis* yields allspice (*q.v.*) and P. *acris,* bay oil. *See* EUCALYPTUS: FEIJOA; GUAVA.

MYRTLE, the *Myrtus communis* of botanists, as now found growing wild in many parts of the Mediterranean region. It is a low-growing, evergreen shrub. with opposite leaves, varying in size. but always small, simple. dark-green. thick in texture. and studded with numerous receptacles for oil. When the leaf is held up to the light it appears as if perforated n-ith pinholes owing to the translucency of these oil cysts, The fragrance of the plant depends upon the presence of this oil. .Another peculiarity of the myrtle is the existence of a prominent vein running round the leaf within the margin. The flowers are borne on short stalks in the axils of the leal-es. The fruit is a purplish berry. enclosing very numerous minute seeds. Many varieties are in cultivation. The typical species is quite hardy in the south of England. The Chilean guava (*M. ugni*), a shrub with ovate. dark-green leaves and white flowers succeeded by globular red or black glossy fruit with a pleasant smell and taste. is a greenhouse shrub, hardy in southwest Britain. The common myrtle is the sole representative in Europe of a large genus (100 species) which has its headquarters in extra-tropical South America, while other members are found in Australia and New Zealand. The genus *Myrtus* also gives its name to a very large family. Myrtaceae (*q.v.*). Myrtle is also used for the bog myrtle (see SWEET-GALE), the crape myrtle (*Lagerstroemia indica*). the sand myrtle (*Leiophyllum buxifolium*), the creeping myrtle (*Vinca* minor) and many others.

MYRTLE (MYRTUS COMMUNIS), SHOWING FLOWERING BRANCH AND VERTICAL SECTION OF FLOWER

MYSIA, a district of northwestern Asia hlinor, hounded by Lydia and Phrygia on the south. by Bithynia on the northeast and by the Propontis and Aegean sea on the north and west. Its precise limits are difficult to assign, the Phrygian frontier being vague and fluctuating. while in the northwest the Troad was sometimes included in Mysia, sometimes not.

The most important cities were Pergamum (*q.v.*) in the valley of the Caicus and Cyzicus (*q.v.*) on the Propontis. But the whole seacoast was studded with Greek towns, several of which were places of considerable importance; thus the northern portion included Parium, Lampsacus and Abydos, and the southern Assus, Adramyttium and, farther south, on the Elaitic gulf. Elaea, Myrina and Cyme.

Ancient writers agree in describing the Mysians as a distinct people. like the Lydians and Phrygians. though they never appear in history as an independent nation. That they mere kindred with the Lydians and Carians, is attested by their common participation in the sacred rites at the great temple of Zeus at Labranda. as well as by the statement of the historian Xanthus of Lydia that their language was a mixture of Lydian and Phrygian. Strabo was of the opinion that they came originally from Thrace (see BITHYNIA) and were a branch of the same people as the Mysians or Moesians (see MOESIA) who dwelt on the Danube. The Mysians appear in the list of the Trojan allies in Homer. The first historical fact learned is their subjugation, together with all the surrounding nations. by Croesus of Lydia. After the fall of the Lydian monarchy they remained under the Persian empire until its overthrow by Alexander. They continued to form a part of the Syrian monarchy until the defeat of Antiochus the Great (190–189 B.C.), after which they were transferred by the Romans to the dominion of Eumenes of Pergarnum. After the defeat of the Pergamene pretender Aristonicus (130 B.C.) Mysia became a part of the Roman province of Asia.

See A. H. M. Jones, *The Cities of the Eastern Roman Provinces* (Oxford, 1937); David Magie, *Roman Rule in Asia Minor* (Princeton, 1950)

MYSLOWICE (Ger. *Myslowitz*), a town of Katomice, Poland, on the Przemsa river. It is 120 mi. S.E. of Breslau by rail and an important railway junction. Pop. (1960) 40,000. It became a town in 1857 and is in an industrial area with coal mines: flax spinning and brick making. Taken by Germany in 1939, it was returned to Poland in 1915.

MYSORE, a constituent state of India, in the southern part of the peninsula. bounded north and northwest by Bombay. east by Andhra Pradesh, southeast by Madras, and with the state of Kerala lying against its southtz-estern border. Rlysore is divided naturally into two regions: the hill country called the malnad on the west; and the more open country known as the maidan, comprising the greater part of the state, where the wide-spreading valleys and plains are covered with villages and populous towns.

The drainage of the country is mostly into the Bay of Bengal, and is divisible into three great river systems—the Kistna on the north, the Cauvery on the south, and the northern Pennar, the Palar, and the southern Pennar (Pannaiyar) on the east. Because of either rocky or shallow beds none of the Mysore rivers is navigable. The main streams! especially the Cauvery and its tributaries. support an extensive system of irrigation by means of channels drawn from immense dams (anicuts).

Mysore is a prosperous state. Situated on a healthful plateau, it receives the benefit of both the southwest and northeast monsoons. which, in conjunction with its irrigation system, has brought it a large degree of immunity from famine. Iron and steel, cement, paper, sugar and sandalmood oil are the important industries. An aircraft factory and a telephone factory, the only ones of their kind in India, are located in Bangalore. Manganese, mica and steatite are worked. Kolar district (*q.v.*) contains famous gold fields. The University of Mysore (1916) has most of its component institutions either at Mysore or at Bangalore.

The total area of the state in 1951 was 29,489 sq.mi., subdivided into ten districts. Population (1951) 9,074,972. In 1961 the area of Mysore was increased to 74,122 sq.mi. The state then comprised 19 districts. Seven talukas of Bellary district were transferred from Madras to Mysore in Oct. 1933. The 1961 population, within the boundaries as delimited in 1961, was 23,547,081. Kannada (Kanarese) is spoken by the majority of the people, three-quarters of whom are engaged in agriculture. Of the Christians over two-thirds are Roman Catholics. The state government is as laid down in part B of schedule 1 of the Indian constitution. 1950. The maharaja, in his capacity of *rajpramukh* (*q.v.*), is constitutional head of state., There is an elected legislative assembly of 208 members, a legislative council (mainly elective) and a ministry composed of the chief minister and five other ministers and formed by the majority party in the legislature. Bangalore is the state administrative capital, Mysore city the dynastic capital.

History.—In the earliest historical times the north of Mysore was held by the Kadamba dynasty. whose capital. Banawasi, is mentioned by Ptolemy: they reigned during 14 centuries, though later they became feudatories of the Chalukyas (*q.v.*). The Cheras were contemporary with the Kadambas. and governed the southern part of Mysore till they were subverted by the Cholas in the 8th century. Another ancient race. the Pallavas, held a small part of the eastern side of Mysore, but were overcome by the Chalukyas in the 7th century. These were overthronn in the 12th century by the Ballalas (Hoysalas), an enterprising and warlike race professing the Jain faith. They ruled over most of Mysore, and parts of the modern districts of Coimbatore. Salem and Dharwar. nith their capital at Dwarasamudra (the modern Halebid); but in 1310 the Ballala king was captured by Malik Kafur. the general of Ala ud-Din; and 17 years later the town was entirely destroyed by another force sent by Jlohammed Tughlak. After the subversion of the Ballala dynasty, a new and powerful Hindu sovereignty arose at Vijayanagar.

In 1565 a confederation of the Mohammedan kingdoms defeated the Vijayanagar sovereign at the battle of Talikota. The most important of the petty local chiefs was the *wodeyar* of Mysore, who in 1610 seized the fort of Seringapatam. and so laid the foundation of the present state. His fourth successor. Chikka Deva Raja. during a reign of 34 years, made his kingdom one of the most powerful in southern India. In the middle of the 18th century the famous Mohammedan adventurer Hyder Ali (*q.v.*), usurped the throne. His dynasty. however. was as brief as it was brilliant, and ended with the defeat and death of his son Tippoo at Seringapatam in 1799. Krishnarajah Wodeyar, only five years old. was placed on the throne. and until he came of age in 1811 the state was under the administration of Purnaiya, the Brahman minister of Hyder and Tippoo. When Krishnarajah took over the management of his state he received .an orderly and contented principality with a surplus of two crores of rupees. Within 20 years he had driven his subjects into rebellion and involved himself and his state in heavy debt. The British government therefore assumed the administration in 1831, and placed it in the hands of commissioners. In 1867 it was determined to secure the continuance of native rule in Mysore and on March 25, 1881, Chamarajendra, Krishnarajah's successor, having attained the age of 18 years, was publicly entrusted with the administration of the state. He made over to the British a small tract at Bangalore (*q.v.*), forming the "civil and military station," and received in return the island of Seringapatam. By the signing of the "instrument of transfer." the young maharajah, for himself and his successors. undertook to perform the conditions imposed upon him. The maharajah died at Calcutta on Dec. 28. 1894. In 1913 the instrument of transfer was replaced by a treaty. Following the state's accession, without incident, to independent India on hug. 9, 1947, the maharajah was created *rajpramukh* on June 2, 1949.

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MYSORE, the dynastic capital of the state of Mysore, India. 76 mi. S.W. of Bangalore on the Bangalore-Chamrajnagar branch of the Southern railway. Pop. (1961) 253,524. The city, which is spread over 14 sq.mi., has its nucleus in a valley at the foot of Chamundi hill. The palace of the maharaja within the large European-type quadrangular fort contains the ivory and gold throne said to have been presented to Chikka Deva Raj by the emperor Aurangzeb. The former residency, or government house, was built in 1805. The building later used for the district offices was originally built by Col. Arthur Wellesley (duke of Wellington) for his own occupation. The domed building for the public offices in Gordon park. the Maharaja's college and Maharani's College for Women in the university, the Mary Holdsworth hospital, the fine palace offices and the law courts are conspicuous. A teaching and residential university established in 1916 has five colleges in Mysore and six in Bangalore, as well as 22 intermediate and affiliated colleges in the two cities and elsewhere in the state. Mysore was superseded by Seringapatam as the seat of the court from 1610 to 1799, and in 1831, on the British occupation, the seat of administration was moved to Bangalore.

MYSORE TALUKA, which excludes the city, has an area of 303 sq.mi.; pop. (1951) 95,039.

MYSORE DISTRICT (4,622 sq.mi. excluding Mysore city; pop. [1961] 1,669,874) has only two municipalities with more than 15,000 inhabitants—Nanjangud ([1951] 16,737) and Chamrajnagar ([1951] 16.040). At Seringapatam, 10 mi. N. of Mysore city, are the mausoleums of Tippoo and Hyder Ali. The hilly "malnad" runs down the southwest side of the district, the rest being the more open "maidan" at a general elevation of 2,000–3,000 ft. The district is drained by the upper Cauvery and the Kabbani and the Nugu, tributary to it.

MYSTERY. It is necessary to differentiate mystery, Gr. *μυστήριον,* from its homophone, properly written mistery, late Lat. *ministerium,* a trade or craft; hence mystery plays (see DRAMA), those performed by trade-gilds. We must also set aside the Hellenistic meaning, common in modern languages, of "secret," "puzzling occurrence."

Properly, then, a mystery is a Greek rite which is kept secret (*μύειν,* to shut the mouth or eyes) from all save the initiated (oi *μύσται, οἱ μεμυημένοι*). These are specially prepared to have the secret revealed to them, under the guidance of a hierophant (*ἱεροφάντης,* "revealer of holy things"). According to Theon Smyrnaeus (de util. math., p. 15, Hercher) there were four stages: (1) preliminary purification (*καθαρμός*); (2) communication of mystic knowledge, *τελετῆς παράδοσις,* presumably including a sort of sermon of instruction or exhortation; (3) *ἐποπτεία,* or revelation of the holy things, the central point of the rite; (4) the crowning or garlanding of the mystic, who was thus, as it were, badged as a privileged person. We know that the central revelation was something done (*δρώμενον*), not spoken, or not merely spoken; Lucian says (de *saltat.,* 15) that all mysteries included dancing. Hence it is usually, and reasonably, concluded that some sort of pageant or rudimentary sacred drama was shown.

We may now ask why the rites should be secret at all. A plausible but mistaken explanation has recently been revived by O. Kern (Die *Religion* der *Griechen,* i. 1926): the invading Hellenes oppressed, perhaps actually used religious persecution against, the earlier inhabitants of Greece, hence driving their cults into secrecy.

It might be urged in favour of this view that in Crete, according to Diodorus Siculus (v. 77, 3), rites similar to the Greek mysteries lay open to all and had nothing "mysterious" about them, and also that the telesterion or hall of initiation at Eleusis originates in Minoan-Mycenaean constructions, and Eleusis itself has a name probably pre-Greek (*cp.* A. W. Persson in *Archiv* f. *Religionswissenschaft,* xxi., p. 291 ff.; M. P. Nilsson, *Minoan-Mycenaean* Religion, 1927, p. 402, ff.); furthermore, that several survivals of things pre-Hellenic have been more or less certainly traced in the ritual of the mysteries, Eleusinian and other. But these considerations can hardly avail against the facts that the mystic deities include many undoubtedly Greek, as Demeter, *Kore,* Ge, *Aglauros,* the Charites, Hecate, and others; that the ritual is in the hands of noble and distinguished families, not of slaves or other remnants of a conquered population; and that a good magico-religious reason for secrecy can be given. The deities of these cults are one and all chthonian; these, however benevolent, are in their nature dangerous to approach; therefore, to avoid all possibility of disturbance at a critical time, it is but prudent to shroud the whole performance in secrecy, and keep the impure and unprepared at a safe distance.

For the student of Hellenism, the Eleusinian and Orphic ceremonies are of paramount importance; the Samothracian, which vied with these in attractiveness for the later Hellenic world, were not Hellenic in origin; nor wholly hellenized in character, and cannot be considered in an article of this compass.

As regards the Eleusinia, we are in a better position for the investigation of them than our predecessors were; for the modern methods of comparative religion and anthropology have at least taught us to ask the right questions and to apply relevant hypotheses; archaeology, the study of vases, excavations on the site, yielding an ever-increasing hoard of inscriptions, have taught us much concerning the external organization of the mysteries, and have shown us the beautiful figures of the deities as they appeared to the eye or to the mental vision of the initiated.

In seeking to guess what the secret of the mysteries was, we must first rid ourselves of the notion that it was any esoteric philosophy, or elaborate theology kept hidden from the world at large. Negatively, we have no jot of evidence that the initiates were more intelligent than the rest of Greece, or that their belief or practice differed from those of their fellow-countrymen to any marked degree, although there need be no doubt that a certain amount of verbal instruction was given by the hierophant (see below). Positively, we have the repeated insistence, from the Homeric hymn down (*hymn. Homer,* ii., 480) that the initiates saw something which greatly comforted their souls, not that they learned anything of great importance. What they saw was doubtless the sacred *dromenon.* We can realize what effect this might have on excited and believing minds, if we consider the importance, for a pious Catholic, of such impressive ceremonies as the elevation of the Host at mass.[1]

Our evidence is of two kinds. Firstly, a number of works of art show us scenes probably or certainly taken from the ritual of the Eleusinian or other mysteries. But here we may be certain that the artists, even if they themselves had no scruples, would not risk violating the deepest religious sentiments of thousands of their fellow-countrymen. Secondly, we have literary evidence. But this, if pagan, is restrained by the same reasons as the artists' from saying too much; if Christian, the writers seldom, if ever, can be shown to have been initiates themselves; some indeed cannot have been, for they were never pagans, Their

[1]This is well and sympathetically discussed by O. Kern, *Die griechischen* Mysterien der *klassischen* Zeit [1927], especially p. 23 ff. Aristotle [frag. 45, Rose] declares that the mystae learned nothing, but underwent "an experience and an influence" [*παθεῖν καὶ διατεθῆναι;*] an important testimony.

statements are generally uncritical and do not clearly differentiate between the Eleusinian mysteries and others, such as the Orphic, Sabazian, and those of Cybele and Attis.

The questions that the critical analysis of all the evidence may hope to solve are mainly these: (a) What do u e know or what ran we infer concerning the personality of the deities to whom the Eleusinian mysteries were originally consecrated, and were new figures admitted at a later period? (b) When was the mystery taken over by Athens and opened to all Hellas, and what waa the state-organization provided? (c) What was the inner significance, essential content or purport of the Eleusinia, and what was the source of their great influence on Hellas? (d) Can we attribute any ethical value to them, and did they strongly impress the popular belief in immortality? Limits of space allow us only to adumbrate the results that research on the lines of these questions has hitherto yielded.

The paramount divine personalities of the mystery were, in the earliest period of which we have literary record, the mother and the daughter, Demeter and Kore, the latter being never styled Persephone in the official language of Eleusis; while the third figure, the god of the lower world known by the euphemistic names of Pluto (Plouton) and at one time Eubouleus, the ravisher and the husband, is an accessory personage, comparatively in the background. This is the conclusion naturally drawn from the Homeric hymn to Demeter, a composition of great ritualistic value, probably of the 7th century B.C., which describes the abduction of the daughter, the sorrow and search of the mother, her sitting by the sacred well, the drinking of the *κυκεών* or sacred cup, and the legend of the pomegranate. An ancient hymn of Pamphos, from which Pausanias freely quotes and which he regards as genuine[1], appears to have told much the same story in much the same way. As far as we can say, then, the mother and daughter were there in possession at the very beginning. The other pair of divinities known as *ὁ θεός, ἡ θεά* that appear in a jth century inscription and on two dedicatory reliefs found at Eleusis, have been supposed to descend from an aboriginal period of Eleusinian religion when deities were nameless[2]. But for various reasons the contrary view is more probable, that *ὁ θεός* and *ἡ θεά* are later cult-titles of the married pair Pluto-Cora (Plouton-Kore), the personal names being omitted from that feeling of reverential shyness which was specially timid in regard to the sacred names of the deities of the underworld. And it is a fairly familiar phenomenon in Greek religion that two separate titles of the same divinity engender two distinct cults.

The question as to the part played by Dionysus in the Eleusinia is important. Some scholars, like M. Foucart, have supposed that he belonged from the beginning to the inner circle of the mystery; others that he forced his way in at a somewhat later period owing to the great influence of the Orphic sects who captured the stronghold of Attic religion and engrafted the Orphic-Sabazian *ἱερός λόγος*, the story of the incestuous union of Dionysus-Sabazius with Demeter-Kore, and of the death and rending of Zagreus, upon the primitive Eleusinian faith. A saner and more careful criticism rejects this view. There is no genuine trace discovered as yet in the inner circle of the mysteries of any characteristically Orphic doctrine; the names of Zagreus and Phanes are nowhere heard, the legend of Zagreus and the death of Dionysus are not known to have been mentioned there. Nor is there any print within or in the precincts of the *τελεστήριον*, the hall of the *Μύσται*, of the footsteps of the Phrygian deities, Cybele, Attis, Sabazius.

The exact relation of Dionysus to the mysteries involves the question as to the divine personage called Iacchus: who and what was Iacchus? Strabo (p. 468), who is a poor authority on such matters, describes him as "the daemon of Demeter, the founder of the leader of the mysteries." More important is it to note that "Iacchus" is unknown to the author of the Homeric hymn, and that the first literary notice of him occurs in the well-known passage of Herodotus (viii. 65), who describes the procession of the mystae as moving along the sacred way from Athens to Eleusis and as raising the cry *Ἴακχε*. We find Iacchus the theme of a glowing invocation in an Aristophanic Ode (Frogs, 324–398), and described as a beautiful "young god"; but he is first explicitly identified with Dionysus in the beautiful ode of Sophocles *Antigone* (1119); and that this was in accord with the popular ritualistic lore is proved by the statement of the scholiast on Aristophanes (Frogs, 482) that the people at the Lenaea, the winter-festival of Dionysus, responded to the command of "Invoke the god!" with the invocation "Hail, Iacchus, son of Semele, thou giver of wealth!" We are sure, then, that in the high tide of the Attic religious history Iacchus was the youthful Dionysus, a name of the great god peculiar to Attic cult, and this is all that here concerns us to know.

We thus see that Iacchus was an Athenian, not an Eleusinian, god; his abiding-place was Athens, and he merely visited Eleusis for the mysteries. We may indeed conjecture that his votaries read Dionysiac interpretations into Eleusinian dromena. But all this is conjecture. The interpretation of what was shown would naturally change somewhat with the changing sentiment of the ages; but Demeter and Kore, *τὼ θεώ*, and no one else, are the paramount figures at Eleusis from the "Homeric" hymn to Xlaric's invasion. Triptolemus the apostle of corn-culture, Eubouleus—originally a euphemistic name of the god of the under-world, "the giver of good counsel," conveying a hint of his oracular functions—these are accessory figures of Eleusinian cult and mythology that may have played some part in the great mystic drama that was enacted in the hall.

As to the history of the Eleusinian mysteries[1], the legends concerning the initiation of Heracles and the Dioscuri imply that originally they were closed to strangers, which, as they probably were in origin local rites in honour of local deities, is exactly what we should expect. But the "Homeric" hymn implies that they are open to all; with this we may connect the sagas of the conquest of Eleusis by Athens (see EUMOLPUS) and the early unification of Attica under Theseus (see CONSTITUTION OF ATHENS). By what steps the mysteries grew in importance and fame we do not know, but certainly Peisistratus paid attention to them, while Pericles found them highly important and made them more so. Decrees of his time[2] proclaim a holy truce for pilgrims to the festival and invite the subject-allies of Athens to send first-fruits of corn, a part of his imperial policy. The *μυστικός σηκός* at Eleusis is of his date.

At least from the 5th century onwards, Athens was in charge of the organization and external control of the mysteries, the management being in the hands of the archon basileus and a committee of four *epimeletai* (overseers) and a *paredros* (assessor). The State, as elsewhere in Greece, controlled the Church. But the priesthood was Eleusinian. Two ancient clans, the *Eumolpidai* (see EUMOLPUS) and the *Kerukes* (see HERALD) performed the whole ceremony between them; it appears that in the 4th century the *Kerukes* died out and the *Lukomidai* of Phlye took their place, perhaps bringing with them a tendency to Orphism. From the Eumolpidae was chosen the hierophant, who was so holy that his personal name was no longer used when once he was appointed, and he alone might enter the innermost shrine,—or perhaps, for the details are obscure, he and a priestess. Demeter and Kore had also each a *hierophantis* or female hierophant; considering that the Thesmophoria (*q.v.*) was entirely in the hands of women, it is not surprising that they took part in the mysteries also. The *Kerukes,* afterwards the *Lukomidai,* chose the *δᾳδοῦχος* or torch-bearer, who ranked next after the hierophant, from their number.

Turning now to the celebration itself, we can only sketch the more salient features here. On the 13th of Boedromion, the Attic month corresponding roughly to our September, the Ephebi (*q.v.*) marched out to Eleusis, and returned to Athens the next

[1]i. 38, 3; i. 39, 1.

[2]*See* Dittenberger, *Syll.* 83, 39; zoo, 21; *C.I.G.* ii. Add. 1620c; Ephem. archaiol. (1886), *πιν.* 3; Heberdey in Festschrift fur *Benndorf,* p. 3, Taf. 4; Von Prott in *Athen. Mittheil.* (1899), p. 262.

[1]To be distinguished from the Eleusinia, an important festival, but not connected with the mysteries, see Revue des *études grecques,* xxxii., p. 462.

[2]Dittenberger, *Sylloge,* 3rd ed, 21 (=*I.G.* i. 1); 83, 30 ff.

day, bringing with them the "holy things" (ἱερά) to the "Eleusinion" in the city; these ἱερά probably included small images of the goddesses. The 16th was the day of the ἀγυρμός, the gathering of the catechumens, when they met to hear the address of the hierophant, called the πρόρρησις. This was no sermon but a proclamation bidding those who were disqualified or for some reason unworthy of initiation to depart. The legally qualified were all Hellenes and subsequently all Romans above a certain — very youthful — limit of age, women and. as it appears, even slaves; barbarians, and those uncleansed of some notorious guilt, such as homicide, were disqualified. It is certain that there was no dogmatic test, nor would time allow of any searching moral scrutiny, and only the Samothracian rites, in this respect unique in the world of classical religion, possessed a system of confessional. The hierophant appealed to the conscience of the multitude, but the terms of his proclamation, which can only be approximately restored from late pagan and early Christian writers, are not altogether sure. It is known that he demanded of each candidate that he should be "of intelligible speech [*i.e.*, Hellene] and pure of hand"; and he catechized him as to his condition of ritualistic purity — the food he had eaten or abstained from. It appears also from Libanius that in the later period at least he solemnly proclaimed that the catechumen should be "pure of soul" (Or. *Corinth,* iv, 356), and this spiritual conception of holiness had arisen already in the earlier periods of Greek religious thought. On the other hand must be borne in mind the criticism that Diogenes is said to have passed upon the Eleusinia, that many bad characters were admitted to communion, thereby securing a promise of higher happiness than an uninitiated Epameinondas could aspire to.

An essential preliminary was purification and lustration, and after the assembly the "mystae" went to the seashore (ἅλαδε μύσται) and purified themselves with sea water, and probably with sprinkling of pigs' blood, a common cathartic medium. After their return from the sea, a sacrifice of some kind was offered as an essential condition of μύησις, but whether as a sacrament or gift offering to the goddesses it is impossible to determine. On the 19th of Boedromion the great procession started along the sacred way bearing the "fair young god" Iacchus; and as they visited many shrines by the way the march must have continued long after sunset! so that the 20th is sometimes spoken of as the day of the exodus of Iacchus. On the way each wore a saffron band as an amulet: and the ceremonious reviling to which the μύσται were subjected as they crossed the bridge of the Cephissus answered the same purpose of averting the evil eye. Upon the arrival at Eleusis, on the same night or on the following, they celebrated a midnight revel under the stars with Iacchus, which Aristophanes glowingly describes.

The question of supreme interest now arises: What was the mystic ceremony in the hall; what was said and what was done? Two grades in the celebration can be distinguished: the greater was the τέλεα and ἐποπτικά, the full and satisfying celebration, to which only those were admitted who had passed the lesser stage at least a year before. As regards the actual ritual in the hall of the mystae, much is still uncertain. That there was some kind of holy pageant or play, the accusations against Aeschylus and Alcibiades would suffice to prove, and Porphyry speaks of the hierophant and the δᾳδοῦχος acting divine parts. What the subject of this drama was may be gathered partly from the words of Clement — "Deo (Demeter) and Rore became the personages of a mystic drama, and Eleusis with its δᾳδοῦχος celebrates the wandering, the abduction and the sorrow" (Protrept., p. 12, Potter), supported by Apuleius (Met. vi, 2). We may believe then that the great myth of the mother's sorrow, the loss and the partial recovery of her beloved was part of the Eleusinian passion play. Did it also include a ἱερος γάμος? We should naturally expect that the sacred story acted in the mystic pageant would close with the scene of reconciliation, such as a holy marriage of the god and the goddess. But the evidence that this was so is mainly indirect, apart from a doubtful passage in Asterius, a writer of questionable authority in the 4th century A.D. (Econom. *martyr.*, p. 194, Combe). At any rate, if a holy marriage formed part of the passion play, it may well have been acted with solemnity and delicacy. We have no reason to believe that even to a modern taste any part of the ritual would appear coarse or obscene; even Clement. who brings a vague charge of obscenity against all mysteries in general, does not try to substantiate it in regard to the Eleusinia, and another Christian writer noted the scrupulous purity of the hierophant.

It would be interesting to know if the birth of a holy child, a babe Iacchus, for example. was a motive of the mystic drama. The question seems at first sight to be decided by a definite statement of Hippolytus (*Philosoph.*, 5, 8) that at a certain moment in the mysteries the hierophant cried aloud: "The lady-goddess Brimo has borne Brimos the holy child." But a careful consideration of the context almost destroys the value of his authority. For he does not pretend to be a first-hand witness. but admits that he is draning from Gnostic sources, and he goes on at once to speak of Attis and his self-mutilation. The formula may then refer to the Sabazian-Phrygian mystery, which the Gnostics would have no scruple in identifying with the Eleusinian. And the archaeological evidence that has been supposed to support the statement of Hippolytus is deceptive.

The simple structure of the building and the absence of any reference. in the many inscriptions, to expenses for scenery or the like forbid us to suppose that there was any elaborate staging. The pageant-play produced its effect by means oi gorgeous raiment, torches and stately figures.

But the mystic action included more than the pageant-play. The hierophant revealed certain holy objects to the eyes of the assembly. There is reason to suppose that these included certain primitive idols of the goddesses of immemorial sanctity; and, if we accept a statement of Hippolytus (*loc. cit.*), we must believe that the *epoptai* were also shown "that great and marvellous mystery of perfect revelation, a cut corn-stalk." The value of this definite assertion. which appears to be an explicit revelation of the secret, would be very great, if it could be trusted; but unfortunately it occurs in the same suspicious context as the Brimo-Brimos formula, and the same uncritical confusion of Eleusinian with Phrygian ritual is again suspected. for it is known that Attis himself was identified in his mysteries with the "reaped corn," the στάχυς ἄμητος, almost the very phrase used by Hippolytus. Only, it is in the highest degree probable, whether Hippolytus knew anything or not, that a corn token was shown among the sacred things of a mystery uhich possessed an original agrarian significance and was intended partly to consecrate and to foster the agricultural life. But to say this is by no means the same as to admit the view of F. Lenormant[1] and F. B. Jevons[2] that the Eleusinians worshipped the actual corn, or revered it as a clan totem. For of direct corn worship or of totemism there is no trace either at Eleusis or elsewhere in Greece.

Among the δρώμενα or "things done" may we also include a solemn sacrament, the celebration of a holy communion, in which the votary was united to the divinity by partaking of some holy food or drink? To Clement of Alexandria (Protrept., p. 18, Potter) is owed an exact transcription of the password of the Eleusinian mystae; it ran as follows (if Lobeck's emendation of ἐγγευσάμενος for ἐργασάμενος is accepted) : "I have fasted, I have drunk the barley-drink, I have taken (the things) from the sacred chest, having tasted thereof I have placed them' into the basket and again from the basket into the chest." It may be gathered from this that some kind of sacrament was at least a preliminary condition of initiation; the mystae drank of the same cup as the goddess drank in her sorrow, partly — as we say — "in memory of her." partly to unite themselves more closely with her. It is known also from an inscription that the priest of the Samothracian mysteries broke sacred bread and poured out drink for the mystae (Arch, *epigr. Mitth.*, p. 8. no. 14 [1882]). But neither in these nor in the Eleusinian is there any trace of the more mystic sacramental conception, any indication that the votaries believed themselves to be partaking of the actual body of their

[1] C. V. Daremberg and E. Saglio, *Dictionnaire* des *antiquités* grecques el *romaines*, vol. i, p. 1066.
[2] *Introduction* to the Study *of Comparative* Religion (1908).

divinity[1], for there Is no evidence that Demeter was identified with the corn, still less with the barley-meal of which the *κυκεὼν* was compounded. Nor is it likely that the sacrament was the pivot of the whole mystery or was part of the essential act of the *μύησις* itself. In the first place we have an almost certain representation of the Eleusinian sacrament on an archaic vase in Naples[2], probably of Attic *provenance,* and the artistic reproduction of a holy act would have been impious and dangerous, if this had belonged to the inner circle of the mystery. Again, there is no mention of sacrament or sacrifice among the five essential parts of *μύησις* given by Theo Smyrnaeus, nor in the imaginary narrative of the late rhetorician Sopatros (*Rhet. Graec.* viii., 121) who supposes the strange case of a man being initiated by the goddesses in a dream: they admit him to their full communion merely by telling him something and showing him something.

Besides the *δρώμενα,* then, there were also certain things said in the hall, or in the earlier stages of initiation, which we would gladly discover. Part of these were mystic formulae, one of which has been discussed already, the pass-word of the votaries. We gather also from Proclus and Hippolytus *(in* **Tim.** 293[c]; *Ref. Omn. Haer.* 5, 7, p. 146) that in the Eleusinian rites they gazed up to heaven and cried aloud "rain"—%--and gazed down upon the earth and cried "conceive"—*κύε.* This ritual charm—we cannot call it prayer—descends from the old agrarian magic which underlay the primitive mystery. What else the votaries may have uttered, whether by way of thanksgiving or solemn litany, we do not know[3]. But there was also a certain *ἱερὸς λόγος* some exposition accompanying the unfolding of the mysteries; for it was part of the prestige of the hierophant that he was chief spokesman, "who poured forth winning utterance and whose voice the catechumen ardently desired to hear" *(Anth. Pal.,* app. 246); and Galen speaks of the rapt attention paid by the initiated "to the things done and said in the Eleusinian and Samothracian mysteries" *(De usu part. 7.* 14). But we have no trustworthy evidence as to the real content of the *λόγος* of the hierophant. We need not believe that the whole of his discourse was taken up with corn-symbolism, as Varro seems to imply (Aug. *de civit. Dei.* 20), or that he taught natural philosophy rather than theology, or again, the special doctrine of Euhemerus, as two passages in Cicero *(De natur. deor.* i. 42; *Tusc.* i. 13) might prompt us to suppose. His chief theme was probably an exposition of the meaning and value of the *ἱερά* as in an Australian initiation rite it is the privilege of the elders to explain the nature of the "churinga" to the youths. And his discourse on these may have been coloured to some extent by the theories current in the philosophic speculation of the day. But though in the time of Julian he appears to have been a philosopher of Neo-platonic tendencies, we ought not to suppose that the hierophant as a rule would be able or inclined to rise above the anthropomorphic religion of the times. Whatever symbolism attached to the *ἱερά,* the sacred objects shown, was probably simple and natural; for instance, in the Eleusinian, as in Egyptian eschatology, the token of the growing corn may have served as an emblem—though not a proof—of man's resurrection. The doctrine of the continuance of the soul after death was already accepted by the popular belief, and the hierophant had no need to preach it as a dogma; the votaries came to Eleusis to ensure themselves a happy immortality. And in our earliest record, the Homeric hymn, we find that the mysteries already hold out this higher promise. How, we may ask, were the votaries assured? The Egyptianizing theory of Foucart, that they were given directions and spells to take them past the terrors of the underworld, after the manner of the *Book of the Dead,* is wholly improbable. The terror of hell is not normal Greek, although something of the kind existed in Orphism; nor have we any evidence that spells of any kind were taught or that the *λόγος* was regarded as particularly important. If we could be sure that the Minoans had a developed eschatology *(see* Evans in *Journ.* Hell. *Stud.,* xlv. p. 43 ff., but *cf.* Nilsson, *Minoan-Myc. Rel.,* p. 549 ff.), we might suppose some of it to survive; but the matter is very doubtful.

The assurance of the hope of the Eleusinian votary was obtained by the feeling of friendship and mystic sympathy, established by mystic contact, with the mother and the daughter, the powers of life after death. Those who won their friendship by initiation in this life would by the simple logic of faith regard themselves as certain to win blessing at their hands in the next.

That the mysteries preached a higher morality than that of the current standard is not proved. That they exercised a direct and elevating influence on the individual character is nowhere explicitly maintained, as Diodorus (v. 49) maintains concerning the Samothracian. But on general grounds it is reasonable to believe that such powerful religious experience as they afforded would produce moral fruit in many minds. The genial Aristophanes *(Frogs,* 455) intimates as much, and Andocides *(De myster.* p. 36, § 31; p. 44, § 125) assumes that those who had been initiated would take a juster and sterner view of moral innocence and guilt.

Besides the greater mysteries at Eleusis, we hear of the lesser mysteries of Agrae on the banks of the Ilissus. Established. perhaps, originally by Athens herself at a time when Eleusis was independent and closed her rites to strangers, they became wholly subordinated to the greater, and were put under the same management and served merely as a necessary preliminary to the higher initiation into them. Sacrifice was offered to the same great goddesses at both; but we have the authority of Duris *(Athenae,* 253*d*), the Samian historian, and the evidence of an Attic painting, called the ***pinax*** of Nannion[1], that the predominant goddess in the mysteries at Agrae was Kore. And this agrees with the time of their celebration, in the middle of Anthesterion, when Kore was supposed to return in the young corn. Stephanus (*s.v.* "Aypa), drawing from an unknown source, declares that the Dionysiac story was the theme of their mystic drama; an isolated statement with nothing to confirm or interpret it.

The influence of Eleusis in early times must have been great, for we find offshoots of its cult, whether mystic or not, in other parts of Greece. In Boeotia, Laconia, Arcadia, Crete and Thera, Demeter was called Eleusinia, meaning in all probability "goddess of Eleusis." The initiation rites of Demeter at Celeae near Phlius, at Lerna in Argolis, and at Naples, were organized after the pattern of the Eleusinian. But of these and the other Demeter mysteries in the Greek world, there is little to record that is certain and at the same time of primary importance for the history of religion. The Arcadian city of Pheneus possessed a mystery that boasted an Eleusinian character and origin, yet in the record of it there is no mention of Kore, and we may suspect that, like other Demeter-worships in the Peloponnese, it belonged to a period when the goddess was revered as a single personality and Kore had not yet emanated from her. We know much more of the details of the great Andanian mysteries in Messenia, owing to the discovery of the important and much-discussed Andanian inscription of 91 B.C.[2]. But what we know are facts of secondary importance only. We gather from Pausanias (4. 33. 4; *cf.* 4. I. 5. and 4. 26. 8; 4. 27. 6) that the rites, which he regards as second in solemnity and prestige to the Eleusinian alone, were consecrated to the **Μεγάλαι θεαί** (the great goddesses) and that Kore enjoyed the mystic title of Hagnē, "the holy one." The inscription has been supposed to correct and to refute Pausanias, but it does not really controvert his statements, which are attested by other evidence; it proves only that other divinities came at

[1]This is Dr. Jevons's supposition—*op. cit.*—on which he bases an important theory of the whole Eleusinian mysteries and their intrinsic attraction.

[2](Farnell, *Cults,* vol. iii. pl. xv.[b]).

[3]The other formula which the scholiast on Plato *(Gorg. 407 c.)* assigns to the Eleusinian rite: "I have eaten from the timbrel, I have drunk from the cymbal, I have carried the sacred vessel, I have crept under the bridal-chamber," belongs, not to Eleusis, but, as Clement and Firmicus Maternus themselves attest. to Phrygia and to Attis.

[1]Farnell, *Cults of the Greek States,* vol. iii. p. 242, Pl. xvi.

[2]*See* Sauppe, *Mysterieninschrift von* Andania; cf. Foucart's commentary in Le Bas, *Voyage archéol.* 2, No. 326[a]; H. Collitz, ***Dialect-inschriften,*** 4689.

a later time to have a share in the mysteries, such as the Μεγάλοι θεοί who were probably the Cabeiri (*q.v.*). It is clear that the Andanian mysteries included a sacred drama, in which women personated the goddesses. The priestesses were married women, and were required to take an oath that they had lived "in relation to their husbands a just and holy life." We hear also of grades of initiation, purification-ceremonies, but of no sacrament or eschatologic promise; yet it is probable that these mysteries, like the Eleusinian, maintained and secured the hope of future happiness.

The Eleusinian faith is not wholly unattested by the grave-inscriptions of Hellas, though it speaks but rarely on these. The most interesting example is the epitaph of a hierophant who proclaims that he has found that "death was not an evil, but a blessing[1]."

Of equal importance for the private religion of Greece were the Orphic mystic societies, bearing a Thraco-Phrygian tradition into Greece, and associated originally with the name of Dionysus. and afterwards with Sabazius also and the later cult-ideas of Phrygia[2]. The full account of the Dionysiac mysteries would demand a critical study of the Dionysiac religion as a whole, as well as of the private sects that sprang up under its shadow. It is only possible here to indicate the salient characteristics of those which are of primary value for the history of religion.

Originally a great nature-god of the Thraco-Phrygian stock, powerful over all vegetation and especially revealing his power in the vine, Dionysus was forcing his way into Greece at least as early as the Homeric period, and by the 6th century was received into the public cults of most of the Greek communities. We can gather with some certainty or probability his aboriginal characteristics and the form of his worship. Being a god of the life of the earth, he was also a nether divinity, the lord of the world of souls, with whom the dead votary entered into privileged communion; his rites were mystic, and nightly celebrations were frequent, marked by wild ecstasy and orgiastic self-abandonment, in which the votary became at one with the divinity and temporarily possessed his powers; women played a prominent part in the ritual; a savage form of sacramental communion was in vogue, and the animal victim of whose flesh and blood the votaries partook was at times regarded as the incarnation of the divinity, so that the god himself might be supposed to die and to rise again; finally we may regard certain cathartic ideas as part of the primeval tradition of this religion. Admitted among the soberer cults of the Greek communities, it lost most of its wildness and savagery, while still retaining a more emotional ecstatic character than the rest. But this cooling process was arrested by a new wave of Dionysiac fervour that spread over Greece from the 7th century onwards, bringing with it the name of Orpheus, and engendering at some later date the Orphic brotherhoods (thiasoi). This religious movement may have started like the earlier one from the lands north of Greece; but Crete and even Egypt are supposed to have contributed much to the Orphic doctrine and ritual. Plato's contemptuous mention (Rep. 364A) of wandering Orphic initiators brings to our notice a phenomenon unknown elsewhere in Greek religion; the missionary spirit, the impulse to preach to all who would hear, which foreshadows the breaking down of the gentile religious barriers of the ancient world. And it is probable that some kind of "Orphic" propagandism, whether through books or itinerant mystery-priests, or both, had been in vogue some time before Plato. Orphism was known to Pindar (*Olym.* ii. and frags. 129-133 v. Christ) and Euripides, see *Hipp.* 952–4 and, yet more important, frag. 472 (Nauck) which attests the antiquity of these mystic Dionysiac associations in Crete. The initiated votary proclaims himself as sanctified to Zeus of Ida, to Zagreus and to the mountain-goddess Rhea-Cybele; he has fulfilled "the solemn rite of the banquet of raw flesh," and henceforth he "robes himself in pure white and avoids the taint of childbirth and funerals and abstains from meat" And—what is most significant—he calls himself by the very name of his god—he is himself Βάκχος. In spirit and in most of its details the passage accords well with the Bacchae of Euripides, which reflects not so much the public worship of Greece, but rather the mystic Dionysiac brotherhoods. Throughout this inspired drdma the votary rejoices to be one with his divinity and to call himself by his name, and this mystic union is brought about partly, though Euripides may not have known it, through "the meal of raw flesh" or the drinking of the blood of the goat. or the kid or the bull. The sacramental intention of this is confirmed by abundant proof; even in the state-cult of Tenedos they dressed up a bull-calf as Dionysus and reverentially sacrificed it (Ael. *Nat.* an. 12. 34); those who partook of the flesh were partaking of what was temporarily the body of their god. The Christian fathers at once express their abhorrence of this savage ὠμοφαγία and reveal its true significance (Arnob. *Adv. nat.* 5. 119); and Firmicus Maternus (De error., p. 84) attests that the Cretans of his own day celebrated a funeral festival in honour of Dionysus in which they enacted the life and the death of the god in a passion-play and "rent a living bull with their teeth."

But the most speaking record of the aspirations and ideas of the Orphic mystic is preserved in the famous gold tablets found in tombs near Sybaris, one near Rome, and one in Crete. These have been frequently published and discussed; and here it is only possible to allude to the salient features that concern the general history of religion. They contain fragments of a sacred hymn that must have been in vogue at least as early as the 3rd century B.C., and which was inscribed in order to be buried with the defunct, as an amulet that might protect him from the dangers of his journey through the under-world and open to him the gates of Paradise. The verses have the power of an incantation. The initiated soul proclaims its divine descent: "I am the son of Earth and Heaven." "I am perishing with thirst, give me to drink of the waters of memory." "I come from the pure": "I have paid the penalty of unrighteousness": "I have flown out of the weary, sorrowful circle of life." His reward is assured him: "O blessed and happy one, thou hast put off thy mortality and shalt become divine." The strange formula ἔριφος ἐς γάλ' ἔπετον "I a kid fell into the milk," has been interpreted by Dieterich (Eine Mithras-Liturgie, p. 174) with great probability as alluding to a conception of Dionysus himself as ἔριφος, the divine kid, and to a ritual of milk-baptism in which the initiated was born again[1].

We discern, then, in these mystic brotherhoods, the germs of a high religion and the prevalence of conceptions that have played a great part in the religious history of Europe. And as late as the days of Plutarch they retained their power of consoling the afflicted (*Consol. ad. uxor.*, c. 10).

The Oriental mysteries, associated with Attis, Cybele, Isis and Sabazius, which invaded later Greece and early imperial Rome, were originally akin to these and contained many concepts in common with them. But their orgiastic ecstasy was more violent, and the psychical aberrations to which the votaries were prone through their passionate desire for divine communion were more dangerous. Emasculation was practised by the devotees of Attis, whatever the reason may have been[2], and the high priest himself bore the god's name. Or communion with the deity might be attained by the priest through the bath of blood in the taurobolium (*q.v.*), or by the gashing of the arm over the altar. A more questionable method which lent itself to obvious abuses, or at least to the imputation of indecency, was the simulation of a sacred marriage, in which the catechumen was corporeally united with the great goddess in her bridal chamber (Dieterich, *op. cit.* pp. 121–134). Prominent also in these Phrygian mysteries were the conception of rebirth and the belief, vividly impressed by solemn pageant and religious drama, in the death and resurrec-

[1]*Eph.* arch. (1883) p. 81.

[2]The best account of the origin and development of the Dionysiac religion is in Rohde's Psyche, vol. i.; for Orphic ritual and doctrine see Roscher's Lexikon, art. Orpheus; J. E. Harrison, Prolegomena *to the* Study of Greek Religion, pp. 455–659, with critical appendix by G Murray on the Orphic tablets; and *cf.* ORPHEUS.

[1]*See* also C. W. Vollgraff, ἔριφος ἐς γάλ' ἔπετον (over den oorsprong der dionysische mysterien). Amsterdam, 1924.

[2]*See* H. J. Rose in *Class. Quart.*, xviii. p. 11, ff.; A. D. Nock, in Archiv f. *Relig.*, xxiii., p. 25, ff.

tion of the beloved Attis. The Hilaria in which these were represented fell about the time of our Easter; and Firmicus Maternus reluctantly confesses its resemblance to the Christian celebration (Farnell. Cults, iii, 299).

The Eleusinian mysteries are far more characteristic of the older Hellenic mind. These later rites breathe an oriental spirit, and though their forms appear strange and distorted they have more in common with the subsequent religious phenomena of Christendom. And the Orphic doctrine may have even contributed something to the later European ideals of private and personal morality. (See *Archiv* fur Religionswiss. (1906), article by Salomon Reinach.)

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MYSTERY AND DETECTIVE STORIES. Although the mystery story as a minor literary genre, a convenient category for book reviewers, is not old, its origins are lost in the blackout of antiquity. Its seeds are found in the folklore of the oldest nations: little tales, hints. anecdotes, superstitions. that are as old as recorded time. They are part of ethnology, philosophy. religion; and their long growth into a department of literary art or artifice parallels the history of man's mind.

MYSTERY STORIES

In that history the emotion of fear always has bulked large, and the oldest and strongest of man's fears is fear of the unknown. Mystery. by definition, is that which is unknown. But tied in with fear of the unknown is the emotion of curiosity concerning it; and out of that fear and curiosity perhaps mas born the mystery story. At first a tale of wonder and terror concerned largely mith supernatural matters, it later became a subsidiary of romance; and in still later times, notably our own, it came to be a sort of game invented and played for intellectual relaxation and artificial excitement.

Today a mystery story is, loosely, any story containing a mystery. It may be, and frequently is, a tale of horror and terror; but it may also be a pseudoscientific fantasy (*see* Science Fiction). a tale of diplomatic intrigue. an affair of codes and ciphers and secret societies, a crime story or a dozen other things involving an enigma. In the beginning. however, it was a tale of spectres and the supernatural.

It will be noted that the detective story per se is omitted from the above list. By recent arbitrary definition, the detective story, lustiest offspring of the mystery story, is a separate and distinct division oi literature, a pure form that demands individual consideration. However, it is obviously a mystery story; the separation is largely one of convenience.

Early **History.**—While mystery stories cannot always be classified nith exactness—since mystery is everywhere present—they may be divided, for easy understanding, into three groups: ghost stories, riddle stories and detective stories.

Ghost Stories, the Gothic and Beyond.—The literature of ghosts, as already stated, is time old. The middle ages took over the dark heritage of antiquity and amplified it with academically formulated magic and cabalism. Perhaps the ghostly angle—complicated by devils, ghouls, ruined castles, subterranean passages and suchlike medieval claptrap—began to emerge most clearly as a department of romance in the 18th century, with what is called the Gothic tale.

It was invented by a worldly Englishman. Horace Walpole, whose Castle *of* Otranto (1764) may be said to have founded the horror story as a permanent form. Among his outstanding successors were Ann Radcliffe (*The Mysteries of Udolpho,* 1794), Matthew Gregory Lenis (The *Monk,* 1796). Charles Robert Maturin (*Melmoth the Wanderer,* 1820) and the early American novelist Charles Brockden Brown (*Wieland,* 1798). Mary Godwin Shelley, the wife of the poet, took a hand in the game, with her famous novel Frankenstein (1818), still a classic horror story, and nith it introduced the pseudoscientific note—the creation out of charnel fragments of a monster that ultimately destroyed its creator.

The influence of the Gothic tale persisted well into the 19th century in the work of such writers as J. Sheridan Le Fanu and Wilkie Collins; indeed, it is obvious in Bram Stoker's gruesome vampire tale *Dracula,* published as late as the year 1891. And pseudoscientific nightmares have not ended with H. G. Wells. Greatest of all names in the field, however, is that of Edgar Allan Poe (1809–49), who first forced the tale of mystery and horror into the artistic regions of pure literature and invented the modern short story form.

Poe's most relevant successors perhaps have been Le Fanu, a strangely neglected Irish genius, Robert Louis Stevenson, Arthur Conan Doyle. Ambrose Bierce. Arthur Machen, Algernon Blackwood, Lord Dunsany and the American *fantaisiste* H. P. Lovecraft. But any such list of masters is inevitably and unfairly incomplete—such isolated masterpieces as W. W. Jacobs' "The Monkey's Paw" have not infrequently lifted writers of a more miscellaneous genius into the front rank of mystery masters.

Riddle Stories.—Riddle stories too began in time out of mind, for the enjoyment of puzzles is as old as humanity itself. But there is a practical utility in puzzle solving, also, that no doubt was recognized by the ancients; regular exercise is as necessary for the brain as for the body. The riddle of Samson, propounded in the Bible (Judg. xiv. 12–18), is the most famous early example; but, although Samson has been called the father of riddles. it may be that older and better ones were even then buried in antiquity.

Among the Egyptians, puzzling was a religious rite. and the Sphinx was their goddess. Such was the esoteric religion of the Egyptians that all the priests were riddlers and their religion one vast enigma. The classic riddle of the Sphinx, however. belongs to Grecian mythology. Its date is not authenticated, but it is of antiquity, for Sophocles wrote about it in the 4th century B C.

So much for antiquity. The riddle story came down the years as did the ghost story, and not infrequently the two overlapped. Its distinguishing feature, at the moment, is that the reader be confronted with a number of mysterious facts and situations, explanation of which is reserved until the end of the story. Unlike the pure detective story—which also, of course. is a riddle story—there may be no clues, either leading or misleading, to assist or to trick the reader. The nhole operation of reading may be one of sustained wonder and abiding curiosity.

A good example of the riddle story may be one describing a search for lost treasure. in which mysterious conditions are encountered. In many such. a cipher or cryptogram is added to the tale to complicate the over-all mystery with an interior riddle that most readers find irresistibly attractive.

Poe's great short story "The Gold Bug" is a classic example of this ingenious and popular story plot. Of another kind is Kipling's short mystery "The Sending of Dana Da," a tale involving a plethora of cats visited upon a hater of cats. In the more sinister field of murder are innumerable tales of roguery involving mystery and crime but without the familiar detective interludes. Two notable—almost notorious—riddle stories of modern times offered no solution to the riddle posed and gained wide attention by their novelty—"The Lady or the Tiger" by Frank R. Stockton, and "The Mysterious Card" by Cleveland Moffett.

More nearly kin to the detective story than any of these are the spy stories. the secret service stories, the tales of international intrigue and adventure that, in our own day, have been entertainingly written and prolifically produced by such men as E. Phillips Oppenheim, John Buchan, Francis Beeding (joint pseud, of J. L. Palmer and H. A. St. G. Saunders), Valentine Williams, H. C. McNeile and William Le Queux to name only half a dozen out of many nho are typical.

These stories are on the border line between adventure and bona fide detection; in certain instances—*Bulldog Drummond, Clubfoot, et al*—they overlap the pure detective story and almost force an entrance into the more select field.

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DETECTIVE STORIES

The detective story, as a literary form, celebrated its 100th anniversary in April 1941. Pedantry asserts that its seeds are to be found in the earliest folklores. and it is true that the antecedents of the various motifs combined in the genre are as old as man's mental habits. of which they are in part the history. The puzzle motif is as old as the Prophets, and the Erinyes theme—revenge relentlessly tracking down the wicked—is anterior to literature. Alleged examples of the detective story, in this prenatal sense: have been dug from the pages of Aesop, Herodotus. Cicero, Vergil and the authors of the Apocryphal Scriptures; specimens have been found in all the literatures of the east. Best of these. perhaps, is the Apocryphal account of Daniel's superb sleuthing in the story of "Bel and the Dragon." in which the prophet is shown to have anticipated Sherlock Holmes by many centuries.

Medieval literature also yields relevant tales and legends from the writings of Boccaccio, Chaucer and others. revealing detective habits of thinking in certain fictive characters; and more pertinent examples are outstanding in the *Arabian Nights*. Most striking of modern prototypes is a famous chapter in Voltaire's *Zadig*, an 18th-century romance in which the philosopher-hero accurately describes a lost horse and dog, although he has seen neither, by pure Holmesian deduction.

Nevertheless. the detective story as we know it was born in the pages of *Graham's Magazine*, a Philadelphia journal, in April 1841, with the publication of a short story, "The Murders in the Rue Morgue." by Edgar Allan Poe. Of this story. Dorothy L. Sayers has observed that "it constitutes in itself almost a complete manual of detective theory and practice." A sequel. "The Mystery of Marie Rogêt," appeared in *Snowden's Ladies' Companion*, of New York, in the issues of Nov. and Dec. 1842 and Feb. 1843. Poe's third and last pure detective story, "The Purloined Letter," was published in a Philadelphia annual. *The Gift*, for the year 1845, in which year all three stories; with others, were brought together in a book called simply *Tales*, the most important volume in the history of the detective story. Each of the three tales celebrated an exploit of the chevalier C. Auguste Dupin. who must be called the first fictional detective, and this for a good reason: the profession of detective had only recently been invented. and until there were detectives in the world to write about, no stories about them were possible.

If anybody preceded Poe, it was François Eugbne Vidocq, the reformed French thief, who established the world's first official detective bureau, at Paris in 1817. and published his *Mémoires* in 1828–29. There is no doubt that Poe read this book and was influenced by it; but presumably—and ostensibly—Vidocq's volume was a factual record of his own experience, not a fictional detective story. And if Poe drew some of his inspiration from the French book—the background of his tales was the Paris of Vidocq's brigade de sûreté—Dupin was no Vidocq: he was Poe himself in a new role invented for the occasion, that of the perfect reasoner: the divine amateur, later to find world popularity in the epic figure of Sherlock Holmes. It may be noted, however, that Poe did not use the word detective in any of his stories: that was to come later.

With Poe's three tales of ratiocination, almost miraculously the detective story sprang into flower full blown. "The extraordinary thing," says H. Douglas Thomson, in *Masters of Mystery*, "is that at its very inception the principles and canons of detective fiction writing were brilliantly conceived, even with a touch of finality." It is not known why Poe stopped at the third story: he may have tired of his creation or, as is more likely, the public response may have been lukewarm. Two other mysteries by this author, "The Gold Bug" and "Thou Art the Man," are sometimes called detective stories, but strictly speaking they are outside the canon.

Poe was ahead of his public. Twenty years were to elapse before the infant he had laboured and then deserted was adopted; and then it was a parent from another land. The year was 1866 when Emile Gaboriau, who had been contributing stories of military and fashionable life to the Parisian newspapers, began to publish his *L'Affaire Lerouge* in *Le Pays* and woke up one morning to find himself famous. Thereafter until his death in 1873 he was a busy man, for he had invented the long detective story. and it was a spectacular success. Other detective novels flowed from his pen —*Le Dossier 113, Le Crime d'Orcival, Monsieur* Lecoq—and his detective creations. Père Tabaret and Lecoq, now stand with Dupin on the shelf of illustrious practitioners. Less clever than Dupin, they were more humorously alive and more recognizably human—Tabaret, the bibliomaniac amateur; Lecoq, the brilliant professional. With Dupin they are the forerunners, the immediate ancestry, of Sherlock Holmes.

It is possible that Gaboriau was familiar with Poe's *Tales*, in the translation of Baudelaire (1856–57), but more likely that he was directly influenced by Vidocq, whose *Mémoires* were looted by scores of French writers of the period, among them Balzac, Hugo and Dumas. These masters, however, never wrote a detective story. Gaboriau's only relevant contemporary was his successor and imitator Fortuné du Boisgobey, author of a line of sensational police romances, of which the first, *Le Forçat Colonel*, was published in 1872.

But before Gaboriau had ceased to write, the movement had crossed the channel; the next landmark in detective fiction was English. In 1868, within a year of the appearance of *L'Affaire Lerouge*, a famous book was published in London—The *Moonstone*, by Wilkie Collins.

An earlier masterpiece by Collins, *The Woman in White*, had appeared in 1860. but, although an excellent mystery, it was not a detective story. In *The Moonstone*, Collins wrote what many critics have called the greatest detective story of them all. However that may be—and the detection in the book is not exhibitional. but a device to catalyze the elaborate ingredients—it was the first full-length detective novel in English and is properly a classic. With Sergeant Cuff, the professional detective who raised roses in his unprofessional moments, says Thomson. "the paradox was born, the detective with a sensibility greater than his sense." With Sergeant Cuff also, it has been said, "character began to raise its head."

Throughout all these years Charles Dickens had been writing voluminously in England without producing a detective novel. He was, however. interested in police work and had watched the growth of England's protective system with alert appreciation of its possibilities for literature. In 1829 Sir Robert Peel had established the London metropolitan police force: with a backdoor opening on a spot called Scotland Yard; and in 1842 a detective branch had been added, with headquarters in the Yard itself. Thus the scene was set; and it may be said that Dickens in a sense inaugurated the long literature that followed those momentous events when, in 1853, he made his friend Inspector Field a character in *Bleak House*. However, *Bleak House* is not a detective novel. Suddenly, in the last year of his life, and probably under the influence of Collins. he began to write *The Mystery of Edwin Drood* but died with the novel half finished on his desk. The fragment was published in 1870 and remains to this day the most exasperating detective story in the world. Hundreds of literary detectives have tried to penetrate its mystery and none has succeeded. There can be little doubt. though, that the book is another landmark in the history of detective fiction.

In America. meanwhile, a young woman named Anna Katharine Green was getting ready to write The *Leavenworth Case*, first of a long line of melodramatic novels of crime and detection from the same hand. The book appeared in 1878 and is still its author's most famous story. although possibly not her best. It is an American classic, however. the first detective novel by an American and the first by a woman in any language. Stilted and old-fashioned as Miss Green's books now seem, her plots, says Howard Haycraft, in *Murder for Pleasure*, are "models of careful construction that can still hold their own against today's competition."

Two remarkable events occurred in 188; to make that year memorable in the history of the detective story. Out of Australia came a sensational thriller, *The Mystery of a Hansom Cab*, by

Ferpus Hume, to become the greatest commercial success in the annals of literary crime. When Hume died. in 1932, more than joo ooo copies had gone over the counter. This famous tale is scarcely readable today but historically it is important.

That nas the first event. The second was the appearance of Sherlock Holmes, still the greatest name in detective literature. His creator, Arthur Conan Doyle, was a young Scotch-Irish physician. who had been inspired by an insufficiency of patients to try his hand at writing. *A Study in Scarlet,* first of the Holmes stories, nas a potboiler that brought him only £2 j. It appeared just before Christmas 1887, and there was no sequel until 1890, when *The Sign of Four* nas written for an American magazine. Neither story set England on fire. but both mere widely pirated in America, in the absence of an international copyright act. The widespread popularity of the detective dates from July 1891, when "A Scandal in Bohemia." first of the shorter *Adventures of Sherlock Holmes,* was published in the *Strand Magazine,* to be followed by 23 others over the next two years. The last 12 became the *Memoirs of Sherlock Holmes,* and in the final story Holmes was killed off by his creator, a deed of violence that shocked the world. By that time, however, the doctor's future had been assured; he had given up medicine and was—as he confessed—heartily tired of his famous puppet, who was obscuring his more important work in the historical field.

But public indignation harassed him until he was forced to bring Holmes back to life. In 1902 he yielded to supplication and published *The Hound of the Baskervilles,* a reminiscence of Sherlock Holmes; in 1905 he surrendered unconditionally in *The Return of Sherlock Holmes,* in which he resurrected the detective with great ingenuity. Three other volumes folloned: *The Valley of Fear,* in 191j; *His Last Bow,* in 1917; and *The Case-Book of Sherlock Holmes,* in 1927

Sir Arthur Conan Doyle died in 1930, leaving behind him the greatest reputation in the history of detective fiction and a detective whose name bids fair to remain a permanent part of the English language.

For the inspiration that led Conan Doyle to write the tales of Sherlock Holmes we have to thank, first, his unemployment; second, his admiration for the work of Poe and Gaboriau; and, last, his happy recollection of the methods and mannerisms of his old teacher, Joseph Bell of Edinburgh. who was the living prototype of the detective. Most of the stories are told by the amiable and obtuse Doctor Watson, a fictional character almost as famous and well loved as Holmes himself. In Watson, it is fair to assume, we have a self-portrait of Conan Doyle, the impecunious Portsmouth physician, who contributed them both to the gallery of immortals.

Thus. says Dorothy L. Sayers, "the ball—the original nucleus deposited by Edgar Allan Poe nearly 40 years earlier—was at last set rolling. As it went, it swelled into a vast mass—it set off others—it became a spate—a torrent—an avalanche of mystery fiction."

In England and America writers were quick to try their talents at the popular game, and for the most part the Sherlock model prevailed. Best of immediate imitations was *Martin Hewitt, Investigator* (1894), by Arthur Morrison, and its several sequels. Simultaneously, pseudoscientific detection made its appearance in the tales of L. T. Meade and her collaborators. Clifford Halifax and Robert Eustace, a series that began with *Stories From the Diary of a Doctor* in 1894.

The aestheticism of the 1890s was reflected in the genre, to some extent, in M. P. Shiel's *Prince Zaleski* (1895); and Grant Allen closed the decade with three excellent volumes, of which the best was *Hilda Wade,* (1900).

The 20th century opened with the Baroness Orczy's anonymous detective, *The Old Man in the Corner,* functioning brilliantly in the magazines (book publication was delayed), and between the years 1907 and 1911 three detectives of the first water appeared in book form: Dr. John Thorndyke, in R. Austin Freeman's *The Red Thumb Mark* (1907), A. E. W. Mason's Hanaud, in *At the Villa Rose* (1910), and G. K. Chesterton's Father Brown, in *The Innocence of Father Brown* (1911). Father Brown, the little English Roman Catholic priest, has been called one of the immortals, and Thorndyke is indubitably great, a scientific investigator whose science is as sound as it is fascinating. In 1913 *Trent's Last Case,* by E C Bentley, was hailed by critics as one of the great masterpieces of the genre The Sherlock Holmes period may be said to have ended, in England. with Ernest Bramah's *Max Carrados* (1914), a volume of notable short stories introducing the first blind detective.

The American scene in the early years of the century produced detective stories in number but only a few that were important. Still remembered is the work of Jacques Futrelle, best viewed in *The Thinking Machine* (1907), and Arthur B. Reeve. whose stories in *The Silent Bullet* (1912) introduced the long series about Craig Kennedy.

More important are Mary Roberts Rinehart and, perhaps, Carolyn Wells. Mrs. Rinehart's *The Circular Sfaircase* (1908) was the first of several books—on the border line between detection and mystery—that helped to make her for a time the most popular of American storytellers. Miss Wells, with less talent, wrote more than 70 detective novels. most of them starring her Sherlockian creation Fleming Stone

High spots of the period were *In the Fog* (1901), by Richard Harding Davis; *Tlzrough the Wall* (1909), by Cleveland Moffett; *The Mystery of the Boule Cabinet* (1912), by Burton E. Stevenson; and *The Achievements of Luther Trant* (1910), by William MacHarg and Edwin Balmer.

In the last book the methods of the psychological laboratory mere used for the first time in fictional crime detection.

America's outstanding contribution to detecti e fiction. after Poe's Dupin stories. was *Uncle Abner: Master of Mysteries,* by Melville Davisson Post, which was not published until 1918; but as early as 1896 Post had begun his career in crime literature. His first attempts were stories of legal chicanery, but by 1909 his tricksy lawyers had gone over to the side of law and order, and this superlative technician was moving into the field of pure detection. In the Uncle Abner stories. tales of early Virginia, he produced an American classic and added the first great American investigator to the gallery of illustrious detectives Post's only comparable contemporary was Frederick Irving Anderson, who published just three books between 1914 and 1930 and was, in consequence, forgotten between volumes. His best-known work is *The Book of Murder* (1930).

Of the years between World Wars I and II it is difficult to write briefly. For a time the most popular writer of detective fiction in the norld probably was J. S. Fletcher. whose excellent novels were given a tremendous impetus by President Wilson's publicized pleasure in *The Middle Temple Murder* (1918). Then, in 1920, another great landmark made its appearance in England: this was *The Cask,* by Freeman Wills Crofts, a book of remarkable quality that has influenced profoundly the modern detective story as a whole "Mr. Crofts." says John Carter "combined the elaboration of Gaboriau nith an integrity of method nhich set an altogether new standard for the many police detectives who have followed [his] Inspector French."

And the years from 1920 onward introduce, one after another, names that today are household words among readers of detective fiction: Poirot, in Agatha Christie's *Mysterious Affair at Styles* (1920); Reggie Fortune, in H. C. Bailey's *Call Mr. Fortune* (1920); Lord Peter Wimsey, in Dorothy L. Sayers' *Whose Body?* (1923); Anthony Gethryn, in Philip MacDonald's *The Rasp* (1924); Dr. Priestly, in John Rhode s *Paddington Mystery* (1925); Roger Sheringham, in Anthony Berkeley's *Layton Court Mystery* (192j); J. G. Reeder, in Edgar Wallace's *The Mind of Mr. J. G. Reeder* (1926).

Others who contributed notable volumes of detection in this period were Eden Phillpotts and A. A. Milne, authors more widely known in other fields. In *Enter Sir John* (1928) Clemence Dane and Helen Simpson created a popular actor-detective, Albert Campion, languid hero of a dozen distinguished books by Margery Allingham, although he made his first appearance in 1928, did not reach his peak until 1934.

All in all, the third decade of the century was memorable—a golden age of the detective story.

In America also, in this decade, important deeds mere accomplished. at least four fictional detectives of stature were added to the records. Chronologically. Charlie Chan was first: a new and appealing figure in the world of fantasy, he made his bow in *The House Without a Key* (1925), by Earl Derr Biggers. Five other novels now celebrate his exploits and, aided by the motion pictures, the aphoristic little Chinese-American lives in the affection of readers more surely than many better detectives.

Philo Vance, his immediate successor, became the best American detective in the English tradition. With Vance. according to Howard Haycraft, "overnight, American crime fiction came of age." Introduced in *The Benson Murder Care* (1926), by S S. Van Dine, his later appearances broke records for detective fiction and made him for some years the most famous fictional sleuth in the world.

Van Dine, his reputed creator, was in reality Willard Huntington Wright. a well-known critic of the arts—and, like his hero, a dilettante—who brought all his imposing erudition in several fields to the task of making Vance one of the immortals of detective fiction. In spite of considerable pretentiousness and some lack of humour, it may be admitted that he succeeded.

Ellery Queen, as writer and detective, entered the field in 1929. The name is a pseudonym concealing the identities of Frederic Dannay and Manfred B. Lee; but Queen also is the central figure in the stories written under that name. Since his appearance in *The Roman Hat Mystery,* his adventures have been increasingly popular; his name is the trade-mark of a reliable brand of entertainment.

Last and most important of the four leading American writers of the period is Dashiell Hammett, ex-Pinkertonian and graduate of the pulp magazines, whose unsentimental narratives established new standards of realism in the detective story field In five novels of startling originality, backgrounded largely by the underworld of American gangsterdom, Hammett invented what has been called the hard-boiled school of crime fiction; but he did more than that—he created a definitely American style, separate and distinct from the English pattern which had been slavishly followed by American writers for generations. As character studies alone, it is claimed, his stories approximate capitalized "Literature."

His influence, however, while enormous, was not altogether good: it has been the more meretricious of Hammett's spectacular bag of tricks that have been exploited by his less talented imitators, in particular his not infrequent salaciousness. First of the Hammett novels was *Red Harvest* (1929). His masterpiece is generally believed to be *The Maltese Falcon* (1930), one of the all-time high points in its field. His most sensationally successful story, *The Thin Man* (1934), was the last of an extraordinary quintette. Summing up his short and brilliant career. critical opinion finds that no other writer of modern times has so basically changed and influenced the detective story form.

Most popular of American writers after Hammett were Erle Stanley Gardner, author of the persistent Perry Mason novels and, under the pseudonym A. A. Fair, of the deeds of Donald Lam and Bertha Cool; Rex Stout, whose fat, orchid-raising Nero Wolfe with his assistant, Archie Goodwin, seems to have become a permanent part of the new mythology; and Raymond Chandler. Hammett's most relevant successor. In England the best traditions of Holmes, Thorndyke, *et al.*, were carried on in the literate entertainments of such writers as Nicholas Blake, Michael Innes. Ngaio Marsh and Cyril Hare. A topflight practitioner hailed on both sides of the Atlantic is the Anglo-American writer John Dickson Carr (Carter Dickson).

On the continent of Europe. except in France, few detective stories of distinction were published at any time. Germany's efforts along the years have been abortive and ponderous; and examples of Scandinavian detective literature, although readable, are unexceptional and not strictly canonical. In France two writers of high importance must be noted in Gaston Leroux and Maurice Leblanc. Leroux's *Le Mystère de la chambre jaune* (1908) has been called the masterpiece of French detective fiction. In Arsène Lupin, in the same period, Leblanc created a romantic rogue. half detective, who ranks with E. W. Hornung's Raffles in popular esteem.

It was not until 1930 that a writer came to stand with Gaboriau, Leroux and Leblanc: then there appeared a figure of international interest, Georges Simenon. His masterful and masterly Inspector Maigret became popular in 17 languages. Introduced to the English-speaking world in *The Crime of Inspector Maigret* (1932), he joined the immortals; in the opinion of a critic, "the greatest character in detective fiction since Sherlock Holmes."

(V. STA.)

The Boom.—Quantitatively speaking, the detective story's climb to the world popularity it enjoys in the second half of the 20th century was slow until comparatively recent times. From its beginnings with Poe in 1841 up to and including 1920, an estimated 1,300 new titles mere published in English-speaking countries; whereas from 1921 to 1940, inclusive, more than 8,000 new titles were published. It is also estimated that about 1,700 new writers of detective stories appeared in the years 1921–40, as against only 300 in the preceding 80 years. World War II brought an inevitable hiatus, which makes continued comparison difficult. Following its conclusion. however. production quickly regained prewar levels. More importantly, the postwar years witnessed two developments which increased the readership of detective stories astronomically: (1) the phenomenal rise of paper-bound books published in huge editions; and (2) the growth of book clubs. While exact statistics are unavailable, it may be safely asserted that if the prewar readership of detective stories could be numbered in the hundreds of thousands, the postwar audience might be counted in the millions.

Coincident with this broadening of its audience, the arbitrary and rather doctrinaire separation of the detective story from other forms of mystery fiction *(see* above) tended to disappear. By the 1950s most recognized authorities were treating detective-mystery-crime fiction as a single if multibranched genre. An interesting subspecies to emerge in the postwar years was the psychological or suspense novel, with its emphasis primarily on the why of crime as distinguished from the traditional who and how. Like the hard-boiled detective novel before it, the suspense novel. after a brief crest of popularity, tended to be absorbed back into the mainstream of mystery fiction, while influencing the more orthodox mystery novel healthily in the direction of imaginativeness and heightened awareness of human values. More generally, critics on both sides of the water noted a trend away from the story of pure detection, or so-called chess puzzle, and toward the novel of character, with a crime or detection motif.

Although the postwar years were marked by a high level of competence in mystery writing, they produced fewer recognizable titans than the preceding decades: a development not unusual in a maturing literary form.

Nevertheless a few writers may be mentioned whose fame seems secure for more than the moment. In England, Josephine Tey *(The Franchise Affair, The Daughter of Time)*, Raymond Postgate *(Verdict of Twelve)* and Edgar Lustgarten *(One More Unfortunate)* upheld the dignity of the British detective novel, though departing frequently from the classical formula; while Eric Ambler and Manning Coles gave new stature to the tale of intrigue and espionage.

In America the period produced a number of writers whose importance rests less on scintillating solo performances than on a highly competent, continuing body of work; of these, Frances and Richard Lockridge, with their Mr. and Mrs. North narratives, may be cited as representative.

In the field of the suspense story Dorothy B. Hughes and Cornell Woolrich (pseudonym, William Irish) won high standing, among many.

Two timely events considerably influenced the production of mystery fiction. especially in the C.S. In 1941 *Ellery Queen's Mystery Magazine* was established, the first quality periodical in the field; its American success was followed, after World War II, by editions published in France, Great Britain, Italy, Brazil, Australia, Japan and Mexico. Founded in 1945, Mystery Writers of

America, Inc., is a professional organization dedicated to elevating the standards of mystery fiction and the economic status of its members. Boasting a membership of more than 400 active writers, and with flourishing chapters in New York, Chicago, Los Angeles and San Francisco, its annual "Edgar" awards (named, of course, for Edgar Allan Poe) are as eagerly awaited in the mystery field as the Academy of Motion Picture Arts and Sciences' "Oscars" in the motion-picture industry.

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MYSTICISM, a phase of thought, or rather perhaps of feeling. which from its very nature is hardly susceptible of exact definition. It appears in connection with the endeavour of the human mind to grasp the divine essence or the ultimate reality of things, and to enjoy the blessedness of actual communion with the Highest. The first is the philosophic side of mysticism; the second, its religious side. The first effort is theoretical or speculative; the second, practical. The thought that is most intensely present with the mystic is that of a supreme, all-pervading, and indwelling power, in whom all things are one. Hence the speculative utterances of mysticism are always more or less pantheistic in character. On the practical side, mysticism maintains the possibility of direct intercourse with this Being of beings—intercourse, not through any external media such as an historical revelation, oracles, answers to prayer, and the like, but by a species of transfusion or identification, in which the individual becomes in very truth "partaker of the divine nature." God ceases to be an object to him, and becomes an experience.

Universality.—In the writings of the mystics, ingenuity exhausts itself in the invention of phrases to express the closeness of this union. hlysticism differs, therefore, from ordinary pantheism in that its inmost motive is religious; but, whereas religion is ordinarily occupied by a practical problem and develops its theory in an ethical reference, mysticism displays a predominatingly speculative bent, starting from the divine nature rather than from man and his surroundings, taking the symbolism of religious feeling as literally or metaphysically true, and straining after the present realization of an ineffable union. The union which sound religious teaching represents as realized in the submission of the will and the ethical harmony of the whole life is then reduced to a passive experience, to something which comes and goes in time, and which may be of only momentary duration. Mysticism, it will be seen, is not a name applicable to any particular system. It may be the outgrowth of many differing modes of thought and feeling. Most frequently it appears historically, in relation to some definite system of belief, as a reaction of the spirit against the letter. When a religion begins to ossify into a system of formulas and observances, those who protest in the name of heart-religion are not unfrequently known by the name of mystics. At times they merely bring into prominence again the ever-fresh fact of personal religious experience; at other times mysticism develops itself as a powerful solvent of definite dogmas. Mysticism appears in various phases in all the higher religions known to history. Its distinctive characteristics emerge in the religions of India and Persia as well as in the faith of Islam These subjects are dealt with elsewhere; but its relation to Judaism and the religions of Greece requires special mention here. For opposite reasons, neither the Greek nor the Jewish mind lent itself readily to mysticism: the Greek, because of its clear and sunny naturalism; the Jewish, because of its rigid monotheism and its turn towards worldly realism and statutory observance. It is only with the exhaustion of Greek and Jewish civilization that mysticism becomes a prominent factor in Western thought. It appears, therefore, contemporaneously with Christianity, and is a sign of the world-weariness and deep religious need that mark the decay of the old world. Whereas Plato's main problem had been the organization of the perfect state, and Aristotle's intellect had ranged with fresh interest over all departments of the knowable, political speculation had become a mockery with the extinction of free political life, and knowledge as such had lost its freshness for the Greeks of the Roman Empire. Knowledge is nothing to these men if it does not show them the infinite reality which is able to fill the aching void within. Accordingly, the last age of Greek philosophy is theosophical in character, and its ultimate end is a practical satisfaction. Neoplatonism seeks this in the ecstatic intuition of the ineffable One. The systematic theosophy of Plotinus and his successors does not belong to the present article, except so far as it is the presupposition of their mysticism; but, inasmuch as the mysticism of the mediaeval Church is directly derived from Neoplatonism through the speculations of the pseudo-Dionysius, Neoplatonic mysticism fills an important section in any historical review of the subject.

Neoplatonism.—Neoplatonism appears in the first half of the 3rd century, and has its greatest representative in Plotinus. He develops the Platonic philosophy into an elaborate system by means of the doctrine of emanation. The One, the Good, and the Idea of the Good were identical in Plato's mind, and the Good was therefore not deprived of intelligible essence. It was not separated from the world of ideas, of which it was represented as either the crown or the sum. By Plotinus, on the contrary, the One is explicitly exalted above the νοῦς and the "ideas"; it transcends existence altogether (ἐπέκεινα τῆς οὐσίας), and is not cognizable by reason. Remaining itself in repose, it rays out, as it were, from its own fullness an image of itself, which is called νοῦς, and which constitutes the system of ideas of the intelligible world. The soul is in turn the image or product of the νοῦς, and the soul by its motion begets corporeal matter. The soul thus faces two ways—towards the νοῦς, from which it springs, and towards the material life, which is its own product. Ethical endeavour consists in the repudiation of the sensible; material existence is itself estrangement from God. (Porphyry tells us that Plotinus was unwilling to name his parents or his birthplace, and seemed ashamed of being in the body.) Beyond the καθάρσεις, or virtues which purify from sin, lies the further stage of complete identification with God (οὐκ ἔξω ἁμαρτίας εἶναι, ἀλλὰ θεὸν εἶναι). To reach the ultimate goal, thought itself must be left behind; for thought is a form of motion, and the desire of the soul is for the motionless rest which belongs to the One. The union with transcendent deity is not so much knowledge or vision as ecstasy, coalescence, *contact* (ἔκστασις, ἅπλωσις, ἁφή, Ennead., vi. 9. 8–9). But in our present state of existence the moments of this ecstatic union must be few and short.

It will be seen from the above that Neoplatonism is not mystical as regards the faculty by which it claims to apprehend philosophic truth. It is first of all a system of complete rationalism; it is assumed, in other words, that reason is capable of mapping out the whole system of things. But, inasmuch as a God is affirmed beyond reason, the mysticism becomes in a sense the necessary complement of the would-be all-embracing rationalism. The system culminates in a mystical act, and in the sequel, especially with Iamblichus and the Syrian Neoplatonists, mystical practice tended more and more to overshadow the theoretical groundwork.

Dionysius **Areopagiticus.**—It was probably about the end of the jth century, just as ancient philosophy was dying out in the schools of Athens: that the speculative mysticism of Neoplatonism made a definite lodgment in Christian thought through the literary forgeries of the pseudo-Dionysius (*see* DIONYSIUS AREOPAGITICUS). The doctrines of Christianity were by that time so firmly established that the Church could look upon a symbolical or mystical interpretation of them without anxiety. The author of the *Theologia mystica* and the other works ascribed to the Areopagite proceeds, therefore, to develop the doctrines of Proclus with very little modification into a system of esoteric Christianity. God is the nameless and supra-essential One, elevated above goodness itself. Hence "negative theology," which ascends from the creature to God by dropping one after another every determinate predicate, leads us nearest to the truth. The return to God (ἕνωσις, θέωσις) is the consummation of all things and the goal indicated by Christian teaching. The same doctrines were preached with more of churchly fervour by Maximus the Confessor (580–622).

The West.—St. Maximus represents almost the last speculative activity of the Greek Church, but the influence of the pseudo-Dionysian writings were transmitted to the West in the 9th century by Erigena, in whose speculative spirit both the scholasticism and the mysticism of the middle ages have their rise. Erigena translated Dionysius into Latin along with the commentaries of Maximus, and his system is essentially based upon theirs. In Erigena mysticism has not yet separated itself in any way from the dogma of the Church. There is no revulsion, as later, from dogma as such, nor is more stress laid upon one dogma than upon another; all are treated upon the same footing, and the whole dogmatic system is held, as it were, in solution by the philosophic medium in which it is presented. No distinction is drawn, indeed, between what is reached by reason and what is given by authority; the two are immediately identical for Erigena. In this he agrees with the speculative mystics everywhere, and differentiates himself from the scholastics who followed him. The chief representatives of scholasticism aim at demonstrating that the content of revelation and the teaching of reason are identical, but this is only an equation of two things which have been dealt with on the supposition that they are separate. Mysticism, on the other hand, is marked on its speculative side by even an overweening confidence in human reason; and this is pre-eminently visible in the work of Erigena. Nor need this be wondered at if we consider that the unity of the human mind with the divine is its underlying presupposition. Hence where reason is discarded by the mystic it is merely reason overleaping itself; it occurs at the end and not at the beginning of his speculations. Even then there is no appeal to authority; nothing is accepted from without. The appeal is still to the individual, who, if not by reason then by some higher faculty, claims to realize absolute truth and to taste absolute blessedness.

Anti-dialectical.—Mysticism first appears in the mediaeval Church as the protest of practical religion against the predominance of the dialectical spirit. It is so with Bernard of Clairvaux (1090–1153), who condemns Abelard's distinctions and reasonings as externalizing and degrading the faith. St. Bernard's mysticism is of a practical cast, dealing mainly with the means by which man may attain to the knowledge and enjoyment of God. Reason has three stages, in the highest of which the mind is able, by abstraction from earthly things, to rise to *contemplatio* or the vision of the divine. More exalted still, however, is the sudden ecstatic vision, such as was granted, for example, to Paul. This is the reward of those who are dead to the body and the world. Asceticism is thus the counterpart of medieval mysticism; and, by his example as well as by his teaching in such passages, St. Bernard unhappily encouraged practices which necessarily resulted in self-delusion. Love grows with the knowledge of its object, he proceeds, and at the highest stage self-love is so merged in love to God that we love ourselves only for God's sake or because God has loved us. "As the little water-drop poured into a large measure of wine seems to lose its own nature entirely and to take on both the taste and the colour of the wine; or as iron heated red-hot loses its own appearance and glows like fire; or as air filled with sunlight is transformed into the same brightness so that it does not so much appear to be illuminated as to be itself light—so must all human feeling towards the Holy One be self-dissolved in unspeakable wise, and wholly transfused into the will of God. For how shall God be all in all if anything of man remains in man? The substance will indeed remain, but in another form, another glory, another power" (De diligendo *Deo*, c. 10).

Mysticism was more systematically developed by Bernard's contemporary Hugh of St. Victor (1096–1141). The Augustinian monastery of St. Victor near Paris became the headquarters of mysticism during the 12th century. It had a wide influence in awakening popular piety, and the works that issued from it formed the textbooks of mystical and pietistic minds in the centuries that followed. Hugh's pupil, Richard of St. Victor, declares, in opposition to dialectic scholasticism, that the objects of mystic contemplation are partly above reason, and partly, as in the intuition of the Trinity, contrary to reason. He enters at length into the conditions of ecstasy and the yearnings that precede it. Bonaventura (1221–1274) was a diligent student of the Victorines, and in his *Itinerarium* mentis ad Deum maps out the human faculties in a similar fashion. He introduces the terms "apex mentis" and "scintilla" (also "synderesis" or συντήρησις) to describe the faculty of mystic intuition. Bonaventura runs riot in phrases to describe the union with God, and his devotional works were much drawn upon by mystical preachers.

Theology of the Heart.—From the 12th and 13th centuries onward there is observable in the different countries of Europe a widespread reaction against the growing formalism and worldliness of the Church and the scandalous lives of many of the clergy. Men began to feel a desire for a theology of the heart and an unworldly simplicity of life. In the beginning of the 13th century the foundation of the Dominican and Franciscan orders furnished an ecclesiastical and regular means of supplying the same wants, and numerous convents sprang up at once throughout Germany. The German mind was a peculiarly fruitful soil for mysticism, and a number of women appear about this time, combining a spirit of mystical piety and asceticism with sturdy reformatory zeal directed against the abuses of the time. Even before this we hear of the prophetic visions of Hildegard of Bingen (a contemporary of St. Bernard) and Elizabeth of Schonau. In the 13th century Elizabeth of Hungary, the pious landgravine of Thuringia, assisted in the foundation of many convents in the north of Germany. (For an account of the chief of these female saints see the first volume of W. Preger's *Geschichte* der *deutschen* Mystik.) Mechthild of Magdeburg appears to have been the most influential, and her book *Das fliessende* Licht der *Gottheit* is important as the oldest work of its kind in German. It proves that much of the terminology of German mysticism was current before Eckhart's time. Mechthild's clerico-political utterances show that she was acquainted with the "eternal gospel" of Joachim of Floris. Joachim had proclaimed the doctrine of three world-ages—the kingdom of the Father, of the Son, and of the Spirit. The reign of the Spirit was to begin with the year 1260, when the abuses of the world and the Church were to be effectually cured by the general adoption of the monastic life of contemplation.

Very similar to this in appearance is the teaching of Amalric of Bena (d. 1207); but, while the movements just mentioned were reformatory without being heretical, this is very far from being the case with the mystical pantheism derived by Amalric from the writings of Erigena. His followers held a progressive revelation of God in the ages of the Father, Son and Holy Spirit. Just as the Mosaic dispensation came to an end with the appearance of Christ, so the sacraments of the new dispensation have lost their meaning and efficacy since the incarnation of God as Holy Spirit in the Amalricans. With this opposition to the Church they combine a complete antinomianism, through the identification of all their desires with the impulses of the divine Spirit. Amalric's teaching was condemned by the Church, and his heresies led to the public burning of Erigena's De *divisione naturae* in 1225.

Eckhart.—In Meister Eckhart (?1260–1327) the German mind definitively asserts its pre-eminence in the sphere of speculative mysticism. Eckhart was a distinguished son of the Church; but in reading his works we feel at once that we have passed into quite a different sphere of thought from that of the churchly mystics; we seem to leave the cloister behind and to breathe a freer atmosphere. The scholastic mysticism was, for the most part, practical and psychological in character. It was largely a devotional aid to the realization of present union with God; and, so far as it was theoretical, it was a theory of the faculties by which such a union is attainable. But in Eckhart the attitude of the churchman and traditionalist is entirely abandoned. His system enables him to give a profound significance to the doctrines of the Church; but, instead of the system being accommodated to the doctrines, the doctrines—and especially the historical facts—acquire a new sense in the system, and often become only a mythical representation of speculative truth.

The political circumstances of Germany in the first half of the 14th century were in the last degree disastrous. The war between the rival emperors, Frederick of Austria and Louis of Bavaria, and the interdict under which the latter was placed in 1324 inflicted extreme misery upon the unhappy people. From some places the interdict was not removed for twenty-six years. Men's minds were pained and disquieted by the conflict of duties and the absence of spiritual consolation. The country was also visited by a succession of famines and floods, and in 1348 the Black Death swept over Europe like a terrible scourge. In the midst of these unhappy surroundings religion became more inward in men of real piety and the desire grew among them to draw closer the bonds that united them to one another. Thus arose the society of the Friends of God (Gottesfreunde) in the south and west of Germany, spreading as far as Switzerland on the one side and the Netherlands on the other. They formed no exclusive sect. They often took opposite sides in politics and they also differedin the type of their religious life; but they uniformly desired to strengthen one another in living intercourse with God. Among them chiefly the followers of Eckhart were to be found. Such were Heinrich Suso of Constance (1295–1366) and Johann Tauler of Strasbourg (1300–1361), the two most celebrated of his immediate disciples. It was doubtless one of the Friends who sent forth anonymously from the house of the Teutonic Order in Frankfort the famous handbook of mystical devotion called Eine deutsche Theologie, first published in 1j16 by Luther.

Jan van **Ruysbroeck (1294–1381)**, the father of mysticism in the Netherlands, stood in connection with the Friends of God, and Tauler is said to have visited him in his seclusion at Groenendal near Brussels. He was decisively influenced by Eckhart, though there is noticeable occasionally a shrinking back from some of Eckhart's phraseology. Ruysbroeck's mysticism is more of a practical than a speculative cast. He is chiefly occupied with the means whereby the unio *mystica* is to be attained, whereas Eckhart dwells on the union as an ever-present fact, and dilates on its metaphysical implications. Towards the end of Ruysbroeck's life, in 1378, he was visited by the fervid lay-preacher Gerhard Groot (1340–1384), who was so impressed by the life of the community at Groenendal that he conceived the idea of founding a Christian brotherhood, bound by no monastic vows, but living together in simplicity and piety with all things in common, after the apostolic pattern. This was the origin of the Brethren of the Common Lot (or Common Life). The first house of the Brethren was founded at Deventer by Gerhard Groot and his youthful friend Florentius Radewyn; and here Thomas à Kempis (*q.v.*) received his training. Similar brother-houses soon sprang up in different places throughout the Low Countries and Westphalia, and even Saxony.

Mystics and the Reformation.—It has been customary for Protestant writers to represent the mystics of Germany and Holland as precursors of the Reformation. In a sense this is true. But it would be false to say that these men protested against the doctrines of the Church in the way the Reformers felt themselves called upon to do. There is no sign that Tauler, for example, or Ruysbroeck, or Thomas à Kempis had felt the dogmatic teaching of the Church jar in any single point upon their religious consciousness Nevertheless, mysticism did prepare men in a very real way for a break with the traditional system. Mysticism instinctively recedes from formulas that have become stereotyped and mechanical. On the other hand its claim for spiritual freedom was soon to be found in opposition also to the Reformers. The wild doctrines of Thomas Munzer and the Zwickau prophets, merging eventually into the excesses of the Peasants' War and the doings of the Anabaptists in Munster, first roused Luther to the dangerous possibilities of mysticism as a disintegrating force. He was also called upon to do battle for his principle against men like Caspar Schwenkfeld (1490–1561) and Sebastian Franck (*c.* 1499–*c.* 1543), the latter of whom developed a system of pantheistic mysticism, and went so far in his opposition to the letter as to declare the whole of the historical element in Scripture to be but a mythical representation of eternal truth. Valentin Weigel (1533–1588), who stands under manifold obligations to Franck, represents also the influence of the semi-mystical speculation that marked the transition from scholasticism to modern times. The final breakdown of scholasticism as a rationalized system of dogma may be seen in Nicolas (or Nicolaus) of Cusa (1401–1464), who insists that all real apprehension of God is by way of a "knowledge above knowledge." The influence of later mediaeval mysticism is seen in Jacob Boehme (1575–1624).

Other Forms of Mysticism.—Mysticism did not cease within the Catholic Church at the Reformation. In St. Theresa (1515–1582) and John of the Cross the counter-reformation can boast of saints second to none in the calendar for the austerity of their mortifications and the rapture of the visions to which they were admitted. But, as was to be expected, their mysticism moves in that comparatively narrow round, and consists simply in the heaping up of these sensuous experiences. The speculative character has entirely faded out of it, or rather has been crushed out by the tightness with which the directors of the Roman Church now held the reins of discipline. The gloom and harshness of these Spanish mystics are absent from the tender, contemplative spirit of François de Sales (1567–1622); and in the quietism of Mme. Guyon (1648–1717) and Miguel de Molinos (1627–1696) there is again a sufficient implication of mystical doctrine to rouse the suspicion of the ecclesiastical authorities.

In the 17th century mysticism is represented in the philosophical field by the so-called Cambridge Platonists, and especially by Henry More (1614–1687), in whom the influence of the Kabbalah is combined with a species of Christianized Neoplatonism. Pierre Poiret (1646–1719), an ardent student of Tauler and Thomas à Kempis, exhibits a violent reaction against the mechanical philosophy of Descartes, and especially against its consequences in Spinoza. The first influence of Boehme was in the direction of an obscure religious mysticism. J. G. Gichtel (1638–1710), the first editor of his complete works, became the founder of a sect called the Angel-Brethren. All Boehme's works were translated into English in the time of the Commonwealth, and regular societies of Boehmenists were formed in England and Holland. Later in the century he was much studied by the members of the Philadelphian Society, John Pordage, Thomas Bromley, Jane Lead, and others. The mysticism of William Law (1686–1761) and of Louis Claude de Saint Martin in France (1743–1803), who were also students of Boehme, is of a much more elevated and spiritual type. The "Cherubic Wanderer," and other poems, of Johann Scheffler (1624–1677), known as Angelus Silesius, are more closely related in style and thought to Eckhart than to Boehrne.

The religiosity of the Quakers, with their doctrines of the "inner light" and the influence of the Spirit, has decided affinities with mysticism; and the autobiography of George Fox (1624–1691), the founder of the sect, proceeds throughout on the assumption of supernatural guidance. Stripped of its definitely miraculous character, the doctrine of the inner light may be regarded as the familiar mystical protest against formalism, liberalism, and scripture-worship. Swedenborg, though selected by Emerson in his Representative Men as the typical mystic, belongs rather to the history of spiritualism than to that of mysticism as understood in this article. He possesses the cool temperament of the man of science rather than the fervid Godward aspiration of the mystic proper; and the speculative impulse which lies at the root of this form of thought is almost entirely absent from his writings. Accordingly, his supernatural revelations resemble a course of lessons in celestial geography more than a description of the beatific vision.

Analysis.—The term mysticism is often extended by popular usage and philosophical partisanship to the whole activity of the German idealistic thinkers who followed Kant; but this looseness of phraseology only serves to blur important distinctions. However absolute a philosopher's idealism may be, he is erroneously styled a mystic if he moves towards his conclusions only by the patient labour of the reason. Hegel therefore, to take an instance, can no more fitly be classed as a mystic than Spinoza can. It would be much nearer the truth to take both as types of a thoroughgoing rationalism. In either case it is of course open to anyone to maintain that the apparent completeness of synthesis really rests on the subtle intrusion of elements of feeling into the rational process. But in that case it might be difficult to find a systematic philosopher who would escape the charge of mysticism; and it is better to remain by long-established and serviceable distinctions.

So, again, when Récéjac defines mysticism as "the tendency to draw near to the Absolute in moral union by symbolic means," the definition, as developed by him, is one which would apply to the philosophy of Kant. Récéjac's interesting work, *Les Fondements de la connaissance mystique* (Eng. trans. 1899), though it touches mysticism at various points, and quotes from mystic writers, is in fact a protest against the limitations of experience to the data of the senses and the pure reason to the exclusion of the moral consciousness and the deliverances of "the heart." But such a position is not describable as mysticism in any recognized sense. On the other hand, the term is in place where the movement of revulsion from a mechanical philosophy takes the form rather of immediate assertion than of reasoned demonstration, and where the writers, after insisting generally on the spiritual basis of phenomena, either leave the position without further definition or expressly declare that the ultimate problems of philosophy cannot be reduced to articulate formulas. Examples of this are men like Novalis, Carlyle and Emerson, in whom philosophy may be said to be impatient of its own task.

Modern Studies. — Study of the subject may be said to begin with Dean Inge's Bampton Lectures on Christian Mysticism (1899). It has since been pursued along the parallel routes of psychology, history and philosophy of religion, with the result that the claim of mysticism to be regarded as a genuine form of human experience is justified. These aspects of mysticism cannot rigidly be separated, or indeed understood in isolation, each being of vital importance to the rest.

William James, in his epoch-making Gifford Lectures on *The Varieties of Religious Experience* (1902), originated the serious study of mysticism, especially from the psychological point of view, and attempted to discover its relation to other forms of consciousness. Although based on material chosen from too restricted a field, the publication of this book revolutionised the attitude of students towards religious psychology. The conception of the subconscious was now first used to provide an explanation and sanction for the ecstatic and other abnormal phenomena found in connection with mysticism, and an attempt was made to distinguish the accompaniments of genuine religious apprehension from their pathological imitations.

These researches have continued vigorously, especially in America and France. Pratt's *Religious Consciousness* (1921) represents the matured result of the movement started by James. Considerable advance has been made towards the correlation and better understanding of such types as the prophet, visionary and religious revivalist, in all of whom a strong mystical impulse is commonly at work. The hostile study of mysticism from the psychological standpoint has its chief exponent in J. H. Leuba, and to some extent in the work of experimental psychologists such as P. Janet, whilst an approach midway between the philosophical and psychological is provided by Bucke's *Cosmic Consciousness*, a curious work which has exercised considerable influence. Delacroix's sympathetic but penetrating analyses of the evolution of the great mystics have shed much light on the psychological characteristics of religious genius. Valuable studies of the nature of mystical contemplation, and restatement in modern terms of its processes, have been produced by Roman Catholic scholars, the best being those of Père Poulain, S.J.

Influence of Psychology. — The psychological study of mystical phenomena has illuminated many historical problems, especially those connected with prophecy and the origins of religious movements. The treatment of the subject in such works as Heiler's *Das Gebet* and *Der Katholizismus* or Brémond's monumental *Histoire du Sentiment religieux en France,* is symptomatic of the changed outlook. Material available for students of historical mysticism has been much enriched. Good texts and translations of many masterpieces of European mysticism have appeared, with valuable studies such as those of Abbot Butler and Rufus Jones, based on the historical method.

The changed outlook of physical science, the new understanding of its limitations and the marked revolt from 19th-century materialism, have brought about a *rapprochement* between mysticism and philosophy. Inge's *Philosophy of Plotinus* (1918) and Otto's widely discussed essay *Das Heilige* (The Idea of the Holy, 1924) show different aspects of the reaction of philosophy to mysticism. But this is also felt in the pure metaphysics of Wittgenstein, and in the inimical attitude of Croce and his school. The greatest and ultimately most influential expositions of the place of mysticism in theistic philosophy, and its limitations and rightful relation with other aspects of knowledge, are Von Hiigel's *Mystical Element of Religion* and *Eternal Life*. These books have affected all modern religious thinkers, and may provide the starting-point of a critical realism harmonising the mystical, moral and intellectual approaches to reality. In America, Hocking's *Meaning of God in Human Experience* is probably the most important philosophic contribution to this subject.

Modern Practical Mysticism. — The first quarter of the 20th century saw, especially in France, a revival of genuine Christian mysticism; possibly the beginning of what later historians may recognise as a "mystical epoch." Its most impressive document is the *Spiritual Journal* of the lady known as Lucie-Christine (1844–1908), a record which bears comparison with the historical classics of mysticism. Its most striking product is the career of the hermit saint of the Sahara, Charles de Foucauld (1858–1916). These stand out among a number of more obscure personalities, such as Elizabeth de la Trinité (1880–1906) and Madeleine Sémer (1874–1921), all of whom claim and describe with a conviction and sobriety compelling respect the characteristic mystical experience and certitude. From India, the autobiography of the saintly Hindu theist Maharshi Devendranath Tagore (1817–1905), and the experiences of the Christian convert Sadhu Sundar Singh (born 1889), whose career and personality have made a widespread impression, provide unspoilt examples of first-hand mysticism, and deepen the sense of unity in the spiritual intuitions.

The revived interest in mysticism has had popular results in several directions. It has seemed to endorse the shallow eclecticism in which many escape the difficulties of belief. Its superficial peculiarities have been exploited by theosophists and other apostles of eccentric religiosity. It has produced numerous bastard cults, mostly hailing from America though often wearing Oriental disguise; cults mainly compounded of pantheism, quietism and crude autosuggestion, and offering a "mystical religion" to those seeking a spiritual home full of modern conveniences and devoid of discipline. On the other hand, its spirit has affected for good the literature and activity of the organised Churches; shifting the emphasis from tradition to experience, and bringing back into focus those mysterious realities which religious symbols and institutions seek to express.

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schichte der Deutschen Mystik im Mittelalter, 3 vol. (1874–93). *See* also articles on the greater mystical writers named.

(A. S. P.-P.; E. Un.; X.)

MYTHOLOGY (Greek *mythos,* "story"; *logos,* "discussion" or "account" of anything) is the study of the traditional tales of any people or of mankind in general (for example, of Greek, Indian or Chinese stories). The term is used, more loosely, to describe the collectivity of such tales (as, the mythology of Zeus, Thor, etc.). Most peoples, though not all, have a number of these traditions, sometimes embodied in written works such as epic and other poems, sometimes oral, as in the case of illiterate or preliterate peoples whose beliefs have been collected and studied by modern scholars. It is often found that oral stories passed on from generation to generation of narrators, who are frequently professionals, have a fixed form, whether in verse or not. Tales current in Ireland and parts of the Scottish Highlands are of this kind. Such stories may be classed as unwritten literature.

Classification. — Traditional tales fall into three classes, myth proper, saga (or legend) and *Märchen,* or folk tales. Of these, the myths deal with customs, especially religious customs; with natural phenomena of the most varied kind, from the creation of the world to the shape of a rock; and with the supposed character and activities of whatever gods or other supernatural beings are worshiped. A saga, however, is popular history, regularly having behind it some real event which has impressed the general imagination, such as a battle or a raid. It is therefore founded upon fact, however much fanciful embroidery may have been added. A *Märchen,* or folk tale, has no such foundation and no serious purpose, but is told simply to amuse or to interest, being thus a forerunner of the novel or short story. Prolonged study of folk tales from all over the world has shown that they have a great number of themes in common (*e.g.,* the youngest child or other inferior person turns out to be brilliantly successful). It is disputed whether this is due to independent origin, the human imagination being apt to work along much the same lines everywhere, or to distribution from one or more centres. The truth probably is that both factors are involved. A good story often spreads across linguistic and cultural frontiers in a remarkable fashion (thus, Homer's tale of Odysseus and the Cyclops is found in substance among the Lapps, who certainly did not get it direct from the *Odyssey).* Such motifs as the grateful rewarding of a kind action or the finding of some magical or other wonderful means of achieving one's desires seem to arise simply from universal human sentiments and wishes.

Origins. — While saga and folk tales are easily accounted for, the rise of the myth is a matter much discussed from various points of view. Examination of the abundant material shows that among many peoples myth is so closely connected with magico-religious ritual as to form part of it. "Myth is a true story because it is a sacred story, not only by virtue of its content but because of the concrete sacral forces which it sets to work. The recital of myths of the beginnings of things is part and parcel of cult, because it is cult itself and helps to gain the ends for which cult is carried on, namely, the preservation and increase of life" (R. Pettazzoni, *Miti e Leggende,* vol. i, p. x). Thus, the recital of a myth of creation (which often must be done only at certain times of the year and at certain hours of the day) not only has the effect of informing the younger members of the community how, in the opinion of their people. the world came to be, but actively helps to preserve it as it is and to prevent it from relapsing into some kind of primeval chaos. But it has yet to be proved that this type of custom was observed by all peoples. Thus, there is no proof that the stylized Hebrew account of creation was ever formally recited as part of a religious ceremony, and the numerous Greek myths concerning the early days of the universe (Greece had, apparently, no creation myths proper) were never, so far as is known, part of any rite. Their telling was not restricted to any particular date or to any particular time of day or night, and they had no fixed, unalterable form, but varied in their phrasing, even in many of their details, from one narrator to another. This is not to say that there was no connection between Greek myths and Greek ritual, however. There is the myth of the rape of Kore, the young corn goddess, by Hades, the god of the underworld, and of her subsequent reunion with her mother Demeter, in the "Homeric" hymn to Demeter (about 7th century B.C.) ; and it is to be supposed that something of the kind was represented, by mimetic dancing or otherwise, at the Eleusinian mysteries *(see* H. J. Rose, *Modern Methods* in *Classical Mythology,* pp. 9–12). But in general Greek myths are etiological—*i.e.,* purporting to explain such things as the details of a particular cult — and are not part of the cult itself. Rome too had abundant ritual, but apparently no native myths at all. The explanation for this seems to be that, once satisfied that their gods possessed power (described by the term *numen* in Latin from at least the 2nd century B.C.), and that they could be induced to exercise it for the benefit of their worshipers, the Romans were incurious as to what kind of beings the gods were and as to what they did besides using *numen.* The Greeks, like numerous other peoples, were more inquisitive.

Several instances exist of far-traveled myths. That of Heaven and Earth, husband and wife who used to be closely embraced until their children separated them by force, is to be found in Greece and in New Zealand. Intervening forms are being discovered. but its origin is at present unknown.

It should be noticed that myth has its part also in magical ritual. Narrative forms an important element in many charms employed by all manner of peoples. Thus in the Finnish *Kalevala,* Väinämoinen, wounded with an iron weapon, recites the story of the origin of iron as part of his cure. Often the story is of a miraculous healing, and the moral is pointed somewhat thus: "As the disease of So-and-so was healed, so may his ailment be who uses this charm."

Development. — Once existent, myths form the material of imaginative works, often long and elaborate, among those peoples who are sufficiently advanced to produce anything of the kind. This involves a more or less complete severance between myth and ritual, for although the general outlines of the story are usually unchanged (thus, in Greek tradition, Zeus must always be represented as overthrowing his father Kronos), the author, generally a poet, has a free hand in describing how the events came about. His attitude may vary from deep and sincere reverence to the most frivolous handling of the matter, and accordingly he may be anything from a devout worshiper of the gods involved in the story to a complete unbeliever, using them simply as ornaments for his narrative or as "epic machinery." The possession of poetic powers, again, may be regarded as anything from direct inspiration by supernatural beings such as the Greek Muses to simple literary training and ability. .(The Muses are repeatedly invoked in Homer to tell the story which they know exactly, whereas mortals hear only a vague rumour of it.) Furthermore, myth need not be the author's only material; he is generally at liberty to add saga and folk tales as he sees fit. A good example of the result of this procedure is the story of the Argonauts (*q.v.*) as it has survived. This may well have originated as a record of some actual voyage of traders or pirates, but many of the details are of pure folk tale type, using well-known themes, while the mythical element is present in several forms.

Criticism. — Clearly, works such as the tale of the Argonauts cannot reveal the ultimate origin of myths, or even of folk tales; this belongs to the remote past of human history. Ever since naïve belief in myths ceased, a number of theories have been put forward in both ancient and modern times to explain their existence. The most vulgar and in some ways the most persistent of these theories is the so-called rationalistic method. This consists simply in accepting the ancient tales as true, once those parts in which the theorist does not believe have been got rid of. The presence of these in the narrative is explained in various ways. It may be held to be due to a misunderstanding of ambiguous wording or of figurative speech, or to be the sheer fancy or some poet who gave the tale its present form, or the like. This interpretation is well illustrated by the "rationalization" of the Attic legend of the abduction of the princess Oreithyia by Boreas, god of the north wind. Some explained this by saying that a strong blast of wind from the north blew her off high ground so that she was killed. (Plato, in the *Phaedrus,* criticizes the fabrication of such explanations as time ill-spent.)

What might be regarded as a special form of this method is that known as Euhemerism. from its originator. Euhemerus (*q.v.*) of Messene (late 4th and early 3rd centuries B.C.). In his day two tendencies were prominent. One was literary: when poets used the great figures of mythology, they tended to humanize them to such an extent that little of their divinity was left. The other tendency was political: the rulers of the great kingdoms of that time were often given divine honours after death. or even in life. Hence, Euhemerus found some to believe his alleged discovery that the traditional gods were really kings and other prominent persons of early days, who had been deified out of gratitude or flattery. The myths concerning them were to be interpreted as noteworthy but still perfectly natural exploits in peace or war. This theory had a grain of truth in it. for several divine figures in various parts of the world can be traced, certainly or plausibly, to human origins. but as a general explanation it is absurd. It had, however. a considerable success long after its author's death. when Christian controversialists adopted it, or what they knew and understood of it, to reinforce their attacks on the pagan gods.

Another hypothesis concerning myths originated early and continued late. This was that the wise ancients had embodied certain philosophic truths in mythical form—in other words, that the myths were allegories, and that their incredible or shocking features were nothing but spurs to the curiosity of those who heard them and were intended to lead to discovery of the underlying verities. Such allegorizations were of two principal kinds. The earlier (which continued to be popular, perhaps especially with the Stoics) was physical, the divine characters in the myths being personified natural forces. Thus Hera, in Greek tradition, was the air (Greek *aër*, almost an anagram of the goddess' name). Granted this. the tales of her shrewish temper and of her quarrels with her husband Zeus and with sundry other figures. human and divine, ceased to be objectionable; for, however unworthy of a deity such behaviour might be. it is a plain fact that atmospheric disturbances often take place. The details, of course, varied with the current scientific and other theories. For instance, the persistent identification in late Roman times of all manner of gods with the sun accorded with the religious and political conditions of the age, in which solar cult was very prominent. Corresponding to it was the undisguised despotism of the imperial government, with all power concentrated in the hands of one man, who thus was to the civilized world what the sun is to the visible heavens.

The second kind of allegorization mas metaphysical or theological. The latter term is used by the writer Sallustius (4th century A.D.), who illustrates it by an elaborate interpretation of the Greco-oriental myth of the Great Mother of the Gods (*q.v.*) and her relations with her favourite Attis. Every detail is pressed into service to signify some doctrine concerning the divine nature or to justify the ceremonies used in the worship of the goddess (De *dis et mundo,* 4, pp. 6–11 of the edition of A. D. Nock. 1926). Although this fantastic method of interpretation lingered on into modern times, notably in the work of Georg Friedrich Creuzer (1771–1858), it is obviously quite without foundation in its classical form, since the original myth-makers lived long before there were any theories. physical or other. for them to allegorize. Creuzer, indeed, saw this and credited the storytellers merely with vague, if grandiose, conceptions of religious matters, mhich he supposed that they had embodied in symbols at first uniform for all peoples and later mildly misunderstood.

Even with this modification, there is little or nothing to commend this idea. Any fragment of truth that is to be found in it resides in the fact that the oldest myths seem to have been the creation of some of the best minds among early peoples. These minds, untrained in reasoning and with very little factual knowledge to guide them. had yet a certain creative power, comparable to that of a poet or other artist—a point rightly insisted on by E. Jensen (*Mythos und Kult bei Naturvölkern,* p. 88). By virtue of this they shaped a kind of vision. crude indeed, and often absurd or even revolting, of the reality which they dimly guessed to lie behind the bewildering phenomena surrounding them. This vision was as yet far from being scientific or philosophical thought, but it was in some sense the forerunner of both. Because these minds had as yet no approach to a scientific or philosophical vocabulary, it necessarily expressed itself in a kind of imagery which may perhaps justifiably be called symbolic.

Modern **Investigations.**—An early and very necessary stage in modern studies. based on common sense. on the collection of evidence and on an assessment of the credibility of the authorities, was the denial of the more fanciful explanations of myths. A pioneer in this regard was C. A. Lobeck (1781–1860), who swept away a vast amount of cloudy speculation. For the most part, this speculation was founded on absurd misunderstandings of what classical writers had said, or mere supposed to have hinted, concerning both myths and the less well-known kinds of ritual, such as the Eleusinian mysteries and the so-called Orphic writings. But Lobeck and his contemporaries knew little of any but the Greek material and its Roman adaptations. The nature-myth school of Max Müller (*q.v.*), whose principal works were published at various dates from 1856 to 1897. represented an advance in this respect. Starting from the rich mythology of Sanskrit, Müller interpreted much classical and other material in the light of etymological equations. on the basis of a theory concerning primitive language, mhich he thought to have had an inaccurate vocabulary apt to lead to all manner of misunderstandings. Myth was thus largely a "disease of language," and its contents were chiefly metaphorical descriptions of celestial phenomena, such as sunrise. Although his theories mere based on premisses largely false, his investigations and those of his followers led to more examination of comparative material from all parts of the world. In consequence, there developed a clearer understanding of what myths are and of the ways in which they may be supposed to originate; as also of their relations, which are far from simple, to religious beliefs and customs.

Another very necessary process was the critical examination of documentary material. where such existed. This was done for Greece. especially, by K. O. Müller (*q.v.*), and after him the work was continued by many scholars. In order to judge whether a myth is the product of a comparatively primitive mind or of some more sophisticated imagination, it is above all useful to know at least its approximate date. It is often also desirable to know its place of origin; *i.e.,* whether it began among the more advanced or the more backward sections of the people concerned. Thanks to such researches the myths of the Vedas. for example, are no longer imagined to be in any proper sense primitive, although they are certainly old; and a fantastic tale from Ovid is not placed on a level with one of Homer's, nor equated with a local legend of some obscure place in Arcadia, the home of much that is early in origin.

Another productive source of information on myths is the comparative method of research. Myths or customs, especially religious or social customs, are often inexplicable if research is confined to one nation or even to one race. They become intelligible, however. if similar tales or rites belonging to other sections of humanity are examined, especially if the second group of people is connected geographically or historically with the first; thus, for Indian material. Persian rather than Egyptian or Hebrew tradition should be looked to. But it sometimes happens that a distant people. unconnected so far as is knonn with the object of examination. will furnish a welcome clue. The assembling of such material commonly involves investigation and recording of the traditions of illiterate peoples and therefore goes hand in hand with the collection of folk tales. Folk tales, however, are often, perhaps most commonly, obtained from people of the European peasant type. These stories are characteristic. that is. of the less literate classes of nations well above savagery or barbarism. and especially of country people. Many of the most famous collections of folk tales, such as that of the brothers J and W. Grimm, have drawn wholly or chiefly on this source.

By the late 1950s the newest method of seeking for the ultimate meaning of myths was the psychoanalytic. This line of research, however, though held to be promising, mas not very far advanced. As Jung puts it: "In view of the enormous complexity of psychic phenomena. a purely phenomenological point of view is, and will be for a long time, the only possible one and the only one with any prospect of success." (C. G. Jung and C. Kerényi, *Introduction to a Science of Mythology,* p. 218, Eng. trans. by R. F. C. Hull, Routledge & Kegan Paul Ltd., 1951). Up to that time, indeed, research had often been hampered by the strained application to mythological material, not seldom uncritically gathered and ill-understood, of premature theories concerning the activities of the human mind, generally the subconscious or unconscious mind. Little that was likely to be of permanent value had yet been achieved; but it was fairly clear that typical situations and figures prominent in dreams and other fantasies bore a resemblance to the content of some myths. Certain scholars believed that careful and critical investigation of this complex material by suitably qualified researchers would in time throw much-needed light on the problems involved. It was certain at least that these traditional tales, whether connected or not with religious or magical rites, are the offspring of imagination and not of formal reasoning; and it was thought, therefore, that a better understanding of the nature of imagination ought to help investigators to perceive the genesis of these its products.

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(H. J. R.)

MYXEDEMA, the medical term for a constitutional disease caused by a deficiency or hypofunction of the thyroid gland, and occurring in adults; cretinism is essentially the same condition appearing in early childhood.

There are two forms, myxedema proper and operative myxedema *(cachexia strumipriva).* Myxedema was termed Gull's Disease from Sir William Gull's observations in 1873. Women are more often the victims than men, in a ratio of six to one. It frequently affects members of the same family and may be transmitted through the mother; it has been observed sometimes to follow exophthalmic goitre. The symptoms are a marked increase in bulk and weight of the body, puffy appearance of skin which does not pit on pressure, the line of the features becoming obliterated and getting coarse and broad, the lips thick and nostrils enlarged, with loss of hair, subnormal temperature and marked mental changes. There is striking slowness of thought and action, the memory becomes defective, and the patient becomes irritable arid suspicious. In some instances the condition progresses to that of dementia. The basal metabolic rate is very low. The thyroid gland itself is diminished in size, and may become completely atrophied and converted into a fibrous mass. The untreated disease is progressive, but the course is slow and the symptoms may extend over 12 to 1j years, death from asthenia or tuberculosis being the most frequent ending.

Symptoms similar to the above may follo complete removal of the thyroid gland. Kocher of Berne found that, in the total removal of the gland by operation, out of 408 cases operative myxedema occurred in 69, but it is thought that if a small portion of the gland is left, or if accessory glands are present, these symptoms will not develop. The treatment of myxedema, like that of cretinism, is by administration of thyroid extract.

MYXINE, a genus of cyclostome fishes known as slime eels. They are closely related to the hagfish, differing in having a single external gill opening. They have similar parasitic habits. See HAGFISH; CYCLOSTOMATA.

N IN all known alphabets the letter N has stood in close connection with M, the particular form of one being generally reflected in the other. Semitic (*nun,* originally probably meaning "fish") and Greek (*nu*) are its predecessors. In the inscriptions from Thera the form was consistently . Other forms were from Corinth and in the Ionic alphabet of Abu-Simbel. In the Lydian alphabet the form was ; Etruscan had sometimes the curious form corresponding to its five-stroked (M). The Latin forms were N and N.

The minuscule cursive form of the 6th century was , probably accounted for by the writing of the letter without taking the pen from the paper commencing at the top of the left-hand vertical stroke. This would cause the oblique stroke to rise from left to right instead of being downward in direction. The Carolingian

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	B.C. 1,200	
CRETAN	1,100-900	
THERAEAN	700-600	
ARCHAIC LATIN	700-500	
ATTIC	600	
CORINTHIAN	600	
CHALCIDIAN	600	
IONIC	403	
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	N
URBAN ROMAN		N
FALISCAN		И
OSCAN		N
UMBRIAN		
CLASSICAL LATIN AND ONWARDS		N

DEVELOPMENT OF THE LETTER "N" FROM THE EARLIEST TIMES TO THE PRESENT DAY

hand developed the rounded minuscule form n. From this derives the modern minuscule. The sound that the letter has represented throughout its history is the dental nasal, the nasals being of all sounds the least liable to change. Before the velar consonants *k,* hard *c,* hard *g, q,* and *x,* however, *n* has the velar sound heard in "long" as distinguished from the dental sound heard in "lawn" (*e.g.,* in "ink," "angle," "relinquish"); but not so in "unkempt," "ingrate," where *n* ends the prior member of a compound. *See* also ALPHABET. (B. F. C. A.; J. W. P.)

NABATAEANS, a people of ancient Arabia, whose settlements gave the name of Nabatene to the borderland between Syria and Arabia from the Euphrates to the Red sea. The history of the Nabataeans cannot be carried back beyond 312 B.C., at which date they were attacked without success by Antigonus I (*Cyclops*) in their mountain fortress of Petra.

The Nabataeans were Arabs—as their proper names show—who came under Aramaic influence. They wrote a letter to Antigonus "in Syriac letters," and Aramaic continued to be the language of their coins and inscriptions when the tribe grew into a kingdom, and profited by the decay of the Seleucids to extend its borders northward over the more fertile country east of the Jordan.

They occupied Hauran, and about 85 B.C. their king Aretas (Harithath) became lord of Damascus and Coele-Syria. Allies of the first Hasmonaeans in their struggles against the Greeks (I Macc. v, 25, ix, 35; II Macc. v, 8), they became the rivals of the Judean dynasty in the period of its splendour and a chief element in the disorders which invited Pompey's intervention in Palestine.

The Roman arms were not very successful, and King Aretas retained his whole possessions, including Damascus, as a Roman vassal. (*cf.* II Cor. xi, 32). As "allies" of the Romans the Nabataeans continued to flourish throughout the first Christian century. Their power extended far into Arabia, particularly along the Red sea; and Petra was a meeting place of many nations, though its commerce was diminished by the rise of the eastern trade route from Myoshormus to Coptos on the Nile. A sober, acquisitive, orderly people, wholly intent on trade and agriculture (Strabo, xvi, 4), they might have long been a bulwark between Rome and the wild hordes of the desert but for the short-sighted cupidity of Trajan, who reduced Petra and broke up the Nabataean nationality (A.D. 105). *See* SEMITIC LANGUAGES.

(W. R. S.; S. A. C.)

NABHA, a municipality and tehsil (subdivision) in Patiala district, Punjab state, India. The town, founded in 1755, is on the Northern railway, 37 mi. W. of Ambala. Population (1951) 25,676.

NABHA TEHSIL (240 sq.mi.; pop. [1951] 92,587) includes part of the former princely state of the same name (area 947 sq.mi.; pop. [1941] 340,044). Its territories were scattered; one section with 12 separate tracts lay in the territories of Patiala and Jind states, in the east and south of the Punjab; the other was in the extreme southeast. Nabha, founded by a member of the Sikh Phulkian family, established its independence about 1763. In 1807–08, the raja obtained British protection against threatened encroachments of Ranjit Singh. During the Mutiny in 1857 the raja was loyal to the British and was rewarded by grants of territory.

In April 1948, after India became independent, Nabha joined a union of five Phulkian states, which, on Aug. 20, 1948, merged with the Patiala and East Punjab States union (PEPSU). On Nov. 1, 1956, PEPSU was merged into Punjab state.

NABIGHAH, AL- (AL-NABIGHAH AL-DHUBYANI) (fl. *c.* A.D. 600), one of the six pre-Islamic Arab poets whose works were collected before the middle of the 2nd century of Islam; his poetry is represented in the anthologies *al-Sumut* (*see* MU'ALLA-

QAT) and *Hamasah* (*q.v.*). After living much of his life at the court of the kings of Hira he fled for a time to the court of Ghassan because, according to legend, his poem praising the beauty of Queen Mutajarida, wife of Ring Nu'man of Hira, was inspired by an accidental view of her unveiled charms. Later he was pardoned and returned to Hira but after Nu'man's death withdrew to live with his own tribe, the Dhubyan. He wrote mainly eulogies and satires concerned with the strife between Arab tribes. His vivid, sensitive verse shows a fine poetic imagination.

BIBLIOGRAPHY.—There are editions of his poems by W. Ahlwardt in *Diwanr of the Six Ancient Arabic Poets* (1870); *H.* Derenboure, Le *Diwan de Nabiga Dhobyani* (1869); and by 'Abd-al-Rahman Sallam and Mohammed Jamal (1934).

NABIS, tyrant of Sparta, seized the throne after Sparta's heavy defeat by the Achaean League in 207 B.C. He seems to have put into practice the "four points" of the revolutionary program of the day, abolition of debt, division of land, confiscation of personal property and liberation of slaves, though he does not appear to have tackled the Helot problem very completely. Whether he was the monster of cruelty represented by Polybius it is difficult to say. No revolutionary leader gets fair play from contemporary historians as a rule, and few revolutionary leaders can afford very gentle measures. In any case, he carried out more thoroughly the aims of Xgis and Cleomenes and extended his system to Argos, which was put into his hands by Philip V in 198. The Achaeans under Philopoemen first attacked him in 201, and defeated him at Scotitas. Later in 195 B C. after the conclusion of the war with Philip the Romans under Flamininus turned their attention to the affairs of Greece. The league was unanimous for war against Nabis, and Flamininus duly undertook it. Nabis organized a vigorous defense and raised an army of 10,000 from Sparta with the help of the enfranchised Helots. After some desultory fighting and a good deal of negotiation, Nabis obtained peace at the price of losing Argos and some harbours, and the internal affairs of Sparta were left undisturbed. As soon as the Romans had gone Nabis was embroiled with the Achaeans again. He uas eventually murdered by some Aetolian auxiliaries, and Philopoemen ruthlessly suppressed one of the few whole-hearted attempts at social revolution in Greek history.

See Plutarch, *Philopoemen;* Polyb., xiii–xx; Paus., iv–viii; Liv , 31–35; W. W. Tarn, in *The Hellenistic Age* (1923), and *Hellenistic Civilization* (1927).

NABOB, a corruption of the word nawab, a native Indian ruler. In the 18th century it nas sarcastically applied to Englishmen who returned with fortunes from the east.

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NACHTIGAL, GUSTAV (1834–1885), German explorer of the Sahara, was born at Eichstedt in Brandenburg on Feb. 23, 1834. He studied medicine at the universities of Halle, Wurzburg and Greifswald and practised for several years as a military surgeon. He then went to Tunis as physician to the bey and took part in several expeditions into the interior. In 1868 he was sent on a mission to the sultan of Bornu by the king of Prussia and traveled there via Tibesti and Borku, parts of the central Sahara then unknown to Europeans. From Bornu he went on to Baguirmi and then via Wadai and Kordofan to arrive in Cairo in Nov. 1874. This journey was described in Sahara *und Sudan,* 3 vol. (1879–81); he was awarded the gold medals of the Royal and Paris Geographical societies and became president of the Berlin Geographical society. Nachtigal was German consul-general at Tunis, 1882–84, and was then sent by Bismarck to west Africa, ostensibly to inquire into trade, but really to annex territory for Germany. As a result Togoland and the Cameroons were added to the German empire. Nachtigal died on the homeward voyage, at sea off Cape Palmas, on April 19, 1885.

See Heinrich Schiffers, *The Quest for Africa,* pp. 303–310 (1957). (R. M. P.)

NACOGDOCHES, Texas, U.S., and county seat of Nacogdoches county, is located near the Angelina river about 130 mi. N.E. of Houston. It was named for the Nacogdoche Indians. The site was first visited by the La Salle expedition in 1687; Mission Nuestra Senora de Guadalupe was founded by the Spaniards in 1716. Fears of the French resulted in abandonment in 1718. The Spaniard Antonio Gil Ybarbo reoccupied it in 1779, when it was chartered, and rebuilt the Old Stone Fort, which was restored in the 1920s. Nacogdoches was the gateway from the east to Spanish territory and was a place of unrest and violence. It was the scene of smuggling and freebooting activities, such as those of A. Leal and Philip Nolan; revolutionary movements, related first to Mexican independence, and later to that of Texas; and Indian unrest culminating in the expulsion of the Indians after the rebellion promoted by Vicente Cordova in 1838.

Stephen F. Austin State college (see TEXAS: Education) is located there. A diversified economy based on agriculture and lumbering has characterized its history after the coming of the railroad in 1882. The council-manager form of government was adopted in 1936.

For comparative population figures see table in TEXAS: *Population.* (J. L. WR.)

NADELMAN, ELIE (1885–1946), Polish-American sculptor, was born in Warsaw. Pol., on Oct. 6, 1885, the son of a master jeweler. He left home at 19 and first saw Greek sculpture, the dominant influence in his art, in Munich. In 1903 he went to Paris, where he studied Rodin's work, whose analyses of plastic forms as intersecting curves anticipated Cubism and had wide effects on contemporary art. His first one-man shows in Paris (1909), London (1911) and New York (1915) were sensational successes. He emigrated to the U.S. in 1917 and became a citizen in 1927. A sensitive portraitist and masterful architectural sculptor, in his last decade Nadelman worked on small-scaled grand-style sculpture fitted to modern domestic living. He died in New York city, Dec. 28. 1946.

BIBLIOGRAPHY.—Elie Nadelman, *Vers la beauté plastique* (Drawings) (1921); Lincoln Kirstein, *Elie Nadelman* (1948); Lincoln Kirstein, *Elie Nadelman Drawings* (1949). (L. E. K.)

NADIA, a district in West Bengal, India. Area, 1,527 sq.mi.; pop. (1951) 1,144,924; the former British-Indian district of Nadia (2,879 sq.mi.) was divided at the 1947 partition, the territory northeast of the Bhairab river going to form Kushtia district in East Pakistan. Standing at the head of the Gangetic delta, Nadia is an alluvia! plain, the level of which has been raised by deposits of silt, so that it is subject to inundation only in years of high flood. Along the northeastern boundary flows the main stream of the Ganges (Padma channel), of which the remaining rivers of the district are offshoots. The Bhagirathi on the southwestern border and the Jalangi meandering through the centre of the district are the chief of those offshoots, called distinctively the Nadia rivers. In former times the Nadia rivers afforded a regular means of communication between the Ganges and the seaboard; but the levels of the river beds have risen and, except in the rains, the rivers have diminished to shallow streams. The land no longer receiving a fertilizing deposit of silt, the productivity of the sandy soil has been reduced. Rice is the staple crop.

Industries include cotton weaving, brass and pottery works, processing of sugar and oil.

The headquarters of the district are at Krishnagar (pop. 1951 50,042), 55 mi. N. of Calcutta: which contains the residence of the maharaja of Nadia. The town of Nabadwip or Nadia. 7 mi. W. of Krishnagar, was formerly on the east bank of the Bhagirathi, which has since changed its coarse. Pop. (1951) 56,298. It is celebrated for its capture by the Moslems in the 12th century; for the sanctity and learning of its pundits; and as the birthplace of Chaitanya, the Vaishnava reformer. Krishnagar and Nabadwip each contain an undergraduate college of Calcutta university.

NADIR, a term used in astronomy for the point in the heavens exactly opposite to the zenith, the zenith and nadir being the two poles of the horizon; that is, the zenith is directly overhead, the nadir directly unclerfoot.

NADIR SHAH **GHAZI, MOHAMMED** (1883?–1933), king of Afghanistan. born April 10, 1883?, at Dehra Dun, India. After the abdication of Amanullah (*q.v.*) in 1929, Nadir Shah defeated Habibullah, known as *Bacha-i-Sakao* ("the son of the water carrier"), who had seized the throne, and became king on Oct. 16. He was assassinated at Kabul, Nov. 8, 1933, by an Amanullah supporter.

His son Mohammed Zahir Shah succeeded him.

NAEVIUS, GNAEUS (*c.* 270–201 B.C.), the second in the triad of early Latin epic poets and dramatists, between Livius Andronicus and Ennius. A native of Capua, he seems nevertheless to have been a Roman citizen. He served in the First Punic War. His career as a dramatist, which began in 235, only five years after the first play ever produced in Rome, continued for 30 years. An attack in one of his plays on the noble family of the Metelli, making fate rather than merit responsible for their consulships (*fato* Metelli *Romae fiunt consules;* the reference is to L. Caecilius Metellus, consul 206) provoked the threatening reply that the Metelli would punish the poet Naevius (*malum* dabunt *Metelli Naevio* poetae) and led to imprisonment, followed by residence (perhaps exile), at Utica, where he died.

He is reported to have spent his time in prison writing two plays, in which he apologized for his rudeness. An epitaph, attributed to the poet himself, but probably written nearly 100 years after his death, recalls his epic poetry by the Saturnian verse in which it is cast, and his drama by the fine tribute that, since he died, "they have forgotten at Rome how to speak the Latin tongue."

Like Livius, Naevius translated Greek tragedies and comedies. Six such tragedies are known by title, among them two (*Danae* and *Equos Troianus*) which were produced also by Livius and suggest that Naevius deliberately challenged comparison with the older poet. Of his comedies more than 30 titles are known, many of them of the Latin type (*Corollaria, Nervolaria, Tunicularia*) familiar from Plautine plays. Fragments are scant) but sufficient to show that, far surpassing Livius, Naevius may be regarded as the creator of that apt, forcible and colourful language which is the constant delight of readers of Plautus. His attitude to his originals was more independent than that of Livius: he transferred elements from one play into another. added song where the originals lacked it, and increased the variety of metre. He also added contemporary references and political comment, such as that which proved his undoing. But he broke entirely new ground in writing at least two plays on national subjects (praetextae): Romulus (perhaps the same as Lupus), on the birth of Romulus and Remus, and *Clastidium,* celebrating the victory there of M. Claudius Marcellus over the Celts in 222 B.C., and probably produced at Marcellus' funeral games in 208.

While Rome was fighting the Second Punic War, Naevius chronicled the events of the first in his Carmen Belli Poenici. For his facts he may have relied, apart from his own observation, on oral tradition at Rome; it is uncertain whether the history of Rome by Fabius Pictor, which became a source for the history of the wars, was already available. Force of diction. enhanced rather than impeded by the harsh staccato rhythm of the Saturnian metre, and an over-all plan, which comprised the wanderings of Aeneas (including apparently his sojourn with Dido at Carthage as a cause of the war between Rome and that city), make good the claim of this chronicle to the rank of an epic poem. Naevius undoubtedly had Hellenistic models for the epic treatment of contemporary history, but when it is measured against the *Odusia* of Livius, this poem shows in its conception the same originality as does the creation of the praetextae. The *Bellum Punicum* seems to have exercised considerable influence on the Annals of Ennius and on Virgil's *Aeneid,* but this cannot be closely defined, since only about 60 lines of the poem remain.

Remarkable ancient judgments on Naevius are those of Volcacius Sedigitus (*c.* 100 B.C.), who placed him third, after Caecilius and Plautus, in a somewhat arbitrary canon of Roman writers of comedy, and Cicero, who likened his epic, as pleasing despite some lack of polish, to a work of the sculptor Myron.

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NAEVUS. A naevus is a nonmalignant. growth which is usually present at birth or shortly thereafter. The growth may consist of any tissue present in the skin such as blood vessels, pigment-forming cells, hair follicle cells and connective tissue. The most common naevi are those of blood vessels ired birth marks), and pigment forming cells (brown birth marks or moles).

The blood vessel naevi are of three types: (1) superficial (port wine stain) (2) elevated (strawberry markj and (3) deep (cavernous). The superficial type remains throughout life and is exceedingly difficult to treat without leaving a bad scar or obvious defect in the skin. The elevated type almost always disappears spontaneously by puberty or before, and the deep type should be treated very early in life (X-ray or radium) to obtain the best results.

The pigmented spot or mole may turn into a malignant tumour but the incidence of such malignant change in this naevus is about one in a million. It is estimated that every individual has about 14 moles and it is apparent that removing all pigmented naevi from everyone as a preventive measure would be highly impractical. If a mole increases in size, changes in colour or begins to bleed or form a crust it should be removed and examined to be sure it has not become malignant. (RD. B. S.)

NAGA HILLS, a mountainous and forested region on the India-Burma frontier. betneen the Brahmaputra and Chindwin river valleys. The region includes the Patkai range to the northeast of the Nagas proper. is continued southwestward by the Barail range and forms part of the Arakan Yoma system. The Barail-Naga-Patkai chain forms a 250-mi. barrier shutting off Manipur and Upper Burma from Xssam. Japvo (9,826 ft.), in the Barail range south of Kohima. is the highest mountain in Assam; and on the Burmese side a range detached from the main Nagas by the intrusion of the Tuzu-Dilli tributary of the Chindwin begins in the southwest with Sampurre (12,622 ft.).

NAGA HILLS DISTRICT (INDIA) has an area of 4.259 sq.mi.; pop. (1951) 205,950. The raids of the head-hunting Nagas led to punitive expeditions and the gradual British occupation of the hills. A frontier district was formed in 1866; in 1880 it was decided that the Naga hills should be administered as British territory. During the operations of 1917–19 against the Kukis of Manipur the boundary was brought to Burma north of Manipur, embracing the territory designated as the NAGA TRIBAL AREA and renamed Tuensuang Frontier division (2,091 sq.mi.; pop. [1951] 7,025 [excluding the part B tribal areas where no census was taken]). The district headquarters, Kohima (pop. [1951] 4,125), was occupied by the Japanese in March–June 1944.

NAGA HILLS SUBDIVISION (BURMA) is an unadministered part of Upper Chindwin district, Sagaing division. Area 3,785 sq.mi.

NAGANO, OSAMI (1880–1947), Japanese admiral. planned and ordered the attack on Pearl Harbor, Dec. 7. 1941. Born in Kochi, he was educated at the naval academy and staff college. In 1913 as a language officer in the U.S., he studied law at Harvard university and took courses at the War college. As naval attach6 in Washington (1920–23), he attended the Washington Naval conference (1921–22); the Geneva Naval Limitations conference (1935); and the London Naval conference (1935–36). Naval minister in 1936–37, he became naval chief of staff in April 1941. His reputation rose after Pearl Harbor, but later reverses caused his dismissal in Feb. 1944. Having admitted personal responsibility for the Pearl Harbor attack. he died on Jan. 5, 1947, while on trial before the International War Crimes tribunal.

NAGANO is the name of both a landlocked prefecture in central Honshu, Japan, and its capital city. Most of the prefecture is over 2,600 ft. in elevation and 15 peaks, mostly volcanic! are over 9.800 ft. The harnessing of such large rivers as the Tenryu, Kiso, Chikuma and Shinano made it a leading hydroelectric producer. Most activity centres in small mountain basins (Suwa, Matsumoto, Ina, Iida, Zenkoji basins) over 1,600 ft. elevation, where sericulture and apple raising are agricultural specialties. Rich forest land, one-third in national forests, is an important resource. Limited industry is based on sericulture. Area j.262

sq.mi.; pop. (1960) 1,981,433.

Nagano, in the Zenkoji basin, is the capital and largest city (pop. [1960] 160,522) of Nagano prefecture. Formerly known by the name of Zenkoji, it dates from the 7th century A.D. and grew as a great shrine and post town. Besides administration and education (two universities), Nagano has a commercial function.. (J. D. EE.)

NAGAS, a group of tribes inhabiting the northern part of the hills dividing Assam from Burma. Within the group are tribes of mixed origin, varying cultures and very different physique and appearance, but having enough in common to make it generally possible to say. within the area indicated, whether a given tribe is Naga (as distinct from Kachin, Kuki. Kachari, etc.) or not.

Every sort of political organization is found from the autocracy of tabooed chiefs (Konyak tribes) through gerontocracy (Ao tribe) to purest democracy (Angami tribe). Patrilineal exogamy is everywhere the social rule, but there are indications of the pre-existence of matrilineal and perhaps totemistic systems and of leviritical polyandry. Dual organization (*q.v.*) is found and communal houses for the unmarried. Some tribes (*e.g.*, Sema. Chang) practise polygyny: monogamy is more common, divorce being easy and frequent. Inheritance of land always passes in the male line.

Agriculture is practised by all tribes, some growing rice on elaborately built-up and irrigated terraces (Angami, Tangkhul), others growing it dry, and others using millet, Coix *lachryma* or taro as the staple crop, with rice, maize, sorghum, yams and sago as subsidiary. Millet is often grown on dry terraces among pollarded alders: cotton is grown. cattle are kept and numbers of mithun (*bos frontalis*), which has generally, but not everywhere, displaced the buffalo. Dogs are reared for food as well as for hunting. Fishing is carried on, particularly with the use of intoxicants which kill or incapacitate the fish.

hlanufactures and the arts include weaving (on simple tension looms): dyeing, pottery. blacksmith's work and rough wood carving. Material culture shows many links with Indonesia and Melanesia. and the northern tribes make huge wooden xylophones, membraneless drums often suggestive of dugout canoes with carved figureheads. which are beaten to raise an alarm or celebrate important events. The prevailing weapon is the throwing-spear, but crossbows are used by some tribes. also guns. Music and dancing are most highly developed in the southern tribes, but are everywhere popular. The numerous tribal languages are tonal and agglutinative, belonging to the Tibeto-Burmese family; within each language area almost every village has its own dialect.

See J. P. Mills, ***The** Ao Nagas,* with bibliography (1926). (J. **H.** H.)

NAGASAKI, a Japanese prefecture. includes the islands of Tsushima, Iki. Hirado-shima and the Goto-retto. It has a very irregular shape, with rounded Shimabara peninsula in the southeast and Nomo and Nishisonogi peninsulas (which enclose Omura bay) in the southwest. Dominated by mountains. it has limited agricultural land that is worked intensively (rice. sweet potatoes and mandarin oranges). Its thriving fisheries support a seafood processing industry. Although coal is mined. there is little industry except in the capital city of Nagasaki (shipbuilding) and the naval base of Sasebo. The city of Nagasaki has one of Japan's largest Christian communities. Area of the prefecture 1,578 sq.mi.; pop. (1960) 1,760,421. (J. D. EE.)

NAGASAKI, capital and largest city of Nagasaki prefecture, western Kyushu, Japan, is the administrative, commercial and cultural nucleus of the prefecture. A port city, it is located at the head of a narrow, deep-cut bay at the meeting point of the Nomo and Nishisonogi peninsulas. The city is like an amphitheatre in form. the crooked streets and tiered houses clinging to the hillsides that enclose the inner bay. Reclaimed land at bayside and the Urakami basin at the head of the bay provide a little level land.

Nagasaki's early growth was based on its overseas contacts. Subsequent to the arrival of the first Portuguese ships in 1571, it became the principal port for calls by foreign ships. Christianity, introduced by Roman Catholic priests. established a firm foothold in Nagasaki in spite of grievous persecutions. With the enforcement of foreigner exclusion measures, it became the sole remaining point of contact with foreigners after 1636. Only the Dutch were permitted to remain in residence on small Deshima (an island on the eastern coast of the bay, now a reclaimed part of the mainland). Through that modest station passed a trickle of books and information that acquainted Japanese authorities with main developments in the west. Scholars also went there to learn Dutch and foreign science and culture. When Japan was emerging from its feudal past in the last half of the 19th century, Nagasaki benefited from nearby coal deposits to become one of the leading east Asian coaling stations. It was the winter port for the Russian Asiatic fleet prior to 1903. The development of oil-burning ships, competition from northern Kyushu coal fields and ports, a limited hinterland and distance from main Kyushu industrial areas later reduced its importance. Nagasaki's limited industrial growth stems mostly from the large Mitsubishi shipyards and supplier industries, which are grouped along the western and inner parts of the bay. The innermost portion of the city was destroyed on Aug. 9, 1945, by the second atomic bomb dropped on Japan by U.S. forces in World War II (estimated 64,000 casualties, including 39,000 dead). Pop. (1960) 344.153. (J. D. EE.)

NAGAUR, a city, tehsil and district of Rajasthan, India; before April 7, 1949, part of the principality of Jodhpur. The town, 75 mi. N.E. of Jodhpur city, has a wall more than 4 mi. in circuit. Populations (1951): town 19,588; tehsil (2,608 sq.mi.) 206,572; district (6.883 sq.mi.) (1961) 932.707.

The district is in general a sandy plain 1,000–1,500 ft. above sea level. Marble is quarried. The largest town is Ladnun (20,914), 48 mi. N.E. of Nagaur.

NÄGELI (NAEGELI), **KARL WILHELM VON** (1817–1891). Swiss botanist famous for his investigations on the origin of cells and for his versatility in research, was born on March 26, 1817, at Kilchberg, near Zurich. He studied botany under A. P. de Candolle at Geneva, graduated at Zurich in 1840. then devoted himself to the microscopical study of plants. He became professor in the University of Zurich and of botany in the universities of Freiburg, Ger. (1852) and Munich (1858), where he died on May 10, 1891. Nägeli extended Robert Brown's discovery of the nucleus to the principal families of cryptogams and asserted that it is present in all plants. He investigated the "mucous layer" (Schleimschicht) in cells and showed this to be the living matter of the cell. This discovery was made independently and at the same time by Hugo von Mohl, who called the living substance "protoplasm." Nageli also investigated the mode of growth in a large number of plants belonging to the algae, mosses. liverworts and angiosperms. He discovered the spermatozoids and antheridia of ferns. He also wrote papers on the anatomy of vascular plants, and introduced the concept of "meristem" as opposed to permanent tissue. In addition he studied the structure, development and various forms of starch grains. In his last book Nageli introduced the idea of a substance which he called "idioplasm" as the definite material basis of heredity. He corresponded with Gregor Mendel (*q.v.*) but does not seem to have grasped the essentials of Mendel's discoveries.

Among his more important contributions to science were a series of papers in the Zeitschrift fur *wissenschaftliche* Botanik (1844–46); Die *neuern* Algensysteme (1847); Gattungen *einzelliger* Algen (1849); *Pflanzenphysiologische* Untersuchungen (1855–58), with C. E. Cramer; Beitriige *zur wissenschaftlichen Botanik* (1858–68); and finally. *Mechanisch-physiologische Theorie* der Abstammungslehre (1884).

See C. E. Cramer, *Leben und Wirken von Carl von Naegeli* (1896).

NAGOYA, a city and capital of Aichi prefecture. Japan. is one of the country's leading industrial centres. It has a deltaic location on the Nobi plain facing deep-cut Ise bay. Nagoya's modern rise dates from 1610, when a great castle was erected by the Owari branch of the powerful Tokugawa family. Subsequently, political and economic power became centred there. After the collapse of the feudal order, Nagoya continued as the commercial hub of a broad central Honshu area between the spheres of Tokyo and Osaka, earning the title, "central capital."

Its industry is predominantly light because of the long distance from coal sources and the late development (1907) of its port facilities. Among its assets are a central location and abundant hydroelectric power from the rivers of central Honshu. Historically strong in cotton textile production, Nagoya is the economic nerve centre for a nest of industrial satellite cities in Aichi, Gifu and Mie prefectures. Lumber and wood products, vehicles (automobiles and airplanes). machinery and machine tools. ceramics. electric steel, synthetic fibres and electrochemicals are among the products of its diversified industry.

The city is laid out on a rectangular plan with exceptionally broad main avenues for traffic and fire control. Burned badly in World War II, it put an impressive city reconstruction plan into effect and built many new public and private buildings in the main commercial and residential districts. Several railways, including the main Tokaido line. converge on Nagoya. Its harbour (30 ft. deep) has berthing facilities for 30 ships totaling 135,000 tons and excellent cargo handling and storage installations. Canals link the port and industrial areas. With a population of 1,591,935 (1960). it was the third largest city of Japan. (J. D. Ee.)

NAGPUR, a city, with *tehsil* (administrative subdivision), and a district of Maharashtra state, India. The city formerly was the capital of the state of Madhya Pradesh. The old capital of the Gond dynasty expanded beyond all recognition between 1852, when it came under British rule, and mid-20th century. Its population, 84,000 in 1872, had expanded to 643,186 by the 1961 census.

Once the terminus of a branch line Xagpur became an important railway centre of the Eastern and Central lines, being halfway between Bombay and Calcutta and between Madras and Delhi. It is connected by a narrow-gauge railway with Chindwara and Chanda. It is also an important junction for internal air services. It is the commercial as well as the administrative capital of the state and its centre of education. being the seat of Nagpur university (1923), with its law, technological and teachers training colleges. and of 10 of its 16 affiliated undergraduate colleges. It is the see town of both Anglican and Roman Catholic dioceses.

The whole area is dominated by the hill and fort of Sitahaldi. overlooking the civil station on the west, the city proper on the east and north, and the suburbs of Sitabaldi and Craddock Town to the south. This hill was the scene of the famous battle of Nov. 1817 where a small British force of less than 1.500 repulsed the Maratha army of 20.000. The only regular troops in Nagpur in the 19jos were those stationed in this fort, but it is the headquarters of the auxiliary force. Besides cotton textile mills, there is canning of fruits and vegetables. Handloom weaving is carried on by Koshtis, who produce fine fabrics and silk-bordered cloths. At one time there was also a large community of Momins or Mohammedan weavers. Ten miles northeast of Nagpur is the once-important cantonment and trade centre of Kamptee (36.165). founded in 1821.

Nagpur District has an area of 3,842 sq.mi. and in 1961 had a population of 1,511,187. It is on an extension of the Berar plain eastward of the Wardha river. In the western part Deccan trap overlies sandstone formation. In the eastern part the sandstone is broken up by granite and the juxtaposition of these formations, which meet at Sitabaldi, makes the geology of the district interesting.

In the north and northeast valuable deposits of manganese ore are norked. These are among the best in the world. but by the mid-1950s reserves were reported to be running low and were not expected to last more than 30 years.

The sacred hill of Ramtek in the northeast, with its gleaming white temples, is a landmark for miles around. The drainage of the east is to the Wainganga, and of the west to the Wunna and Wardha rivers. The plain is broken up in the west by ranges of flat-topped hills, but there are many plains, fertile valleys and pockets of rich land.

Agriculture is varied; it was developed by the Kunbis, the great cultivating Maratha caste, and by Raghvis and Kirars, immigrants from upper India. To the west the cropping is mainly cotton and *jowar;* in the centre and south wheat, linseed. and pulses are the chief staples. On the northeast and southeast there is a considerable area of rice. There are fine betel leaf plantations and the district is famous for its orange groves. Government forests cover 500 sq.mi., mostly concentrated in the reserves along the Pench river in the north, but isolated blocks of not much value are scattered over the nhole district.

NAGYKANIZSA, a town of west Hungary, Zala megye, a railway junction and agricultural market town. It has large flour mills. distilleries, breweries and vegetable-preserving works, manufactures bricks and trades in cereals and cattle. It was once a powerful fortress, important during the attacks of the Turks who held it in 1600–90. Pop. (1960) 34.222 mun.

NAHA, largest city of Okinawa Island, Ryukyu Islands, on the island's southwestern coast, was the capital of Japan's pre-World War II Okinawa prefecture and became the seat of both U.S. military and Okinawan governments after the war. Its port, which can handle ships of 10,000 tons, makes it the commercial centre for the Ryukyu chain. Destroyed during World War II, it was revived with U.S. support. Pop. (1960) 222,799.

(J. D. Ee.)

NAHUM (Hebrew for "rich in comfort [is God]"), an Old Testament prophet. Of the prophet himself: all that is known is the statement of the title that he was an Elkoshite. But the locality denoted by the designation is quite uncertain. The original heading of Nahum's prophecy is contained in the second part of the superscription: "(the book of) the vision of Nahum the Elkoshite." The first part ("Oracle concerning Nineveh") is a late editorial insertion. but correctly describes the main contents of the little book.

Contents. — Chapters i and ii. The prophecy against Nineveh in its present form really begins with chapter ii, 1, followed immediately by v. 3, and readily falls into three parts, viz. (1) ii, 1, 3–10; (2) ii. 11–13; and (3) iii. Here (1) describes the assault on Xineveh. The city is mentioned by name in ii. 8 (9 Heb. text). its capture and sack; (2) contains an oracle of Yahweh directed against the king of Assyria; (3) again gives a vivid picture of war and desolation which are to overtake and humiliate Nineveh, as they have already overtaken No-Amon (*i.e*, Egyptian Thebes, vv. 8–10). The absence of distinctly religious motive is remarkable.

Chapter i forms the exordium of the prophecy of doom against Nineveh. Its tone is exalted, and a fine picture is given of Yahweh appearing in judgment. The effects of the divine anger on the physical universe are forcibly described (vv. 3–6); on the other hand, God cares for those "who take refuge in Him" (v. 7), but overwhelms His enemies (w. 8–12*a*). In the following verses (12*b*–1j) the joyful news is conveyed to Judah of the fall of the oppressor.

Regarding chapter i and ii, 2 (=i and ii, 1, 3, Heb. text) there has been much discussion in recent years. It was long ago noticed that traces of an alphabetic acrostic survive in this section of the book. In vv. 12*b*, 13 and (certainly) 15 (=ii, 1 Heb,) Judah appears to be addressed. The text of i, 1–15, ii, 1–2 has been reconstructed by H. Gunkel and G. Bickell so as to form a complete alphabetic psalm with contents of an eschatological character, and is regarded by them as a later addition to the book. It is generally held by scholars that i, 1–8, 13, 1j and ii, 2 certainly do not proceed from Nahum (i, 9–12 may, however, belong to the prophet). No satisfactory solution has been reached.

Date. — The date of the composition of Nahum's prophecy must lie between 612, when Nineveh was captured and destroyed by the Babylonians and Medes, and the capture of Thebes (No-Amon), uhich is alluded to in iii, 8–10, in 663 B.C. On the whole a date somewhat near 612 is more prbbable. The poetry of the book is of a high order.

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NAIAD, in Greek mythology a nymph of flowing water (*naiein,* "to flow"). See Nymph (myth.).

NAIDU, SAROJINI (1879–1949), Indian poetess, orator in languages and nationalist, eldest child of Aghorenath Chattopadhyaya. principal of the Nizam's college, Hyderabad, Deccan, was born in that city on Feb 13,1879. She matriculated at the Madras university when only 12, and began soon after to write English verse.

Sent to Britain in 1895, she studied at King's college in London. and Girton college, Cambridge. Her volumes of verse were sponsored by such discerning critics as Arthur Symons and Edmund Gosse. and included *The Golden Threshold, The Bird of Time* and *The Broken Wing.* They were translated into the chief Indian vernaculars and European languages, and her verse was frequently set to music. Her marriage to M. G. Naidu. a rajput who became head of the medical service in Hyderabad state, was resented in orthodox Hindu circles on grounds of caste. Mme. Naidu soon deserted the poetic muse to promote social and political reform and the feminist movement—fields nhich gave scope for fiery oratory and telling nit—and increasingly identified herself nith the advanced wing of the Indian National Congress party. At Kanpur in 1925 she nas the first Indian woman to preside at an annual session. She threw herself into Mohandas Gandhi's civil disobedience movement in 1930, and underwent the first of several imprisonments.

She accompanied the mahatma to London when he was the sole representative of the National Congress party at the second session of the Indian round table conference. Though inclined to realism, she supported the attitude of aloofness from, and then of avoned hindrance of. India's great part in the war effort of the United Nations. Following on the decision in Xug. 1942 to embark on mass civil disobedience, she was arrested nith other members of the working committee of the Congress party. being released in March 1943 on grounds of health. In 1947 she became governor of the United Provinces.

Mme. Naidu died in Lucknow, India. on March 2, 1949.

(F. H. BR ; X.)

NAIL. Iron nails were in common use during the Roman occupation of Britain, large numbers having been found in places where they were manufactured by the Romans There is a striking similarity between the forged Roman nail (fig. 1N) and the type of nail manufactured in modern times.

The forging of nails was an industry of some importance in Great Britain up to the end of the 17th century, giving way only before the advent of machinery and the cut and machine-headed nail.

Wire Nails.—The use of wire for nail making completely revolutionized the method of manufacture Nails made from drann wire are produced so cheaply that they can be purchased at almost the same price as the wire from which they are made. Cut nails, sheared from plates or flat stock. are produced, but the quantities in which these nails are used are so small that they are negligible items of trade.

Nail manufacturers' catalogues show about 100 different types of nails or fasteners made of round wire, but the number of items. by gauges and sizes, runs over 400. Fig. 1 shows many common types of nire nails.

Screw-type nails are used to some extent. principally as roofing nails. This type of nail tends to drive more easily, rotates as it enters the wood and retains greater holding power than does a similar nail of round wire. One method in common use for the manufacture of this type of nail is to produce it as a round wire nail and then pass the nail between two rolls and roll four or five spiral flutes into the shank. Another type of nail developed to increase holding power has annular serrations or saw-tooth ridges around the shank that are designed to bite into the grain of the wood when forces tend to aithdran the nail. This particular type of nail is used to some extent for fastening composition-type shingles and siding.

Forming wire nails is a typical cold heading operation. Stresses and pressures in various parts of the nail machine are great. and nail machines are relatively massive. There are principally four component parts in a nail machine: (1) a hammer mounted in a crosshead to which is imparted reciprocating motion through a connecting rod and a crankshaft; 12) a set of cam-actuated slides which hold case-hardened tools that form the point and cut the nail after it is headed; (3) another set of cam-actuated slides that hold the dies that grip the round wire and act as an anvil for the hammer forming the head; and (4) a reciprocating feed

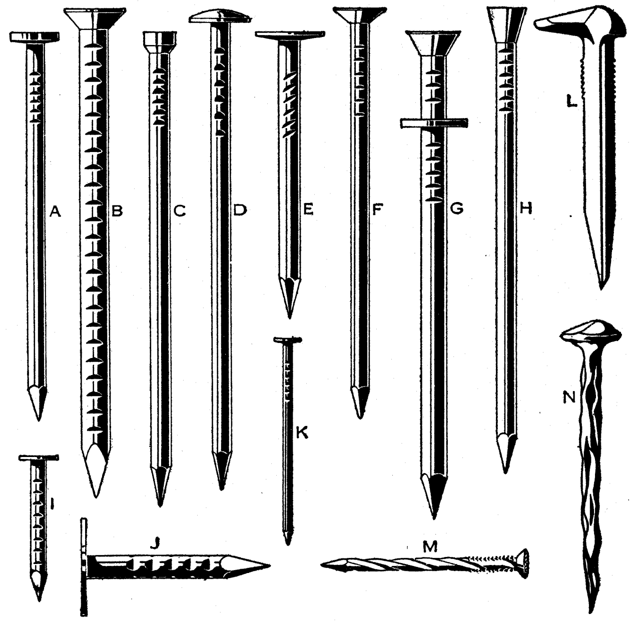

FIG. 1.— VARIOUS KINDS OF NAILS

(A) Common, (B) barbed car, (C) finishing, (D) clinch, (E) slating, (F) countersunk, (G) double-head form, (H) flooring brad, (I) broom, (J) roofing, (K) fine nail, (L) dog spike, (M) screw nail, (N) Roman

table that straightens the wire as it unwinds from the coil and feeds through the heading dies the proper amount of wire stock for the nail.

In machine operation, the feed table straightens and forces wire through the header dies in sufficient amounts to provide stock for the head; the header dies then grip the wire and the hammer moves forward to form the head. During the forward travel of the hammer, the feed table is retracted. ready to feed material into the machine for the next nail. After the head is formed, the hammer is withdrawn and the feed table moves forward with wire for another nail. After the feed table has completed its forward travel and the header dies have gripped the wire. the cutting and pointing tools move together, form the point and cut off the nail. The cycle is repeated for each nail; at every revolution of the crankshaft.

Nail machines operate at varying speeds to turn out 150, 12-in. spikes to over 600 cigar-box nails per minute. After nails are cut. they are placed in rumblers, with a small amount of sawdust, and rumbled for Ij or 20 min. to remove "ahiskers" and to be polished. They are then dumped into kegs for shipment.

Staples.—As staples are a form of nail. their manufacture is usually carried on nith that of nails. They are made in all sizes from both bright and galvanized wire. The three different forms of points on staples are illustrated in fig 2; the names themselves indicate the difierence in the style of point. The term presser point simply means that the point is so sharp and fine that the staple can be stuck into the wood by simple pressure previous to being hammered down.

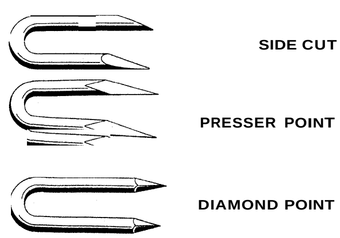

FIG. 2 — FENCING STAPLES

Points are selected according to the hardness of wood used

The several types of machines used in making staples follow the same principle as those for straight nails, the wire being automatically fed forward from the swift. and the operation of cutting and pointing being immediately followed by the bending of the wire into its required shape to form the staple. (R. M. Hu.)

NAIL VIOLIN, a musical curiosity invented by Johann Wilde, a musician in the imperial orchestra at St. Petersburg. It consisted of a wooden soundboard about 1) ft. long and 1 ft. wide, bent into a semicircle. In this soundboard were fixed a number of iron or brass nails of different lengths, tuned to give a chromatic scale. and the sound was produced by friction with a strong bow, strung with black horsehair.

NAIMA, MUSTAFA (16jj–1716), Turkish historian, wrote a history. *Tarih,* of the period 1591–1659. Born in Aleppo, he went at an early age to Istanbul where he entered palace service and held various offices. Protected and encouraged by Hiiseyin Pasha. the grand vizier. he was appointed official chronicler (1709). He died during a campaign in the Morea in 1716. His history is a compilation from the work of his predecessors (Sharihülmen-arzadc whose work is lost. Kâtib Chelebi, Hasanbeyzade and others), together with his own comments. In the introduction he states that the aims of a historian should be objective criticism of sources, avoidance of flattery and a straightforward and unadorned style. This advice he himself followed.

The *Tarih* was published in two volumes (1730) and in six volumes (1884).

See C. Fraser's partial Eng. trans., *Annals* of *the Turkish Empire from 1591 to 1659 of the Christian era* (1832). (F. I.)

NAINI TAL, a town and district in the Kumaon division of Uttar Pradesh, republic of India. The town (which is the divisional headquarters) is 6,400 ft. above sea level. Pop. (1951) 12,350. Naini Tal is a popular sanatorium for the residents in the plains. It is situated on a lake, surrounded by high mountains. and is subject to landslides; a serious catastrophe of this kind occurred in Sept. 1880. There are several European schools and a college of Agra university, besides military barracks.

Naini Tai. District comprises the lower hills of Rumaon and the adjoining Tarai or submontane strip. Area, 2,635 sq.mi. Pop. (1951) 335,414. The district includes the Gagar and other foothills oi the Himalayas, which reach an extreme height of nearly 9,000 ft. The Bhabar tract at their base consists of boulders from the mountains, among which the hill streams are swallowed up. Forests cover vast areas of the hill country and the Bhabar. Beyond this is the Tarai, moist and extremely unhealthy. There the principal crops are rice and wheat. In the hills a small amount of tea is grown, and a considerable quantity of fruit.

NAINSOOK, a light and fine cotton fabric of the plain calico weave, and of texture similar to that of lawn and cambric. It is usually bleached and sometimes striped and checked and finished with a very soft feel for use as lingerie and underwear.

NAIRN, a royal and small burgh and the county town of Nairnshire, Scot.. on the Moray Firth, at the mouth of the Nairn, 16 mi. E.N.E. of Inverness by road. Pop. (1951) 4,700. The town attracts many summer visitors by its mild and dry climate, good sea bathing and golf courses. Salmon, herring and white fishing are carried on. There is a good harbour. constructed by Thomas Telford in 1820 and enlarged by the building of a dock in 1932. Nairn (originally Invernairn) was made a royal burgh by Alexander I (d. 1124); but his charter, having been lost, was confirmed by James VI in 1589.

NAIRNE, CAROLINA, Baroness (1766–184j), Scottish song writer, was born in the "auld hoose" of Gask. Perthshire. on Aug. 16, 1766. She was descended from an old family settled in Perthshire in the 13th century, and could boast of kinship with the royal race of Scotland. Her father, Laurence Oliphant, was one of the foremost supporters of the Jacobite cause, and she was named Carolina in memory of Prince Charles Edward. In 1806 she married W. M. Nairne, who became Baron Nairne in the year 1824. She brought out a collection of national airs set to appropriate words. To this collection, *The* Scottish *Minstrel* (1821–24), she contributed a large number of original songs, adopting the signature "B. B."—"Mrs. Bogan of Bogan." The music was edited by R. A. Smith. She died at Gask on Oct. 26. 1845. Among her most famous songs are: "The Laird o' Cockpen," "The Fife Laird," "John Tod." "Charlie is my darling." "Caller Herrin'" and the "Land o' the Leal." For vivacity, genuine pathos and bright wit her songs are surpassed only by those of Burns.

For Lady Nairne's songs, see *Lays from Strathearn, arranged with Symphonies and Accompaniments for the Pianoforte by Finlay Dun* (1846); vol. i of the *Modern Scottish Minstrel* (1857); *Life and Songs of the Baroness Nairne, with a Memoir and Poems of Caroline Oliphant the Younger,* edited by Charles Rogers (1869, new ed. 1886). *See* also T. L. Kington-Oliphant, *Jacobite Lairds* of *Gask* (1870).

NAIRNSHIRE, a northeastern county of Scotland, bounded west and south by Inverness-shire, east by Moray and north by the Moray firth, Pop. (1951) 8,719. The area is 162.9 sq.mi. There are 9 mi. of coast. It is the fourth smallest county in Scotland. The seaboard, skirted by sand banks dangerous to navigation. is lined by low dunes extending into Moray. Traces of old marine terraces are seen at elevations of 100, 50 and 25 ft. above present sea level. Parallel with the coast is a deposit of blown sand and gravel about 90 ft. high stretching inland for 4 or j mi. This and the undulating plain behind are a continuation westward of the fertile Laigh of Moray. The lowland rocks are Old Red Sandstone, widely covered with glacial deposits consisting of lower and upper boulder clays. with later gravels forming ridges on the moorland between the Findhorn and Nairn rivers. From this region southward the land rises rapidly to the confines of Inverness-shire. where the chief heights occur. This higher land consists of the eastern, Dalradian, or younger Highland schists. with associated granite masses. Several border hills exceed 2,000 ft. in elevation.

The only rivers of importance are the Findhorn and the Nairn, both rising in Inverness-shire. The Findhorn after it leaves that county takes a northeasterly direction down Strathdearn for 17 mi. and enters the sea to the north of Forres in Moray after a total course of 72 mi. At Dulsie bridge (18th centuryj it flows through a narrow rocky gorge where its course is very picturesque. The Nairn, shortly after issuing from Strathnairn, flows to the northeast for 12 mi. out of its complete course of 38 mi. and falls into the Moray firth at the county town. There are eight lochs. all small; that of Clans contains crannogs, or ancient lake dwellings.

The country was originally peopled by the Gaelic or northern Picts. Stone circles believed to have been raised by them are found at several places, particularly in the Nairn valley. To the north of Dulsie bridge is a monolith called the Princess stone. Mote hills and stones with cup markings are also common. Beyond the occasional finding of Roman coins. there is little evidence of effective Roman occupation. St. Columba and his successors made valiant efforts to Christianize the Picts, but it was long before their labours began to tell. although the saint's name was preserved late in the 19th century in the annual fair at Auldearn called St. Colm's market, while to his biographer Adamnan (corrupted into Evan or Wean) was dedicated the church at Cawdor, where an old Celtic bell also bears this name. By the 10th century the Picts had been subdued with the help of the Norsemen. and Nairn, which was one of the districts colonized by the Scandinavians as part of the ancient province of Moray, soon became an integral portion of the kingdom of Scotland. Hardmuir. between Brodie and Kairn, is the heath where Macbeth is reputed to have met the witches.

Territorially Moray was greatly contracted in the reign of David I. and thenceforward the history of Kairn merges in the main in that of the bishopric and earldom of Moray. The thane of Cawdor was constable of the king's castle at Nairn, and when the heritable sheriffdom was established toward the close of the 14th century this office was also filled by the thane of the time. Cawdor castle dates from the 15th century and is still inhabited. At Auldearn. where once stood a royal castle, the marquess of Montrose defeated the Convenanters in 1645.

The soil of the alluvial plain, or Laigh, is light and porous and careful cultivation has rendered it very fertile. and there is some rich land on the Findhorn. Oats, barley and potatoes are grown and sheep and cattle are reared. There are many dairy farms. The poorer arable land at a higher level is used chiefly for producing winter keep for breeding stock. Other industries include whisky distilling. granite quarrying. brickmaking and processing seaweed for fertilizers and feeding stuffs. There is also a small salmon fishing Industry, but sea fishenes have much declined.

The railway from Forres to Inverness crosses the north of the shire.

The population was 8.719 in 1951, Gaelic and English being spoken by 140 persons, as compared uith 410 in 1931. Nairn (pop, 1951, 4,700), the county town, is the only royal burgh and only small burgh. Nairn and Moray shires combine to return one member to parliament. There are no county districts. The shire forms a sheriffdom with Inverness, Moray and Ross and Comarty and a sheriff-substitute from Elgin sits also at Nairn.

NAIROBI, the capital of Kenya colony. British East Africa, is inland about 300 mi. N.W. from Mombasa and is 5,453 ft. above sea level. It is situated on a gentle slope at the head of the Athi plains and from it can he seen Mt. Kenya and Mt. Kilimanjaro and the Aberdare mountains. The climate is pleasantly warm. Once just a water hole. Nairobi has grown rapidly since its first settlement at the end of the 19th century. In 1899 the railway from the coast to Uganda reached Nairobi and a principal depot was established there. In 1905 the government was moved there. In 1919 Nairobi was granted the status of a municipality and in 1950 it became a city. Its local authority consists of a city council. aldermen and a mayor.

The 1948 census of its population was 118.976, (10,830 Europeans). Although the racial groups tend to live in their own areas, public facilities are generally available to all. There are good hotels, parks and playing fields and some fine modern public and private buildings, the most interesting of which are Parliament building, Church House and the Royal Technical College of East Africa. There are schools for all children of European and Asian descent and for some of the African children. Those who are able receive secondary education (Africans at schools outside Nairobi), and for higher education the Royal Technical college takes pupils of all races in sciences and arts. The African population is mostly not settled permanently in Nairobi and many men who work there maintain their families on small-holdings in the African reserves in other parts of Kenya.

Nairobi is the most important urban centre in East Africa; besides being the capital of Kenya it is also the headquarters of the East African railways. the East Africa high commission and many other interterritorial services. In banking and business, many firms including a number from overseas, have their East African headquarters in the concentrated commercial centre of the city, which is also the shopping area. Shops vary from large modern European ones to the old Indian bazaar type. Near by, and well supplied with railway sidings, is the industrial area The main industries are building materials. food and tobacco products, railway and light engineering. The Coryndon museum, Kenya National theatre, the East Africa conservatoire of music and broadcasting stations are in the city, and Nairobi National (game) park is in the vicinity.

Nairobi is reasonably well served by roads and rail lines. The main routes are south to Mombasa and Tanganyika and, via the highlands and Lake Victoria, to Uganda, with regularly scheduled buses and trains. There are two airports, one international and the other for local services. (D. Hs)

NAISMITH, JAMES (1861–1939), U.S. physical education director and inventor of the game of basketball, was born at Almonte. Ont.. Canada, on h'ov. 6, 1861. He was educated at McGill university, Presbyterian theological college at Montreal and the Young Men's Christian Association training college, Springfield, Mass. (now Springfield college) where he also taught physical education. Later he was director of physical education at the Young Men's Christian Association college in Denver (1895–98), obtained an M.D. from the University of Colorado in 1898, and headed the physical education department at the University of Kansas (1898–1937). He died at Lawrence, Kan., Nov. 28, 1939.

With Luther Gulick, his fellow physical education instructor at Springfield, h'aismith began experimenting with winter indoor games and originated basketball in 1891. See BASKETBALL: *Origin.* (J. D. McC.)

NAIVASHA, the name of a lake and town in the Rift Valley province of Kenya. The lake, which is roughly circular with a length of 10 miles, lies 6,150 ft. high on the crest of the highest ridge in the eastern Great Rift valley between the Kikuyu escarpment (east) and the Mau escarpment (west). It is fed by the Gilgil and Morendat rivers, which run in deep gullies, but it has no known outlet. The water of the lake is fresh but slightly alkaline; the shore in many places is lined with papyrus. North and northwest the lake is closed in by the volcanic Eburru hills; to the south towers the extinct volcano of Longonot. The former Crescent Island has now joined with the southern shore of the lake. The lake is famous for its bird life, including many kinds of geese and duck. Naivasha was discovered in 1883 by Gustav Adolf Fischer (1848–1886), and visited in the same year by Joseph Thomson, the Scottish explorer. The main railway from Mombasa to Lake Victoria and Uganda skirts the eastern side of the lake, and on the railway close to the lake is built the town of Naivasha, 6,230 ft. above the sea, 395 mi. north by rail from Mombasa. Nonnative population (1948) 422. The country around Naivasha is especially suitable for cattle and sheep raising.

NAJARA, ISRAEL BEN MOSES, Hebrew poet, was born in Damascus and wrote in the latter part of the 16th century (1587–1599). .He was inspired by the mystical school, and his poems are marked by their bold, sensuous images, as well as by a depth of feeling unequalled among the Jewish writers of his age. He often adapted his verses to Arabic and Turkish melodies. To tunes which had been associated with light and even ribald themes, Najara wedded words which reveal an intensity of religious emotion which often takes a form indistinguishable from love poetry. Some pietist contemporaries condemned his work for this reason; but this did not prevent many of his poems from attaining wide popularity and from winning their way into the prayer-book.

He published during his lifetime a collection oi his poems, Songs of Israel (*Zemiroth Israel*), in Saied in 1587; an enlarged edition appeared in Venice (1599–1600). Others of his poems were published at various times, and W. Bacher has described some previously unknown poems of Najara (Revue des *études* juives, no. 116 et seq)

NAKHICHEVAN, an Autonomous Soviet Socialist Republic of U.S.S.R.. created in 1921, and linked administratively with the Azerbaijan S S.R.. from which it is, however, separated by a strip of Armenian territory. It is bordered on the south and southwest by Iran and on the north and east by the Armenian S.S R. Area 2,085 sq mi. Pop. (1956 est.) 129,000. Though the republic is small, its relief is varied. In the southwest it consists of the valley on the left bank of the Araxes river, which there forms the boundary between Russia and Iran, and along the left bank of which goes the railway loop from Tiflis on the Black sea–Caspian line, which links Armenia and the south of Azerbaijan with Baku, and from which a branch line goes to Tabriz from Dzhulpha in the Nakhichevan republic. The republic thus forms a centre for trade between Russia and Iran. From the valley of the Araxes the Armenian or Transcaucasian plateau rises to a height of about 10,000 ft.

The industries of the region are mainly silk weaving, cotton cleaning and wine production. The numerous small cotton-cleaning enterprises were reorganized after the revolution into two large government factories.

Of the mineral wealth in the republic, salt, lead, sulphur. arsenic, copper, sulphur pyrites and coal, only salt is exploited. Curative arsenical and sulphur springs have been known to the native shepherds for centuries.

The population consists chiefly of Armenians and Azerbaijan Turks, with some Russians in the towns of Nakhichevan (pop. 11,700) and Ordubat (pop. 3,665). The number of schools and teachers has markedly increased, and there are Turkish, Armenian and Russian schools, but many children still receive no education. Grants from the central government of the U.S.S.R. provided for the building of a school, hospital and electric station in the town of Nakhichevan, and a grant was also made for the repair and rebuilding of the small factories. and the irrigation canals, and the development of cotton, silk and salt production. The region was important at an early date because it lay on the route from Teheran and Tabriz to Caucasia. It was laid waste by the Persians in the 4th century, by the Seljuk Turks in the 11th century and by the Mongols in the 13th century. From that time until 1828.

when by the peace of Turkman-chai it passed under Russian rule. it was a khanate vassal to Persia and was frequently devastated during the wars between Persia. Armenia, Turkey and Russia. Its importance for trade and its great fertility helped it to recover after each of these disasters and after the more recent 1917–20 period of disorder and struggle.

NAKHICHEVAN, a town of the U.S.S.R., the administrative centre of the Nakhichevan Autonomous Soviet Socialist Republic in 39° 14′ N., 45° 24′ E., on the Kishchai river and at the terminus of a short line linking it with the railway that runs north of the Araxes river and which is connected with Baku. The town is on a spur of the Karabagh mountains at an altitude of 2,940 ft. Pop (1959) 25,000, mainly Tatars and Armenians. It has an electric plant, motor-driven flour mills and a leather factory. A little to the southeast of it, a branch railway goes to Tabriz.

An ancient site on the Tiflis to Tabriz and Teheran road, the town had much transit trade, especially in salt. between Persia and the north in prerailway days. Armenian tradition claims Noah as its founder, and a mound of earth as his grave. Ptolemy mentions it as Naxuana.

The Persians sacked the town in the 4th century and it did not revive until the 10th century. Alp Arslan. Sultan of the Seljuk Turks, captured it in 1064 and the Mongols raided it in the 13th century. From this period onward it was a bone of contention between Persians. Armenians and Turks. By the peace of Turkmanchai in 1828 it became Russian. The present houses have for the most part been quarried from ancient ruins. A gateway with a Persian inscription and the 12th-century tower of the khans remain.

NAKHON NAYOK is the name of both a *changwat* and its capital in Thailand northeast of Bangkok on the central plain and adjacent to the zone of hills which separates northeast Thailand from the central plain. Located on the windward side of these hills. the *changwat* receives 89 in. of rainfall annually, about double the average of the central plain. It is not a rich agricultural area. partly due to its acid soil and to poor transportation. In 1960 the *changwat* had an estimated population of 153.683. and the city 8.048. The capital is on the Nakhon Nayok river, and is linked to the Pa Sak river canal system. (T. F. B.)

NAKHON PATHOM is the name of both a *changwat* and its capital in Thailand west of Bangkok on the Chao Phraya river delta plain. With an area of 841 sq.mi., the *changwat* in 1960 had an estimated population of 354,324, and a heavy population density of 421 per square mile. Alluvial soils, 49 in. of rain annually, supplementary irrigation from the Nakhon Chai Si river. a Chao Phraya distributary, nearness to the Bangkok market. well-developed transportation facilities and industrious people all contribute to making this one of the most productive and richest *changwats* in Thailand. The chief products are rice, hogs, coconuts, pomelo and other fruits.

The city of Nakhon Pathom (pop. [1957 est.] 26,357) is 29 mi. W. of Bangkok on the railroad line connecting Bangkok with Singapore. It is on a hard-surfaced highway extending from Bangkok to peninsular Thailand. At the head of a canal constructed from the Nakhon Chai Si river, it has access to the delta waterways. In addition to being the transportation and commercial centre of the *changwat,* it is a religious and military centre for the entire kingdom. The largest stupa (Phra Pathom) of Thailand, on which construction started in 1860, is there. The new stupa mas built on top of an Indian stupa dating from A.D. 500. (T. F. B.)

NAKHON RATCHASIMA (formerly known as KORAT) is the name of a *changwat* in Thailand and its capital. The *changwat* holds a strategic location in the southwest corner of the northeast geographic region because it is closer and more accessible to Bangkok than any of the other *changwats*. Northeast Thailand is in the Mekong river watershed and contains about one-third of the land and a little less than two-thirds of the country's population. The *changwat* population (1,094,774) in 1960 averaged 145 persons per square mile (area 7.564 sq.mi.). The population is a mixture of Thai, Laotian and Cambodian. Most of the area is in forest and grazing land. The rural population is concentrated chiefly on the flood plains and tributaries of the Moon river where rice can be grown under irrigation on the alluvial soils. Most of the 45 in. of rain falls during the wet season from May to November. The farms produce rice, corn, tobacco, cattle and hogs. The biggest farm problem is the more efficient use of water resources.

The city of Nakhon Ratchasima (pop. [1957 est.] 41,037) is the transportation. commercial, financial and governmental centre of the northeast. From the city, which is 192 mi. N.E. of Bangkok, a trunk railway line bifurcates toward the north 110 mi. to the Mekong river at Nong Khai, and west 165 mi. to Muang Ubon. Chief commodities shipped to Bangkok by rail are rice and livestock. A net of all-weather roads connects all the *changwats* and their principal cities in the northeast with this centre. A modern asphalt trunk highway 150 mi. long and air transport connect this capital nith Bangkok. One of Thailand's gunnysack factories is in Nakhon Ratchasima. Ruins indicate that settlement on the Moon river is very old and except for a few short-lived conquests by Cambodia the area has been a part of Thailand since the 14th century. (T. F. B)

NAKHON SAWAN, a province *(changwat)* in central Thailand. Area, 3,736 sq.mi.; pop. (1960) 580 504. The capital, Nakhon Sawan (Paknampho) (1957 est., 30,252) and chief upcountry river port, is situated at the point where the Nan and Ping rivers join to form the Menam Chao Phraya. Chumsaeng, the second town of importance, is 19 mi northeast by railroad, at the confluence of the Yom river with the Nan. Roth towns are collection points for teak logs floated downriver. Nakhon Sawan produces rice, beans, maize, cotton. jute and sesame. (G. W. SK.)

NAKHON SI THAMMARAT, a city and capital of the *changwat* of the same name, near the east coast of peninsular Thailand. on a railroad spur, 370 mi. S. of Bangkok by rail, is one of the oldest cities in Thailand. It was founded more than 1 000 years ago. Sometimes called Ligor until the 13th century, it was the capital of a powerful kingdom which dominated the middle of the Malay peninsula. The manufacture of nielloware for which Thailand is known around the world originated there. Pop. (1960) 25.919.

The *changwat* of Nakhon Si Thammarat had an area of 3,926 sq.mi. and population (1960) of 730,402. Abundant rainfall (110 in.), areas of fertile young soils and industrious people make it one of the best agricultural centres in peninsular Thailand. Rice, fruit, and coconuts are the chief farm products. Its outport on the Gulf of Thailand is Pak Phanang, where Wat Mahathadu, over 1,000 years old. is a famous temple. (T. F. B.)

NAMAQUALAND, a region of southwestern Africa, extending along the west coast more than 600 mi. from Damaraland (22° 43′ S.) on the north to 31° S., and stretching inland 80 to 350 mi. It is divided by the lower course of the Orange river into two portions — Little Namaqualand to the south and Great Namaqualand to the north.

Little Namaqualand forms part of Cape Colony (see CAPE OF GOOD HOPE; Great Namaqualand is the southern portion of South-West Africa. The people of Namaqualand are the purest surviving type of Hottentots. and number about 20,000 to 30,000.

NAME (IN LINGUISTICS). A name may be defined, broadly. as a word or small group of words indicating a particular entity in its entirety without necessarily or essentially indicating any special quality of the entity. The term "common name" is sometimes used roughly as the equivalent of "noun"; the present article is concerned with what are more specifically "proper names," although a wholly logical distinction has never been established between the two classes. (See also NAME [IN LOGIC].)

To illustrate something about the nature and manner of origin of names, a situation may be assumed in which two English-speaking persons are wrecked on an island with several other persons of whose language and individual names they are ignorant. At first they are also ignorant of any individual qualities of the others except for gross external ones. and so they will be likely to speak in such terms as "that fellow with the limp." This may be called a description, serving to distinguish the individual by means of a special quality. In a few days, however, the two will undoubtedly be referring to the other by some handier expression. such as Limpy, and he will at the same time have assumed individuality. so that the word will bring to mind many physical and mental characteristics, that is to say, a whole person. It continues to indicate a special quality, but does not essentially do so, since it calls to mind the complete individual, and has in fact come to be a handy formula for that very purpose. After a while Limpy's foot may heal so that he walks perfectly. His name, however, can remain unchanged. since it has ceased to be primarily a description and refers to him as a whole.

Similarly a place name may be taken. such as Dartmouth. an often-used example. The town was named originally because it stood at the mouth of Dart river. as it still does. But now the word is norinally used to name the town without particular reference to its site, and may readily be used for other towns, not so located.

In the effort to escape from this all-inclusive but often no longer descriptive quality of a name. poets and orators often coin epithets. Thus "The Eternal City." though indicating the same entity that Rome does. is purposefully used to direct the mind to a certain aspect. If the name Rome should go out of use and the other become the regular appellation. it would then most likely lose its specific, evocative force as bringing to mind the "eternity" of the city and would become a label to refer to the city in all its aspects, contemporary and ancient, just as Rome now does.

The fact that under proper circumstances Rome will call to mind something other than the Italian city can be taken as demonstrating that a name, like a common noun, may have different applications or meanings. Similarly, it must be recognized that the same entity, by common practice, may have a different name on different occasions: The saine man may now be called Jack; now. John; now, Evans; now. Shorty. Even numbers can lose their natural quality of distinguishing a particular aspect. Fifth avenue has come to be just as much a name as Park avenue, evoking all the qualities of the entity. Who thinks of 10 Downing street with any reference to 9 Downing street?

Of concern to theorists. and also a practical matter as regards capitalization in English, is the problem of collective names; plural names, and names derived from collectives and plurals. The problem is usually considered in connection with names for people, but exists with other classes of names; *e.g.,* the Canary Islands. There is much to be granted to the view that no name should exist in the plural (Eskimos) or should he preceded by the indefinite article (an Eskimo). On the contrary, the ordinary practice of linguistic process easily, even if inconsistently, sets up entities composed of what might then be called "subentities," just as a mathematician distinguishes between $a + b$ and $(a + b)$. Present usage in English accepts as names the appellations of legally recognized: well-organized and sharply defined groups, and those of their members. The line of distinction, however, is vague. Differences in the conception of what is to be considered a name (as shown by capitalization) can be readily observed; inconsistencies can be found in the work of a single author and even within a single chapter.

At this point the impossibility of a distinction between names (proper names) and ordinary nouns (common names) becomes evident. If "Englishman" is to be considered a proper name, why should not "man" have the same status? Each specifies! equally, a representative of a class. In fact. "man" indicates a clear and basic biological entity. whereas "Englishman" rests upon the vague and comparatively superficial entity of nationality. The German practice of capitalizing all nouns seems to recognize this impossibility of distinction. and works for consistency and ease in writing; on the other hand, the principles of capitalization, and thus the conception of names, in English and many other languages permit more subtle effects, and seem to reflect a conception that is in harmony with some basic human principle of classification, even if it is not satisfactorily defined by logicians.

A11 naming thus rests upon the recognition of entities, but in practice a particular entity will be named only if it is important enough to make a name for it useful. Thus, in a large flock the rams and bellwethers may have names but not the ordinary sheep. A (proper) name. as opposed to a (common) noun. may therefore be said, finally, to be assigned to individual entities of sufficient interest and importance. This, in human society, includes all human beings (no completely nameless humans exist) and a vast number of items in their environment (rivers, towns, mountains, houses, etc.).

Classes of Names.—Since the individual person is probably the most easily recognizable of all entities and since it is useful to have names for people, personal names are generally conceded to have been the first to be applied. Their tremendous number and great importance make them still of outstanding interest, and most people think of them first when "name" is mentioned. The ramifications of naming are, however, vastly complicated, and it represents a much larger segment of human activity than is usually recognized. as the following rough classification of names may demonstrate.

1. Personal names (see below).
2. Quasi-personal names. Here are to be included names for individual animals, for personified objects (*e.g.,* dolls. weapons, ships) and for personified abstractions (*e.g.,* Hope). Also individual wild animals are sometimes named, and primitive peoples often conceive personality as existing in inanimate objects.
3. Names for things not definitely personified but sufficiently important to be individualized. A stone may be usefully named because it marks a boundary, or a tree because it is a good bearer of nuts.
4. Place names (see below). These are an obvious extension of (3): they have assumed an importance secondary only to (1).
5. Kames of tribes (gentiles, or ethnics), groups, etc. These are an extension of (1), and arise with the recognition of a kind of communal personality. The problem of collectives arises chiefly in connection with this class.
6. Names of institutions (including religions and sects) and corporations. These are an outgrowth of (5), arising with the development of civilization and legal systems.
7. Titles; *i.e.,* the names of books and other works of art. These. developing at comparatively late date, have become of great importance. They may be considered a development of (3) in the direction of the abstract, but what is actually named, even in the case of a statue or painting, is not so much the physical thing as what might be called the artistic or abstract entity.
8. Brand names; *e.g.,* Coca Cola, Vaseline. These are an important modern phenomenon. As with titles, what is named is a kind of exemplar; one buys "a bottle of Coca Cola," or. by compression, "a Coca Cola," much as one buys "a copy of *Hamlet.*"
9. Kames of events in history; *e.g.,* the Sicilian Vespers, the Renaissance.
10. Names of abstractions not personified; *e.g.,* Stoicism.

With nearly all of these groups the proviso "including legendary, mythological and fictional examples" must be inserted.

PERSONAL NAMES

The statement by Herodotus (iv. 184), echoed by many later writers. to the effect that the members of a certain African tribe possessed no personal names was based upon hearsay and need be given no credence. Historical and anthropological research has failed to discover any people lacking names. The theory has even been advanced that the first words were the names based upon cries by nhich individuals "trade-marked" themselves for the practical purpose of identification. Scholars agree that the use of personal names arose at an extremely early period in human development.

Personal names are derived regularly from ordinary words or from other names. Much less commonly they are derived from the synthesis of essentially meaningless units, such as parts of words single syllables or mere sounds or letters. This last method is comparatively unimportant, but is of much theoretical interest.

In general every human being receives some name shortly after birth whether in a matter of minutes or days or neeks, and nhether or not this name is considered permanent or temporary. This name is necessarily given by others than the individual receiving it. and these others are generally a parent or both parents. or at least some member or members of the family or group. Since these are well-wishers of the child, the name in any society will ordinarily be a "good" one, whether chosen because of religious feeling. family pride, fashion or mere practicality. Apparent exceptions can be noted, as when a child in some demon-fearing tribe may be given a name such as Filth to deceive the evil spirits into thinking he is not worth troubling. Occasionally (much more rarely than is commonly supposed) the Puritans gave names such as Humility and Tremble; though these names may appear sadistically inspired, we must remember that they must have seemed excellent to parents of particular religious convictions.

Since a name is generally considered important, its bestowal is often a solemn occasion and a ritual, even, or perhaps especially, among primitive peoples. Such bestowal of a name, however. does not usually prevent the use of a pet name, and this may later displace the "real" name for practical purposes, and sometimes even officially.

Because a newly born child possesses only minimal individuality, few even of its physical traits being determined, fitting descriptive names can rarely be applied, although parental pride may indulge in such a name as the Greek Callias "beautiful." Some peoples have resorted to numbering their children (*e.g.,* the Roman *praenomina,* Quintus, Sextus, etc.), although in such cases the original name is sometimes (though not among the Romans) considered to be only temporary. In contrast to the rarity of truly descriptive names, incident names are common. These are suggested by the time or circumstances of birth, or sometimes of pregnancy. Ben-oni "son of my sorrow" (Genesis xxxv. 18) was the name of an infant whose mother died in childbirth; it is another example of an "unpleasant" name, and mas also used by the Puritans, perhaps being given on similar occasions. Even among modern peoples incident-naming, particularly with reference to the occasion of birth. is far from uncommon. and many a child is thus called June, or Noël. or even Christmas. Incident-names, but mingling a strong euphemistic quality, are the very numerous saints' names (including even the French Toussaint; "all saints") given, partly at least. because of the day of birth.

As already pointed out, the desire to give a child a "good" name regularly imparts a euphemistic flavour, but many namings are even more definitely so intended and consciously try to start the child out under proper auspices. A baby may be put into what is conceived to be a proper relationship with the tribal totem by being called Wolf, or Son-of-the-Wolf. Even among the Puritans such auspicious names mere much commoner than their opposites, *e.g.,* Hope. Constant. Increase! Comfort, Satisfaction. Names that dedicate a child to some god, or in some way connect him with the god, are extremely common (especially in Semitic languages). and many modern names are thus derived; *e.g.,* John from the Hebrew "Jah is gracious," Theodore from the Greek "gift of God," various names beginning in Os- from a Germanic deity.

Coinparatively uncommon, but increasing in importance, is the actual manufacture of a personal name from sounds, letters or syllables. Though the practice, or something similar to it. is probably of ancient date, its great development is to be found in the 20th century, especially in the United States for girls' names. Thus have been coined Kathetta, Marilla, Elizene, ClarEtta, D'an, Johnny-D. D-Etta and a host of others.

Inevitably, after the passage of a few generations, names lose touch with their origins, tend to be repeated, and to become "just names." The common practice of naming a child "after" someone, usually some member of the family, is chiefly responsible, along with the power of tradition which makes the use of an established name seem safer and more suitable. With the continuation of this practice, a name. which is by nature and purpose conservative and less subject to linguistic change, which is the inevitable fate of all linguistic forms, may therefore become meaningless to later generations and degenerate into a mere label or tag. This loss of lexical meaning. afflicts especially names borrowed from one language into another (cf. John, above). In compensation the name acquires a new richness of suggestion as the result of remembered people who have borne it. Thus, today. few know that Thomas means "twin" and was originally applied to one of twins; on the contrary, a boy is so named "after" his father. or someone else. or because "Tom is a good name for a boy." Often the name will he given with both ideas in mind. and perhaps even with the additional thought of Thomas Jefferson and/or all the St. Thomases.

The original name, however given, may be replaced, and such is the regular practice among some peoples. The name may be changed at some definite time, as at puberty, or it may be changed on the occasion of some exploit. Again, a "good" name is sought. The person to be named may now have attained sufficient maturity to choose his own name. or aid in doing so. Since he will by now have attained individuality, the name can often be descriptive, either of appearance or of character, or it may spring from an exploit Since there is often a close association of names nith magic and religion, the new name may have to be "good" in these connections also.

Such full-fledged change of names has not been a noteworthy feature in the tradition from nhich modern European and American naming has sprung, but the giving of additional names has been of great importance, since the use of family names has developed from it Such additional names were once known as surnames or nicknames, but modern usage confines the former to mean family names and the latter to mean names of informal or derogatory character The older term *to-name* has therefore been revived as a technical term, and will be so used here.

In their nature and manner of giving, to-names differ profoundly from names bestowed at birth and names that wholly replace previous ones. They may be bestowed by the person himself or his well-wishers, but more commonly are bestowed by the community. They are often bestowed by people who are good-naturedly making fun of the individual. or even who dislike him. As a result to-names may be "good" as when the Roman general Scipio is called Africanus because of his victories in Africa. More frequently they are commonplace or mildly derogatory. A few express actual disgust or hatred.

Since the development of multiple and family names, to-names have had little practical function and are not much used, except insofar as individuals. often temporarily as children, may be called by pet names. Even most of the so-called nicknames are only conventionally altered forms of real names, *e.g.,* Bill and Jack, and are scarcely to be considered to-names.

In earlier periods, however. to-names were very widely applied and used, and served much the same purpose that family names now serve. As nould be suggested by their generally being commonplace and lacking the "good" quality, to-names seem to have originated for reasons that were primarily practical in the worldly sense. In particular they afforded a good means of distinguishing identically named persons. of whom there are many in most communities. To-names may be actually bestoued or may begin as descriptions (the big John; John who lives at the wood; John. the tanner) Like other descriptions. these pass into names. in English, by shortening. by sloughing off their grammatical apparatus and by being capitalized in writing (Big John, John Atwood. John Tanner). Many such double names look exactly like the modern combination of given and family names, and once really functioned as such, but they differ by not being hereditary. John Atwood's son John. even if he lived in the same place, was not called John Atwood; he might have been called John Priest because of real or imagined piety.

Nearly all to-names, and therefore the family names which develop from them. can be conveniently classified into five groups, according to their manner or origin. (1) They are descriptive of the person's appearance or character; (2) they record an incident or exploit; (3) they identify him by his connection with some other person. usually his father; (4) they give his residence or former residence; (5) they specify his occupation.

Among many peoples and over long periods of time the combination of given name and to-name has functioned satisfactorily and efficiently to identify individuals.

The inherited family name is a comparatively recent development in the European tradition.

Although a few families among the Greeks identified themselves by the patronymic of a real or reputed ancestor, the Etruscans and, learning the custom from them, the Romans are the first Europeans to make regular use of family names. The Roman three-name system was awkward and not highly efficient, but endured until the end of the empire. It then died out, largely because of the opposition of Christianity, under which only the single baptismal name was recognized, though to-names were used for practical distinction.

A modern development of hereditary names began in the middle ages, with royal and noble families. One dynasty of England. for instance, bore the name Plantagenet from a nickname of Geoffrey IV, count of Anjou. Noble families often identified their head by suffixing the name of the estate. This last was in the nature of a to-name as long as it applied only to the titleholder, but it eventually began to be taken by the younger sons and to be considered hereditary. The modern revolution in naming thus seems to stem from feudalism and the family pride associated with it.

Once started, the growth of the use of hereditary names proceeded steadily. The *bourgeoisie* aped the nobility; the lower orders aped both. This desire to be in style was probably an important factor. In addition, the growth in the size of population units and the necessity for more careful keeping of written records presumably aided the process.

The nen system was more efficient than the old one. A family name identifies the children before they can achieve any kind of surname except a patronymic. It remains fixed and certain through a man's (but not a woman's) life, whereas he may have one to-name as a young man and have that one forgotten and another put upon him later, or may even bear two to-names at once, perhaps being called one thing by his family and friends and another by people uho dislike him. Though to-names are more individualistic and colourful. a family name is correspondingly unlikely to be embarrassing, because everyone realizes that it does not describe the hearer. Moreover. as with all names, the original meaning is generally forgotten. Anyone may be embarrassed because someone bearing the same family name is involved in a scandal, but he is rarely concerned about the actual meaning. The modern triumph of the family name system can thus be adequately explained, both on socio-cultural and practical grounds.

British and American Naming. — Since names are a matter of language and tradition, the practices of naming among the English-speaking peoples can be considered together, with certain specification of diiferences developing since the beginnings of an American tradition.

The Anglo-Saxons, both before and after their Christianization, used a naming system that was also employed by other Indo-European-speaking groups; it is the best attested Indo-European practice, but probably neither the oldest nor the only one. This was a system by which each personal name was formed of two ordinary words; *e.g.*, Hrothgar (Roger), "fame-spear."

As commonly happens with naming, literal significance was not greatly considered, and names were produced, such as Wigfriih, "war-peace." which makes no sense and may be compared to such a modern coinage as Luanda. This system was efficient for the small population groups of the time; if it is assumed that only 100 elements were in use, approximately 10,000 different names were available. To-names were therefore scarcely required, though no doubt they existed. In practice many names were shortened, and nicknames could be used. The only approach to family names seems to have been the practice, at least among royal families, of alliterative naming, or of employing a common initial name-element for all of the sons. Since the Danes and Anglo-Saxons used the same methods of formation, and spoke related languages, the name-pattern of Britain was not greatly affected by the Danish invasion. The chief effect of the Norman conquest was to introduce the use of a few favourite names, themselves of Scandinavian origin but modified by Latin and French influence, and still further modified by transference into English. Thus we may account for the forms and the continuing popularity of' William especially, and also of Robert, Richard and Henry (Harry).

Toward the end of the 12th century the church protested against the use of the old heathen names. But even though these objections could not make head against the popularity of the Norman names among the upper classes, the insistence upon the use of biblical and saintly names worked nothing less than a revolution. From this period dates the popularity (and, in some instances, the first recorded English use) of such names as John, James, Michael, Mary, Anne, Elizabeth, Agnes, Catherine and Margaret. Although the number of names in the Christian tradition was considerable, only a few came to be popular. Since at the same time the coinage of new names became almost impossible, the period of the later middle ages threatened to become nomenclaturally poverty-stricken. Only the almost universal use of to-names (and soon, of family names) saved the situation. At the same time there was a great flourishing of variants, so that anyone named Richard might be distinguished from other Richards by being called Dick, Rich, Rick, Hitch, Hitchcock, Dickon or Hud, to mention only a few. Many family names are based on such nicknames.

During the same period of the later middle ages to-names stiffened into family names by becoming hereditary. In the process, however, what might be called the centre of the name-pattern moved considerably in the direction of the commonplace, because to-names mere usually given by other people but a man had a good chance of determining what to-name became his family name, or at least of avoiding one he did not want. Thus such persona; descriptive~as Little, and Reed ("Red"), are preserved, probably because the bearers had no great objection to passing those names on to their children, but such a common derogatory nickname as Fatty, if preserved at all as a family name, is very rare. Names seeming to be derogatory can usually be found to have some other origin, as with Coward, which is from cow-herd or cow-ward.

Geographically, the use of family names began in London and other more developed districts and worked outward. The process was scarcely complete by 1500, even for England, and in the outlying parts of Wales, Scotland and Ireland the use of family names was not universal even in the 18th century.

The chief later British development in family names has been the tendency, basically because of family pride, toward hyphenization (Burne-Jones, Sackville-West).

In modern times the most notable tendency in given (Christian, baptismal, etc.) names has also been toward multiplicity. In English-speaking countries a second given name (middle name) was uncommon before 1700, but by 1850 was ordinary. The use of three given names is fairly common in Great Britain.

Given names, as in any country, are partly controlled by conservative forces (*e.g.*, established religion, family pride), and partly by forces working for change (*e.g.*, fashion, desire for novelty). As important postmedieval influences on naming may be mentioned Puritanism (rejection of the names of nonbiblical saints, emphasis on the Old Testament) and Romanticism (great fondness for Charles, revival of old names such as Alfred, Guy, Guenevere). Any name becoming well known is likely to be more widely used, especially if it carries with it some "good" suggestion, such as piety or patriotism or stylishness. Thus George really became an English name after St. George came to be considered the patron saint of England (about 1360); it grew more popular with the accession of the Hanoverian kings, and in the United States with the emergence of George Washington. Similarly, the Anglo-Saxon name Edward became important because of its use by English kings. Thomas, also, became a characteristically English name because, it would seem, of the popularity of St. Thomas à Becket.

In modern times any popular hero or heroine, even a character in a novel, is likeiy to give vogue to a name. Such influence, however, is easily overemphasized. It must be remembered that an actor or actress may well assume as a stage name some name that is already becoming fashionable. In that same way, the popularity of Charles may have been aided by the novel Sir Charles *Grandison* (1753), but since the name had already begun to rise in popularity before that time, it may be argued that Richardson actually chose his hero's name for this reason.

Special American Developments. — In the United States the chief special developments in the use of family names are (1) the transformation of old names under the influence of frontier illiteracy; (2) the adoption of family names, generally English, by Negroes and Indians; and (3) the adoption of English names or the anglicization of foreign names by non-English-speaking immigrants.

In given names American usage is notable for the strong Puritan use of Old Testament names in early New England (Joseph, Samuel. Benjamin, David. Joel. Ezra, Adlai). Another development is the xidespread coinage of women's names (see above).

Particularly American also is the use of Jr., as a kind of to-name. and the writing of the signature in the form John Q. Public, as opposed to the British use of J. Q. Public or J. Quincy Public. Hyphenated family names and the use of more than two given names are generally held to be British practices and viewed with little favour.

The second quarter of the 20th century was marked by a considerable change in naming habits in the United States. The proportion of children called by such traditionally common names as John and Mary had declined and many new given names, especially original family names, had become popular. The use of the mother's family name as the child's second given (middle) name has gained considerably.

Scholarship and Relationships. — Most scholarship upon personal names has concentrated upon their etymology, manners of origin and method of development. Statistical and historical study of naming as a social phenomenon is little advanced. Although as yet failing to be as useful a tool as the study of place names (see below), the study of personal names has been of aid to genealogists and linguists, and occasionally to historians.

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PLACE NAMES

The giving of local names depends, much like that of personal names, upon (1) a sense that a place is an entity which possesses an individuality differentiating it from other places. and (2) a sense that a place is useful and therefore worth naming. The recognition of these requirements necessitates no high degree of intelligence and onomastic reaction is easy. Hence place names arose at a very early period, and occur in all recorded languages.

Originally place names need not have been fully differentiated from common nouns. Just as people now living near a large river say ordinarily "the river," so a primitive tribe thus located, and perhaps knowing no other river, must have spoken. Place naming in a fuller sense would have begun when the people recognized two examples of the same class, and distinguished "the red river" from "the black river," whence eventually Red river and Black river. The original quasi-place name thus became what is now called, by biological analogy, the generic (river), and the element used to distinguish between examples of the same class became the specific (red, black). This principle, in fact, is not limited to toponomy, or to nomenclature in general — father may be any father or Father (Jones). In many instances, however, the development proceeded conversely, so that the original common noun became a specific; *e.g.*, from Anglo-Saxon words meaning "the river" several English streams now bear the name Ray or Rea.

The specific-generic principle of place naming. which is highly efficient and so widespread as to be considered universal, rests upon the basic linguistic principle of classification. Ordinary practice in most languages permits the combination of generic and specific into one "word," *e.g.*, Charlestown. and also the omission of either half under the proper circumstances. so that people may say or write either "the Ohio," or "the river," at the same time knowing the full name to be "the Ohio river." In English the specific generally precedes, but it may follow (Lake Mead) or be appended in a phrase (the Bay of Islands).

In spite of the widespread use of the specific-generic principle, different languages naturally differ in their methods of forming place names. Those possessing locative endings are likely to use them liberally. French and Greek employ the article more freely than English does. but Latin lacks an article and so cannot omit it as a mark of a name. The fully developed place name in English generally omits the article; *e.g.*, France, Long Island. The article, however, is used with plurals (the British Isles), and commonly with certain generics. *e.g.*, desert, sea.

This complicated subject of the omission of the article is involved in English with the distinction between evolved and bestowed names. The former begin as mere makeshift identifications; *e.g.*, "the river where the pine trees grow." This can become "the river of the pines," and then "the pine river," and finally "Pine river," or the evolution may be somewhere arrested. At a point sometimes difficult to sense the identification assumes the quality of a name. Bestowed names, on the contrary, arise when a place is consciously labeled by some definite act of naming. Since such a name is likely to be a fully developed one, evolution does not commonly occur, although it may take over to simplify an overcomplicated name, as when El Pueblo de la Reina de los Angeles de la Porciúncula is shortened to Los Angeles.

The giving of place names, as already stated, depends upon entity and use. Primitive peoples, lacking large geographical conceptions, have names for small and obviously useful natural features such as springs, but are not likely to have a sense of the entity of a long river or to have any sense of its usefulness as a whole. Therefore they may not have a single name for it, but may have names for particular pools, reaches and rapids. A mountain is likely to be even harder to conceive as an entity; a range of mountains, still more so. As knowledge increases, larger features are named, often by the process of extending a name in its application; for instance, Italy, Africa and Siberia were originally but small parts of the areas later so denominated. With the development of civilization and geographical knowledge names must be applied to larger and more abstract entities, such as oceans, continents and archipelagos, and eventually to features such as submarine basins, of which earlier peoples were necessarily ignorant.

At the same time a developing civilization gives rise to numerous man-created entities, such as villages. towns. fortresses, provinces and streets. and these also are named. A significant distinction, however, exists between such names and those of natural features. The man-created entities are somewhat less definitely "places" than are natural features, being less surely connected with an actual spot. Towns have changed location, moving the name with them. Primitive villages may bear merely the tribal name, and shift location with the tribal migrations. Even a modern city is often conceived as consisting not of the place, but of the people; its name, then, approaches the status of a collective personal name. In addition, any sovereign or corporate entity such as a city or state possesses a name much as a corporation does. Nevertheless these "habitation-names" are usually considered to be place names, partly because they have a geographically definable location and partly because many of them, such as Liverpool, go back to evolved names of natural features. More doubtful, but sometimes considered to be place names. are the names of such things as bridges, tunnels and individual buildings.

Types of Specifics. — The number of specifics is very large, but their usage may be considered under nine heads, and a useful classification of place names thus results, even though the existence of many borderline examples must be recognized. It must also be emphasized that this classification is of kinds of usage, not of the specifics themselves. Thus a specific such as Lincoln might give rise, according to circumstances, to an incident name, a possessive name. a commemorative name or even to something else.

Descriptive *names* employ a specific indicating a long-enduring quality of the generic (Clear brook, Roaring river, Stinking spring, Pliocene ridge). Less purely descriptive, but generally so classified. are names that identify by means of a possibly impermanent association (Boundary mountain, Mill river, Lone Pine creek). Similar to these latter are the relative descriptive names which identify by indicating a relation to something else (North sea, Ten Mile creek, Fourth crossing). Many counterpart names thus arise, *e.g.*, Big river may not actually be very large, but may be named because it is larger than a neighbouring Little river.

Incident names arise from an incident occurring at the place and making it memorable (Massacre lake, Hungry Moose creek). Names of persons are often applied to natural features for this reason. as are also the names of animals. Thus, Crocodile river need not indicate that those beasts were especially numerous there, but merely that a single crocodile happened to impress himself upon early explorers. Nearly all names used by primitive peoples are either descriptive or incident names.

Possessive *names* spring from the idea of ownership, whether legal or informal (Culp's hill, Bakersfield)! though the possessive form of the noun need not be maintained. Under this heading may be included most ethnic names (Zululand, Cheyenne river) and many mythological names derived from the names of gods and spirits. These two subclasses, however, are also closely connected with associative-descriptives and with commemorative names. Possessive names appear at an early stage of culture, but probably arise subsequently to the first two classes.

Commemorative names are those given consciously "in honour of" someone or something (many religious and patriotic namings); here are to be included most transfer names (Megara from Greece to Sicily; Boston from England to the United States).

Euphemistic names are those bestowed a-ith the idea of making a good impression or establishing favourable auspices (Euxine sea. Beneventum, Greenland, Cape of Good Hope). Commemorative and euphemistic names may be considered to arise somewhat later in cultural development than the above-mentioned classes.

Manufactured names are those constructed from recombined sounds or letters, out of fragments of old words, from initials, by backward spellings, etc. (Tesnus, from Sunset; Tonolo, from an arrangement of selected letters). Such names are probably of comparatively late origin; no certain example seems to be known before 1600.

Shift names result from the mere shift of the specific from one generic to another in the vicinity (White lake, though it may not be white, takes that name because it is near White mountain). The resulting group is called a name-cluster.

Folk-etymologies, though they may be said merely to transform old names, really produce what are essentially new names! through the mishearing and misinterpretation of an obsolete or foreign word (Picketwire from Purgatoire). Backformation (River Cam from Cambridge) may be considered a phase of folk-etymology

Mistake names arise from failure in transmission. either oral or written (Oregon, from an error on a map). These last three classes differ from the others in that they arise secondarily from other names, and seldom by a conscious process of naming.

The number of names in a given area will be greater because of any factor that increases the number of places easily to be conceived as having entity (*e.g.*, more variegated topography), and also because of any factor leading to more intensive use of land (*e.g.*, denser population). Longer continuous linguistic and cultural tradition is also an important factor, since names established for any reason tend to persist. From such factors. and doubtless from others less easily appraised, spring varying local habits of name giving: thus in some countries every farm and even every field bears a name, but else here such units do not. The density of names thus differs greatly in different areas (according to estimates, South Dakota, .2 to the sq.mi.; U.S., 1; Keos, Greek island, 17; Norway, 40; Bohuslan, Swedish province, 150). Such differences, however, result partly from differences in judgment as to what is to be considered a place name.

Notable periods of naming occur when an uninhabited country is being explored or developed. or when the speakers of a new language are imposing themselves upon a country. In such periods not only are names established for the most important natural features but also for many of the habitation sites that will later become the cities. Because of the general turmoil associated with such a situation, the names are likely to be impermanent. Thus, during the period of the settling of the United States, thousands of names appeared, only to disappear; five once-current European names are recorded for Hudson river, in addition to North river, still in limited use.

Once established firmly: however, place names cling with great pertinacity, and frequently survive, though suffering great change of form, even through periods of shift in population and language. This tenacity renders place names valuable to the study of history and prehistory. and necessitates careful study of the alterations to which they are subject. In general, being a part of language. place names change pronunciation along with the rest of the language. Thus, when the pronunciation of English vowels shifted in the later middle ages, this change occurred in place names as in other words. Certain special iactors, however, must be noted. (1) Place names, consisting of specific-generic, are on the average at least twice as long as ordinary words, and so are especially subject to the linguistic forces applicable to long words. (2) Many place names, whether because originally from foreign words or because long-enduring and therefore affected by the obsolescence of native words, are or become meaningless to the ordinary speaker, and thus are peculiarly subject to the processes of folk-etymology. (3) The usage of most place names is highly local, and they are thus susceptible to dialectal variation and even to personal whim. Place names thus tend to depart from the rest of the language and to become unintelligible to the ordinary person, except insofar as they are "re-interpreted" by folk-etymology. By means of earlier recorded forms and by the methods of comparative philology, however, the trained linguist is able to penetrate most of the disguises, and even the most cryptic are not beyond his attempts. As a result the study of place names has proved highly rewarding, and has been assiduously pursued during the 20th century, particularly in western Europe.

Place Names of Western Europe. — In this area the "place-name pattern" indicates what is sometimes called a "prehistoric base," *i.e.*, a scattering of names that defy explanation by means of any otherwise recorded language, and are therefore held to represent one that existed at some very remote period. Attempts have been made to elucidate some of these names. Thus to a basic root **kal-* (Calahorra), also supposed to exist in numerous variants, such as **kar* (Carcasonnej and possibly even in **al-* (Alps), has been assigned a large number of names, and the meaning "rock" has been postulated, extended in one direction to mean "mountain," and in another to include "fortress," and even "house" and "village." Such conclusions must still, however. be viewed as highly hypothetical. Iberian and Ligurian were previously coupled with the basic "stratum." The modern tendency, however, is to connect the former with Basque and to restrict it to the Iberian peninsula with some extension into France, and possibly into Britain. Ligurian is now generally considered to represent an early extension of Indo-European, importact only in the region of northwestern Italy and southwestern France. After about 1945 much attention was directed toward another possibly early Indo-European stratum to which the term "Illyrian" has been attached.

In contrast to these uncertain early influences is the clear Celtic imprint. As a result of shorter or longer Celtic occupation a recognizable stratum of names extends all the way from central Europe to Ireland and Portugal. As such many names may be noted of rivers (Rhine, Avon). strongholds and sites (Verdun, Vienna. Madrid) and districts (Kent, le Maine). Noteworthy is the derivation from the names of Celtic tribes of about 40 French cities, including Paris.

As comparatively unimportant in the western European name-pattern may be considered the few names left by Greeks, *e.g.*, Nice, Antibes, Ampurias; and by Semites, *e.g.*, Cadiz, Cartagena. The Romans, however, exercised a tremendous influence, and not merely in Italy. Thus arose not only the names of innumerable villages, but also of many important cities; *e.g.*, Saragossa. Aix, Coblenz, Cologne. Direct Roman influence upon names in Britain seems to have been negligible, but indirectly, from Latin words adopted by the natives. *e.g.*, *castra* and *colonia*, have sprung names such as Lancaster. Chester and Lincoln.

The Germanic migrations affected the pattern strikingly. The appellations of tribes were fixed upon whole regions (Lombardy, Burgundy, Wessex), and even produced the names England and France. In England, where the speech of the invaders supplanted the Celtic speech, the place names became predominatingly Anglo-Saxon. and this Germanic domination was enhanced by the later Scandinavian invasions. In France, Spain and Italy, however, the Germanic influence on names varies, regionally, from moderate to negligible. Naming was active during the period of the revival after the dark ages; the modern languages had then emerged, and most of the new nanies sprang from them, though a certain Latin influence was still exercised through the Church. Because of the Church influence many religious names appeared; especially noteworthy are the numerous names of towns and villages commemorating saints.

By 1500 the basic European name-pattern was well established, and even most of the smaller names were fixed. Still. naming is a continuous process. Thus, in France, though most cities bear names of medieval or more ancient origin, Le Havre dates only from 1517 and Lorient from 1664. In the British Isles the continuing process is observed \\-ith Londonderry, Fort William and Port Sunlight, as well as with the naming of innumerable streets and estates.

Wars and revolutions continue to affect the names, as in the shifts from St. Petersburg to Petrograd to Leningrad. Revivals of nationalism also have strikingly influenced the pattern in Greece and the Republic of Ireland. In Italy the attempts to recall past glories produced such shifts as that from Girgenti to Xgrigento.

Place Names of the United States.—The place-name pattern of the United States is typical for countries whose development lies mainly in the historical period. The discoverers found a situation such as is to be expected in a region thinly inhabited by primitive tribes. Names were rather sparse; they were descriptive or incident names; according to the principles of entity and use only such features were named as were of interest to a primitive people and were recognizable by them. Europeans adopted some of these names, but since these were generally unintelligible, they were used as mere counters and often misapplied. Thus Connecticut, "at the long estuary," applying only to the river near its mouth, was extended to the whole stream. and then to the colony. At a later period Indian names that had acquired sentimental value were transferred to new sites; a striking example is Wyoming, originally applied to a small valley in Pennsylvania.

Much more commonly the Europeans, of whatever nationality, gave names in their own languages. These were often descriptive (Colorado river. Marblehead, Detroit), or sprang from incidents (Cape Fear, Rancheria de la Espada). Many were commemoratives (Virginia, numerous saints' names in French and Spanish territory), and many of these were transferred from "the old country" (Thames river, Harlem). During more than three centuries, while the country was being explored and settled, thousands of names. and eventually millions, arose by bestowal and evolution. All possible methods of naming were represented; all phases of the history and social development of the American people were enshrined in the names. Enlarged geographical conceptions and an increasing density of population resulted in more and more naming. The necessity of establishing so many names in such a short time, because of the rapidity of settlement, resulted in much repetition and in a great use of transfer names taken in seemingly haphazard fashion from various parts of the world; *e.g.*, Toledo, Athens. Odessa. Nevertheless not a little ingenuity was also displayed, and occasionally some sense of poetry. as in John Frémont's naming of the Golden Gate.

The typically American use of the manufactured name seems to have arisen in an attempt to gain more variety. Although beginning as early as Saybrook (1635), it was a special development of the last half of the 19th century and subsequently. Many manufactured names are *boundary names,* such as Calexico and Mexicali (both from California and Mexico), and Texarkana (from Texas, Arkansas and Louisiana).

Toward the end of the 19th century the "big names" had all been fixed, and the process became one of filling in. Significant dates are the fixing of the last state-name (Wyoming, 1868) and the establishment of the Board on Geographic Names (1890), a federal agency to regulate governmental naming. Place-naming in the United States! however, is still in a comparatively active period because of the constant naming of towns, districts and streets, and the filling-in by the naming of lesser natural features.

Place-Name **Scholarship.**—As a result of the differences in the nature of the problems in Europe and in the United States. the methods and interest of onomatologists have differed greatly. European scholars, lacking historical information, have generally worked by linguistic methods, drawing what help they could from geography. history and anthropology. They have been essentially etymologists. The usual European scholar has little interest in names that have arisen since the middle ages, and are therefore of no etymological interest. Many European scholars have been intensely concerned with the ancillary use of place-name study as a tool for the investigation of prehistory.

American scholars rely mainly on the methodology of history. Not primarily etymologists, they are likely to consider the establishment of the etymology as a mere primary step, of not much significance unless the reason for the application can be established. They are more likely than European scholars to be informed as to the processes of place-naming and more likely to be interested in recent and current naming.

Since the study of place names deals with an important human activity. it is justified in its own right. but it is also of ancillary value to many other studies, such as linguistics. history, geography, archaeology, anthropology and folklore. A zoologist may study place names to establish the former habitat of an animal. Probably the greatest "external" triumphs of the study have been in connection with the establishment of the locations. and something of the social organizations, of various peoples when historical records are lacking. Thus place names make certain a Saxon occupation of the Calais region in France at some time during the period of Germanic migrations. Similarly such study, almost without historical aid, has established that many Norwegians settled in northwestern England (about goo), and is even able to support the assertion that these came in small groups, not in an invading army, had an Irish element mingled with them, and lived on comparatively peaceable terms with the English.

Nevertheless, evidence derived from the study of place names must be used with caution, and is seldom conclusive except when a whole "pattern" can be demonstrated. Individual names may show close resemblance or even be identical as the result of coincidence. as with Georgia in the Caucasus and Georgia. U.S., or Miami (Ohioj and Miami (Fla.), and many others. In the newer countries, such as those of both the Americas, there has been constant transfer of names at a sophisticated level and for what may be called somewhat extraneous reasons. Thus California has been shown to be derived from a Spanish romance. Corinto in Nicaragua resembles the Greek Corinth only by being a port. Odessa in the U.S. may indicate not a settlement of Ukrainians but a nheat-growing district.

Without historical evidence coincidences are often baffling, as with the three widely-separated tribes known to the ancient Greeks as Enetoi. Such cruxes can only be approached by a meticulous combination of linguistic: historical, archaeological, geographical and anthropological techniques.

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NAME (IN LOGIC). A name is a word, symbol or expression having the kind of meaning which can be explained only by saying that a sentence in which the name is used is intended to be about something which the name denotes. (See DENOTATION.)

By some logicians the term *name* is restricted to the narrow category of what are sometimes called logically proper names; *i.e*, names which denote uniquely, which are simple, in the sense of having no analysis into meaningful parts, and which supposedly have denotation without connotation. But by others the word name is used rather in a broader sense than is customary in everyday usage and in linguistics; and it is this broader sense which will be treated in the present article.

Historical changes in the meaning of names (see the discussion of particular examples in NAME [IN LINGUISTICS] above). and variabilities and uncertainties of meaning which occur in the natural languages are the concern of the linguist rather than the logician. And many complicating features of the meaning and usage of names in the natural languages, however unavoidable in the actual use and development of a language, are best regarded for purposes of logical analysis as irregularities that have to be removed. This leads ultimately to a formalized language (see LOGIC). But we here use for illustration a natural language, English, abstracting from uncertainties of meaning which might be urged as doubts against some of the examples.

Traditionally, names have been classified according to their denotation, as *concrete* names. denoting physically concrete things, collective names, denoting collections or classes of concrete things, and abstract names denoting abstract entities, or according to the connotation (*q.v.*), as negative (if they connote the not having of a specific property) or positive (in the contrary case), as relative (if, like "father," "friend," "cause," they connote the bearing of a specific relation) or nonrelative.

More fundamental, however, is the distinction between *singular* names, or constants, which have as a part of their meaning that there is one unique thing denoted, and *common* names. or general names, which do not have uniqueness as part of their meaning. (Proper name is convenient as a synonym of *singular* name, in view of other meanings of the word *singular;* but by many the term proper name is used rather for some more restricted class of names.)

Examples of singular names are the place name "Dartmouth," which denotes the town Dartmouth; the personal name "James Mill," which denotes the man James Mill; the phrase, "the father of John Stuart Mill," which (as would be said even by those logicians who do not class such descriptive phrases as names) denotes the same man James Mill; the personal name "Chiron." which purports to denote a certain centaur; the collective name "mankind," which denotes the class of men; the abstract name "courage," which denotes the property or quality of being courageous. The fact that more than one town has the name of "Dartmouth" and more than one man that of "James Mill" constitutes an equivocacy of these names, but does not prevent them from being singular names, as each one purports to denote uniquely. On the other hand, "Englishman" is a common name since, without equivocacy, it denotes James Mill, and also denotes John Stuart Mill, and Guy Fawkes, and Alexander Pope, etc. "Son of Henry VIII" is a common name, as it is no part of the meaning of the name that there is only one; but "the son of Henry VIII" is a singular name. "Bachelor" is a concrete common name; "centaur" is a concrete common name, though denoting nothing; "throng" is a collective common name; "virtue" is an abstract common name (as both courage and honesty, *e.g.,* are virtues).

In the construction of formalized languages both common names and names denoting nothing have generally been avoided, in the interest of simplicity—except so far as the variables which occur in most formalized languages (see LOGIC) may be regarded as partial analogues of the common names. It is an interesting question whether these familiar features of natural language can be reproduced in a formalized language, or whether they have some inherent inconsistency or unsuitability that prevents it. But statements containing either common names or denotationless names can always be reformulated so as to use instead only the constants and variables of the usual formalized languages (an example is the reformulation of "All bachelors are red-haired" as $(x)\,[B(x) \supset R(x)]$ in the language L described in SEMANTICS IN LOGIC). (Ao. C.)

NAMPA, a city in the centre of the Boise valley in southwestern Idaho, U.S., 20 mi. W. of the city of Boise. Founded Sept. 8, 1886, on the main line of the Union Pacific at the junction of a branch to Boise, Nampa was a hamlet in the desert until irrigation transformed the area into farms in 1891. The town gained importance through the efforts of W. H. Dewey, an early Idaho settler who made Nampa the hub of two more branch railways and in 1902 undertook a major development of the townsite. His Dewey Palace hotel was a landmark for a generation. A sugar factory, milk condensery, several major vegetable seed producers and the Pacific Fruit Express shops are the major industries. Nampa is the home of Northwest Nazarene college, a denominational college founded in 1913. The community sponsors the annual Snake River Stampede, one of the leading rodeos in the northwest. The name Nampa is from the name of a leader of the western Shoshone Indians. For comparative population figures see table in IDAHO: Population. (M. D. B.)

NAMUR, one of the nine provinces of Belgium, between Hainaut on one side and Liège and Luxembourg on the other, extends from Brabant up the Meuse to the French frontier. Area, 1,413 sq.mi.; pop. (1955 est.) 364,125 or 258 per sq.mi. It is fertile north of the Meuse and forested in the south. There are a few iron and coal mines between the Sambre and Meuse, and the quarries are important. Arboriculture, especially fruit-tree plantation, is increasing. There are three administrative arrondissements, Namur, Dinant and Philippeville, 14 cantons and 366 communes.

NAMUR (Flemish NAMEN), a town of Belgium, capital of the province of Namur. Pop. (1955 est.) 32.078. The town lies on the left bank at the junction of the Sambre and Meuse rivers, while the rocky promontory forming the fork between them is crowned with the old citadel, which occupies the site of the old castle of the counts of Namur. This citadel was abandoned for military purposes, and its hill was converted into a park, while the crest was occupied by a hotel reached by a cogwheel railway. Namur is connected with the citadel by two bridges across the Sambre, and from the east side of the promontory there is a fine stone bridge to the suburb of Jambes. This bridge was constructed in the 11th century and rebuilt in the reign of Charles V. It is the only old bridge in existence over the Belgian Meuse. The cathedral of St. Aubain or Albin was built in the middle of the 18th century. The church of St. Loup is a century older and is noticeable for its columns of red marble from the quarry at St. Rémy near Rochefort. There is a considerable local industry in cutlery, and there are tanneries and glassmaking factories.

In the feudal period Namur formed a marquisate in the Courtenay family. Jousts on stilts were a medieval custom that lasted into recent times there. Don John of Austria made Namur his headquarters in the Netherlands, and died here in 1578. Louis XIV took it in 1692 and Vauban renewed the defenses but William III retook it in 1695, though the French held it again from

1702 to 1712 In 1893. under the new scheme of Belgian defense, the citadel and its detached works were abandoned, and in their place nine outlying forts were constructed at a distance of from 3 to 5 mi Namur was the scene of intense fighting in both World Wars I and II.

NAN, a province (*changwat*) in northern Thailand, formerly an autonomous principality. Its area (4,515 sq mi.) comprises the upper Nan river basin and the surrounding mountains, which isolate it from Laos to the north and east and from Chiangrai and Phrae provinces to the west. A single road connects the capital. Nan (1957 est.. 12,785), with the nearest railroad station, Denchai, 84 mi to the southnest.

Major products are teak logs, floated downriver to Bangkok mills, and tobacco. The population, 239 037 in 1960, is predominantly Thai-Lao. but includes a variety of tribal peoples, most notably Lu, Tin, Khamu and Yao. (G W. SK.)

NANA SAHIB, the common designation of Dandu Panth, an adopted son of the former peshma of the Marathas. Baji Rao, who took a leading part in the great Indian mutiny (q v.) and was proclaimed peshwa by the mutineers. Nana Sahib had a grievance against the British government because it refused to continue to him the pension of 800,000 rupees (£80,000), which was promised to Baji Rao by Sir John Malcolm on his surrender in 1818. This pension, however, was intended only to be a life grant to Baji Rao himself. For this refusal the Nana bore the British a lifelong grudge, which he satisfied in the massacres at Cawnpore (Kanpur; *q.v.*). In 1859, when the last rebels disappeared into Nepal, he was among the fugitives. His death was reported some time afterward, but his real fate is obscure.

See G. O. Trevelyan, *Cawnpore* (London and Cambridge, 1865).

NAN-CH'ANG, the capital of the province of Kiangsi, China, on the Kan Chiang near the lake Po-yang Hu, 160 mi. S.E. of Wuhan. Pop. (1957 est.) 508,000. Nan-ch'ang is situated on the east-nest railroad connecting Hangchow in Chekiang province with Chu-chou (Chuchow) in Hunan province. A second railroad station in Nan-ch'ang's left-bank industrial suburb is the terminus for a line going northnard to the Yangtze river port of Chiu-chiang (Kiukiang). Nan-ch'ang is the largest city of the Po-yang lake basin one of China's chief rice-growing areas. In addition to rice, the city also trades in tea, grown on near-by hillsides, and in cotton. tobacco and hemp. Industries that have developed in the left-bank suburb include factories for the processing of vegetable oils and fats. paper, textiles, machinery and agricultural implements. Kiangsi Agricultural institute and Medical college are located in Nan-ch'ang.

An old walled town. it was formerly situated on Po-yang Hu. Over the years the sediments carried by the Kan Chiang built up a delta that pushed the lake shore as far as 20 mi. from the city The city mall was razed in modern times. The two banks of the city are linked across the Kan Chiang by a bridge and ferries. During the Chinese-Japanese War, the Japanese occupied Nan-ch'ang from 1939 to 1945. (T. SD.)

NANCY, a town of northeastern France, the capital formerly of the province of Lorraine, and now of the dkpartement of Meurthe-et-Moselle, 219 mi. E. of Paris on the railway to Strasbourg. Pop. (1954) 120,484.

At the close of the 11th century Odelric of Nancy, brother of Gérard of Xlsace, possessed at Nancy a castle which enabled him to defy the united assaults of the bishops of Metz and Trèves and the count of Bar. In the 12th century the town was surrounded with walls, and became the capital of the dukes of Lorraine; and in 1477 Charles the Bold was defeated here by René II. (See SWITZERLAND: *History.*) Refortified by Charles III, it was taken by the French in 1633. After the peace of Ryswick in 169; it was restored to Duke Leopold. He founded academies. established manufactures and set about the construction of the new town. But it was reserved for Stanislas Leczinski, the last of the dukes of Lorraine, to make Nancy one of the palatial cities of Europe. The city, which became French in 1766, was occupied by the allies in 1814 and 1815 and put to ransom by the Prussians in 1870. After the Franco-German War the population was greatly increased by the immigration of Alsatians and of people from Metz and its district.

Although Nancy remained outside the area of actual fighting during World War I it was bombarded by German aeroplanes and long-range guns, but the damage was not very serious.

Nancy stands on the left bank of the Meurthe 6 mi. above its junction with the Moselle and on the Marne-Rhine canal. The railway from Paris to Strasbourg skirts the city on the southwest side; other railways — to Metz, to Épinal by Mirecourt, to Château Salins — join the main line near Nancy and make it an important junction. The town consists of two portions — the Ville-Vieille in the northwest, with narrow and winding streets, and the *Ville-Neuve* (16th–18th centuries) in the southeast, with wide straight streets. Between the two lies the Place Stanislas, and on all sides rise imposing buildings of the 18th century — the town hall, episcopal palace, etc. A fine triumphal arch erected by Stanislas in honour of Louis XV leads from the Place Stanislas to the Place Carrière, which forms a beautiful tree-planted promenade, containing at its further end the government palace (1760) now the residence of the general commanding the XX army corps, and adjoins the so-called Pépinière (nursery) established by Stanislas.

The cathedral in the Ville-Neuve, built in the 18th century, has a wide façade flanked by two dome-surmounted towers. Of particular interest is the church of the Cordeliers, in the old town, built by René II. about 1482 to commemorate his victory over Charles the Bold. Pillaged during the Revolution period, but restored to religious uses in 1825, it contains the tombs of the counts of Vaudémont. Here also is a chapel built at the beginning of the 17th century to receive the tombs of the princes of the house of Lorraine. The church of St. Epvre, rebuilt between 1864 and 1874 on the site of an old church of the 13th, 14th and 15th centuries, has a fine spire and belfry and good stained glass windows. Of the old ducal palace, begun in the 15th century by Duke Raoul and completed by René II., there remains but a single wing, partly rebuilt after a fire in 1871. The entrance to this wing, which contains the archaeological museum of Lorraine, is Gothic of the early 16th century. One of the greatest treasures of the collection is the tapestry found in the tent of Charles the Bold after the battle of Nancy. Of the old gates of Nancy the most ancient and remarkable is the Porte de la Craffe (1463). The town hall contains *a* museum of painting and sculpture.

Nancy is the seat of a bishop, a prefect, a court of appeal and a court of assizes, headquarters of the XX. army corps, and centre of an *académie* (educational division) with a university comprising faculties of law, medicine, science and letters, and a higher school of pharmacy. There are also tribunals of first instance and of commerce, a board of trade-arbitrators, and a national school of forestry. The industries of Nancy include printing, brewing, cotton- and wool-spinning and the weaving of cotton and woollen goods, and the manufacture of tobacco (by the State), of boots and shoes, straw hats, pottery, casks, embroider~machinery, motor cars and spare parts, engineering material, farm implements and iron goods.

NANDI (CEMUAL), an East African people of the so-called "Nilo-Hamitic" group who inhabit the eastern part of the Kenya highlands. The name is used in the narrow sense for a group numbering about 100,000 who live southeast of Mount Elgon and also, in a wider sense. to include the following related peoples: Kipsigis (Kipsikis, Lumbma); Terik (Nyangori); Elgeyo (Keyo); Kamasiya (Tuken); Elgonyi (Kony) and Sebei (Sapei), who number, taken together, between 200.000 and 300,000. Except for the Sebei, who live on the Uganda side of Mount Elgon, all are in Kenya.

Nandi cultivate millet, maize, sweet potatoes and other crops with iron hoes. but their principal interest is their cattle, which. besides providing food and bridewealth payments, are of great ritual importance. Cattle supply both milk and blood, the latter being taken by puncturing a vein in the beast's neck without killing it. A man's cattle are distributed among his kinsmen as a precaution against epidemic diseases and raids, which, before the establishment of British administration in 1896, were a popular activity among the Nandi and related peoples.

The people are divided among 17 exogamous, totemic patrilineal clans, which are dispersed throughout Nandiland. The most important traditional social groups, however, are the age sets formed by youths upon circumcision and initiation. Each set remains in power during some 15 years of warriorhood, after which it ceremonially hands over to the succeeding set.

Prior to British administration, political and jural authority resided in local councils of elders. Ritual experts of Masai origin —*orkoiyot*—are in charge of divining and rain making.

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NANDU, the Brazilian name for the rhea (*q.v.*).

NANKANA, a people resembling the Bura and the Mampursi, living in the Navoro district of the Northern Territories, Ghana, and across the Upper Volta border in the Leo district. They speak a Mossi dialect.

See Cardinal, *The Natives of the Gold Coast.*

NANKEEN, a cotton cloth originally made in China and now imitated in various countries. The name is derived from Nanking, the city in which the cloth is said to have been originally manufactured. The characteristic yellowish colour of nankeen is attributed to the peculiar colour of the cotton from which it was originally made.

NANKING (NAN-CHING), capital of Kiangsu province, China, on the south bank of the Yangtze river, 160 mi. W.N.W. of Shanghai. Pop. (1953 census) 1,091,600. The city of Nanking dates from the beginning of the Ming dynasty (1368), although it is built on the site of a city which for more than 2,000 years appeared under various names in the history of the empire. The more ancient city was originally known as Kin-ling; under the Han dynasty (202 B.C. to A.D. 23) its name was converted into Tan-yang; by the T'ang emperors (A.D. 618–906) it was styled Kiang-nan and Sheng Chow; by the first sovereign of the Ming dynasty (A.D. 1368–1644) it was created the "southern capital" (Nanking) and was given the distinctive name of Ying-t'ien; and with the accession to power of the Manchu rulers it was officially known as Kiang-ning, though still popularly called Nanking. It was the seat of the imperial court only during the reigns of the first two emperors of the Ming dynasty, and was deserted for Shun-t'ien (Peking) by Yung Lo (Ch'eng Tsu), the third sovereign of that line, who in 1403 captured the town and usurped the crown of his nephew, the reigning emperor.

The T'aip'ing rebels, who carried the town by assault in 1853, swept away all the national monuments and most of the public buildings it contained, and destroyed the greater part of the magnificent wall which surrounded it. The wall, of which only small portions remain, was about 70 ft. in height, measured 30 ft. in thickness at the base, and was probably 20 mi. in circumference and pierced by 13 gates. Encircling the north, east and south sides of the city proper was a second wall which enclosed about double the space of the inner enclosure. In the northeast corner of the town stood the imperial palace built by Hung Wu (Chu Yüan-chang), the imperial founder of the modern city. After suffering mutilation at the overthrow of the Ming dynasty, this building was burned to the ground on the recapture of the city from the T'aip'ing rebels in 1864.

The most conspicuous public building at Nanking was the famous porcelain tower, which was designed by the emperor Yung Lo (1403–28) on a previously sacred site to commemorate the virtues of his mother. The building was begun in 1413. In shape the pagoda was an octagon and was about 260 ft. in height. The outer walls were cased with bricks of the finest white porcelain, and each of the nine stories was marked by overhanging eaves of green glazed tiles.

Nanking was formerly one of the chief literary centres of the empire. It was taken by the British in 1842 and made a treaty port by the French treaty of 1858, but was not formally opened. Its proximity to Chen-chiang (Chinkiang), where trade had established itself while Nanking was still in the hands of the rebels, made its opening of little advantage. In 1899 it was voluntarily thrown open to foreign trade by the Chinese government, and in 1909 it was connected by railway with Shanghai, and became the southern terminus of the Tientsin-P'u-k'ou railway.

The nationalist government moved the capital of China to Nanking in 1928 and Nanking remained the legal capital when the government moved to the wartime capital of Chungking after the Japanese invasion. After 1928 Nanking developed rapidly and a number of new buildings such as a modern railway station and several ministries were built by the government and broad boulevards were constructed. Modern airfields and shipping facilities increased the importance of Nanking as a communication centre. Outside the city the famous Sun Yat-sen mausoleum was erected in memory of the founder of the Chinese republic. In Nov. 1937 Nanking fell to the Japanese troops. The "rape of Nanking" which followed was fully authenticated by many neutral witnesses. From 1940 to 1945 Nanking was the seat of the puppet government of Wang Ching-mei. Following the defeat of Japan, the Nationalist government officially returned to Nanking, May 5, 1946, after an absence of eight years.

The Communists seized Nanking in April 1949, and on Oct. 1, 1949, they proclaimed the People's Republic of China with its capital at Peking. Although Nanking ceased to be the national capital, it became the administrative seat of Kiangsu in 1952, when the provincial capital was moved from Chen-chiang to Nanking.

Traditional industries of Nanking included satin, cotton (nankeen cloth), porcelain, paper and ink. Modern industries are concentrated in the riverside suburb of Hsia-kuan (Siakwan) and especially in the left-bank suburb of P'u-k'ou (Pukow), terminus of the trunk railroad to Tientsin. P'u-k'ou has a chemical fertilizer plant and a tractor factory. (T. SD.)

NAN-NING, capital city of the Kwangsi Chuang Autonomous Region, south China and 330 mi. west of Canton. Pop. (1953) 194,600. Nan-ning is situated about 30 mi. below the junction of the Li Chiang or Tso Chiang and the Yu Chiang, which form the Yü Chiang, the main southern branch of the Hsi Chiang. The city is served by the Hunan-Kwangsi railroad, which connects the Chinese rail system with North Vietnam.

Nan-ning was opened voluntarily to foreign trade by China in 1907 to offset French influence at Lung-ching (Lungtsin), the former Lungchow, a treaty port near the North Vietnam frontier. Nan-ning is the highest accessible point for steam junks on the Hsi Chiang, except during the low-water season in winter when navigation is seriously affected above Wuchow (Wu-chou). Nanning consists of an old walled city on the left bank of the Yü Chiang and the former foreign commercial settlement just south of the walled town. During the Chinese-Japanese War, the city was temporarily occupied in 1940 by the Japanese.

After the Communist take over in 1949, the city regained the status of provincial capital, which had been briefly shifted to Kuei-lin (Kweilin), and resumed its historic name of Nan-ning, after having been known officially as Yung-ning from 1913 to the end of World War II.

Nan-ning's traditional orientation toward Canton by the natural route of the Hsi Chiang was sharply altered in 1951 with the coming of the railroad. This line connected Nan-ning with central China and with North Vietnam. During the Indochina hostilities, ending in 1954, Nan-ning was a base of support for the Communist forces of North Vietnam against the French. Nanning's trade was further reoriented in 1955, when a newly completed railroad opened a direct outlet from Kwangsi to the South China sea at the port of Chan-chiang (Tsamkong).

Nan-ning is the centre of a fertile subtropical agricultural area, whose principal products are aniseed, sugar cane and fruits. It has a flour mill and a meat-packing plant. With the recognition of the cultural identity of the Chuang-language minority (of the Thai ethnic group), Nan-ning became the cultural centre of the Chuang people and, in 1958, the capital of the Kwangsi Chuang Autonomous Region, which replaced Kwangsi province.

(T. SD.)

NANNYBERRY (*Viburnum* lentago), a handsome North American shrub or small tree of the honeysuckle family (Caprifoliaceae), called also black haw, sheepberry, wild raisin and sweet viburnum, sometimes planted for ornament. It is native to rich soil from Quebec to Hudson bay and southward to New Jersey, Georgia and Colorado. The nannyberry, though usually a shrub, sometimes grows 30 ft. high, with a trunk diameter of 10 inches. It has slender branches, ovate: long-pointed, finely-toothed leaves and bears small white flowers in showy clusters, two to five inches broad. The oval, bluish-black, sweet, edible fruit ripens in late autumn.

NANSEN, FRIDTJOF (1861–1930), Norwegian explorer, scientist, artist, statesman and humanitarian, awarded the 1922 Nobel peace prize, was born at Frøen on the outskirts of Christiania on Oct. 10, 1861. He went to school in Christiania where, in 1880, he passed his entrance examination to the university without particular distinction. He chose to study zoology, because field work would give him the chance of living an outdoor life, and also enable him to make use of his artistic talents. Although his scientific work was always closest to his heart, he first attained fame as an explorer. His activities were interwoven, but a picture of his life is best given by describing them separately.

As Explorer.— As a young man Nansen was a great outdoor athlete, an accomplished skater and skier, and a keen hunter and fisherman. He thus developed an excellent physique which gave him the stamina and endurance he needed on his later arctic journeys. He first encountered arctic conditions in 1882 when he joined the sealing ship "Viking" for a voyage to the Greenland waters. On this voyage he saw at a distance Greenland's mighty icecap which fired his imagination. It occurred to him that it ought to be possible to cross it, and gradually he developed a plan which he announced in 1887. The plan was characteristic of Nansen. Instead of starting from the inhabited west coast he would start from the east coast, and by cutting off his means of retreat would force himself to go forward. The expedition of six left Norway in May 1888. In Iceland the group joined a sealing ship bound for east Greenland waters, and after various difficulties the crossing started on Aug. 16. Facing storms and enduring intense cold and other hardships they reached the highest point of the journey (8,920 ft.) on Sept. 5, and on the 26th struck the west coast at Ameralik fiord. They were forced to winter at the settlement of Godthaab, where Kansen took the opportunity to study the Eskimos and gather material for his book on *Eskimo Life* (Eng. trans., London. 1893). The party returned home in triumph in May 1889.

In 1890 Nansen presented a plan for an even more hazardous expedition before the Norwegian Geographic society, and in 1892 he laid it before the Royal Geographical society in London. He had collected evidence showing that the ice of the Polar sea drifted from Siberia toward Spitsbergen, and proposed to build a ship of such a shape that it should be lifted but not crushed when caught by the ice. He would let the ship freeze in off eastern Siberia, in order to be carried from there by the currents. His plan was severely criticized by contemporary arctic explorers; however, the Norwegian parliament granted two-thirds of the estimated expenses, and the rest was raised by subscriptions from King Oscar II and private individuals. His ship "Fram" (*i.e.,* "Forward"; now preserved outside Oslo) was built according to his ideas. With a complement of 13 men, the "Fram" sailed from Christiania on June 24, 1893. On Sept. 22 she was enclosed by the ice in 78° 50′ N., 133° 37′ E.; she froze in, and the long drift began. She bore the pressure of the ice perfectly. On March 14, 1895. Nansen, being satisfied that the "Fram" would continue to drift safely, left her in 84° 4' N., 102° E.. and started northward with dog sleds and kayaks. accompacied by Hjalmar Johansen. On April 8 they turned back from 86° 14′ N., the highest latitude then reached by man, and headed toward Franz Josef Land. When approaching the northern islands progress was hampered by open water and, because of the advanced season, they wintered on Frederick Jackson Land (named by Nansen after the British arctic explorer) where they stayed from Aug. 26, 1895, to May 19, 1896. They built a hut of stone, and covered it with a roof of walrus hides, and lived during the winter mainly on polar bear and walrus meat, using the blubber as fuel. In spring, when traveling to Spitsbergen. they encountered Frederick Jackson and his party of the Jackson-Harmsworth expedition, on June 17, and returned to Norway in his ship "Windward," reaching Vardo on Aug. 13. The "Fram" also reached Norway safely, having drifted north to 85° 55'. Nansen and his companions on board the "Fram" were given a rousing welcome which culminated on arrival in Christiania on Sept. 9.

As **Scientist.**—Nansen's success as an explorer was mainly due to his careful evaluation of the difficulties that might be encountered, his clear reasoning, which was never influenced by the opinions of others, his willingness to accept a calculated risk. his thorough planning and his meticulous attention to detail. Many of these traits can be recognized in his scientific writings. In 1882 he was appointed curator of zoology at the Bergen museum. He wrote papers on zoological and histological subjects, illustrated by excellent drawings. For one of his papers. "The Structure and Combination of Histological Elements of the Central Nervous System" (Bergen, 1887), the Christiania university conferred upon him the degree of doctor of philosophy. This paper contained so many novel interpretations that the committee which had to examine it accepted it with doubt, but it is now considered a classical paper in its field. On his return from the "Fram" expedition in 1896 a professorship in zoology was established for him at the Christiania university, but his interests shifted from zoology to physical oceanography, and in 1908 his status was changed to professor of oceanography. During 1896–1917 he devoted most of his time and energy to scientific work. He edited the report of the scientific results of his expedition and himself worked up some of the most important parts. He participated in the establishment of the International Council for the Exploration of the Sea and directed for some time the council's central laboratory in Christiania. In 1900 he joined the "Michael Sars" on a cruise in the Korwegian sea. In 1910 he made a cruise in the "Fridtjof" through the northeastern North Atlantic; in 1912 he visited the Spitsbergen waters on board his own yacht "Veslemoy," and in 1914 he joined B. Helland-Hansen on an oceanographic cruise to the Azores in the "Xrmauer Hansen." In 1913 Nansen traveled through the Barents sea and the Kara sea to the mouth of the Yenisei river and back through Siberia. He published the results of his cruises in numerous papers. partly in co-operation with Helland-Hansen. His lasting contributions to the science of oceanographp comprise improvement and design of instruments, some of which were still in use after half a century, explanation of the wind-driven currents of the seas, discussions of the waters of the Arctic and explanation of the manner in which deep- and bottom-water is formed. He also dealt with other subjects, and published in 1911 *In Northern Mists* (2 vol.), giving a critical review of the exploration of the northern regions from early times up to the beginning of the 16th century. Nansen's papers are ail stimulating, but they are not easy reading. He wrote so fluently that he was likely to be verbose and his great attention to detai! made his presentation cumbersome. His great literary talent is, on the other hand, evident in his popular accounts of his journeys, many of which he himself illustrated.

As Statesman and **Humanitarian.**—As Nansen grew older, he became more and more interested in the relations between individuals and nations. In 1905 he took a lively part in the discussion about the dissolution of the union between Norway and Sweden. His attitude may be summarized by his words: "Any union in which the one people is restrained in exercising its freedom is and will remain a danger." On 'the establishment of the Norwegian monarchy. Nansen was appointed its first minister in London (1906–08) and was in the same year created knight of the Grand Cross of the Victorian Order. In 1917 he was appointed head of a Norwegian commission to the United States, and secured a satisfactory agreement with the U.S. government about the import into Norway of essential supplies.

At the first assembly of the League of Nations in 1920 the Norwegian delegation was headed by Nansen who remained one of the outstanding members of the assembly until his death. With his tall and bony frame, his snow-white hair, his flowing mustache, and his broad-brimmed hat at a rakish angle, he made a striking figure in Geneva.

In 1920 the League of Nations gave Nansen his first great task, appointing him high commissioner, responsible for the repatriation of about 500,000 prisoners of war. However, the Soviet leaders would not recognize the League of Nations, but were willing to co-operate with an organization headed by Nansen as a private person. As a result the Nansen Relief organization was created, financed mainly by the International Red Cross and the national Red Cross organizations. In Sept. 1921 Nansen was able to inform the League that 447,604 prisoners of war from 26 countries had been repatriated, and less than a year later he reported that the task was completed. About that time the identification card for displaced persons, the "Nansen passport," was introduced.

In Aug. 1921 he was asked by the International Red Cross to direct an effort to bring relief to famine-stricken Russia. He accepted, and on Aug. 15 a conference at which 13 governments and 48 Red Cross organizations were represented appointed him high commissioner of this new venture. His request to the League for financial assistance was turned down, but by appealing to private organizations, and himself addressing large public meetings, he succeeded in raising the necessary funds. This effort was followed by similar ones for Greece and Armenia, and Nansen never tired in his struggle to reduce suffering and misery.

In 1922 Nansen was awarded the Nobel peace prize, which he gave to the furtherance of international relief work. Another distinction which he cherished equally came to him when the student body of St. Andrews university elected him rector in 1926. In his address at his installation in 1927 he spoke on "Adventure," explaining to the students some of his own philosophy of life.

Between his numerous journeys he found recreation by returning to his scientific problems, by perfecting his technique when preparing etchings, and on short hunting or fishing trips. He died at his home near Oslo on May 13, 1930, and was buried on May 17, Norway's national holiday.

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NANSEN INTERNATIONAL OFFICE FOR REFUGEES. The Office International Nansen pour les Réfugiés was founded in 1931 as an autonomous body under the League of Nations to carry on the work started in 1921 by Fritdjof Nansen (*q.v.*). At the end of World War I there were more than 2,000,000 refugees in Europe and Asia Minor. Of these, approximately 1,250,000 were political refugees from Russia, several hundred thousand were Armenians expelled from Asia Minor and another substantial number was composed of Greeks who fled into Greece as a result of political circumstances in Asia Minor and the Balkans, where their ancestors had been living for several centuries. The remainder were Assyrians, Assyrian Chaldeans, Bulgars and Turks.

The League of Nations accepted responsibility for the legal protection of these refugees, and in 1921 Nansen. well-known polar explorer, became the hrst League of Nations high commissioner for refugees. Nansen's work resulted in the development of the international identity certificate known as the "Nansen passport" and he did much of the pioneer work in civil rights and employment and social security rights for refugees.

In 1935 the League brought under the protection of the office the 7,000 refugees who leit the Saar as a result of the 1935 plebiscite. Administrative funds were voted by the assembly of the League on a diminishing scale until Dec. 31, 1938, the date set for final liquidation of the office. The League had always considered its interest in refugees to be of a temporary nature and, although it accepted responsibility for their legal protection, it wished to avoid responsibility for their relief.

Nansen's objective had been to make refugees self-supporting. However, the depression of the 1930s made the task of finding employment opportunities for refugees unusually difficult. National governments also wished to avoid relief grants to refugees unable to work, and the depression reduced the funds of private charitable organizations.

Despite these handicaps the Kansen office carried forward its work. In order that the legal protection of refugees might be assured after the closing of the office, the League provided, through the medium of the convention of Oct. 28, 1933, for the issuance of Nansen identity certificates by the governments signing the convention and for rights of residence, employment, social security and relief for Russians, Armenians and assimilated refugees then under the protection of the Nansen office.

Unfortunately this 1933 convention was ratified by only eight states and in some cases with important reservations. It served as a model, however, in drawing up the 1938 convention concerning the status of refugees coming from Germany, and became important after World War II when once again the world was faced with the problem of stateless persons.

The 1938 Nobel peace prize was awarded to the Nansen office. At the close of the office in Dec. 1938, M. Michael Hansson of Norway, president of the Nansen office, reported 600.000 refugees of the foregoing groups still unsettled and without secure civil status. Their situation was worsened as they became part of the larger numbers of refugees displaced by World War II. (*See* also REFUGEES.)

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NANTERRE, a suburb 8 mi. northwest of Notre Dame de Paris, with a port on the Seine, in the *département* of Seine, at the foot of Mount Valérien, 8 mi. N.W. of Paris on the railway to St. Germain. Pop. (1954) 52.832. The principal manufactures are chemicals, tallow and aluminum; stone is quarried in the vicinity; the town is noted also for its cakes. Nanterre (the ancient *Nemptodurum* or *Nemetodurum*) owes its origin to the shrine of Ste. Geneviève (420–512), the patron saint of Paris.

NANTES, a city of western France, capital of the *département* of Loire-Atlantique, on the Loire, 35 mi. above its mouth, at the junction of the Orléans, Ouest-état and State railways, 55 mi. W.S.W. of Angers by rail. In population (1954, 197,915), Nantes is the first city of Brittany. The Loire there divides into several west branches forming islands over portions of which the city has spread.

History.— Before the Roman occupation Nantes was the chief town of the Namnetes and consisted of *Condovicnum,* lying on the hills away from the river, and of *Portus Namnetum,* on the river. Under the Romans it became a great commercial and administrative centre, though its two parts did not coalesce till the 3rd or 4th century. In the middle of the 3rd century Christianity was introduced by St. Clair. Clotaire I got possession of the city in 560, and placed it under the government of St. Félix, the bishop who caused the Loire to flow under the walls of the castle, After being several times subdued by Charlemagne. Brittany revolted under his successors, and Nominoé, proclaimed king in 842, razed the fortifications of Nantes because it had sided with Charles the Bald. The Normans held the town from 843 to 936. About this time began the rivalry between Nantes and Rennes, whose counts disputed the sovereignty of Brittany. Pierre de Dreux. declared duke of Brittany by Philip Augustus, made Nantes his capital, surrounded it with fortifications and deiended it against John of England. During the Breton wars of succession Nantes took part first with Jean de Montfort, but afterward with Charles of Blois, and did not open its gates to Montfort till his success was assured and his English allies had retired. In 1560 Francis II granted Kantes a communal constitution. Averse to Protestantism. it joined the league along with the duke of Mercoeur, governor of Brittany. who helped to raise the country into an independent duchy; and it was not till 1598 that it opened its gates to Henry IV, who there signed on May 2 the Edict of Nantes which until its revocation by Louis XIV in 1685 was the charter of Huguenot liberties in France. The city was in 1793 the scene of the *noyades* of J. B. Carrier, envoy of the Committee of Public Safety.

The Port.— The maritime port of Kantes is reached by way of the Loire and the ship canal between the island of Carnet and La Martinière ($9\frac{1}{2}$ mi.). Vessels drawing as much as 20 ft. 8 in., and at spring tides, 22 ft., can reach the port. The outer port stretches ½ mi. to Chantenay. The principal quays extend along the right bank of the branch which flows past the town and on the western shore of the island of Gloriette. A slipway facilitates the repairing of ships.

The river port occupies the St. Félix and Madeleine branches and on the Erdre is a third port for inland navigation. The older quarter of Nantes is situated to the east of the Erdre.

Buildings. — The cathedral, built above a 12th-century crypt. was unfinished till the 19th century. There are two interesting monuments in the transept: Michel Colomb's tomb of Francis II, duke of Brittany, and his second wife Marguerite de Foix (1507), and that of Gen. Juchault de Lamoricière, a native of Nantes, by Paul Duhois (1879). Between the cathedral and the Loire stands the castle of Nantes, founded in the 9th or 10th century. Rebuilt by Francis II and the Duchess Anne, it is flanked by huge towers and by a bastion erected by Philip Emmanuel, duke of Mercoeur, in the time of the league. A fine Gothic façade looks into the courtyard. From being the residence of the dukes of Brittany, the castle became a state prison and is now occupied as the artillery headquarters. The chapel in which the marriage of Louis XII with Anne of Brittany was celebrated was destroyed in 1800.

Nantes has an archaeological collection in the Dobrée museum. and in the museum of fine arts a splendid collection of paintings, modern French masters being well represented.

Industries. — Among the more important industries of Nantes are sugar-refining. rice-husking. the manufacture of oil, soap, flour pastes and biscuits, chocolate and the preparation of tinned provisions (sardines. vegetables. etc.) ; the manufacture of tin boxes, tiles, chemical manures, acid, leather, paper. rope. boots and shoes, brushes, porcelain and glass; shipbuilding. metal founding and the construction of engineering material; and wool and cotton-spinning and the manufacture of cotton and other fabrics. rubber goods, hosiery and knitted goods. Coal and petroleum. sugar, coffee, cottonseed, copra, hemp, grain. phosphates and pyrites, timber and pulpwood are imported. Principal exports are machinery, pit props. iron ore, slate, hoops and provisions.

NANTES, EDICT OF, the law promulgated in April 1598 by the French king, Henry IV, which secured a large measure of religious liberty to his Protestant subjects, the Huguenots. Its main provisions may be summarized as follows: (1) It gave liberty of conscience to the Protestants throughout the whole of France. (2) It gave them the right of holding public worship in those places where they had held it in 1576 and the earlier part of 1577; also in places nhere this freedom had been granted by the edict of Poitiers (1577) and the treaties of Nerac (1579) and of Fleix (1580). The Protestants could also worship in two towns in each *bailliage* and *sénéchaussée*. The greater nobles could hold Protestant services in their houses: the lesser nobles could do the same, but only for gatherings of not more than 30 people. In regard to Paris. the Protestants could conduct worship within five leagues of the city instead of ten leagues as previously. (3) Full civil rights mere granted them. They could trade freely, inherit property and enter the universities, colleges and schools. All official positions were open to them. (4) To deal with disputes arising out of the edict, a chamber was established in the parliament of Paris *(le chambre de l'e'dit).* This group was to be composed of ten Roman Catholic and six Protestant members. Chambers for the same purpose, but consisting of Protestants and Roman Catholics in equal numbers, were established in connection with the provincial parliaments. (5) The Protestant pastors were to be paid by the state and to be freed from certain burdens, their position being made practically equal to that of the Roman Catholic clergy. (6) A hundred places of safety were given to the Protestants for eight years, the expenses of garrisoning them being undertaken by the king.

The edict was greatly disliked by the Roman Catholic clergy, and a few changes were made to conciliate them. The parliament of Paris shared this dislike, but was forced by the king to register the edict on Feb. 25, 1599. After similar trouble it was also registered by the provincial parliaments, the last being the parliament of Rouen, which delayed the registration until 1609.

That the strong political position thus secured to the French Protestants was a danger to the state was proved by the troubles which arose during the minority of Louis XIII. After Richelieu had succeeded in crushing th'e quasi-independent power of the Huguenot lords and cities, however, the French Protestants ceased to be a political danger.

With the revocation of the Edict of Nantes, on Oct. 18, 1685, the French Protestants were deprived of all civil and religious liberty.

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NANTEUIL, ROBERT (1623/30–1678), French line engraver, was born in Reims. the son of a merchant. Having received an excellent classical education, he studied engraving under his brother-in-law, Nicholas Regnesson. He became known by his crayon portraits, and was pensioned by Louis XIV and appointed designer and engraver of the cabinet to that monarch. It was mainly because of his influence that the king granted the edict of 1660, by which engraving was pronounced free and distinct from the mechanical arts, and its practitioners were declared entitled to the privileges of other artists. Nanteuil died at Paris on Dec. 9, 1678.

The plates of Nanteuil, several of them almost life-size, number about 300. In his early practice he imitated the technique of his predecessors, working with straight lines, strengthened, but not crossed. in the shadows, in the style of Claude Mellan, and in other prints crosshatching like Regnesson, or stippling in the manner of Jean Boulanger. He then gradually acquired an individual style, modeling the faces of his portraits with the utmost precision and completeness, and employing various methods of touch for the draperies and other parts of his plates. Among the finest of his mature works are the portraits of Pomponne de Bellièvre, Gilles Ménage, Jean Loret, the duc de la Meilleraye and the duchess of Nemours.

NANTICOKE, a city of Pennsylvania, U.S., on the Susquehanna river 7 mi S.W. of Wilkes-Barre in Luzerne county. Main industries are coal mining and the manufacture of cigars, clothing silk and rayon yarn and thread and sportswear.

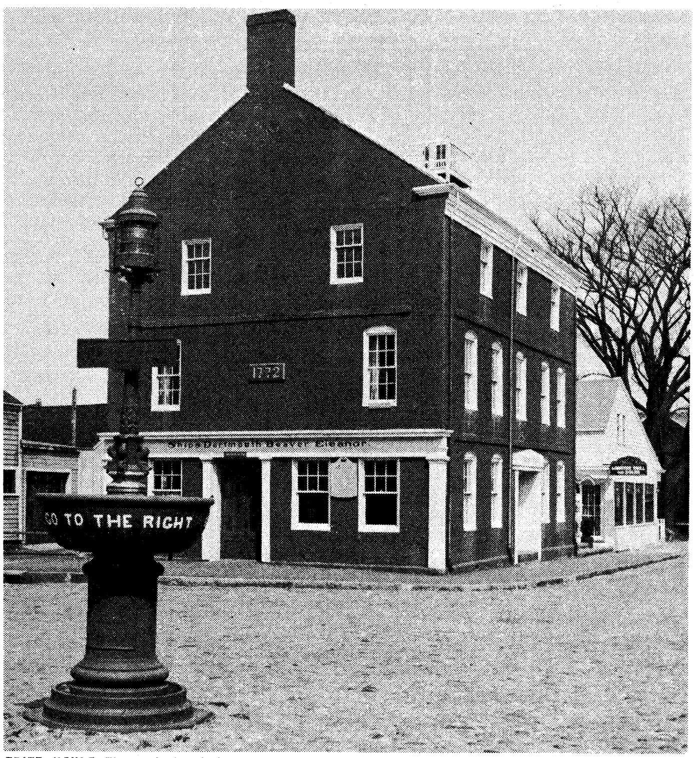
Anthracite coal mining was long the economic mainstay and is still important, but the steady decline of the industry caused serious dislocations, chronic unemployment, and a steady loss in population. For comparative population figures see table in Pennsylvania: *Population.*

The city is named after a shad-fishing Indian village on the uest side of Nanticoke creek. The town nas laid out in 1793 and the first anthracite coal was mined by Col. Washington Lee in 1825. The North Branch canal and the Susquehanna river were important for the transportation of coal before the building of the railroads.

Nanticoke was incorporated as a borough in 1874 and secured a charter as a city in 1926. (L. A. Gr.)

NANTUCKET, a large island off the coast of Massachusetts U.S., about 25 mi. S.E. of Cape Cod. Once the centre of the whaling industry, Nantucket has turned to the tourist and recreation industries for support. The island is nearly 1 j mi. long and averages 3 mi. in width. The land is quite level nith a few low hills, the whole being a terminal moraine of a continental ice sheet The ever-eroding sea has created 88 mi. of sandy beaches around the island. The encircling ocean also modifies the climate markedly, with warmer winters and cooler summers than the adjacent mainland

Nantucket was discovered by Bartholomew Gosnold in 1602, granted to the Plymouth company in 1621. and purchased by Thomas Mayhew in 1641. Agriculture mas never too successful and the settlers quickly turned to fishing, shipbuilding and trading. Whaling began in earnest in the early 18th century and reached its peak just before the American Revolution, when 125 whalers sailed out of Santucket's commodious harbour. British raids during the Revolution, the blockade of the War of 1812 and the general attrition of Nantucket's vessels at sea sapped the commercial strength of the island. although by as late as 1830 it was the third commercial port of Massachusetts. New Bedford had surpassed Nantucket as a whaling centre by 1820 and the development of



FRITZ HENLE FROM MONKMEYER

THE PACIFIC CLUB. NANTUCKET ISLAND. MASS. THE BUILDING WAS THE HOME OFFICE OF THE OWNER OF THE "DARTMOUTH," "BEAVER" AND "ELEANOR." SHIPS THAT WERE RAIDED IN THE BOSTON TEA PARTY (1773). IN 1861 IT BECAME A CLUB FOR WHALING MASTERS. THE UPPER FLOORS NOW SERVE AS COURTROOMS

kerosene destroyed the sperm oil industry by 1860. The population of the island shrank from 6.094 in 1860 to a low of 2,797 in 1920. Attempts were made to introduce some manufacturing after the Civil War but none of them prospered. Gradually, as transportation with the mainland improved, first by boat and later by airplane, the island developed a lively tourist industry nhich brought many visitors and considerable revenue. The population is about 3.000.

The village of Nantucket itself is one of the main attractions with its quaint colonial houses, cobblestoned streets. museums (including a well-known whaling museum) and art galleries. Summer finds the island and its many beaches crowded with vacationers from all over the United States. Santucket is also the name of the county. coextensive with the island; it comes from an Indian word meaning "the faraway land." (G. K. L.)

NANTWICH, a market tonn and urban district in the Nantwich parliamentary division of Cheshire, Eng., 20 mi. S.E. of Chester. Pop. (1951) 8.843. Area 1.8 sq mi. It lies on the Weaver river and is a centre for dairy farming and hunting. The Church of St. Mary is a cruciform building in red sandstone, of the Decorated and Perpendicular periods, with a central octagonal tower. The fine old carved stalls are said to have belonged to Vale Royal abbey, near Winsford. The town is modern in appearance, but 128 older buildings (16th- and 17th-century, many of them half-timbered) have been scheduled for preservation. Churche's mansion. a fine Elizabethan building, has been excellently restored. The grammar school (*c.* 1560) is now coeducational. The salt industry, important in the time of Henry VIII, has lapsed, but there are now brine baths. Nantwich manufacturers clothing, boots and shoes; there is also a tannery and a corn mill.

Remains found in the district indicate a Roman settlement probably because of the salt. The Domesday Book contains a long account of the laws, customs and values of the saltworks. The salting houses were divided betneen the king, the earl of Chester and certain resident freemen. The name of the town appears variously as *Wich* or "town" in Domesday Book and as *Nametwihc* "named" or famous "wich" in 1194. The only town charter was granted by Elizabeth I (1568).

NAOMI (Hebrew, "pleasant"; also NOEMI in Douay version), mother-in-law of Ruth in the Old Testament Book of Ruth. She was the nife of Elimelech of Bethlehem and the mother of Mahlon and Chilion. During a famine in Bethlehem, the family went to the country of Moab. After the death of both her husband and her two sons, Naomi returned with her daughter-in-law, Ruth, to Bethlehem in Judah. Ruth was a native of Moab, but she was devoted to her mother-in-law and insisted on remaining with her. As a result of her misfortunes. Naomi was not recognized readily when she returned to Bethlehem. Whereupon she said, "Call me not Naomi. call me Mara [bitterness] ; for the Almighty hath dealt very bitterly with me." During the harvest, Ruth went to work in the fields of Boaz, a wealthy kinsman of Saomi. After Ruth and Boaz met, Naomi advised and encouraged Ruth to remarry, nhich she soon did. Naomi later became the nurse for Obed, the son who was born to Ruth and Boaz. See RUTH, BOOK OF.

NAOROJI, DADABHAI (1825–1917), Indian politician, was born at Kasik on Sept. 4, 1825, the son of a Parsi priest. During a long and active life, he was prominent in various fields: professor of mathematics at the Elphinstone college (1854); founder of the *Rast* Goftar newspaper; partner in a Parsi business firm in London (1855) ; prime minister of Baroda (1874) ; member of the Bombay legislative council (1885) ; M.P. for Central Finsbury (1892–95), being the first Indian to be elected to the house of commons; and three times president of the Indian National congress. Many of his numerous nritings mere collected in Poverty *and Un-British* Rule *in* India (1901).

NAPALM, the aluminum soap of naphthenic and palmitic acids. When mixed with gasoline it forms a sticky sirup ranging in colour from light tan to brown.

In World War I both Germany and the Allies used raw gasoline in flame throwers (*q.v.*), but it burned too quickly to be fully effective. What was needed was a thickener that would slow donn the rate of burning and increase the range of the weapon. Napalm did this, and it also greatly raised the temperature at which the fuel burned. Harvard university scientists. in cooperation with the U.S. army chemical warfare service, developed the substance in 1942. *See* also CHEMICAL WARFARE.

In World War II. allied forces used great quantities of napalm-thickened gasoline in flame throners and fire bombs. After the U.S. marines had employed the flame thrower effectively against Japanese bunkers on Guadalcanal, the meapon became popular with army troops.

Napalm was also used in incendiary bombs that the air forces rained on Japanese industrial cities. By the end of the war these bombs had burned out 40% of the area of the target cities. During the Korean war (1950–53) napalm was again fired from flame throners, and was poured into 165-gal. fire bombs that were dropped with devastating effect on enemy troops.

See E. W. Hollingsworth, "The Use of Thickened Gasoline in Warfare," *Armed Forces Chemical Journal,* June *1951.* (L. P. B.)

NAPATA, the capital of the ancient kingdom of Cush in Nubia (*q.v.*) from about 750 B.C. to 590 B.C., was situated just donnstream of the fourth cataract of the Sile, near the modern Karima in Sorthern province in the Republic of the Sudan. It was an area rather than a single tonn. extending east and south of Karima from Nuri to Kurru. Its main feature is the hill of Barkal, under which lie the ruins of several temples; for it mas regarded as a holy mountain, the throne of the god Amon, possibly from as early as the New Kingdom (see EGYPT: History). A stele of Thutmose III (1504–1450 B.C.) mentioning a fort was found there, and Amenhotep II (1450–1425 B.C.) sent an Asian prisoner to be hanged on its walls. When about 950 B.C. the Libyans seized power in Egypt, a body of the priests of Amon at Thebes went into voluntary exile at Napata. They appear to have egyptianized the native princes of Cush and to have inspired them to enter a degenerate Egypt about 750 B.C. as reformers. Thus Kashta and his descendants came to constitute the 25th dynasty of Egypt, restoring to a great extent the ancient customs and beliefs which had been abandoned under the New Kingdom. This led to their introducing into Cush the custom of royal burial under pyramids. All their pyramids are at Kurru except the largest, that of King Taharka (688–663 B.C.) which is at Nuri. Taharka also built several Egyptian-style temples at Napata and elsewhere, including perhaps a large copy at Barkal of the temple of Rameses II at Abu Simbel in Nubia. He clashed, however, with the Assyrians in Judaea and was expelled from Egypt. For some time the rulers of Cush thought of reconquering Egypt, but the 26th (Saitej dynasty, originally protégés of the Assyrians, sent an expedition with Greek and Carian mercenaries which sacked Napata in 590 B.C. and caused the transfer of the capital to Meroë (*q.v.*) on the opposite bank; until 315 B.C., however, kings were buried at Nuri, Napata being the religious capital. Royal burials at Barkal on two different occasions even after that have given rise to the hypothesis that Napata may have twice made itself independent of Meroë.

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NAPHTALI was, according to Gen. xxx, 8, a son of Jacob by Rachel's handmaid Bilhah, and full brother of Dan. This may be no more than a reflection of the fact that geographically the tribes of Dan and Naphtali are closely associated. Not only did the land of Naphtali in northern Palestine border on that of Dan. but there is in Deut. xxxiii, 23, an indication that Naphtali dwelled near to Dan in the older seat of the latter tribe in the southwest. The story of the conflict against Sisera, Judg. iv, *et* seq., associates Zebulon closely with Naphtali, and informs us that from Kadesh, the old Amorite city which was the chief place in Naphtali's territory, came the hero Barak.

Naphtali, because of its exposed situation, suffered at the hands of Syria (I Kings xv, 20); it was depopulated by Tiglath-Pileser (II Kings xv, 29). The reference to Naphtali in the blessing of Jacob, Gen. xlix, 21, is obscure and of uncertain interpretation. (W. L. W.)

NAPHTHA, a word originally applied to the more volatile kinds of petroleum, issuing from the ground in the Baku district of the U.S.S.R. and in Iran.

It is mentioned by Dioscorides, and is the naphtha, or bitumen *liquidum candidum,* of Pliny the Elder in the 1st century A.D. By the alchemists, the word was used principally to distinguish various mobile liquids of low boiling point including certain ethers and esters.

The term is now seldom used, either in commerce or in science, without a distinctive prefix, as in the following:

1. Coal-tar naphtha, a volatile commercial product, is obtained by the distillation of coal tar. (See COAL TAR.)
2. Shale naphtha is obtained by distillation from the oil produced by the destructive distillation of bituminous shale.
3. Petroleum naphtha is a name sometimes given in the United States to a portion of the more volatile hydrocarbons distilled from petroleum.

See PETROLEUM: SHALE. OIL.

NAPHTHALENE, a hydrocarbon formed when many organic compounds are passed as vapours through a red-hot tube. This accounts for its presence in coal tar (*q.v.*), from the distillates of which it was first isolated by A. Garden in 1819, and also for its formation in modern processes for the high temperature catalytic cracking of petroleum.

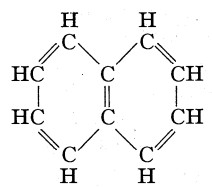
Naphthalene is the most abundant single constituent of coal tar. being present to the extent of about 5%. The amount depends on the type of coal used and increases with rising temperature of carbonization. Naphthalene may be carried with the coal gas through the various purifying chambers and deposited in the service pipes to such an extent as to cause partial blockage. For the technical production of naphthalene the appropriate coal tar distillate, boiling point 170° C. to 230° C., known as middle oil or carbolic oil, is strongly cooled, whereupon the naphthalene crystallizes and may be pressed free from most of the adhering oil. For purification, it is treated with hot caustic soda to remove acidic phenols and then, in the molten state, with a little concentrated sulfuric acid to remove bases and other impurities; it is finally distilled or sublimed.

Properties and Uses.—Pure naphthalene crystallizes in lustrous white plates, melting at 80.1° C. and boiling at 218° C. It is almost insoluble in water, sparingly soluble in cold alcohol and in petroleum spirit, but is readily soluble in ether and in hot alcohol. It is characterized by its volatility, and it readily sublimes. It forms with picric acid a stable crystalline molecular compound, melting point 151° C., the formation of which may be used for the characterization and quantitative estimation of naphthalene. The hydrocarbon has a characteristic odour; as "carbon balls" or moth balls, it was formerly used as a moth repellent but was replaced for this purpose by more efficient insecticides such as paradichlorobenzene, DDT and Gammexane (benzene hexachloride). Naphthalene has toxic properties, and when administered to rabbits produces a form of cataract, or opalescence of the lenses of the eye.

The products obtained by chemical oxidation of naphthalene vary considerably with the conditions and type of oxidizing agent. Chromic acid in acetic acid gives mainly 1:4-naphthoquinone, whereas potassium permanganate in alkaline solution gives phthalonic acid. In acid solution phthalic acid is the chief product, and this is also formed by oxidation with potassium dichromate and sulfuric acid. Phthalic acid was formerly manufactured by oxidizing naphthalene with hot concentrated sulfuric acid in the presence of mercuric sulfate. This process has been superseded by vapour-phase catalytic oxidation with air, using a vanadium pentoxide catalyst; the phthalic acid which is formed is dehydrated to phthalic anhydride, which sublimes into a condenser.

Naphthalene is extensively used as a raw material for the manufacture of dyestuffs and synthetic resins. Phthalic anhydride may be converted into anthranilic acid, an intermediate in the manufacture of indigo; into triphenylmethane dyes; and into anthraquinone and its derivatives. which form the starting material for the preparation of fast vat dyes such as Indanthrene and Flavanthrene. Phthalic anhydride is also much used for the production of alkyd resins and glyptals in which it is combined with polyhydric alcohols such as glycerol (see RESINS). Naphthalene gives rise to a host of substitution products which are important components in the manufacture of azo dyes. These intermediates are principally naphthalene derivatives which contain hydroxyl, amino and sulfonic acid groups in various combinations.

Constitution.—The composition of naphthalene was determined by Michael Faraday in 1826. Its molecular formula, $C_{10}H_8$, shows that at least two carbon atoms have no hydrogen atoms attached to them and in 1866 E. Erlenmeyer, Sr., proposed the structural formula I, based on F. A. Kekulé's structure for benzene. It is usually written in the contracted form II.



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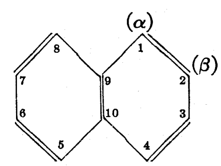
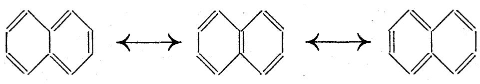


II

The oxidation of naphthalene to phthalic acid indicates the presence of one benzene ring. C. Graebe, in 1868–69, obtained from naphthalene a series of degradation products which showed conclusively the presence of two distinct benzene rings. All subsequent work has confirmed the carbon skeleton shown in Erlenmeyer's formula (I). Corresponding with the two Kekulé structures for benzene there are three possible arrangements of the double bonds in naphthalene:



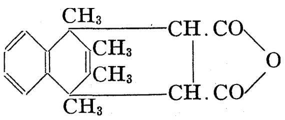
IIa II IIb

The modern view regards naphthalene as a resonance hybrid of which these three are the unexcited forms. L. Pauling and G W. Wheland recognized 42 canonical structures. Positions 1,4,5 and 8 are equivalent to one another (α), and positions 2,3,6 and 7 form a second set of equivalent positions (β), so that if a single substituent is introduced into the molecule there are two possible isomers.

The equivalence of the four α positions was proved experimentally by A. Atterberg. Positions 9 and 10 are devoid of hydrogen and cannot be substituted, although this becomes a possibility in fully reduced naphthalene (decahydronaphthalene).

In their chemical reactions some naphthalene derivatives behave as if they had exclusively the Erlenmeyer structure (II) 2-Naphthol, for example. couples with diazo compounds always in position 1, even with displacement of another substituent. and never in the second *ortho* position, 3. But the specificity of such reactions does not necessarily imply bond fixation and can be interpreted on the basis of quantum mechanical calculations which give a figure of 1.725 for the bond order of the 1:2-bond and 1.603 for the 2:3-bond in naphthalene. These differences are reflected in the small but definite differences in bond length shown in the exact X-ray crystallographic measurements by J. M. Robertson and his collaborators.

By contrast with benzene, which has six π electrons for its ring. naphthalene has only ten π electrons for two rings. Hence if one ring assumes the stable electronic configuration of a fully aromatic structure, the other has the character of an unsaturated side chain linked in two contiguous positions. In this way one can interpret the fact that naphthalene forms addition compounds with much greater facility than benzene. It readily forms a tetrahydride and a tetrachloride and also reacts by addition with alkali metals. It even gives an adduct with maleic anhydride in a Diels-Alder reaction, albeit in small yield. This reaction is much facilitated by alkyl substitution. and 1:2:3:4-tetramethylnaphthalene reacts smoothly to give the anhydride (III) in high yield. Substitution reactions also take place more readily with naphthalene than with benzene.



III

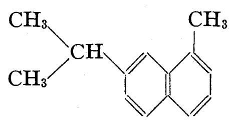
For disubstituted naphthalenes there are 10 possible isomers if the substituents are the same and 14 if they are different. With 3 identical substituents the number of isomers is again 14. but if they are all different 84 isomers are possible.

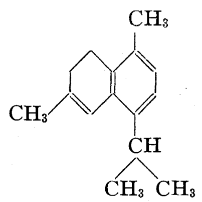
Chemical Reactions.— In its chemical behaviour naphthalene shows the aromatic character associated with benzene and its simple derivatives. Its reactions are mainly reactions of substitution, and naphthalene may be readily chlorinated, brominated, nitrated and sulfonated, and it will undergo the Friedel-Crafts reaction. In reactions such as nitration and halogenation, the substituent mainly enters the more reactive α-positions, although chlorination and bromination lead to a certain extent to β-substitution. Reversible reactions subject to steric hindrance lead to substitution in the less hindered β-positions to an extent which increases with increase in reaction temperature, but varies with the nature of the reagent and sometimes with the solvent. In the sulfonation of naphthalene the α-sulfonic acid is formed at low temperatures (below the melting point of naphthalene) whereas the β-sulfonic acid is formed at high temperatures (optimum temperature, 160° C. to 170° C.). By heating with sulfuric acid, the α-acid is converted into the β-acid.

NAPHTHALENE DERIVATIVES

Homologues.—Many of the alkyl derivatives of naphthalene have played an important part in the elucidation of the molecular structures of naturally occurring sesquiterpenes, triterpenes and related compounds. They are also present in coal tar. The simplest two are α- and β-methylnaphthalenes, both of which are coal tar constituents. E. A. Coulson described a process by which they may be isolated by fractional distillation of a suitable tar oil fraction, using a column having a rectifying efficiency corresponding with about 100 theoretical plates. α-Methylnaphthalene is a liquid, boiling point 240° C., and β-methylnaphthalene is a low-melting crystalline solid. Eight of the ten possible dimethylnaphthalenes have been isolated from coal tar and two of them (1:6 and 2:6) from Rumanian petroleum. The best known of these are the 1:6-, 2:3-, 2:6- and 2:7-dimethylnaphthalenes. The 1:6-compound is a liquid; the other three are solids which crystallize in colourless glistening plates. Of the trimethylnaphthalenes, the 2:3:6-, 1:3:7-and 2:3:5- compounds have been isolated from coal tar, and the 1:2:5-, 1:2:7- and 2:3:6- compounds from a Trinidad petroleum distillate. From the high-boiling fractions of aromatic hydrocarbons obtained by high temperature catalytic cracking of petroleum there have been isolated α- and β-methylnaphthalenes; 1:2-, 1:6-, 1:7-, and 2:6-dimethylnaphthalenes; and 1:2:5- and 1:2:6-trimethylnaphthalenes.

The sesquiterpenes are hydrocarbons of the formula $C_{15}H_{24}$, which occur in the essential oils of certain plants. Some of them are hydronaphthalene derivatives; among these are cadinene, which is present in oil of cubebs, and selinene. present in celery seed oil. Closely related to the latter is eudesmol, $C_{15}H_{26}O$, an alcohol which occurs in eucalyptus oil, and cyperone, an unsaturated ketone which is a constituent of oil of *Cyperus rotundus*. Selinene, eudesmol and cyperone (after reduction) may be converted by dehydrogenation with sulfur or selenium into eudalene, or 1-methyl-7-isopropylnaphthalene (IV). Cadinene under similar conditions gives cadalene or 1:6-dimethyl-4-isopropylnaphthalene (V). The structures of these two naphthalene hydrocarbons have been established by synthesis.



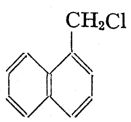


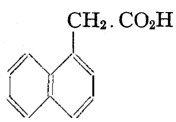
IV V

The pentacyclic triterpenes undergo extensive degradation under the conditions of selenium dehydrogenation. Typical naphthalene derivatives which are formed by this procedure are 2:7-dimethylnaphthalene, 1:2:5-trimethylnaphthalene (agathalene), 1:2:7-trimethylnaphthalene (sapotalene), 6-hydroxy-1:2:5-trimethylnaphthalene and 1:2:5.6-tetramethylnaphthalene. (See also TERPENES.)

To assist the identification of the naphthalene hydrocarbons formed by the dehydrogenation of terpenes, all of the 14 theoretically possible trimethylnaphthalenes have been synthesized as well as all 10 possible dimethylnaphthalenes. Naphthalene homologues may be synthesized either by introducing alkyl groups into simpler naphthalene derivatives or by building up the second ring from a side chain attached to a suitable benzene derivative.

The chloromethylation reaction may be used for the preparation of other types of naphthalene derivatives. Thus, naphthalene itself gives the 1-chloromethyl compound (VI), which may be reduced to α-methylnaphthalene or reacted with potassium cyanide to give a nitrile; this is hydrolyzed to α-naphthylacetic acid (VII), a substance which has found extensive use as a plant-growth sub-





VI VII

stance. It stimulates root formation in a manner similar to the natural plant growth hormone, heteroauxin, or indolyl-3-acetic acid.

Naphthylamines and **Naphthols.**—A very wide range of naphthalene derivatives of these two types with their sulfonic acids is manufactured for use in the dyestuffs industry, being used mainly as components for azo dyes (see DYES). When their potentialities for this purpose were first recognized, their chemistry was very imperfectly understood. hlanufacturing processes in many cases gave rise to mixtures which were difficult to separate, and of which the constituents were poorly characterized and the orientation of their substituents only partly determined. In establishing the chemistry of these derivatives of naphthalene on a firm basis, inestimable service was rendered by the classical researches of H. E. Xrmstrong and W. P. Wynne, who prepared all of the theoretically possible mono-, di- and trichloronaphthalenes (26 in all), established their orientations with absolute certainty and provided a series of reference compounds to which the many naphthalene-, naphthylamine- and naphtholsulfonic acids could be related. P. T. Cleve observed, in 1876, that when a naphthalenesulfonyl chloride was distilled with phosphorus pentachloride it was converted into the corresponding chloronaphthalene, and that β-naphthol when treated in the same way gave β-chloronaphthalene. Xrmstrong and Wynne used this as a diagnostic method and showed that bromo- and nitro- substituents were also displaced by chlorine when the compounds containing them were distilled with phosphorus pentachloride.

Amino groups could be displaced by chlorine by T. Sandmeyer's method, or replaced by hydrogen through the diazo reaction. By such reactions a naphthalene derivative of unknown structure could be converted into a chlorinated naphthalene of known orientation, from which the positions of substituents in the original compound could be deduced.

The preparation of naphthalene derivatives for use as dyestuffs intermediates involves either nitration or sulfonation of naphthalene as the first stage. Nitration leads to a-nitronaphthalene, which crystallizes in yellow needles: melting point 57.8° C.

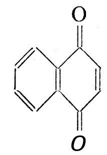
α-Naphthylamine is obtained from α-nitronaphthalene by reduction with iron turnings and water acidulated with hydrochloric acid. After complete reduction, the acid is neutralized and the basic or-naphthylamine is obtained by distillation with superheated steam. It may also be purified by distillation under reduced pressure. It crystallizes in colourless leaflets, melting point 49.2° C. On exposure to air it rapidly acquires a grayish-violet colour and has a somewhat disagreeable odour.

As stated earlier: the position of entry of a sulfonic acid group into the naphthalene molecule is determined by the conditions used. It is very difficult to obtain the pure sulfonic acid by direct sulfonation of naphthalene with sulfuric acid on account of the ease with which it is converted into naphthalene-β-sulfonic acid. The latter acid is, however, readily obtained by sulfonation at high temperatures and is an important intermediate. By fusion of the sodium salt with caustic soda, β-naphthol is formed. and this operation is one of the most important processes in the organic chemical industry. β-Xaphthol crystailizes in colourless plates which melt at 122° C. Its methyl ether, nerolin, has a fragrant odour and is used in perfumery.

β-Xaphthylamine is another important naphthalene derivative prepared from β-naphthol. The hydroxyl group is replaced by an amino group by means of the Bucherer reaction. whereby β-naphthol is heated in an autoclave at 150° C. and 6 atm. pressure with an ammonium sulfite solution prepared by saturating concentrated ammonia solution with sulfur dioxide and then adding an equal volume of concentrated ammonia solution. β-Xaphthylamine crystallizes from alcohol in colourless lustrous scales of melting point 110° C. Unlike the α-isomeride it is odourless when pure. β-Xaphthylamine is probably the agent responsible for causing the bladder cancers to which workers in the dyestuffs industry are sometimes liable. Because of this its manufacture has been largely discontinued in Great Britain. It has been shown experimentally that such bladder tumours can be produced in dogs by administration of β-naphthylamine.

Carboxylic Acids.—Many naphthalenecarboxylic acids have been described, but with few exceptions are of little importance. They have the usual properties of acids of the aromatic series. Naphthalene-1:8-dicarboxylic acid: naphthalic acid, is obtained by oxidation of the coal tar hydrocarbon, acenaphthene. In a similar manner, naphthalene-1:4:5:8-tetracarboxylic acid is formed by oxidative degradation of two of the rings of the tetracyclic hydrocarbon, pyrene (*q.v.*).

Naphthoquinones.—Six different naphthoquinones, $C_{10}H_6O_2$, are theoretically possible, but the only ones which have been prc pared are the 1:4- or α- (1'111), the 1:2- or β- (IX) and the 2:(or *amphi* (X) naphthoquinones. 1:4-Naphthoquinone (VII may be obtained by oxidation of naphthalene with chromic acid acetic acid. but is better prepared by oxidation of 4-amino-1- naphthol. It crystallizes in yellow tablets, melting point 125° C., is volatile in steam and has a characteristic pungent smell. 1:2-



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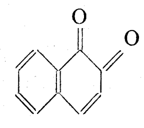

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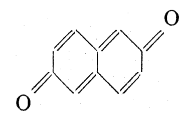
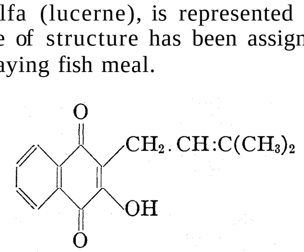


X

Naphthoquinone, formed by oxidation of 1-amino-2-naphthol, forms golden-yellow needles which decompose at 145° C. to 147° C., and is odourless and nonvolatile. It is somewhat unstable, although more stable derivatives are known; *e.g.*, 3:7-dimethyl-1:2-naphthoquinone. 2:6-Naphthoquinone, also nonvolatile and odourless, forms reddish-yellow crystals. These quinones have the high reactivity associated with quinones of the benzene series, and undergo many reactions of addition. An important example, in the case of the 1:4-quinone. is the Diels-Alder addition of dienes, which furnishes a simple route from the naphthalene series to the anthracene series.

Many derivatives of 1:4-naphthoquinone have been found to occur in nature as pigments. An early known example is juglone, 5-hydroxy-1:4-naphthoquinone, which occurs as the colourless leuco compound in unripe walnut shells. Closely related to this is plumbagin, or 5-hydroxy-2-methyl-1:4-naphthoquinone, a yellow pigment found in roots of *Plumbago* species. It has long been known as the active principle of the medicinal drug, Chita, obtained from this source. Lawsone, extracted from the leaves of henna (*Lawsonia inermis*), is 2-hydroxy-1:4-naphthoquinone. Phthiocol, or 2-hydroxy-3-methyl-1:4-naphthoquinone, has been isolated from human tubercle bacilli, but it has been suggested that it may be formed during isolation by degradation of vitamin K. Structurally related to phthiocol is lapachol, a pigment occurring in the grain of a number of African woods (*Bignoniaceae*). Lapachol has been shown to have the structure shown in XI. Introduction of a hydroxyl group into one of the methyl groups of XI gives the structure of lomatiol, the yellow pigment surrounding the nucleus in seeds of Australian *Lomatia*. Vitamin K_1, the antihemorrhagic factor isolated from hexane extracts of dried alfalfa (lucerne), is represented by the formula XII. The same type of structure has been assigned to vitamin K_2, isolated from decaying fish meal.



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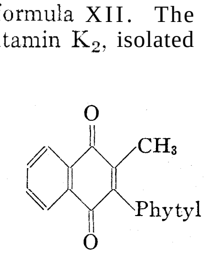
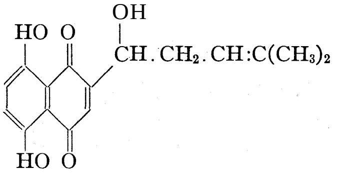
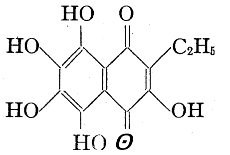


XII

Another group of natural naphthoquinone pigments is derived from naphthazarin (5:8-dihydroxy-1:4-naphthoquinone), long known as a synthetic dyestuff. To this group belongs alkannin, a brown-red pigment occurring as the angelic ester in the root of *Alkanna tinctoria*. It is optically active (laevorotatory), and its enantiomorph is shikonin, isolated from *Lithospermum erythror-*

hizon. These two pigments have the structure XIII. Hydroxydroaerone, which occurs with droserone in *Drosera whittakeri,* a plant growing in the Adelaide district of Australia, is also a naphthazarin derivative (3:5:8-trihydroxy-2-methyl-1:4-naphthoquinone).


XIII


XIV

In many ways the most remarkable of all these substances is echinochrome A, one of several related pigments which have been isolated from sea urchin eggs. It functions as a chemotactic principle and is secreted by the egg to the surrounding sea water to induce motility in spermatozoa with which it comes in contact. It still shows biological activity in dilutions of 1.2×10^9. It is a completely substituted naphthalene derivative of the structure XIV, or a tautomer. *See* also Index references under "Naphthalene" in the Index volume.

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NAPIER, SIR CHARLES (1786–1860), British admiral, second son of the Hon. Charles Napier. R.N., and grandson of the 5th Lord Napier, was born at Merchiston hall, near Falkirk, on March 6, 1786. He became a midshipman in 1800 and lieutenant in 1805. He was appointed to the "Courageux" (74). serving with her in the West Indies, and later was appointed commander of the "Pultusk" brig (Nov. 30, 1807). In Aug. 1808 he was moved into the "Recruit," and in April 1809 took part in the capture of the "Hautpoult" and was promoted acting post captain. Coming home with a convoy. he was put on half pay and spent some time at the University of Edinburgh, and later visited Portugal. He served in 1811 in the Mediterranean and in 1813 on the coast of America. He spent his leisure in Italy and Paris, but was ruined by speculation in a steamboat company. In 1827 he was appointed to the "Galatea," was at the Azores when they were held by the count de Villa Flor for the queen of Portugal, and accepted the offer of the constitutional leaders to take command of the fleet (Feb. 1833). With it he destroyed the Miguelite fleet on July 5, and was struck off the English navy list. He commanded the Portuguese land forces in the defense of Lisbon (1834) and was made Count Cape St. Vincent in the peerage of Portugal.

Napier then returned to England, was restored to his former rank in 1836, and received the command of the "Powerful" in 1838.

In 1840 he was made knight commander of the Bath for his services as second in command in Syria. He was member of parliament for Marylebone from 1842 to 1846. He was promoted rear-admiral in 1846 and commanded the channel fleet from 1846 to 1848.

In the Crimean War he received the command of the Baltic fleet, and hoisted his flag in February 1854. He refused to attack Cronstadt, and a great outcry was raised against him for not obeying the orders of the Admiralty. He was not again offered a command.

He was member of parliament for Southwark from Feb. 1855 until his death on Nov. 6, 1860.

See Major-General E. Napier's *Life and Correspoadence of Admiral Sir Charles Napier, K.C.B.,* 2 vol. (1862); Napier's own *War in Syria,* 2 vol. (1842); *The Navy: its past and present state in a series of letters,* edited by Sir W. F. P. Napier (1851); and *The History of the Baltic Campaign of 1854, from documents and other materials furnished by Vice-Admiral Sir C. Napier, K.C.B.* (1857). *See* also *The Life and Exploits of Comwzodore Napier* (1841); and *Life of Vice-Admiral Sir C. Napier* (1854).

NAPIER, SIR CHARLES JAMES (1782–1853), British soldier and statesman, was born in London, the eldest son of Col. George Napier (a son of the jth Lord Napier) and Lady Sarah Lennox, on Aug. 10, 1782. He was lieutenant in 1800 and captain in the staff corps under Sir John Moore. He became major in 1806 and served in the Danish campaign (1807) and in Portugal, but was badly wounded at Coa and Busaco. He took part in the pursuit of Masséna and became lieutenant colonel (1811) of the 102nd regiment, which he thoroughly reorganized. At Bermuda in 1813 he served against the Cnited States, but returned in 1815 and was made companion of the Bath. From 1822 to 1830 he was military resident of Cephalonia, where he met Lord Byron, and was recommended as commander in chief of the Greek forces. Napier declined, and, after trouble with Sir Frederick Xdams, the high commissioner, he became commanding officer in the north of England during the Chartist riots (1839), although his sympathies were on the popular side.

He accepted an Indian commission in 1841, and in Sept. 1842 was ordered to Sind.

His command in Sind lasted until Aug. 1847. He at once determined to seek the first opportunity of conquering the amirs. He was to be accompanied by James Outram (*q.v.*) who had been British resident in Sind during the Afghan War. On Feb. 1j, 1843, Outram was treacherously assailed at Hyderabad, and on the 17th Napier attacked the Baluch army 30,000 strong, with but 2,800 men. With these 2,800 men, including the 22nd regiment, he won the brilliant and decisive victory of Miani, one of the most amazing in the history of the British army, in which generals had to fight like privates. In March he finally destroyed the army of the amirs at the battle of Hyderabad, and for this service received the knight commander of the Bath. Sind, when it came under British rule, was in a state of anarchy, for the Baluchis had formed a tyrannical military government. The native population was protected by Sir Charles Napier. The difficulties of administration were increased by the necessity of repressing the hill tribes, encouraged to lawless acts by the licence which followed the Afghan War; the later years were made very stormy by attacks in England on the policy of the conquest. Napier left Sind in Aug. 1847 after quarreling with nearly every authority in India.

His short stay in England was occupied with incessant struggles with the directors of the East India company, but the panic in England which followed the news of the indecisive victory of Chillianwalla obliged the company to summon the greatest general of the day to command its armies.

Napier left for India at once, only to find that the victory of Gujrat had been won and the Sikh War was over. He was on good terms with the governor general, Lord Dalhousie, until, in Dalhousie's absence at sea, Napier took upon himself. in face of a threat of mutiny, to alter the regulations regarding allowances to native troops. On Dalhousie's return he reprimanded the commander in chief, and reversed his decision. Napier immediately resigned, and, when Wellington repeated the reprimand. he returned to England.

He died at Portsmouth on Aug. 29, 1853. A bronze statue of him by G. G. Adams was erected in Trafalgar square, London, by public subscription.

Napier also wrote several books on Indian government and the colonial administration of India. These works include *Memoir on the Roads of Cephalonia* (1825); *The Colonies, tveating of their value generally and of the Ionian Islands in particular; Strictures on the Administration of Sir F. Adam* (1833); *Colonization, particularly in Southern Australia* (1835); *Remarks on Military Law and the Punishment of Flogging* (1837); *A Dialogue on the Poor Laws* (1838?); *A Letter on the Defence of England by Corps of Volunteers and Militia* (1852); *Lights and Shadows of Military Life* (trans. from the French, 1840); and *A Letter to the Right Honourable Sir J. C. Hobhouse on the Baggage of the Indian Army* (1849); *Defects, Civil and Military, of the Indian Government* (18j3); *William the Conqueror, a Historical Romance,* edited by Sir W. Napier (1858).

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(1845); *The Administration of Scinde* (1851); *Compilation of General Orders issued by Sir C. Napier* (1850); and Outram, *The Conquest of Scinde, a Commentary* (1846). For his command-in-chief, and the controversy about his resignation, consult J. Mawson, *Records of the Indian Command of General Sir C. J. Napier* (1851); *Minutes on the Resignation of the late General Sir C. Napier, by Field-Marshal the Duke of Wellington*, etc. (1854); *Comments by Sir W. Napier on a Memorandum of the Duke of Wellington* (1854); Sir William Napicr, *General Sir C. Napier and the Directors of the East India Company* (1857); Sir W Lee Warner, *Life of Lord Dalhousie* (1904).

NAPIER (NEPER), **JOHN** (1550–1617), eighth laird of Merchiston, and a distinguished Scottish mathematician who was the inventor of logarithms, was born at Merchiston castle, near Edinburgh, in 1550. At the age of 13, he entered the University of St. Andrews, where he came under the care of the remarkable John Rutherford. His stay at St. Andrews appears to have been short, for he left without taking a degree.

Little is known of his early life, but it is thought that he traveled abroad, as was the custom with the sons of the Scottish nobility. What is certain is that he was back home in 1571, and he stayed either at Merchiston or at Gartness for the rest of his life. The following year, he married Elizabeth, daughter of Sir James Stirling. She died in 1579, leaving him a son and a daughter.

A few years later, he married Agnes, daughter of Sir James Chisholm, and she survived him. From this second marriage there were five sons and five daughters. Napier died at Merchiston on April 4, 1617.

Napier's life was spent amid bitter religious dissensions. He was a passionate and uncompromising Protestant, and in his dealings with the Church of Rome he sought no quarter and gave none. It was well known that James VI of Scotland hoped to succeed Elizabeth I to the English throne, and it was suspected that the help of Philip II of Spain had been sought to achieve this end. Panic-stricken at the peril which seemed to be impending, the general assembly of the Scottish Church, a body with which Napier was closely associated, begged the king to deal effectively with the enemies of the church, and on three occasions Napier was a member of a committee appointed to make representations to the king concerning its well-being, and to urge him to see that "justice be done against the enemies of God's Church."

In Jan. 1594, Napier addressed to the king a letter that forms the dedication of his great work: *A Plaine Discouery of the Whole Reuelation of Saint John.* "Let it be your Majesty's continuall study" he there declared, "to reforme the universall enormities of your country, and first to begin at your Majesty's owne house, familie and Court. and purge the same of all suspicion of Papists and Atheists and Newtrals, whereof the Revelation foretelleth that the number shall greatly increase in these latter daies." This work occupies a prominent place in Scottish ecclesiastical history, for it is the earliest Scottish work on the interpretation of the scriptures.

Follo ing the publication of this work, Napier seems to have occupied himself with the invention of secret instruments of war, for in the Bacon collection at Lambeth palace, London, there is a document bearing his signature, enumerating various inventions "designed by the Grace of God, and the worke of expert craftsmen" for the defense of his country. These inventions included two kinds of burning mirrors, a piece of artillery and a metal chariot from which shot could be discharged through small holes.

Napier devoted most of his leisure to the study of mathematics, particularly to devising methods of facilitating computation, and it is with the greatest of these, namely logarithms, that his name is associated

His contributions to this powerful mathematical invention are contained in two treatises: *Mirifici Logarithmorum Canonis Descriptio*, which nas published in 1614 (Eng. trans., 1857), and *Mirifici Logarzthmorum Canonis Constructio*, which did not appear until 1620, three years after his death (Eng. trans, 1889). In the former. he outlined the steps which led to his invention, these being briefly as follows:

Consider two particles P and Q, the former of which moves along a line segment AZ of finite length, the latter along a line A'Z' whose length is indefinite. Both particles start with the same velocity. but while Q retains this velocity unchanged. that of P alters in such a way that at any point in its path, say B, the velocity is proportional to the distance it still has to go; *i.e.*, BZ. If, when P is at B, Q is at B', then A'B' is defined as the logarithm of BZ. Thus, Napier was able to establish a correspondence between an arithmetical and a geometrical progression, which, it should be noted, is at the root of the modern conception of logarithms. It is clear, however, that the modern conception of logarithms as exponents was quite unknown to Napier. For the development of common logarithms from those of Napier and the part played by Henry Briggs (*q.v.*) in this development, *see* LOGARITHMS: *Invention of Common Logarithms.*

In trying to simplify computation, Napier may well have been led to his invention by a consideration of such a relation as $2\sin A \sin B = \cos(A-B) - \cos(A+B)$, in which the product of two trigonometrical functions can be expressed as the sum (or difference) of two others. The *Descriptio*, besides giving an account of the nature of logarithms, contains a table of natural sines and their logarithms for every minute of the quadrant, to seven figures. These are not what are now called Naperian, *i.e.*, hyperbolic, logarithms, though they are related to them. In this work, Napier confined himself to an account of the use to which logarithms might be put. He promised to explain the method of their construction in a later work. This was the *Constructio*, which also claims attention because of the systematic use in its pages of the decimal point to separate the fractional from the integral part of a number. Decimal fractions had already been introduced by Simon Stevin (*q.v.*) in 1585, but his notation was clumsy. The use of a point as separatrix occurs frequently in the *Constructio.*

Although Napier's invention of logarithms overshadows all his other mathematical work, he has other mathematical contributions to his credit. In 1617, he published his *Rabdologiae, seu Numerationis per Virgulas Libri duo* (Eng. trans., 1667); in this he described ingenious methods of performing the fundamental operations of multiplication and division by means of "rods" or "bones." He also made important contributions to spherical trigonometry, and by his rules of circular parts he was able to resolve all cases of right-angled spherical triangles.

He is also credited with certain trigonometrical relations—Napier's analogies—but it seems likely that Briggs had a share in these.

See C. G. Knott (ed.), *Napier Tercentenary Memorial Volume* (1915). (J. F. ST.)

NAPIER, SIR WILLIAM FRANCIS PATRICK (1785–1860), British soldier and one of his country's most celebrated military historians, was born at Celbridge, near Dublin, on Dec. 17, 1785, a younger brother of Sir Charles James Napier (*q.v.*). He became an ensign in the Royal Irish artillery in 1800, but transferred to the 62nd regiment, and in 1802 was put on half pay. He later became a cornet in the Blues, but soon transferred to the 52nd. Through Sir John Moore he secured a company in the 43rd and joined that regiment at Shorncliffe. He served in Denmark and later in Spain, distinguishing himself during the Corunna campaign.

In 1809 he became aide-de-camp to the duke of Richmond. lord lieutenant of Ireland, but joined the 43rd in the summer when that regiment was ordered to Portugal. (*See* PENINSULAR WAR.) At the skirmish on the Coa river (1810) he was wounded; and in 1811 at Casal Novo, he was shot near the spine. After he left the lines of Torres Vedras he became brigade major, was present at Fuentes de Ofioro, but illness forced his return to England. He later returned to Spain and was present at the storming of Badajoz (1812). He took command of the 43rd regiment (he was now a substantive major) and commanded it at the battle of Salamanca (July 23, 1812). At the battle of the Nivelle (Nov. 10, 1813) he secured the most strongly fortified part of Marshal Soult's position, practically without orders, He served with his regiment at the battle of the Nive, where he was wounded, and at the battles of Orthez and Toulouse. For his services he mas made brevet lieutenant colonel and one of the first companions of the Bath. He then entered the military college at Farnham. He commanded his regiment in the invasion of France after the battle of Waterloo, and remained in France with the army of occupation until 1819, when he retired on half pay.

He studied art but later his major contribution was to be in literature. In 1823 Henry Bickersteth (afterward Lord Langdale) suggested his writing a history of the Peninsular War. The duke of Wellington gave him the whole of Joseph Bonaparte's correspondence which had been taken at the battle of Vittoria. In 1828 the first volume of the *History of the War in the Peninsula and in the South of France* appeared. The publisher, John Murray, was disappointed in the sale of the first volume and Napier published the remainder himself. But the excitement which followed the appearance of each volume is proved by the innumerable pamphlets issued by those who believed themselves to be attacked, and by personal altercations between Napier and many distinguished officers. When in 1840 the sixth and last volume of the *History* was published, his fame was safely established.

In 1830 he had been promoted to colonel, and in 1842 he was made a major general and given the lieutenant governorship of Guernsey. There he managed the relations between the soldiers and the inhabitants, and worked out proposals for a compiete scheme of reform in the government of the island.

In 1845 he published *The Conquest of Scinde,* and in 1851 the corresponding *History of Sir Charles Napier's Administration of Scinde.* In 1847 he resigned his governorship. and in 1848 was made a knight commander of the Bath, and settled at Scinde house, Clapham park. In 1851 he was promoted lieutenant general. His time was occupied in defending his brother Charles and in revising the numerous editions of his *History of the War in the Peninsula.* His energy is the more astonishing when it is remembered that he never recovered from the effects of the wound he received at Casal Novo, and that he often had to lie on his back for months. His life of Charles appeared in 1857. Sir William died on Feb. 12, 1860. Four months earlier he had been promoted to the full rank of general.

See H. A. Bruce (Lord Aberdare), *Life of Sir William Napier,* 2 vol. (London, 1864).

NAPIER AND ETTRICK, FRANCIS NAPIER, Baron (1819–1898), British diplomatist, descended from the ancient Scottish family of Napier of Merchistoun, was born on Sept. 15, 1819, the son of William John, ninth Lord Napier. He entered the diplomatic service in 1840, and held successive posts at Vienna, Constantinople, Naples, Washington and The Hague. In 1860 he became ambassador at St. Petersburg, and in 1864 at Berlin. In 1866 he was appointed governor of Madras, and was at once confronted with a serious famine in the northern districts. In dealing with this and other problems he showed great activity and practical sense, and he encouraged public works, particularly irrigation. In 1872 he acted for a few months as Viceroy, after Lord Mayo's assassination; and on Lord Northbrook's appointment to the office he returned to England, being created a baron of the United Kingdom (Baron Ettrick of Ettrick) for his services. He was for a time a member of the London School Board, and was chairman of the Crofters' Commission in 1883, the result of which was the appointment of a permanent body to deal with questions affecting the Scottish crofters and cottars. He died at Florence on Dec. 19, 1898.

NAPIER OF MAGDAEA, ROBERT CORNELIS NAPIER, 1st Baron (1810–1890), British field-marshal, son of Major Charles Frederick Napier, was born at Colombo, Ceylon, on Dec. 6, 1810. He entered the Bengal Engineers from Addiscombe College in 1826, and after the usual course of instruction at Chatham, arrived in India in November 1828. For some years he was employed in the irrigation branch of the public works department, and in 1838 he laid out the new hill station at Darjeeling. Promoted captain in January 1841, he was appointed to Sirhind, where he laid out cantonments on a new principle—known as the Napier system—for the troops returning from Afghanistan. In December 1845 he joined the army of the Sutlej, and commanded the Engineers at the battle of Mudki, where he had a horse shot under him. At the battle of Ferozeshah on Dec. 21 he again had his horse shot under him and, joining the 31st regiment on foot, was severely wounded in storming the entrenched Sikh camp. He was present at the battle of Sobraon on Feb. 10, 1846, and in the advance to Lahore. He was chief engineer at the reduction of Kote-Kangra by Brigadier General Wheeler in May 1846 and received the thanks of the government. He was then appointed consulting engineer to the Punjab resident and council of regency, but was again called to the field to direct the siege of Multan. He was wounded in the attack on the entrenched position in Sept. 1848, but was present at the action of Surjkund, the capture of the suburbs, the successful storm of Multan on Jan. 23, 1849, and the surrender of the fort of Chiniot. He then joined Lord Gough, took part, as commanding engineer of the right wing, in the battle of Gujrat in Feb. 1849, accompanied Sir W. R. Gilbert in his pursuit of the Sikhs and Afghans and was present at the passage of the Jhelum, the surrender of the Sikh army and the surprise of Attock. At the close of the war Napier was appointed civil engineer to the board of administration of the annexed Punjab province and carried out many important public works. He commanded a column in the first Hazara expedition in Dec. 1852 and against the Boris in the following year. He was appointed military secretary and adjutant general to Sir James Outram's force for the relief of Lucknow in the Indian mutiny in 1857 and was engaged in the actions which culminated in the first relief of Lucknow. He directed the defense of Lucknow until the second relief, when he was severely wounded in crossing an open space with Outram and Havelock to meet Colin Campbell. He was chief of the staff to Outram in the defense of the Alambagh position and drew up the plan of operations for the attack on Lucknow, which was approved by Campbell and carried out by Napier. as brigadier general commanding the engineers, in March 1858. On the fall of Lucknow Napier was appointed C.B. He joined Sir Hugh Rose as second-in-command in his march on Gwalior, and commanded the 2nd brigade at the action of Morar on June 16. On the fall of Gwalior he was entrusted with the task of pursuing the enemy. With only 700 men he came up with Tantia Topi and 12,000 men on the plains of Jaora Alipur and completely defeated him, capturing all his guns (25), ammunition and baggage. On Rose's departure he took command of the Gwalior division, captured Paori in August, routed Ferozeshah, a prince of the house of Delhi, at Ranode in December, and in January 1859, succeeded in securing the surrender of Man Singh and Tantia Topi, which ended the war. For his services Napier received the thanks of parliament and of the Indian government, and was made K.C.B.

In January 1860 Napier was appointed to the command of the 2nd division of the expedition to China under Sir Hope Grant, and took part in the action of Sinho, the storm of the Peiho forts, and the entry to Peking. For the next four years Napier was military member of the council of the governor-general of India and, on the sudden death of Lord Elgin, for a short time acted as governor-general, until the arrival of Sir W. T. Denison from Madras. In January 1865 he was given the command of the Bombay army; in March 1867 he was promoted lieutenant-general, and, later in that year, appointed to command the expedition to Abyssinia, selecting his own troops and making all the preparations for the campaign. He arrived at Annesley Bay in the Red Sea in January 1868, reached Magdala, 420 m. from the coast, in April; stormed the stronghold, freed the captives, razed the place to the ground, returned to the coast, and on the 18th June the last man of the expedition had left Africa. He received for his services the thanks of parliament, a pension, a peerage, the G.C.B., the G.C.S.I., and many academic honors. He held the command-in-chief in India for six years from 1870, during which he did much to benefit the army. He was promoted general in 1874, and appointed a colonel-commandant of the royal engineers. In 1876 he was the guest of the German cronn prince at the military manoeuvres; and from that year until 1883 he held the government and command of Gibraltar. In the critical state of affairs in 1877 he was nominated commander in chief of the force which it was proposed to send to Constantinople. On Jan. 1, 1883, he was promoted to be field marshal. In Dec. 1886 he was appointed constable of the Tower of London. He died in London on Jan. 14, 1890.

See H. D. Sapier, *Field Marshal Lord Napier of Magdala* (London, 1927)

NAPIER, third largest exporting port in New Zealand, on the east coast of North Island, capital of the province of Hawke's Bay, 200 mi. N.E. of Wellington. Pop. (1956) 21.270 (27,507 urban). The town is situated on a peninsula known as Scinde Island

and by virtue of its sunny climate is a popular resort. It is the largest wool centre in New Zealand; the district is agricultural and is renowned for crossbred wools, frozen meats, fruit and canned products which are exported chiefly to Great Britain. The harbour caters for overseas and coastal vessels and is sheltered by a breakwater. The business area was rebuilt after its destruction by fire following a severe earthquake in 1931.

NAPLES (Ital. NAPOLI. Latin. *Neapolis*), the former capital of the kingdom of the Two Sicilies. and since 1860 the chief town of the province which bears its name. lies on the northern shore of the Bay of Naples, It. In 1901, with 547,503 inhabitants. it was the largest city in the country, but was later superseded by Milan. Pop. (1957 est.) 1,115,798 (commune).

The city of Naples is built at the base and on the slopes of a range of volcanic hills, and. rising from the shore like an amphitheatre, is best seen from the sea. To the west of Naples the coastline is broken and irregular and this part of the bay is divided by the promontory of Posilipo. which extends due south, into two small bays—the eastern. with the city of Naples. and the western, the sheltered Bay of Baiae. Silhouetted against the sky to the south of the plain is the cone of Mount Vesuvius. Naples is divided into two natural crescents by a transverse ridge running south from the summit of Vomero hill. which is occupied by the castle of Sant' Elmo, to the promontory of Pizzofalcone. The western crescent. though merely a long narrow strip between the sea and Vomero hill. is the fashionable quarter of Naples. A fine broad street, the Riviera di Chiaja. runs parallel with the coast for 1½ mi. to the foot of the hill of Posillipo. Begun at the close of the 16th century by Count d'Olivares, it was completed between 169j and 1 joo by the duke de Medina Celi. Between it and the sea lie the public gardens of the Villa Comunale. the chief promenade of the city; these gardens. which were first laid out in 1780, have been extended at various times since. The whole edge of the bay from the Castel dell' Ovo. on the island at the tip of the Pizzofalcone promontory. westward to the small port of Mergellina is lined by a massive embankment and carriageway, the Via Caracciolo, constructed in 187j–81. On the hill of Posillipo above Mergellina there are three grottoes, one of which is said to be the tomb of Virgil.

The oldest and by far the largest part of the city, however, lies in the crescent to the east of Pizzofalcone. The character of this shore has been much altered by nevi harbour works, which, with wharves and warehouses, have absorbed the Villa del Popolo ("people's park") originally laid out on land reclaimed from the bay. The western and eastern crescents, and with them the two halves of the city, have now been united by a connecting thoroughfare, on the seaward side of the Castelnuovo and the hill of Pizzofalcone, and also by a tunnel (the Galleria della Vittoria) cut under this hill.

During the middle ages the area of Naples was bounded by the walls built by the emperor Valentinianus (450–455) and the configuration of the ancient town has been preserved in the modern city with its network of roads, though little remains of the buildings of Greek and Roman times. The best-known thoroughfare is the historic Toledo (officially Via Roma). which runs almost due north from the Piazza del Plebiscito in front of the Palazzo Reale as far as the Museo Nazionale ("national museum"). North of Santa Teresa street the Toledo changes its name to Via Nuova di Capodimonte which runs through the Ponte della Sanità (built by the French) to the gates of the Capodimonte palace. This long street divides the city into two parts. Winding from west to east below the hills, the Corso Vittorio Emanuele (opened 1893) runs from the Mergellina railway station to the museum near which it becomes the Via Salvator Rosa.

On the small island of Isola del Salvatore (the Megaris of Pliny), now joined to the shore at the foot of the Pizzofalcone hill by a causeway, stands the Castel dell' Ovo ("egg castle"). In Roman times this castle was owned by Lucullus and was part of his famous villa. On the mainland to the east, by the breakwater guarding the harbour, stands the Castelnuovo ("new castle"). the royal palace originally built (1279–82) in the reign of Charles I. king of Naples and Sicily and count of Anjou, by French architects who also opened up new roads and built other castles and churches. It was the royal residence of the kings of the houses of Anjou and Aragon and was called Castelnuovo to distinguish it from the other royal castles. Castel Capuano and Castel dell' Ovo. It stands on the southeastern side of the Piazza del Municipio. It was rebuilt in 1442 by a Catalonian architect and on the northern side are three of its five massive circular towers between two of which is a triumphal arch (1470) commemorating the entry of Alphonso I into Naples (1442) after expelling the Xngevins. This arch is one of the best examples of medieval architecture in Naples.

On the waterfront south of the Castelnuovo and facing westward on to the Piazza del Plebiscito is the Palazzo Reale, which was built about 1600 by the architect Domenico Fontana on the orders of the Spanish viceroy. The palace was completely restored and enlarged after a serious fire in 1837. The national library, founded in 1734 by Charles de Bourbon, is housed in the palace and possesses over 1,300,000 volumes and many valuable incunabula and manuscripts.

Away from the harbour to the northeast is the Castel Capuano which was founded in the 12th century by William I of Sicily and completed by the emperor Frederick II in 1231. The castle was for a time a royal residence but now houses the courts of justice transferred there in 1540 by Don Pedro of Toledo. Because of its lofty position on the hill of Vomero, the rectangular mass of the Castel Sant' Elmo is perhaps the most impressive of Naples' castles. Standing on the site of an earlier fortress built by Robert the Wise: Sant' Elmo was erected early in the 14th century and enlarged during the 16th century.

A city of palaces and castles, Naples is also famous for its many churches. most of which lie between the Toledo and the Via del Duomo to the east. From this street a flight of steps leads up to the Cathedral of San Gennaro. Dating from the reign of Charles I, the cathedral was rebuilt by Alphonso I after an earthquake. and altered and restored as late as the 18th century. The three naves have Angevin Gothic vaulting but much of the cathedral's beauty is in its chapels. which are adorned with frescoes by Domenichino and others. In a silver tabernacle on the high altar of the chapel of San Gennaro (St. Januarius) are two phials partially filled n-ith the saint's blood. The liquefaction of the blood which takes place annually on the first Saturday of May and on Sept. 19 is the greatest of the city's religious festivals. The cathedral was built beside the ancient basilica of Santa Restituta, said to be on the site of a temple of Apollo, and containing the 5th-century baptistry of San Giovanni in Fonte. The dome is adorned with beautiful mosaics of Christ and the Virgin from the 7th century. North of the cathedral is San Giovanni a Carbonara. noted for its monument to Ring Ladislaus (1428) by Andrea Firenze.

To the east of the Toledo are many churches of medieval foundation. Santa Chiara was founded by King Robert the Wise, count of Anjou, and built between 1310 and 1328. The rococo decoration was completely destroyed and many of the beautifully sculpted Angevin tombs were damaged during World War II. San Domenico Maggiore (1 289) with its many chapels and altars, sculptures and frescoes, is one of the most impressive churches in Naples. St. Thomas Xquinas lived in the monastery adjoining the church when he was professor at the University of Naples (1272). Other churches in this quarter include: San Pietro a Majella, founded early in the 14th century by Giovanni Pipino di Barletta; San Lorenzo (13th century), a fine example of Gothic French architecture; San Filippo Neri (16th–17th century) with paintings by Guido Reni. Domenichino and Andrea da Salerno; the church of Sant' Angelo a Nilo with the tomb of Cardinal Brancaccio by Donatello and Michelozzo; Sant' Anna dei Lombardi, or Monte Oliveto, which contains some of the finest sculpture in the city by such artists as Antonio Rossellino, Benedetto da Maiano and Guido Mazzoni (especially fine is the Chapel of the Holy Sepulchre with the group of life-sized terra-cotta figures by hfazzoni standing in grief-stricken postures about the tomb of Christ). In the Incoronata church to the south, near the Castelnuovo. there are frescoes by an unknown artist, believed to be one of Giotto's pupils.

Naples is renowned for its museums. The most finely situated is San Martino on Vomero hill in the precincts of the fortifications of the castle of Sant' Elmo. Built originally as a Carthusian monastery, San Martino was begun in 1325 but was entirely rebuilt in the 17th century; its church has many fine paintings by Guido Reni, Caravaggio and others. The museum contains examples of Venetian glass, porcelain. silver and marble.

The chief museum, however, is the Museo Nazionale. It was built in 1586 as a barracks and in 1615 was ceded to the university; not until the late 18th century did it become a museum, when the art collections belonging to Charles III of Bourbon, which he inherited from his mother Elizabeth Farnese, were deposited there. It is now one of the finest museums in the world with its great collection of works of art from the ancient world, including masterpieces from the excavations at Herculaneum, Pompeii, Stabiae and Pozzuoli. These include bronzes, Pompeian frescoes and mosaic, terra cottas, ancient glass and gems and a large and valuable collection of Italo-Greek vases. The carved reliefs and marble statuary, which are spaciously exhibited. form perhaps the most impressive of the collections.

On a hill to the far north of the city is the palace of Capodimonte, the building of which was begun in the 18th century during the reign of Charles III, who also opened tapestry and porcelain works in the city. It was made into a museum in 1957 and a collection of delicate porcelain, in particular the Portici porcelain "cabinet," can be seen there, but its chief glory is the collection of pictures transferred from the Museo Nazionale. Among paintings of the Flemish and Italian schools are canvases by Brueghel, Giovanni Bellini, Correggio, Andrea del Sarto and Titian. The little-known 17th century Neapolitan school is well represented by paintings by Bernardo Cavallino and Mattia Preti.

The state archives, including those of the former kingdom of Naples, are kept in the Benedictine monastery in Vico San Severino e Sossio not far from the university; the notarial archives in Via San Paolo, a little to the north, contain all (about 800,000) the original notarial acts from 1450 onward. The Società di Storia Patria, established in 1875 to record and compile the history of the locality, has a good library also.

The San Carlo Opera house, capable of seating about 2,000 spectators, is one of the largest in Europe. It stands near the Palazzo Reale and was originally built in 1737 under Charles III, but was destroyed by fire in 1816 and completely rebuilt in 1876.

Charitable institutions are numerous in Naples. The Reclusorio or poorhouse, founded in the 18th century, besides offering shelter to the poor has a series of industrial schools attached, at which foundling boys are educated and taught trades. There are also several hospitals: the Incurabili, founded in 1510, the Istituto Principi di Piemonte, Cardarelli, Fondazione Pascale, Loreto, Ascalesi and the Ospedale della Pace.

Education and Learning. — The University of Naples. which was founded by the emperor Frederick II in 1224, is well equipped with zoological, mineralogical and geological museums, botanical gardens, a physiological institute and a department of anthropology. The buildings were originally erected in 1557 for the use of the Jesuits. The new building, completed in 1906, stands in the Corso Umberto I (Rettifilo), the street running northeastward, a little way behind the harbour, to the central railway station. The aquarium of the famous marine biological station at Naples, one of the most important in the world, founded by Anton Dohrn in 1872, is situated in the gardens of the Villa Comunale; the marine flora and fauna of the neighbourhood are more varied than those of any district in Europe. There is an observatory on the hill of Capodimonte.

The Royal Society of Naples, dating from 1756, is divided into three academies, namely, moral and political; physical and mathematical; letters, archaeology and fine arts. The Accademia Pontaniana, founded by Antonio Becardella and J. J. Pontanus in 1442, was restored in 1808 and is still extant. The Istituto Universitario Orientale, where foreign languages are taught, owes its existence to Matteo Ripa, who in 1732 established a school for Chinese missionaries. The Conservatory of Music in the monastery adjacent to San Pietro a Majella has been in existence since 1760, and has had many famous pupils, among them Vincenzo Bellini.

The Port. — At an early date the original harbour at Naples, now known in its greatly reduced state as Porto Piccolo and fit only for little boats and lighters, became too small In 1302 Charles II began the construction of the Porto Grande by forming the Molo Grande, which stretched eastward into the bay and was terminated by a lighthouse in the 15th century. By the addition of a pier running northeast from the lighthouse protected by a heavily armed battery, Charles III, in 1740, added greatly to the safety of the harbour. In 1826 the open area to the south of the Porto Grande was formed into the Porto Militare by the construction of the Molo San Vincenzo, 1,200 ft. long. The lengthening of the Molo San Vincenzo to a total of more than 5,000 ft. and the construction of curving moles on the east to meet it, have formed a large outer basin, the *avamporto,* and an inner harbour (Porto Mercantile). New quays ha e been made from the old Immacolatella landing place to the Capitaneria di Porto, close to which is the marine railway station, with piers long enough for the largest liners to lie alongside. The depth of this new harbour is from 25 to 30 ft. To the east are dock basins, silos for grain and other warehouses. A modern station for handling passenger traffic was opened in 1936. In 1956, 9,656 vessels of 15,303,717 tons and with 974,493 passengers arrived, bringing 6,132,605 tons of merchandise; 9,626 ships left with 2,123,012 tons of merchandise and 946,084 passengers. The new drydock is 1,140 ft. long and 132 ft. wide. Large sections of the harbour were utterly ruined by British and U.S. air raids during World War II, but all of them have been built again. The port of Naples is second only to that of Genoa.

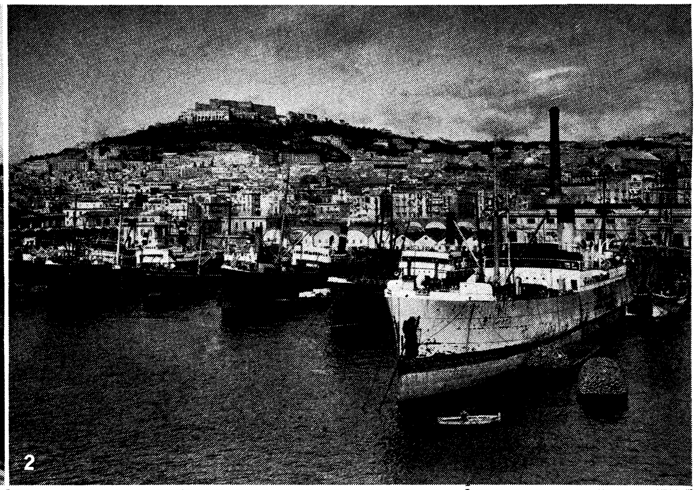
The specialities of Naples are the manufacture of coral and tortoise-shell articles, kid gloves and macaroni, but it has been growing also as an industrial centre.

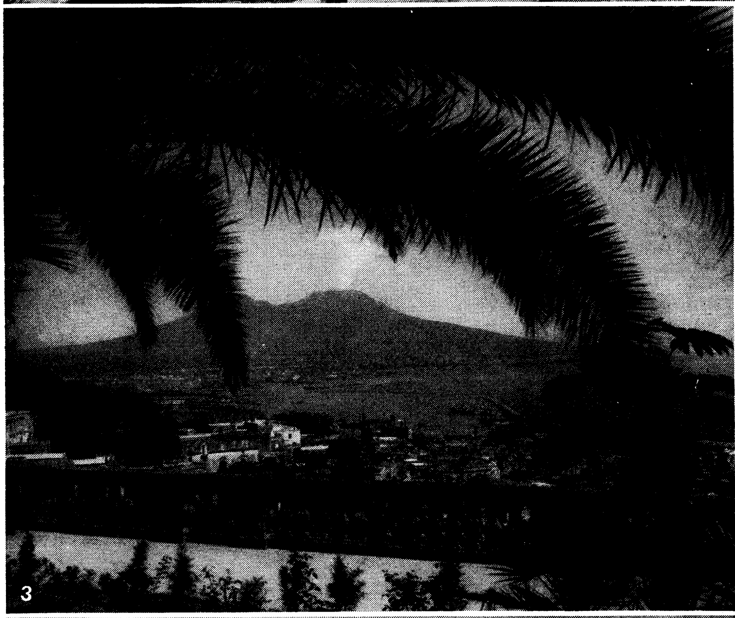
Recent Development. — Naples has grown in modern times at an enormous rate. On the large areas reclaimed from the sea, hotels and great blocks of flats have been erected. The Vomero is now an important suburb. The area of the commune has been built over in every direction, especially toward the east where a special zone has been set aside for the purpose of industrial development. This zone now contains a large number of mills for spinning silk, cotton, jute and wool; factories for making locomotives and automobiles; shipbuilding yards; an oil refinery; iron and steelworks; a huge cement mill; and silos.

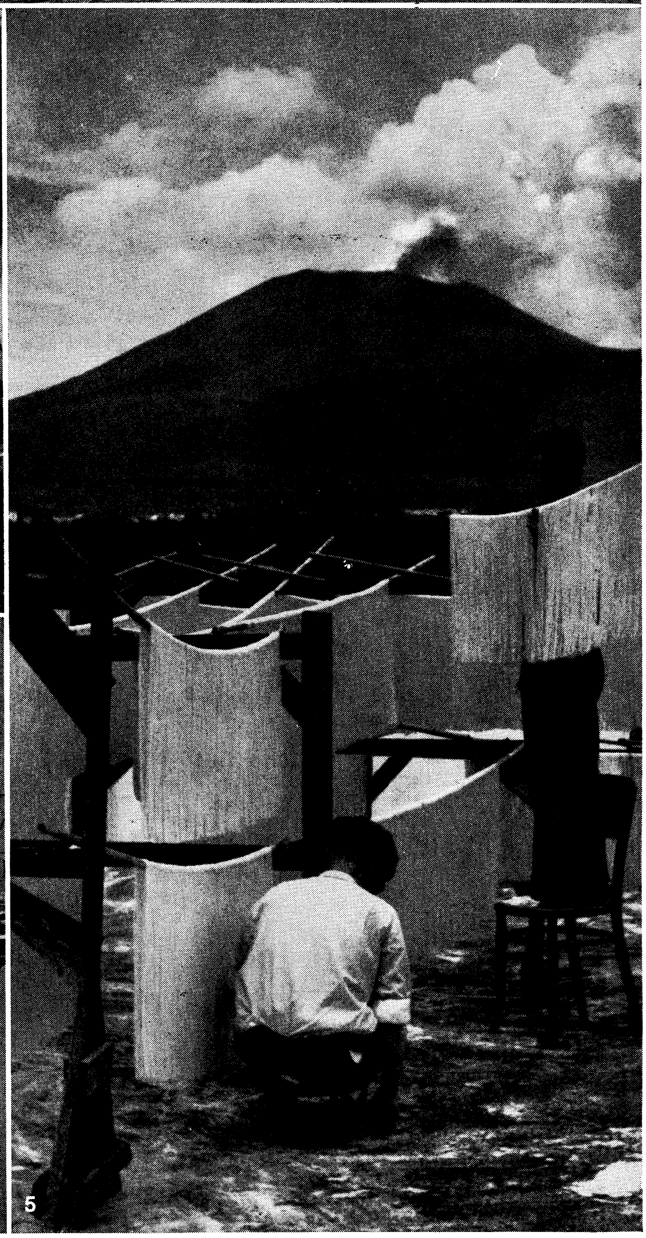
After the cholera epidemic of 1884, Agostino Depretis, then premier, visited Naples, and uttered the famous dictum *Bisogna sventrare Napoli*" ("Naples must be disembowelled.") The worst slums, which lay between the centre of the town and the railway station, were pulled down and a wide street was constructed from the centre of the town to the eastward; a water supply was brought to the town from the hills near Avellino; and a large working-class quarter was erected to the north and beyond the railway station, known as the Rione Vasto. In the late 1950s another business and shopping quarter was being constructed in the centre of the city, replacing an older working-class quarter which had been demolished. There were also new middle-class quarters at Santa Lucia, Vomero Nuovo and Sant' Efremo, Poggioreale, Fuorigrotta, Arenella and Camaldoli, and better houses on the Riviera di Chiaja, Viale Elena and Via Caracciolo at Mergellina, and Via Partenope near the Chiatamone, and an aristocratic quarter in the large extensions made in the Rione Amedeo and Posillipo Alto. The narrow alleys of Porto, Pendino and Mercato were gradually disappearing, and old Naples was vanishing day by day; Via Marittima, one of the largest streets, in which stands the great new Loreto hospital, was opened in 1958.

History. — According to some ancient writers, there were two towns in the 7th century B.C.: Parthenope and Neapolis, which was later called Palaeopolis. According to others, Naples mas founded in the 6th century B.C. by Greek immigrants who settled at Cumae. Although the origin of the city is obscure, it is certain that the Romans conquered it in 328 B C.

As a Roman settlement under the empire, it was enriched with temples, gymnasiums, baths, aqueducts, hippodromes and arenas, and in that period many of the Romans of the upper classes, from a love of Greek manners and literature, were attracted to Neapolis







PHOTOGRAPHS, (1) ACME, (2, 3) EWING GALLOWAY, (4) BURTON HOLMES FROM EWING GALLOWAY, (5) EISENSTAEDT-PIX

NAPLES, METROPOLIS OF SOUTHERN ITALY

1. A general view of the city as seen from a hill on the outskirts
2. The harbour, and castle of Sant' Elmo on the hill in the distance. The harbour was severely bombed in World War II
3. A view over the bay, looking toward Mt. Vesuvius
4. Modern pier on the bay
5. Drying spaghetti in a suburb of Naples, near Vesuvius

by its schools and gymnasiums or for enjoyment of music and of a soft climate. It was the favourite residence of many of the emperors: Nero made his first appearance on the stage in one of its theatres; Titus assumed the office of its archon and Hadrian became its demarch. Marcus Aurelius lived in Neapolis and frequented its schools. It was also the favourite residence of the poets Statius (*c.* A.D. 45–96) and Silius Italicus (A.D. 25 or 26–101), the former of whom was a Neapolitan by birth. It was chiefly at Naples that Virgil composed his *Georgics* and he desired to be buried on the hill of Pausilypon. the modern Posillipo, in its neighbourhood, though his traditional tomb is really a columbarium.

After the fall of the Western Roman empire, the town declined. It was conquered by Odoacer and by a Byzantine army under Belisarius in 536; Totila, the Gothic leader, drove the Byzantines from Naples in 542; ten years later, however, it reverted to Byzantine rule. Naples became a dukedom in the 8th century and preserved its independence against Lombard incursions In 1139 it capitulated and was annexed to the kingdom of Roger II of Sicily. Under the Hohenstaufen emperor Frederick II (Frederick I of Sicily) the city became a centre of learning; in 1224 he built the university where many famous men of letters were numbered among its teachers: Pier delle Vigne, Andrea d'Isernia, Bartolomeo Prignano (Urban VI) and Cino da Pistoia. Charles of Anjou, whd overthrew the Hohenstaufen in southern Italy in 1266, made Naples the capital of his kingdom; during his reign and those of his Angevin and Aragonese successors, the city was enlarged and developed. Many palaces, castles and churches were built. Trade and commerce grew under the influence of Italian settlers from Florence, Pisa and Lombardy. During the 14th century the wool industry flourished.

Through the Aragonese succession Naples became a possession of the Spanish Habsburgs. Despite much unrest (*see* MASANIELLO for the revolt of 1647), epidemics and heavy taxation, the city continued to grow under this regime; development was especially rapid during Don Pedro de Toledo's viceroyalty (1532–59) and the famous Via Toledo was constructed. In 1707, during the War of the Spanish Succession, Naples fell to the Austrians, who retained it under the treaties of 1713–14.

In 1734 the Spanish prince Charles of Bourbon (the future Charles III of Spain) captured Naples, which he made the capital of his independent kingdom of the Two Sicilies. During his reign in this kingdom the royal palaces of Caserta and Portici, the Reclusorio and other famous buildings were built. On becoming king of Spain in 1759, Charles was succeeded by his third son, Ferdinand IV, who in 1799 was expelled by a French Revolutionary army. A republic was then proclaimed. In 1806 Joseph Bonaparte, Napoleon's brother, became king of Naples. Joachim Murat took his place in 1808.

On Ferdinand's restoration (1815), the barrier which already divided the Bourbons from the leading Neapolitan class became unsurmountable and the rising of this minority, who were aiming at the unity of Italy, culminated in the revolution of 1848.

On Sept. 6, 1860, Francis II, the last king of Naples, left the capital, which had fallen to Garibaldi's army. Naples ceased to be governed as a separate entity and came under the national government of Italy with Victor Emmanuel as king. The subsequent history of the city is concerned with attempts to raise the standard of living by increased public services and amenities, to build new districts for the working classes, to encourage industry and to improve the port.

After World War II many new roads and streets were constructed to take in districts which had hitherto been outside the city proper on Vomero, Arenella and Posillipo Alto hills. Great care has been taken in this modernization to preserve the ancient and famous buildings of the city. (*See* also NAPLES, KINGDOM OF.)

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NAPLES, KINGDOM OF, the name conventionally given to the kingdom of Sicily on the Italian mainland (Sicily beyond the Faro), to distinguish it from that of Sicily proper (Sicily on this side of the Faro, *i.e.,* Messina).

The leaders of the Norman house of Hauteville, Robert Guiscard and Richard of Aversa, in 1059 did homage to Pope Nicholas II. (*q.v.*) for all the conquests they made both in the island and upon the mainland. In 1130 Roger de Hauteville (Roger II. as "great count" of Sicily) assumed the style of king as Roger I. In this way the south of Italy, together with the island of Sicily, was converted into one political body.

The **Hohenstaufen.**—After the death of Tancred, son of William II., the emperor Henry VI., of the house of Hohenstaufen, who by his marriage with Constance or Costanza d'Altavilla, daughter of Roger I. (d. 1154), laid claims to the lungdoms of Naples and Sicily, descended into Italy in 1194. He easily conquered both the mainland and the island, but died in 1197. Costanza then had her son, Frederick (b. 1194) proclaimed king, and obtained the support of the Holy See on condition that the kingdom should be once more recognized as a fief of the Church. The Hohenstaufen kings afterwards refused to admit this claim; thus provoking the persistent hostility of the popes and many foreign invasions. Costanza died in 1198, leaving Pope Innocent III. regent and tutor to her son. In 1209 Frederick married Costanza, daughter of the king of Aragon, with whose help he succeeded in reducing a large part of Sicily to obedience. Two years later he was elected king of the Romans, and in 1220 he was crowned emperor in Rome by Pope Honorius III., but continued to reside in Sicily. In 1227 Gregory IX. excommunicated him because he delayed the crusade which he had promised to undertake. Frederick sailed for Palestine the following year and on his return defeated the army which the pope had sent into Neapolitan territory, peace being made at San Germano in 1230 and the excommunication withdrawn. In 1231 he issued the celebrated Constitutions of the Sicilian kingdom at the parliament of Melfi. He died in 1250.

His son Conrad IV. succeeded to the empire, while to his illegitimate son Manfred he left the principality of Taranto and the regency of the southern kingdom. Conrad died in 1254, leaving an infant son, Conradin (b. 1252), and Manfred was appointed vicar-general during the latter's minority. In 1258, on a rumour of Conradin's death, Manfred was offered and accepted the crown of Naples and Sicily. The rumour was false, but he retained the crown, promising to leave the kingdom to Conradin at his death and to defend his rights.

Angevin **and Aragonese.**—In 1265 Clement IV., wishing to rid himself of the Hohenstaufen, induced Charles of Anjou, brother of Louis IX. of France, to come to Italy. Agreeing to accept the kingdom of the Two Sicilies as a fief of the Church, Charles, in 1266, marched southward with the privileges of a crusader (*see* CHARLES I., king of Naples and Sicily). Manfred was defeated and killed at Benevento, and Charles was soon master of almost the whole kingdom.

In Sicily, however, Charles's government soon made itself odious by its exactions and the insolence and cruelty of the king's French officials and favourites. The malcontents were led by the Salernitan noble Giovanni da Procida, who had induced Peter III. of Aragon, husband of Manfred's daughter Costanza, to make good his shadowy claims to the crown of Sicily. On Easter day 1282, just as Charles was preparing an expedition to the East, the popular rising known as the Sicilian Vespers broke out at Palermo and resulted in the massacre of nearly all the French in the island. Peter reached Palermo in September. Pope Martin IV. proclaimed a crusade against the Aragonese, and the war continued for many years. The Sicilian fleet under Ruggiero di Lauria defeated that of the Angevins at Malta in 1283, and in 1284 in the Bay of Naples. Charles I. died in 1286; his heir, Charles the Lame, being a prisoner, was not crowned until two years later. (*See* CHARLES II., king of Naples and Sicily, and FREDERICK III., king of Sicily.).

Charles II. died in 1309 and was succeeded by his second son Robert, who became leader of the Guelphs in Italy. War between

Naples and Sicily broke out once more, when Erederick allied himself with the emperor Henry VII. on his descent into Italy and proclaimed his own son Peter heir to the throne. Robert died in 1342; he had been a capable ruler, a scholar, and a friend of Petrarch, but his authority was limited by the rights-of a turbulent and rebellious baronage (see ROBERT, king of Naples). He was succeeded by his granddaughter Joanna, wife of Andrew of Hungary, who was assassinated in 1345, not without suspicion of Joanna's complicity. Andrew's brother Louis, king of Hungary, attempted to make good his claims on Naples and avenge the murder of Andrew; but as Pope Clement refused to recognize his claims he went back to Hungary in 1348 and Joanna and her second husband Louis of Taranto were crowned at Naples by the pope's legate in 1352, but Niccolb Acciaiuoli, the seneschal, became the real master of the kingdom. Joanna nominated Louis of Anjou her heir, but while the latter was recognized by the anti-pope Clement VII., Pope Urban VI. declared Charles of Durazzo (great-grandson of Charles II.) king of Sicily *al di quà* del Faro (*i.e.* of Naples). Charles conquered the kingdom and took Joanna prisoner in 1381, and had her murdered the following year. Louis failed to drive out Charles, and died in 1384. A period of anarchy followed during the reigns of Charles III. and his son Ladislas, and on the latter's death in 1414 he was succeeded by his sister Joanna II. (*q.v.*), during whose reign the kingdom sank to the lowest depths of degradation. Louis died in 1434 and Joanna in 1435. Alphonso was recognized as king of Naples by Pope Eugene IV. in 1443.

Under Alphonso, surnamed "the Magnanimous," Sicily was once more united to Naples and a new era was inaugurated, for the king was at once a brilliant ruler, a scholar, and a patron of letters. He died in 1458, leaving Naples to his illegitimate son Ferdinand I (*q.v.*) (Don Ferrante), and Sicily, Sardinia, and Aragon to his brother John. Ferdinand died in Jan. 1494, and he was succeeded by Alphonso. In the following September Charles VIII. of France entered Italy and conquered the Neapolitan kingdom without much difficulty. Alphonso abdicated, and his son Ferrandino and his brother Frederick withdrew to Ischia. But Ferrandino. with the help of Ferdinand II. of Spain, was able later to reoccupy his dominions. He died much regretted in 1496 and was succeeded by Frederick. The country was torn by civil war and brigandage, and the French continued to press their claims; until, with Gonzalo de Cordoba's victory on the Garigliano in Dec. 1502, the whole kingdom was in Spanish hands.

Spanish Rule.--On Ferdinand's death in 1516, the Habsburg Charles became king of Spain, and three years later was elected emperor as Charles V.; in 1522 he appointed John de Lannoy viceroy of Naples, which became henceforth an integral part of the Spanish dominions. Spanish rule presently provoked several rebellions. On July 7, 1647, tumults occurred at Naples in consequence of a new fruit tax, and the viceroy, Count d'Arcos, was forced to take refuge in the Castelnuovo. The populace, led by an Amalfi fisherman, known as Masaniello (*q.v.*), obtained arms, erected barricades, and, while professing loyalty to the king of Spain, demanded the removal of the oppressive taxes and murdered many of the nobles. D'Arcos came to terms with Masaniello; but in spite of this, and of the subsequent assassination of Masaniello, the disturbances continued.

In 1670 disorders broke out at Messina, which developed into an anti-Spanish movement; and while the inhabitants called in the French, the Spaniards, who could not crush the rising, called in the Dutch. In 1707 an Austrian army conquered the kingdom and Spanish rule came to an end.

The Bourbons.—In Sicily the Spaniards held their own till the peace of Utrecht, in 1713, when the island was given over to Duke Victor Amadeus of Savoy, who assumed the title of king. In 1718 he had to hand back his new possession to Spain, which, in 1720, surrendered it to Austria and gave Sardinia to Victor Amadeus. In 1733 the treaty of the Escurial between France, Spain, and Savoy against Austria was signed. Don Carlos of Bourbon, son of Philip V. of Spain, easily conquered both Naples and Sicily, and in 1738 he was recognized as king of the Two Sicilies, Spain renouncing all her claims. Charles was well received and, with the Tuscan Bernardo Tanucci as his minister, introduced many useful reforms. In 1759 Charles III., having succeeded to the Spanish crown, abdicated that of the Two Sicilies in favour of his 8-year-old son Ferdinand, who became Ferdinand IV. of Naples and III. of Sicily, with a regency under Tanucci. The regency ended in 1767, and the following year Ferdinand married the masterful and ambitious Maria Carolina, daughter of the empress Maria Theresa. With the help of John Acton, an Englishman whom she made minister in the place of Tanucci, she secured a *rapprochement* with England and Austria.

On the outbreak of the French Revolution the king and queen were not at first hostile to the new movement; but in 1793 they joined the first coalition against France, instituting severe persecutions against all who were remotely suspected of French sympathies. Republicanism, however, gained ground, especially among the aristocracy. In 1798, during Napoleon's absence in Egypt and after Nelson's victory at Aboukir, Maria Carolina induced Ferdinand to go to war with France. The French marched on Naples, but not until Jan. 20, 1799, were the invaders masters of the city. On the 23rd the Parthenopaean republic was proclaimed. The Republicans were men of culture and high character, but doctrinaire and unpractical, and they knew very little of the lower classes of their own country. Meanwhile the court at Palermo sent Cardinal Fabrizio Ruffo to Calabria, to organize a counter-revolution. He succeeded beyond expectation, and with his "Christian army of the Holy Faith" (*Esercito Cristiano della* Santa Fede), consisting of brigands, convicts, peasants and some soldiers, advanced on the capital, whence the French, save for a small force under Méjean, withdrew. On June 13 Ruffo and his hordes reached Naples and, after a desperate battle at the Ponte della Maddalena, entered the city. The French in Castel Sant' Elmo and the Republicans in Castelnuovo and Castel dell' Uovo still held out and finally an armistice was concluded and a capitulation agreed upon, whereby the castles were to be evacuated and the garrisons free to remain in Naples unmolested or to sail for Toulon.

Nelson at Naples.—On June 24 Nelson arrived with his fleet, and on hearing of the capitulation refused to recognize it save in so far as it concerned the French. Ruffo indignantly declared that the treaty had been signed, not only by himself but by the Russian and Turkish commandants and by the British captain, Foote. On the 26th Nelson changed his attitude and informed the cardinal that he would do nothing to break the armistice; while Captains Bell and Troubridge wrote that they had Nelson's authority to state that the latter would not oppose the embarcation of the Republicans, who thereupon embarked on the vessels prepared for them. But on the 28th Nelson, acting on despatches from the court (in reply to his own), held up the vessels and many of the Republicans were arrested. Caracciolo, who commanded the Republican Fleet, was tried by court-martial on board Nelson's flagship, condemned to death, and hanged at the yard arm (*see* CARACCIOLO, FRANCESCO and NELSON, HORATIO NELSON).

On July 8 King Ferdinand arrived from Palermo and the State trials resulted in hundreds of persons being executed, including some of the best men in the country, such as the philosopher Mario Pagano, the scientist Cirillo, Massa, the defender of Castel dell' Uovo, and Ettore Caraffa, the defender of Pescara. After the peace of Amiens in 1802 the court returned to Naples, where it was well received. But when the European war broke out again in the following year King Ferdinand played a double game, appearing to accede to Napoleon's demands while negotiating with Britain. After Austerlitz, Napoleon declared that "the Bourbon dynasty had ceased to reign" and sent an army under his brother Joseph to occupy the kingdom.

Joseph Bonaparte and Murat.—Ferdinand and Maria Carolina fled to Palermo in 1805; in Feb. 1806 Joseph Bonaparte entered Naples as king. A cultivated, well-meaning, not very intelligent man, he introduced many useful reforms and abolished feudalism, but the taxes and forced contributions proved very burdensome. Joseph's authority did not exist throughout a large part of the kingdom, where royalist risings, led by brigand chiefs, maintained a state of anarchy, and a British force, under Sir John

Stuart, defeated the French at Maida in Calabria (July 6, 1806).

In 1808 Napoleon conferred the crown of Spain on Joseph and appointed Joachim Murat king of Naples. Murat continued Joseph's reforms and reorganized the army; and although he introduced the French codes and conferred many appointments and estates on Frenchmen, his administration was more or less native and favoured the abler Neapolitans. The king gained many sympathies; he gradually became estranged from Napoleon and secretly opened negotiations with Austria and Great Britain. In Jan. 1814 he signed a treaty with Austria, and the following month proclaimed his separation from Napoleon. But when Napoleon escaped from Elba, Murat suddenly returned to the allegiance of his old chief, marched into northern Italy, and from Rimini issued his famous proclamation in favour of Italian independence (March 30, 1815). He was subsequently defeated by the Austrians several times and on May 18 sailed from Naples for France (see MURAT, JOACHIM). On the 23rd the Austrians entered Naples to restore Bourbon rule.

The Restoration.—Ferdinand and Maria Carolina had continued to reign in Sicily, where the court's extravagance and the odious Neapolitan system of police espionage rendered their presence a burden instead of a blessing to the island. A bitter conflict broke out between the court and the parliament, and the British minister, Lord William Bentinck, forced Ferdinand to resign his authority and appoint his son regent and introduced many valuable reforms. In 1812 a constitution on British lines was introduced, and the queen, who was perpetually intriguing against Bentinck, was exiled. Bentinck, whose memory is still cherished in the island, departed in 1814. Ferdinand dissolved parliament in May 1815, after concluding a treaty with Austria for the recovery of his mainland dominions by means of an Austrian army. On June 9 Ferdinand re-entered Naples and bound himself in a second treaty with Austria not to introduce a constitutional government. At first he abstained from persecution and received many of Murat's old officers into his army. In Oct. 1815 Murat, believing that he still had a strong party in the kingdom, landed with a few companions at Pizzo di Calabria, but was immediately captured by the police and the peasantry, court-martialled, and shot.

Ferdinand proclaimed himself king of the Two Sicilies at the congress of Vienna. incorporating Naples and Sicily into one state, and abolished the Sicilian constitution (Dec. 1816). In 1818 he concluded a Concordat with the Church, by which the latter renounced its suzerainty over the kingdom, but was given control over education, the censorship, and many other privileges. But there was much disaffection throughout the country, and the Carbonarist lodges had made much progress, especially in the army (see CARBONARI). In July 1820 a military mutiny broke out at Caserta, the mutineers demanding a Spanish constitution although professing loyalty to the king. Ferdinand, feeling himself helpless to resist, acceded to the demand. The new government's first difficulty was Sicily, where the people had risen in rebellion demanding their own charter of 1812, and although the Neapolitan troops quelled the outbreak with much bloodshed the division proved fatal to the prospects of liberty.

This outbreak seriously alarmed the Powers responsible for the preservation of the peace in Europe. At the congress of Troppau (Oct. 1820) the famous protocol was issued affirming the right of collective "Europe" to interfere to crush dangerous internal revolutions. Both France and Great Britain protested against this dangerous principle; but by general consent King Ferdinand was invited to attend the adjourned congress, fixed to meet at Laibach in the spring of the following year. Under the new constitution the permission of parliament was necessary before the king could leave Neapolitan territory. This was weakly granted, after Ferdinand had sworn the most solemn oaths to maintain the constitution. He was scarcely beyond the frontiers, however, before he repudiated his engagements, as exacted by force. The powers authorized Austria to march an army into Naples to restore the autocratic monarchy. General Pepe commander of the Constitutional forces, was sent to the frontier at the head of 8,000 men, but was completely defeated by the Austrians at Rieti on March 7. On the 23rd the Austrians entered Naples, followed soon afterwards by the king. Every vestige of freedom was suppressed, and the inevitable State trials instituted with the usual harvest of executions and imprisonment. Pepe saved himself by flight. (See FERDINAND IV., king of Naples.)

Ferdinand died in 1825 and was succeeded by his son Francis I., an unbridled libertine, under whom the corruption of the administration assumed unheard-of proportions. (See FRANCIS I., king of the Two Sicilies.) He died in 1830 and was succeeded by his son, Ferdinand II., who at first awoke hopes that the conditions of the country would be improved; but on the death of his first wife, Cristina of Savoy, he married Maria Theresa of Austria, who encouraged him in his reactionary tendencies and brought him closer to Austria. The desire for a constitution was by no means dead, and the survivors of the old Carbonari gathered round Carlo Poerio, while the Giovane *Italia* society (independent of Mazzini) promoted a few sporadic outbreaks easily crushed. The following year the Venetian brothers Bandiera, acting in concert with Mazzini, landed in Calabria, believing the whole country to be in a state of revolt; they met with little local support and were quickly captured and shot, but their deaths aroused much sympathy, and the whole episode was highly significant as being the first attempt made by Italians from other parts of the country to promote revolution in the south.

Revolution of 1848.--On Jan. 12, 1848, a revolution under the leadership of Ruggiero Settimo broke out in Sicily. These events were followed by demonstrations at Naples, and on Jan. 28 the king granted the constitution. The popular demand was now that Naples should assist the Lombards in their revolt against Austria, for a feeling of Italian solidarity was growing up. Ferdinand declared war against Austria (April 7, 1848); and a Neapolitan army under General Pepe marched towards Lombardy in May, while the fleet sailed for Venice. But a dispute between the king and the parliament concerning the form of the royal oath having arisen, a group of demagogues with criminal folly provoked disturbances and erected barricades (May 14). The king refused to open parliament unless the barricades were removed. A few shots were fired on the 15th, the Swiss regiments stormed the barricades and street fighting lasted all day. By the evening the Swiss and the royalists were masters of the situation. A new ministry under Prince Cariati was appointed. Parliament was dissolved, the National Guard disbanded and the army recalled from the Po.

In Sicily the revolutionists were bitterly hostile to the Neapolitans. The Sicilian assembly met in March 1848, and Settimo in his inaugural speech declared that the Bourbon dynasty had ceased to reign and that Sicily united her destinies to those of Italy; Settimo was elected president of the Government. After the Austrian victories Ferdinand sent a Neapolitan army under Carlo Filangieri (*q.v.*) to subjugate the island. The troops landed at Messina, whose citadel had been held by the royalists throughout, and after three days' desperate fighting the city itself was captured and sacked. Filangieri marched forward, committing many atrocities. In April he reached Palermo while the fleet appeared in the bay, and tumults having broken out within the city the Government surrendered on terms which granted amnesty for all except Settimo and 42 others.

For a few months after the dissolution of the Neapolitan parliament the Government abstained from persecution, but with the crushing of the Sicilian revolution its hands were free; and when the commission on the affair of May 15 had completed its labours thousands of respectable citizens were thrown into prison, such as L. Settembrini, Carlo Poerio, and Silvio Spaventa. The abominable conditions of the prisons in which the best men of the kingdom were immured were made known to the world by the famous letters of W. E. Gladstone, which branded the Bourbon regime as "the negation of God erected into a system of government." In 1857 Carlo Pisacane, an ex-Neapolitan officer who had taken part in the defence of Rome, fitted out an expedition, with Mazzini's approval, from Genoa, and landed at Sapri in Calabria; but the local police assisted by the peasantry attacked the band, killing many, including Pisacane himself, and capturing most of the rest. The following year, at the instance of Great Britain and France, Ferdinand commuted the sentences of some of the political prisoners to exile. (See FERDINAND II., king of the Two Sicilies.)

In May 1859 Ferdinand died and was succeeded by his son, Francis II. (*q.v.*). Victor Emmanuel, king of Sardinia, wrote to him proposing an alliance for the division of Italy, but Francis refused. In June part of the Swiss Guard mutinied and were shot down; and this affair resulted in the disbanding of the whole force—the last support of the autocracy. Various proposals were made for an alliance with Sardinia, but Francis rejected them and indeed began to negotiate with Austria.

Garibaldi.—In the meantime events in Sicily were reaching a crisis destined to subvert the Bourbon dynasty. Mazzini's emissaries, F. Crispi (*q.v.*) and R. Pilo, had been trying to organize a rising in favour of Italian unity and, although they merely succeeded in raising a few armed bands, they persuaded Garibaldi (*q.v.*) that the revolution, which he knew to be imminent, had broken out. Garibaldi, whose hesitation had been overcome, embarked on May 5, 1860, at Quarto, near Genoa, with 1,000 picked followers on board two steamers, and sailed for Sicily. On the 11th the expedition reached Marsala and landed without opposition. Garibaldi was somewhat coldly received by the astonished population; but he set forth at once for Salemi, where he issued a proclamation assuming the dictatorship of Sicily in the name of Victor Emmanuel, with Crispi as secretary of state. On the 15th he attacked and defeated 3,000 of the enemy under General Landi at Calatafimi; the news of this brilliant victory revived the revolutionary agitation throughout the island, and Garibald was joined by Pilo and his bands. By a cleverly devised ruse he avoided General Colonna's force, which expected him on the Monreale road, and entering Palermo from Misilmeri received an enthusiastic welcome. After three days' street fighting the Bourbonist commander, General Lanza, not knowing that the Garibaldians had scarcely a cartridge left, asked for and obtained a 24 hours' armistice (May 30). Garibaldi went on board the British flagship to confer with the Neapolitan generals Letizia and Chrétien; then he informed the citizens by means of a proclamation of what he had done, and declared that he would renew hostilities on the expiration of the armistice. Although unarmed, the people rallied to him as one man, and Lanza became so alarmed that he asked for an unconditional extension of the armistice, which Garibaldi granted; 15,000 Bourbon troops embarked for Naples on June 7, leaving the revolutionists masters of the situation. The Sardinian Admiral Persano's salute of 19 guns on the occasion of Garibaldi's official call constituted a practical recognition of his dictatorship by the Sardinian (Piedmontese) Government. In July further reinforcements of volunteers under Cosenz and Medici, assisted by Cavour, arrived at Palermo with a good supply of arms furnished by subscription in northern Italy. Garibaldi's forces were now raised to 12,000 men, besides the Sicilian *squadre*. Cavour's attempt to bring about the annexation of Sicily to Sardinia failed, for Garibaldi wished to use the island as a basis for an invasion of the mainland. When the Garibaldians advanced eastward they encountered a force of 4,000 of the enemy under Colonel Bosco at Milazzo; on July 20 a desperate battle took place, resulting in a hard-won Garibaldian victory. The Neapolitan Government then decided on the evacuation of the whole of Sicily except the citadel of Messina, which did not surrender until the next year.

The news of Garibaldi's astonishing successes entirely changed the situation in the capital, and on June 25, 1860, the king granted a constitution, and appointed A. Spinelli prime minister. Disorders having taken place between Liberals and reactionaries, Liborio Romano was made minister of police in the place of Aiossa. The king appealed to Great Britain and France to prevent Garibaldi crossing the Straits of Messina, and only just failed (for this episode see under LACAITA, SIR JAMES). On Aug. 19 Garibaldi crossed with 4,500 men and took Reggio by storm. He was soon joined by the rest of his troops, 15,000 in all, the Neapolitan army collapsed before Garibaldi's advance, and the people rose in his favour almost everywhere. On Sept. 6 the king and queen sailed for Gaeta; on the 7th Garibaldi entered Naples alone, although the city was still full of soldiers, and was received with delirious enthusiasm; on the 11th a part of the royalists capitulated and the rest retired on Capua. Cavour now decided that Sardinia must take part in the liberation of southern Italy, for he feared that Garibaldi's followers might induce him to proclaim the republic and attack Rome, which would have provoked French intervention; consequently a Piedinontese army occupied the Marche and Umbria and entered Neapolitan territory with Victor Emmanuel at its head. On Oct. 1 and 2, 1860, a battle was fought on the Volturno and the Garibaldians, although inferior in numbers, were victorious. On the 26th he met Victor Emmanuel at Teano and hailed him king of Italy and subsequently handed over his conquests to him. On Nov. 3 a plebiscite was taken, which resulted in an overwhelming majority in favour of union with Sardinia under Victor Emmanuel. Garibaldi departed for his island home at Caprera, while L. C. Farini was appointed viceroy of Naples and M. Cordero viceroy of Sicily. The last remnant of the Bourbon army was concentrated at Gaeta, the siege of which was begun by Cialdini on Nov. 5; on Jan. 10, 1861, the French fleet, which Napoleon III. had sent to Gaeta to delay the inevitable fall of the dynasty, was withdrawn at the instance of Great Britain; the fortress surrendered on Feb. 13 and the royal family departed by sea. The citadel of Messina capitulated a month later and Civitella del Tronto on March 21. On Feb. 18 the first Italian parliament met at Turin and proclaimed Victor Emmanuel king of Italy. Thus Naples and Sicily ceased to be a separate political entity and were absorbed into the united Italian kingdom.

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(L. V.; X.)

NAPOLEON I. (1769–1821), emperor of the French. Napoleon Bonaparte was born at Ajaccio on Aug. 15, 1769, the year following the reunion of Corsica with France. His father, Charles Buonaparte—it was not until after 1796 that the spelling Bonaparte was adopted—came of a good family which had been established in the island since the 16th century. The family origins may perhaps be traced to Tuscany, an Italian province, the relations of which with Corsica had always been close. Napoleon himself, in later years, scoffed at the exaggerated tales invented by flatterers and courtiers, of the lordly status formerly held by the family at Treviso and Bologna. Yet his father was undoubtedly of noble birth, and was the delegate of the Corsican nobility at Paris. Charles Buonaparte married Laetitia Ramolino, a woman of strong character and great personal beauty. He was a lawyer by profession and brought up a large family in difficult times. After the Corsicans had, several times, revolted against their Genoese masters, the republic of Genoa, despairing of ever bringing the rebels to submission, ceded its rights to France, against which the Corsicans, led by Paoli (*q.v.*) at first attempted resistance. Charles Buonaparte joined Paoli's party. He even joined him in his campaign, taking with him his wife and children.

lest they should be seized as hostages by the French. When Paoli was beaten and had to fly Charles Buonaparte became reconciled to French rule and benefited by the protection of M. de Marbeuf, the governor, to whom he was able to make himself useful. In 1779, sent on a mission to Versailles, he took with him his second son, Napoleon, for whom M. de Marbeuf had obtained a bursary at the military academy at Brienne.

EARLY LIFE

These facts enable us to understand the character of Napoleon. He was born a Frenchman, of a family which, unwilling at first to become French, afterwards unreservedly accepted the *fait accompli*. From the age of ten he was educated with other boys of his own class by French people according to French ideas. Though we must make due allowance for heredity, family influence, and the impressions of early childhood, it is an exaggeration to explain Napoleon, as historians since Stendhal have been too much inclined to do, entirely in the light of his Corsican and Tuscan origin, and to see in him the incarnation of a condottiere, or of a 14th century Italian city despot, a modem Castruccio Castracani. It is more important to bear in mind that young Bonaparte, born in an island which had only just become part of France, shared neither the traditions nor the prejudices of his new country.

In 1789, at the age of 20, he came into the Revolution with an open mind, feeling neither like nor dislike for many things which other Frenchmen either regretted or frankly detested. If he remained Corsican in temperament he was, by virtue of the instruction he had received, and the books he had read, pre-eminently a man of the 18th century. His occasional early philosophical writings leave no doubt as to this side of his character, which is also illustrated by the life-long habit of epigrammatic, well-turned, often paradoxical expression, a trait which he had in common with Chamfort and Rivarol; witness his celebrated definition of love as "*une* sottise faite *à deux*." Further, having lost his father in 1785, and having been designated by him as the head of the family, although he was the second and Joseph the eldest son, he had known poverty and the responsibility of helping to provide for his mother, brothers and sisters. Success was more necessary to him than to others, and the upheaval of 1789 favoured the ambitious.

We must realize therefore that he entered the Revolution in rather an unusual frame of mind, occasionally ardent, joining the Jacobins without hesitation, but also capable of coolly judging events as when on June 20, at the capture of the Tuileries, he was moved to scorn by the weakness of Louis XVI. We must also remember that, having begun his studies at the cadet school at Brienne, he completed them at the Ecole Militaire in Paris, where (1784–5) he received a solid grounding in the work of an artilleryman and an officer. It would be wrong to look on him as a kind of self-taught genius, a god of war, who might be said to have discovered, taught, and even created strategy and tactics.

The Artillery Officer.—He himself acknowledged, modestly and loyally, his debt to his teachers. He had studied the treatises of Bourcet and of Guibert, who had evolved from modern armaments new principles and methods of warfare. As a sub-lieutenant at Auxonne, after leaving the Ecole Militaire, he received at first hand instruction from baron du Teil, brother of the author of a remarkably advanced work on the use of modern artillery. He profited by the instruction, and always spoke of it with appreciation. However gifted a man may be, he still needs inspiration and counsel, and learns more from his predecessors than he himself passes on to his contemporaries and to posterity. The genius of Napoleon was not least evident in the way in which he made use of the instruction which he received. Curiously enough, Guibert in his *Système* de *guerre moderne* had predicted that a great man would arise to put into practice the military theories which were then taking shape. These facts, which place Napoleon in his proper intellectual environment, seem to the writer to throw more light on his mind and his character than would countless anecdotes of his childhood and schooldays, such as that at Brienne he was nicknamed *Paille au nez* by his companions because of the way in which he pronounced *Napolione*.

Between his spells of garrison duty at Valence and at Auxonne as a young artillery officer, a part of his early career of which little is known was passed in the leave which he spent on more than one occasion in Corsica, where the somewhat complicated affairs of his family demanded his presence. At Ajaccio in Sept. 1789, he found his elder brother Joseph deep in the affairs of the democratic party which had inevitably, with the progress of the Revolution, become the party of France. Paoli, who had at first thought that events in France would bring about Corsican independence, had soon been disillusioned, Jacobinism being essentially a unifying and centralising force. He inclined therefore to the counter-revolution and entered the opposite camp.

Napoleon, promoted lieutenant in 1791 on the reorganization of the artillery, was stationed for another three months at Valence, where he continued his studies, and even wrote an essay on a subject set for competition by the academy of Lyons: "What are the principles and institutions most likely to bring about the greatest happiness of mankind?" He treated the subject in the style and according to the principles of Jean Jacques Rousseau. When, years afterwards, Talleyrand showed him the essay, he threw it into the fire.

He was again in Corsica from Sept. 1791 to May 1792. Feeling ran high in the island, as a result of the disestablishment of the Catholic Church. He plunged into political intrigue, outstayed his leave, and became liable to the penalties in force against deserters and émigrés. On April 20, 1792, however, the legislative assembly had declared war on Austria. Officers were needed. Instead of undergoing any penalty, Bonaparte, whose zeal for the Revolution was well known, was made a captain. In this capacity he remained in Paris for several months, and witnessed the great events of the Revolution. After the September massacres, he went to Ajaccio to take home his sister Elisa from the convent of Saint Cyr which had just been closed. This was his last visit to his native country. The break with Paoli was now complete. Bonaparte was on the side of the "*patriotes*," while the old champion of independence was appealing to the English against the Republic, One and Indivisible. Paoli was victorious. Bonaparte and his family, now entirely ruined, had to fly from the island and take refuge in France. This was the termination of what we may call his "insular" period. As he himself said afterwards, once he had left Ajaccio, more important affairs left him little time to think of Corsica and Paoli.

Early Military Opportunities.—In Sept. 1793, Napoleon Bonaparte was still unknown to the world whirh was to ring with his name. Amazed himself at his extraordinary career, and the incredible swiftness of his rise to power, he said in Saint Helena to Las Cases, "Centuries will pass before the unique combination of events which led to my career recur in the case of another." Favourable circumstances were also required to bring the young artillery officer to the front, and these were not lacking. The republic, which had challenged half Europe, had to face foreign and civil war, under conditions of anarchy. Bonaparte was a Jacobin, with a great reputation as an artillery officer. At Beaucaire, on his way to Paris, he had written a pamphlet, the *Souper* de *Beaucaire*, in which he had refuted the arguments of three Southern federalists or counter-revolutionaries. It is probable that it reflects a conversation which actually took place in an inn of the little town beside the Rhone. Its publication attested the patriotism of its author. The good word of Robespierre's brother and of Napoleon's compatriot, the deputy Salicetti, were also of assistance. At this juncture it was necessary to recapture Toulon, the inhabitants of which had rebelled against the Convention and called in the assistance of an English squadron. An able officer of artillery was required to direct the siege operations. Bonaparte was chosen.

There has since grown up the legend of "the great Napoleon at the siege of Toulon," though the part which he really played was essentially that of a technical expert. He found in command General Carteaux, formerly an artist, who was too ignorant even to understand that to take Toulon he must capture the position which commanded the roadstead. Things were no better under his successor, Doppet, and until the arrival of General Dugommier, a soldier of greater experience, who, together with Gasparin, the people's commissary, recognized the knowledge and good sense of the young artillery officer.

On the fall of Toulon in Dec. 1793, Napoleon was promoted general of brigade, and in Feb. 1794 he was given the command of the artillery of the army of Italy. These were still subordinate positions, offering little opportunity for prominence. He spent the next few months — the period of the Terror — in inspecting fortifications and was even for a time "suspect" for having reconstructed an old fort at Marseilles, a town which had also risen against the Convention. He had rejoined the army of Italy, when fresh disaster seemed imminent. After the 9th Thermidor, his relations with the Jacobins became compromising. Accused of having disclosed certain plans to the younger Robespierre, he was arrested, but, in default of evidence, was released on Carnot's instructions. Nevertheless his position at this juncture was extremely precarious. Under the nerveless leadership of Schérer, he had no opportunity of distinguishing himself in the Italian campaign except at Saorgio and on the Roja. He was marking time, in fact. Like a true soldier he detested the campaign in la Vendée, and he refused the command of an infantry brigade which was to be sent against the Western royalists. Aubry, the minister of war, removed him from the active list in consequence.

Reverses. — He now experienced real poverty, and had to sell his books and his watch. He thought of taking service with the sultan to re-organize the Turkish army. Madame Tallien, wife of the member of the Convention, whom he met at this time, interested herself in him and made his peace with the authorities. When Kellermann lost the lines of the Apennines it was remembered that Bonaparte knew Italy, he was taken into consultation, and joined the topographical service of the army.

At this time, in the autumn of 1795, Hoche, Marceau and Joubert were already famous; Bonaparte was still unknown. It looked almost as if fortune were definitely against him. The only thing which he had brought back from his campaigns was the itch and, probably, the malaria, which made him very ill. He was obliged to shave his head, which was later on to bring him the nickname of *"le petit tondu."* Small in stature, thin, yellow-faced, badly dressed, his person was unimposing and no one would have seen in him the future emperor of the French.

The Insurrection of 1795. — It needed a day of revolution and of civil war to bring him into prominence, by giving him the chance to do the Republican Government a service, the vital service of saving the Republic. In the autumn of 1795 the majority of the people of Paris were chafing against dear food, *assignats* and never-ending war. The Convention, by declaring for a constitution designed to keep its own members in power, provoked an insurrection, which, owing to the weakness of General Menou, very nearly succeeded. The Convention then placed the deputy Barras in command of the home forces. He, having known and learnt to value Bonaparte at the siege of Toulon, asked for, and obtained, his appointment as second in command. The young general at once assumed complete control, issued rapid orders, forestalled the insurgents who were about to capture the artillery parked at Les Sablons, and shot them down in the rue Saint-Honoré, on the steps of the church of Saint-Roch. In less than a day he had subdued a serious royalist rising (*13 Vendémiaire* — Oct. 4, 1795). He had saved the republic and earned the nickname *Général Vendémiaire.*

ITALIAN AND EGYPTIAN CAMPAIGNS

Italy. — His first reward was the hand of Josephine, a beautiful Creole, widow of the viscount de Beauharnais, who had been guillotined during the Terror. Josephine, whose morals were none too strict, was living at this time mainly by her wits. The general was six years younger than she, but he seemed to be on the threshold of a brilliant career, and the marriage freed her from poverty. He had, in fact, as his second reward been appointed commander in chief of the Army of Italy. Like Josephine, the government of the Republic was at the end of its financial resources. At this moment, indeed, there was difficulty enough in feeding the troops; it was hoped they would live on the conquered territory. At the beginning of March 1796 Bonaparte married Josephine. At the end of the month he arrived at his headquarters at Nice.

His army consisted of thirty thousand starving soldiers, in want of everything. He issued to them the famous proclamation: — "You are badly fed and all but naked. . . . I am about to lead you into the most fertile plains in the world. Before you are great cities and rich provinces; there we shall find honour, glory, and riches." He entered Italy on April 10. His plan of campaign — the separation of the Piedmontese from the Austrians — was very simple; he executed it successfully after severe actions at Montenotte, Millesimo and Dego.

While he was conducting the campaign, he did not forget that he was a general of the Revolution, and issued to the Italian people proclamations which, while treating the Catholic religion with respect, spoke the language of liberty. The king of Sardinia took fright, and, on the advice of the Archbishop of Turin, sued for peace to an army "with neither artillery, cavalry, nor shoes to its feet." The pope and the dukes of Parma, Modena and Tuscany were not long in following the example of Victor Amadeus. Great political schemes were taking shape in Bonaparte's mind, but first he had to beat the Austrians. This was, indeed, his first experience of large-scale operations. The crossing of the bridge of Lodi was a bold achievement which made his name known in a day all over France and indeed all over Europe. That day, by an old camp custom, his soldiers dubbed him corporal, and another nick-name, the *"petit caporal,"* stuck to him.

New Republics. — In May, some weeks after the setting out of his ragged army, he entered Milan in triumph. He could write to the directory: "The republic holds all Lombardy." At that same moment he received from Paris orders which upset all his plans. Sure that his resignation would not be accepted, he sent it in, and, while waiting for the answer, harried the Austrians, whose generals "faithful to the old system of warfare. scattered their troops in small detachments before a man who practised mass-movement." The further Bonaparte advanced with so small an army, the greater was the need for skill and boldness. At Arcola he suffered in his own person, by falling into a swamp. These "miracles of genius and courage" were crowned by the victory of Rivoli, followed by the preliminary negotiations of Leoben (April 18, 1797). "No other general could show such fourteen months." He had forced Austria to sue for peace. He had founded the Cispadane, the Cisalpine, and the Ligurian republics, which brought a large part of Italy under the same *régime* as France, and preparations were begun for its annexation. He had been able to provide for his army by requisitioning; to conquer without costing the treasury anything, and had even sent money to Paris. Finally when the Republicans, having lost their majority in the Councils, were in need of help, Bonaparte, though he had cause for complaint against the directory, sent them his subordinate Augereau, for the *coup de force* of Fructidor (Sept. 1797) directed against the royalists and the moderates. True, the royalists and moderates wanted peace, while Bonaparte agreed with the Jacobins, and aspired to secure France's "natural frontiers."

He was able to congratulate himself on fulfilling both desires by the Treaty of Campo-Formio (Oct. 17, 1797). By it the emperor ceded to France both Belgium and the left bank of the Rhine. Glorious as it was, however, and in keeping with Revolutionary foreign policy, the treaty, far from ending the war, perpetuated it. To assure the permanence of these conquests the goodwill of England was necessary, and England was not in a position to give it; compulsion was therefore necessary. The whole story of Napoleon up to Waterloo turns on this. Henceforth he was to struggle against England, and in that struggle he was in the end to be vanquished.

England and Egypt. — The brusqueness of his manner, and still more his popularity with the masses made him an object of suspicion, in spite of the services which he had rendered the Republic. He, on his side, despised the corrupt government of the directory, "a government of lawyers," whether Jacobin or moderate. He soon realised that their plans for an invasion of England had no chance whatever of success. In any case he thought it prudent to quit France for a time. The East had always fascinated him. "Only in the East can one do great things," he said. Reading and reflection had convinced him that Egypt was one of the keys of the world. This idea had already emerged in the days of Louis XIV., and was taken up again during the 18th century wars between France and England; there too Napoleon had his forerunners. He planned to strike at the power of England through Egypt and the route to India, and to stir the imagination of his own country-men. The directory accepted the scheme.

The Egyptian expedition was thus indirectly to be the means of forcing the British government to recognise the territorial acquisitions of the Revolution. The weakness of this plan, a weakness inherent in the whole struggle with England, was that France had no navy. Though Bonaparte, by a fortunate combination of circumstances, was able to land his army near Alexandria (July 1, 1798), Nelson, a month later (Aug. 1), destroyed the French fleet at Aboukir. From that moment the Egyptian expedition, instead of being *"le* commencement *d'une* grande chose" was merely an adventure. In vain Bonaparte executed a brilliant campaign, capturing Cairo, and subduing the country in three weeks. Of the great expedition nothing has endured but famous sayings, such as "Soldiers, from these pyramids forty centuries look down on you"; the Institute of Egyptology; the diffusion of the French language in the valley of the Nile; and, in Bonaparte's own case, a romantic touch of orientalism, symbolised by his faithful mameluke Roustan. Nevertheless, to carry through his great scheme, he undertook the conquest of Syria. Acre, under Admiral Sidney Smith, held out. "That man made me miss my destiny," he said later.

18th BRUMAIRE AND THE CONSULATE

The Coup **d'État.**—The expedition was, in fact, a failure. Bonaparte realized that there was nothing to be done in Egypt. At the same time came news which told him that there was work for him in France. The directory was in difficulties both at home and abroad. Disorder was rampant, finance and currency desperate, discontent everywhere. The Government, not knowing which way to turn, swayed one day to the Jacobins, the next to the moderates. In Germany the war continued, and in Italy the Republican armies suffered a series of reverses, and invasion was only checked with difficulty by Brune at Bergen, and by Masséna at Zurich. The restoration of the monarchy seemed inevitable. The republic could be saved only by a military leader.

"I seek a sword," said Sieyès, nne of the five directors, racking his brains for a general to whom he could confide the defence of the Republic. At that crucial moment Bonaparte decided to return. He went boldly on board a frigate, slipped through the English cruisers in the Mediterranean, and landed at Fréjus on Oct. 8, 1799. He was greeted with shouts of "Long live the republic." He was the man of the hour for all those who desired an end of anarchy but were opposed to the return of the Bourbons. Without him the Revolution was a lost cause. This consideration is essential to the understanding of the famous coup d'e'tat of the *18* Brumaire (Nov. 9, 1799).

The *coup* d'e'tat was organized, indeed, from within. Not only had Bonaparte accomplices among those in power, he had not even to offer or to impose himself; he was sought out. Baudin, a deputy from the Ardennes, and a staunch Republican, died of joy when he heard of the return of *"Général* Vende'miaire," who was once more to save the Republic. Of the five directors, Sieyks, though a regicide, had given up hope of saving the country except by a dictatorship, of which he hoped to be the head, with Bonaparte as his strong right hand. Roger-Ducos was of the same opinion. The third, Barras, was corrupt, and would do anything for money. Only the remaining two, Moulin and Gohier, were immovable in their Jacobinism, and had to be silenced. Resistance could come only from political circles, the assemblies, or perhaps from part of the army, where Jacobinism was still strong. The conspirators were assured in advance of the support of public opinion It is, therefore, essential to note that the coup d'e'tat was conceived and organized by Sieyès, who took charge of the parliamentary side, while Bonaparte was an executive agent charged with assuring the support of the army. We must not forget that from its origin to the days of *Fructidor* and *Prairial,* the Revolution had undergone many forcible changes and had violated its different constitutions over and over again.

The pretext for the transference of the two legislative assemblies from Paris to Saint Cloud on the *18 Brumaire* was *a* terrorist plot invented for the occasion. The plan, though well laid, all but miscarried. On the first day, that of *18* Brumaire, all went well, and, as the Convention had done in Vende'miaire, the assemblies placed Bonaparte in command of their forces. On the morrow at Saint Cloud, affairs took a dangerous turn. The Upper Chamber or Council of the "Ancients" had been won over, but the lower or Council of the Five Hundred, whose Jacobin members had had time to summon their forces, greeted the general with shouts of "Down with the dictator! Outlaw him!" Bonaparte lost the thread of his speech, lost countenance, and for a moment was surrounded by a threatening crowd of deputies. Soldiers came to his assistance; however, the day would have been lost but for his brother Lucien, who had made his way in politics and was president of the assembly. Declaring that the right of free speech had been outraged, he dramatically threw off his insignia and rushed into the court of the Orangery to harangue the still hesitating soldiers. Bonaparte, having recovered from a fainting condition, appeared, his face bleeding where, in his agitation, he had scratched it. This made the soldiers think that he had been wounded. General Eeclerc, his brother-in-law, thus charged at the head of his grenadiers and cleared the hall of the refractory deputies. That very evening Bonaparte, Sieyks and Roger-Ducos were elected "consuls" by the Council of the Ancients.

The Revolution was not over. Bonaparte was to continue it under monarchical forms, and to give it at last a government. Sieyks dreamed of giving a constitution to France, but France had worn out so many constitutions during the last ten years! Bonaparte, who had used the "ideologues" as stepping stones to power, now made it clear to them that they had a master; and of Sieyks' constitution, only such portions as suited him remained. Authority was narrowing its limits. Five directors had given place to three consuls.

First Consul. — Immediately after, Napoleon became the first, the only one, elected for ten years. Public opinion gave him what was practically unlimited power. Disillusion and anxiety made him master of France. Some were tired of violence and disorder. Others, who had profited by the Revolution to possess themselves of national property, feared the return of the Bourbons and its restoration to its former owners. The mass of the people therefore, desired the consolidation of the new re'gime. Had it not been for the *18* Brumaire, it is probable that the restoration of the legitimate branch would have taken place much sooner, before the Napoleonic empire had consolidated the results of the revolution by permanent institutions. The great mistake of the royalists was to look upon Bonaparte as another General Monk. He replied with disdain to the overtures of the comte de Provence—the future Louis XVIII. The royalists in their turn hastened to resume the struggle against him, thus definitely marking him as the representative of the "revolution in arms."

The Revolution was further indissolubly bound to its idea of "natural frontiers," and could not surrender the conquests which the rest of Europe refused to recognise. The war had to go on, whether they liked it or not—a fact which entailed government by a soldier. With the rest of his heritage, Bonaparte had to accept the necessity which had made the weak directory as warlike as the Convention. His term of power served merely to postpone the inevitable catastrophe.

Reforms. — His first work was to restore order and to regulate the administration of government. Here his lack of prejudice helped the first consul. As has already been said, being of French education, but not of French origin, he neither disliked nor regretted the old *régime.* He was thus able to adopt the strong points of the old monarchical system and reject the weaknesses of revolutionary democracy. The Revolution had made the system of election universal, in the civil service, in the magistracy, and in the police: a fault which killed successive governments. Bonaparte replaced the elected committees by prefects and sub-prefects, thus re-establishing and multiplying the old *intendants*. Unwilling to restore completely the independence of the magistracy, of which the parlements had availed themselves against the crown, he gave the government the right to nominate magistrates, while making them, in the interests of justice, irremovable. Thus, making use of the experience both of the monarchy and of the revolution, Bonaparte framed the system known as the constitution of the year VIII. based on administrative centralization which subordinated the nation to the State, and which has been so convenient for governments that it has been kept in being by all the succeeding régimes. Altered only in detail, it subsists today.

At the outset Bonaparte justified the hopes aroused by his *coup d'état*. The mass of the people longed for peace at home and abroad. He appeared to fill the rôle of peacemaker. Having rid himself of Sieyès, he associated with himself, for form's sake, two other consuls, Cambacérès and Lebrun, men of ripe age and moderate views, the latter of whom had been secretary to Chancellor Maupeou under Louis XV. When a plebiscite was taken, the First Consul was approved by three million votes. He immediately reassured both the solid middle class. and the revolutionaries who had enriched themselves during the Revolution. He wiped out the last relics of Jacobinism, by suppressing the progressive forced loans, and the law of hostages. He re-opened the churches and pacified the Vendée by putting an end to religious persecution and thus indicating a forthcoming *concordat* with the Pope. With the help of a former official of the monarchy, Gaudin, who became duke of Gaeta, he reorganised the finances, and prepared the way for a return to a stable currency.

Marengo and Elohenlinden. — Abroad his task was more difficult. There is no reason to think that Bonaparte was not sincere in trying to put an end to hostilities, though he may have wished to prove to the peace party that peace was unobtainable. The proof, in any case, was quickly forthcoming. The emperor of Russia having retired from the coalition, it remained to deal with England and Austria. The first consul offered a cessation of hostilities. It was a mistake to think that England, so long as she remained mistress of the seas, would ever allow France to retain possession of the mouths of the Scheldt. Pitt refused. Then Bonaparte made another miscalculation. **A** smashing victory on the Continent would, he thought, compel England to yield. He persisted in this erroneous idea until Waterloo. His history henceforth is a striving for the impossible, *i.e.*, the capitulation of Great Britain on a point she had never admitted — the annexation of Belgium — by a France, which was powerless at sea.

Seven months after the 18 *Brumaire*, he boldly crossed the Alps by the Great Saint Bernard to compel Austria to make peace. On June 14, 1800, the hardly won victory of Marengo made him once more master of Italy. Together with Moreau's victory at Hohenlinden in December, it forced the Emperor Francis to sign the treaty of Lunéville, by which Austria recognized all the conquests of the Revolution. The left bank of the Rhine became part of France, and was divided into departments. This was the triumph of Bonaparte and of the revolution. For the first time in history France had regained her "natural frontiers," those of Gaul as known to Caesar.

By the treaty of Lunéville, the British government lost her last Continental ally. The war was costing dear, and many people were weary of it. Trade was severely affected. The first consul, who knew this, resumed in appearance the preparations for invasion, which had been begun in 1797. When, after the fail of Pitt, negotiations were begun with the London cabinet, he strove to drive a bargain, renouncing all claims on Egypt. In March 1802, the treaty of Amiens was signed. It was. and could only be a truce, but the French saw in it definitive peace, and the prestige of the first consul was increased.

Extensions of Power. — In the midst of his success there was one seed of anxiety. He was in power only for ten years. Three had already passed, and opposition was beginning to make itself felt. A Jacobin conspiracy was discovered. Soon after he narrowly escaped being killed by an infernal machine. Former terrorists were thought to be responsible, but Fouché, the minister of police, found that the criminals were royalists instigated by the irreconcilable Cadoudal. Then the Tribunate instituted by Sieybs, opposed Bonaparte's favourite ideas; the Concordat with the Pope, the Order of the Legion of Honour, the Civil Code. Their opposition would become more formidable as the ten year period drew to a close. Definitely to establish the Consulate, and to make it safe from attack, permanence was desired. Thus by a natural progression opinion tended towards the revival of the monarchy in favour of the first consul. He himself was silent, asked for nothing, and let his friends work for him This they did most effectively.

After the triumph of the peace of Amiens, they proposed a national token of gratitude. The Senate accorded only a prolongation of power for a further ten years. This was a discomfiture. Then Cambacérès thought of consulting the people whether Napoleon Bonaparte (his Christian name was beginning to be used officially) should be made consul for life. It was carried by three and a half million to less than ten thousand votes. The first consul also received the right to choose his successor (Aug. 1802). Although he then had no children, there was nothing to prevent him from choosing his son, if he should have one.

Hereditary monarchy was thus on the point of being re-established, after so many solemn protestations to the contrary. From that time the sovereigns of Europe began to regard Bonaparte as one of themselves. They matched him "climbing step by step towards the throne," though there were to be further happenings before he reached it. It would be an error to accuse him of having sought to gain the crown by means of a new war. The establishment of the empire was an indirect consequence of the renewal of hostilities in May 1803, the immediate cause of which was a dispute over Malta and the interpretation of the treaty of Amiens, though for reasons easily understood, and beyond the control of statesmen, peace could never have been more than a truce. Could England allow France to remain in permanent, possession of the finest coast line and most valuable ports of the Continent from Rotterdam to Genoa? To put the question is to answer it. And we must remember that Napoleon had received Belgium and Holland in trust for the Revolution.

Counterplots. — France and England slowly prepared for a struggle which this time must be carried to the bitter end. The twice abandoned plan of invading Great Britain was again resumed, and a camp was formed at Boulogne. Meanwhile the irreconcilable royalists, encouraged by the first consul's new difficulties, conspired with General Pichegru to assassinate him. Georges Cadoudal, who had landed in France, succeeded in implicating the celebrated Moreau, jealous of the first consul. The discovery of this plot infuriated Bonaparte. He accused the *émigrés* of ingratitude, publicly affirmed his republican sympathies, and declared that the intention was to destroy the revolution in his person. He determined to strike.

A young prince of the house of Condé, the duke of Enghien, one of the Bourbons, was forcibly seized on the territory of the duchy of Baden, summarily tried and shot. Bonaparte has been universally condemned for this judicial murder, which set "a ditch filled with royal blood" between the older dynasty and the throne upon whose steps he stood. His regicide monarchy was no longer suspect even to the fiercest republicans. Just as the infernal machine had contributed to the success of the first plebiscite, the conspiracy of Cadoudal and Pichegru facilitated the proclamation of the empire. The first consul had escaped the conspirators, and the danger helped his cause.

THE FIRST EMPIRE

The consulate for life seemed too precarious; a Napoleonic dynasty would survive its founder. Since his enemies, who were the enemies of the revolution, wished to destroy him "he must be made king or emperor, so that heredity should reinforce his power by ensuring him of natural and unquestioned successors and, by rendering useless crimes against his person, should remove the temptation to commit them." (Thiers.)

Thus France returned to hereditarv monarchy, approved by a unanimous vote of the Senate, and by a plebiscite. The empire was proclaimed on May 18th, 1804, the title of emperor being chosen because the word king was inseparably connected with the Bourbons, and because it sounded more impressive, more military. It evoked, moreover, memories of Rome and of Charlemagne And, like Charlemagne, Napoleon wished to be crowned by the Pope, not in Rome but in Paris. After some hesitation Pius VII. granted his request. On Dec. 2, at Notre Dame the amazing ceremony took place, and the soldier of the revolution became the anointed of the Lord. Moreover he took the crown from the hands of the Pope, and placed it on his own head. And Josephine the Creole adventuress, became empress. But Napoleon could dare all. He built up a new nobility, he gathered together a court France approved of everything. When the wife of Marshal Lefebvre (the celebrated *Madame Sans-Gêne,* who had been a washer-woman) became the duchess of Dantzig he dared even ridicule.

Boulogne, Ulm and **Cadiz.**—The empire united the old France with the new; in it revolutionary and monarchical ideas were combined. There was general satisfaction. Prosperity had returned with ordered government. No one troubled about the one weak point. The empire could not be really established, nor the conquests of the revolution assured, without the defeat of the British power. Napoleon did not forget it, and in the midst of his re-organization of home affairs, his thoughts were on the camp at Boulogne. He knew that to settle finally with England he must overcome her on her own ground, and must have therefore, were it only for one day, free passage across the Channel. A third coalition was forming. He could, he was sure, defeat its forces by land, but this new victory would be no more effective than earlier ones, so long as the British navy, was undefeated. With the help of Admiral Decriis, Napoleon had laboured since the days of the consulate to re-establish the French navy, ruined by the Revolution. But a navy is not built in a day. Failure at Boulogne was to change the fortunes of the empire.

Yet the plan was bold and simple. France had two squadrons. The destruction of one mattered little if, while it fought, the other could slip into the Channel and for 24 hours assure the transport of the troops gathered at Boulogne. On this strategy everything turned; it failed. Villeneuve failed Napoleon, as Grouchy was to fail him at Waterloo. The admiral was uneasy about his equipment, his officers, and his raw and untrained crews. His anxiety was shared by Decriis, the minister of marine. Napoleon spent the month of Aug. 1805 in cruel suspense. Villeneuve, he learnt at last, had not dared to enter the Channel and instead of bearing towards Brest, was making sail to the south. Once more the invasion of England must be abandoned, or at least postponed. Austria was openly threatening, Russia was arming, Prussia could not be depended upon. Austria must be brought to the knees without delay. Napoleon broke up the camp at Boulogne, marched into Germany with amazing rapidity ("The emperor makes war with our legs," said his soldiers) and forced General Mack to surrender at Ulm on Oct. 19.

Two days later this magnificent victory, with all those which were to follow it, was nullified. Villeneuve, blockaded by Nelson in Cadiz, had tried to escape. The British fleet, though smaller in numbers, had destroyed the Franco-Spanish off Cape Trafalgar. From that day the French empire was doomed. Napoleon was faced with the hopeless task of subduing England, absolute mistress of the seas. All his future was governed by that impossibility.

Austerlitz and **Jena.**—Because he had not crossed the Straits of Dover, he was to go in vain even to Moscow. In vain he sought to triumph first over the Continental powers, hoping then to find the British government discouraged and in a mood for compromise. The Russians having offered battle, he defeated them, and also a fresh Austrian army, in the most brilliant of his victories, that of Austerlitz (Dec. 2, 1805), exactly a year after his coronation. In a few weeks the third coalition was wiped out.

The armies of France, under the single command of a man who was a military genius and an absolute sovereign, seemed invincible. Napoleon. and perhaps he alone, knew that no decision had been reached. He rejected Talleyrand's plan for a reconciliation with Austria, and, returning to the idea which had inspired his Egyptian expedition, planned to strike at England through the East. By the peace of Pressburg he made of a subjugated and diminished Austria a means of communication with Constantinople. The vision was taking shape. To realize it, however, he must dominate all Europe. Within a few years he exhausted the Empire in the attempt. With the conquest of Belgium as a starting point, the revolution urged its successor to vast enterprises, for which neither the military genius of Napoleon nor his political ability would suffice. It was not mania for conquest but the logical development of these schemes which led him to annexations and dangerous territorial adjustments which disquieted all Europe. His brother Joseph became king of Naples, his brother Louis king of Holland. He formed the states of Southern Germany into the Confederation of the Rhine, with himself as president. Prussia, charged with closing the Baltic to the English, was promised Hanover, and the Bourbons, dethroned in Naples, were to have the Balearic isles. After the death of Pitt, he tried to conciliate England by offering secretly to restore Hanover. These diplomatic moves served only to make him two enemies, Prussia, which he had humoured for so long, and Spain, a former ally.

The Prussian campaign saw another of the lightning strokes which he understood so well. The Prussian Army, which had lived on the reputation gained under the great Frederick, was routed at Jena (Oct. 1806). In a few weeks the defence had collapsed, and Napoleon was master of the greater part of Prussia.

The Subjugation of Europe — Since Prussia had refused to lend herself to his schemes, he would make northern Germany another annex to his empire, himself closing the Baltic and eventually all Europe, to English commerce. From Berlin he promulgated the Continental blockade, an idea arising naturally out of the situation, simple, easy to set out on paper, but entailing the suppression of the independence of all the nations of Europe, since the prohibition of trade with England to be effective must be general. The Continental blockade was the consequence of and the counter-strike to Trafalgar.

But Napoleon was caught in a net from which there was no escape. He had set himself an endless task. After Ulm had to come Austerlitz, after Austerlitz, Jena. After Jena he had to complete the conquest of Prussia, and to complete it, to defeat Russia, penetrate further into the East, cross the Vistula. At Eylau (Feb. 8, 1807), three hundred leagues away from France, he fought in the snow a bloody and inconclusive battle. A new effort, the calling up of next year's conscripts was demanded of Frenchmen "that peace might be won." In June at Friedland, the *grande armée* was again victorious.

Once more Napoleon had the illusion that the goal was reached, that he was master of Europe and could hold England to ransom. The tzar Alexander, highly strung and impressionable, was now won over to the idea of an agreement with the emperor of the French for a policy of partition on 18th century lines. This time Turkey was to be divided instead of Poland. Napoleon was convinced that, allied with Russia against England, able to close the Mediterranean against her, threatening her even in India, he would force her to her knees. The meeting at Tilsit, and the conclusion of the pact of friendship between the emperor of the East and the emperor of the West, seemed to justify the costly victories which had led the French army as far as the Niemen.

Spain, Prussia and Austria. — The first disappointment was that the Franco-Russian alliance determined England to fight more fiercely than ever; her answer was a declaration of war against Russia, and the bombardment of Copenhagen. The Continental blockade everywhere led to increasing difficulties. Portugal showed no eagerness to shut out English trade. Junot had to be sent there with an army. Spain was also giving trouble, and Napoleon determined to drive the Bourbons from Madrid. As if he were transferring prefects, he placed his brother Joseph on the throne of Charles IV., and succeeded him at Naples by Murat, who had married Caroline Bonaparte. At the same time the occupation of the Papal States by General Miollis, charged with enforcing the blockade, embroiled him with the Pope. The system drove Napoleon to increasing severity. To hold Germany and Italy, together with the Adriatic coasts, and the Spanish peninsula, would soon require a standing army of a million men, while the patience with which his conquests and his violence were endured would decrease in proportion to the dispersion of his troops.

Spain gave the signal for resistance. The Spanish people refused to recognise Joseph, and a wide spread insurrection broke out. When, in July 1808 General Dupont surrendered at Baylen, the Napoleonic empire suffered its first military reverse. The news resounded all over Europe. At the same time an English army landed in Portugal and Junot succumbed to superior numbers. Napoleon's desire to direct and control Spanish affairs had not only caused the English to be received as liberators, but had committed himself to an endless struggle against a people in arms. The uprising of the Spanish nation was infectious. In Prussia, in Tirol, in Dalmatia, patriotism was extolled, and the idea of a holy war for national independence took root and grew. In later days the emperor realized that Spain had been his first check, and that the limit of his power had been attained. In spite of a fresh interview at Erfurt, at which the two emperors paraded their friendship before an audience of kings, the Franco-Russian alliance languished. The partition of Turkey was hindered by the question of Constantinople, which neither emperor wished to see in the power of the other. Alexander was beginning to doubt the power of his new friend. Napoleon, feeling that the ill-success of his policy in Spain was injuring his prestige, determined himself to cross the Pyrenees, and re-establish Joseph in Madrid.

Incited by England and lavishly supplied with English money, Austria took advantage of his absence to re-enter the struggle. Napoleon had to return in haste from the Ebro to the Danube. The Austrian plans were carefully laid, and their opposition was far from negligible. Essling was a difficult, and Wagram (July 1809) a costly victory, but in both he carried the day.

Russia. — From these very successes, however, there arose a further complication. Napoleon had made use of Poniatowski and his Poles against the Austrians. Alexander, who, in any case, had remained neutral, feared that Napoleon was planning the reconstitution of Poland. Abandoning his former ally, he denounced the Continental blockade, and had in his turn to be encountered. The idea of conquering England by Europe and Asia, the sea by the land, had brought about a result which, though it seems at first absurd, was yet the logical conclusion.

It was with no light heart that Napoleon decided to carry the war into Russia. He still hoped that it might not be necessary, if Spain were subdued and if the United States, to whom he had ceded Louisiana and promised Florida, declared war on England, which, attacked in its vital interests by the Continental blockade, would at last sue for peace. There was no doubt that the blockade was having a disastrous effect on British trade; its results on the commerce of other nations were no less serious. Holland refused to enforce it, and Napoleon was obliged to resume control from his brother Louis, who had espoused the cause of his new subjects. He annexed the country, and divided it into departments, thus giving England a fresh reason for remaining under arms. In this way the Continental blockade led either to fresh wars or to expansions of territory which the English inevitably refused to recognise, since they had never recognised those revolutionary conquests which the new ones consolidated.

France was growing uneasy. Common sense made it clear that this extension of territory and of war could not go on indefinitely, and yet no end was in sight. Far-seeing members of the emperor's own circle, such as Talleyrand and Fouché, began to fear that affairs were going wrong. "If it only lasts," said Laetitia Ramolino, *Madame Mère*. Yet the empire never seemed so great, nor the future so secure as in 1810.

Marie-Louise. — Already on a level with kings, Napoleon in his second marriage equalled the proudest dynasties. The head of the house of Habsburg gave him the hand of his daughter. Josephine, though she was loved by the people and her dethronement regretted, was growing old and she had given him no heir. He was tired of her, and anxious to ensure the succession. The emperor of Austria must have shared his confidence in the future, since he was willing to accept the "Corsican ogre" as his son-in-law. The marriage contract with the archduchess was modelled on that of Louis XVI. and Marie-Antoinette, into whose family he was now admitted, in one of the most extraordinary episodes of even his life. The following year Marie-Louise bore him a son; the empire had an heir, who was given the title king of Rome, as the heir to the Holy Roman Empire had been named king of the Romans. But in 1811 Rome was but the capital of the department of the Tiber. The pope had been deported to Savona and was about to be imprisoned at Fontainebleau. By the Continental blockade the restorer of Catholicism in France had been led to alienate Catholics all over the world. Nevertheless, excommunicated, having driven the Bourbons from Naples and from Madrid, the man who 20 years before had been an insignificant officer with neither name nor fortune, married a daughter of the Habsburgs. Confident in his star, he carried all before him.

Though his marriage gratified his ambition, Napoleon had decided upon it only after the failure of negotiations for an alliance with a sister of Alexander. He would have preferred a Russian princess, for more than one old veteran of the Revolution, remembering Marie-Antoinette, asked why the "little corporal" should marry another "Austrian." But the Russian emperor was gradually disengaging himself from the alliance, on which Napoleon was ceasing to rely.

Moscow.—Realising that the Russians would never consent to the extension of the French empire, which under the necessity of the Continental blockade had ended by annexing the Hansa towns of Bremen and Hamburg, and making them the principal cities of two of its hundred and thirty departments, he saw that war was inevitable. French territory now stretched to the Baltic, and the nearer its boundaries approached those of Russia, the greater was the danger of conflict. Difficulties arose continually over Oldenburg, Poland, the East, and the reluctance of Russia to abandon trade with England. The two allied emperors were arming against each other. These preparations were themselves a further offence. Convinced that this new struggle had been decreed by fate, and that his work would not be accomplished till he had vanquished Russia as he had vanquished Prussia and Austria, Napoleon now assembled for the campaign of 1812 the greatest army which the world had yet seen, an army of "twenty nations" made up of contingents from all the peoples allied to or dependent on France, a sort of Western crusade against Asiatic Russia. By natural inclination, as much as by policy, Napoleon raised again for this crusade the battle cry of the Revolution, the liberation of nationalities, of which the reconstitution of Poland was to be the token. He forgot that the Spaniards were already fighting for their independence, and that the nationalism, awakened by principles of the Revolution, was stirring the people of Germany. Alexander, who could play many parts, also spoke the language of liberalism, invoked justice, enlisted on his side the countries defeated and subjugated by France or in rebellion against her, and prepared for peace with Prussia and Austria by complicity in the partition of the Polish provinces. Napoleon was thus to stake everything on the inevitable Russian campaign. Victorious, he would be master of the East, of Constantinople, of all Europe, and would at last force the English to capitulate. Defeated, he himself would have given the signal for the debacle. The war which began in 1792, having carried the French to the gates of Moscow was to return by a swift and violent revulsion to the gates of Paris.

In June 1812 the grande *armée* crossed the Niemen. According to their custom, the Russians declined battle. Alexander had said that he would retire if necessary beyond Tobolsk, while Napoleon imagined himself dictating peace from Moscow. The Russians set fire to the city, and made no peace. Then began a retreat which after the passage of the Beresina became a disaster. In the month of December, Ney and Gérard arrived at Konigsberg almost alone. The *grande armée* had melted away. Realising the extent of the catastrophe, and its probable effects in Europe and in France itself, the emperor had secretly left the army, which was kept in ignorance of his departure. The news of General Malet's conspiracy, which had reached him in Russia, had shown him how precarious was his position and how much weakened his prestige.

The Loss of Germany. — The subsequent history of the Empire is the story of a rapid return to the conditions under which Napoleon had assumed the dictatorship in 1799. The Republicans themselves on the *18th Brumaire* had entrusted him with the task of saving the Revolution and its conquests. To this end France had allowed him to take the crown, to found a dynasty, to overrun three-quarters of Europe and to raise countless armies. All in vain. In a few months he was back at his starting point.

The Spanish insurrection of 1809 had encouraged England to persevere, and had revived the resistance of the conquered peoples. The disasters of the Grand Army in 1813 spurred on his enemies still more. "A few more sacrifices," said the English, "and our end is accomplished." Not even the long hoped for declaration of war by the United States, due not to French diplomacy but to the doctrine of the freedom of the seas as opposed to the English "tyranny at sea," could affect the determination of the British government. Everything pointed to a vast change of fortune in favour of the cause of which England, at one moment, had remained the sole champion. Nationalist propaganda was bearing fruit in Germany. Prussia, while still protesting fidelity to Napoleon, had shifted her allegiance, and secretly reconstituted her army. A Prussian corps in French service, commanded by General York, went over to the Russians. Its defection made a great sensation in Germany and hastened the continued retreat to the Elbe of the remnants of the French army. The Prussian government then unmasked and, obedient to popular opinion, proclaimed a war of liberation and independence.

Napoleon chose to consider his Russian defeat as an accident. In Germany it would always be easy for him, he thought, to beat the Prussians and the Russians; having raised and trained a fresh army he did, in fact, beat them at Lutzen and at Bautzen. The campaign of 1813 opened well. He was, however, justly apprehensive of Austria, and instead of following up these fresh successes he agreed to an armistice, so as to be ready for the third adversary. A coalition of Austria, Prussia and Russia had no terrors for him. He wished to settle with it as quickly as possible, thinking that he held enough cards to secure even from England a favourable peace. The victory of Dresden (Aug. 27) seemed to justify this. But, one after the other, his generals, badly served by their contingents from the Germanic Confederation, were beaten in the field. and his plans were delayed. At Leipzig, where he had returned to prevent the junction of his three opponents, Napoleon fought a three days' battle (Oct. 16–19), during which his Saxon troops went over to the enemy. Having lost this immense battle, and all Germany with it, he had to fall back to the Rhine. In November what had been the *grande armée* entered Mainz, after fighting its way through the Bavarians who in their turn had betrayed him.

Was it possible, on the banks of the Rhine, to secure peace on the basis of "natural frontiers"? The question had been identical under the Revolution. Prussia showed herself at last as the German power most fiercely opposed to France, and England insisted on the renunciation of Antwerp. This was, as it had been during twenty years of war, the question at stake.

Disintegration. — Holland had risen against French rule. Belgium was tired of conscription and of taxes, and there also was awaking an old, invincible consciousness of nationality. The British government, well informed on the condition of' France, was aware of her exhaustion. Everything, they knew, had been organized for conquest, nothing for defence. The Allies were much superior in numbers. Even within its own boundaries the Napoleonic empire was tottering. Their determination to finish the business once and for all carried even more weight than Prussia's hatred, and the negotiations which took place before the Allied entry into Paris were for that reason insincere. It had been clear since 1798 that, with England undefeated, France could make peace only on returning to her former frontiers.

No one knew better than Napoleon himself that he was, as the Convention and the directory had been, bound hand and foot by the war and its conquests. He must defend those conquests to the end, or perish with them, as the Revolution had perished. The very nature of his power and the conditions on which he had received it, forbade him that honourable and prudent peace which he has been vainly reproached for failing to achieve. First the allies would have none of it, though their unwillingness was veiled to give the impression in France that only the insensate ambition of the emperor stood in the way; secondly. no government of revolutionary origin could accept the former boundaries. The situation was the same as in 1799. "As things are," said Napoleon, "no one but a Bourbon can succeed me."

The Bourbons, however, succeeded him for another reason. When the Allies invaded France in 1814, they were not in agreement on the form of government. They had not made war for the re-establishment of the monarchy before or now. The Austrian emperor preferred the regency of his daughter Marie-Louise, which would have given him control of French policy. The emperor of Russia dreamed of a king of his making, such as Bernadotte, one of the luckiest adventurers of the Revolution, who by an unprecedented combination of circumstances had become crown prince of Sweden and had betrayed Napoleon. Prussia, concerned only with her own aggrandisement, cared little who ruled in France provided that she obtained her share of the spoils.

Thus Castlereagh, who wished to see France smaller, but free and in subjection neither to Austria nor to Russia, became convinced that a Bourbon monarchy alone would fulfil England's conditions, since, according to Albert Sorel, "this government of principles and not of expedients would be neither the debtor nor the client of any of the Allies." Unknown to, or uncomprehended by the French, this was the reason for the restoration, which to them seemed to be arbitrarily imposed by the enemy, though, in accordance with the English theory of the balance of power, it was intended to preserve their national independence.

Napoleon's campaign in France, the most brilliant of them all, was a barren masterpiece. Albert Sorel has compared his victories, Brienne, Champaubert, Monttnirail, Montereau, to that of Valmy. The Allies hesitated and wondered whether to negotiate. But just as the Revolution had demanded that the enemy should quit French territory, so Napoleon insisted on the guarantee of "natural frontiers." He could do no less, but the object of the coalition was to deprive France of them. "We must reassume the uniform and the courage of '93." he said in Feb. 1814. He clung instinctively to the Revolution, and welcomed the proffered assistance of Carnot, former comrade of Robespierre, and one of the few revolutionaries who had held aloof from the empire. The allies on their side remembered that when, after Valmy, the invaders had retired behind the Rhine, Revolutionary France had decided to pursue them. This recollection stiffened their determination, and strengthened their alliance. The four powers bound themselves afresh by the pact of Chaumont, and resumed the offensive, determined to dictate terms of peace.

Everything was crumbling around Napoleon. With the last levies which France could give him, scarcely more than children, he again tried to hold back the enemy, then to outflank and defeat them. His plans failed for want of men. On March 30 the Allies were masters of Paris, and a German wrote from Montmartre, "Nine and a half centuries ago our emperor Otto planted his eagles on these hills."

Abdication. — On April 11, 1814, at Fontainebleau, Napoleon abdicated. Not only had his Senate, the child of the *Corps Législatif* of *Brumaire,* itself the child of the Convention, deserted him and declared for the Bourbons, but his marshals fiercely urged him to renounce his sovereignty and leave the country. They had returned to the position before the 18 *Brumaire*, from which the Directory had sought to escape. It is again Albert Sorel who notes that the empire ended, as the consulate began, by one of those "days" which had overthrown so many revolutionary governments. On May S, Louis XVIII. entered Paris, while the fallen emperor landed on the island of Elba where his sovereignty was recognized. The former master of Europe now reigned over a few square miles. But he was only forty-five and in the full force of his powers. A man of such immense energy and such ardent imagination could not resign himself so easily to defeat.

Only 25 years separated the beginning of the revolutionary era from his fall. A quarter of a century, however crowded with events, is a short space of time. What had happened? In the part of its programme which included republican government, and "natural frontiers," the Revolution had doubly failed: first, when to save itself it had had recourse after the 18th *Brumaire* to a dictatorship, to absolute sovereignty, to the empire; and again when after incessant fighting for "natural frontiers," the empire had ended by laying France itself open to invasion. Conditions which the Revolution would never accept even though the refusal involved a military despotism, were now imposed. France was obliged to return to her former boundaries, and this involved the restoration of the Bourbons. It was the only possible solution, and there were few in 1814 who did not accept it. Talleyrand, who was far from being a legitimist, played a principal part in the restoration, simply because he realized that it was the only solution. Any government, whether republican or imperial, which sprang from the revolution, was doomed to war, and France had already waged war to the limit of her strength. The monarchy alone could assume the heavy responsibility of concluding peace on the terms offered. Hence when the French had forgotten the disasters and the despotism of the empire arose the reproach that the Bourbons had "returned in the baggage waggons of the enemy."

The return of Louis XVIII. was accompanied by the grant of the "Charter," and representative government. He did not restore the institutions of pre-revolutionary France, but on the contrary, retained those of Napoleon, of the year VIII., even confirming the greater number of his prefects in their office. It remained to make peace in Europe. Louis XVIII. and Talleyrand, making use of the jealousies which had arisen among the allies, sought to make the general settlement as favourable as possible to France. The Congress of Vienna was still sitting when, early in March 1815, the news came "like a bombshell" that "Bonaparte" had escaped from Elba. It had all to be done over again.

There are few examples in history of such sentimental and passionate episodes as the return from Elba. Though the good sense of the French protested against the adventure, it caught at their hearts. Napoleon brought with him so many memories, and with them the tricolor. The daring of his landing in France recalled the return from Egypt. He had only to appear, and almost all France rushed to support him. Yet moderate men realized that the emperor's new adventure was all but hopeless, and would end in a catastrophe even worse than that of 1814. Liberals regretted the loss of the "Charter." France was sick of war, and the abolition of conscription had been the most insistent demand made on the Bourbons. Napoleon maintained that he had been recalled by the people, universally dissatisfied with the restored monarchy. There was, of course, unavoidable friction between the old émigré 'society and the new. There were in particular soldiers who had held out alone in Germany, Holland and Italy, and had not returned to France till after the convention of April 23. These had not witnessed the invasion, and felt that the fall of the emperor had been undeserved. There was also to be reckoned with, the discontent of the officers who had been placed on half pay.

None of this was really serious, however. Only the presence of Napoleon himself, escaped from his island prison, could have brought about the flood of popular feeling by which he re-conquered France in three weeks. He had only to appear and all was forgotten, the disasters of yesterday and those which his return implied, the slaughter which had brought curses on his name, the detested conscription. Officers and men rallied round him. He had not lost his power of appealing to them, and he stirred their hearts by memories of past glory. After the first moments of hesitation the detachments first sent against him declared for him. Grenoble, then Lyons opened its gates. Marshal Ney, who had undertaken to apprehend him and to bring him back if necessary in a cage, wavered, was carried away, and fell into his arms.

The Hundred Days.—Having landed in the gulf of Juan with a handful of men on March 1, 1815, he was at the Tuileries on the 20th, and Louis XVIII. had fled to Ghent.

A hundred days: the adventure lasted no longer, and was doomed from the outset. Three months' madness. To understand why Napoleon, who, ten months before, had been deserted and denied by all, became the master of France in three weeks in a rush of passionate enthusiasm, we must take into account the change in himself, and the new rôle which he played in opposition to the Bourbons. He was not only a military genius. He was a supremely able politician, and his talents had been perfected during the revolution. He now awoke its memory, talking to the soldiers of glory and to the people of peace and liberty. The former despotic emperor returned a demagogue. Two things menaced him. There was first the fear that the allies would again take up arms, but that he assured the people would be prevented by his father-in-law, the emperor of Austria. Then there was his own despotism. But he told the peasants that they were threatened with the revival of tithes, seigniorial privileges and rights. "I come," he said, "to free you from bondage and serfdom." He who had restored the rights of the Church, and founded a new nobility now incited the mob against the nobles and the priests. To the Liberals he promised representative government, the freedom of the press, everything which Louis XVIII. had already granted, but with a new revolutionary tinge. The idea of a liberal Napoleon conformable with the principles of the Revolution, remained in men's minds. From it dates that alliance of the Bonapartists with the Liberals which disturbed the restoration and the reign of Louis Philippe, and paved the way to the era of Napoleon III.

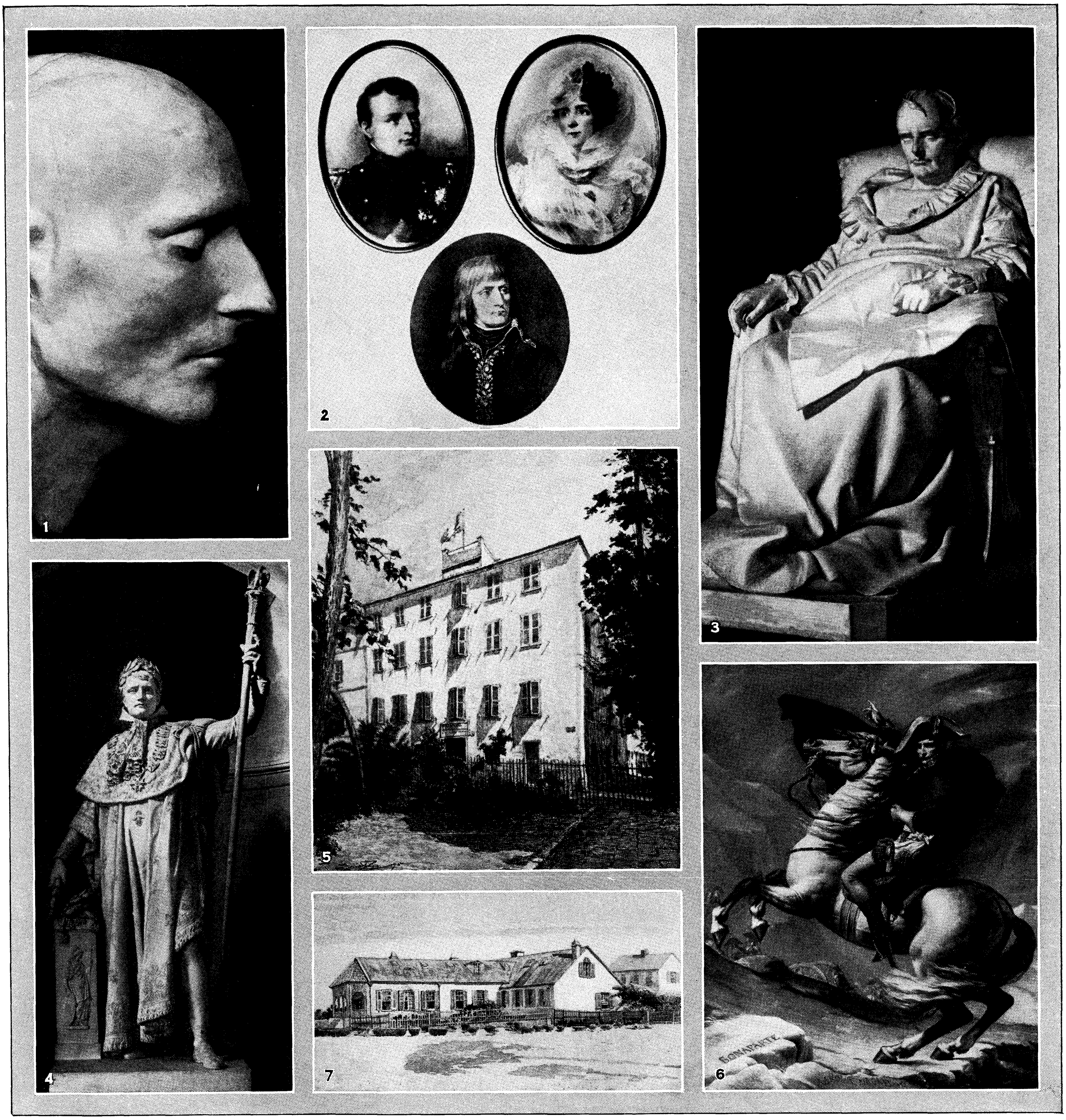
Abroad the consequences of the return from Elba were no less grave. The allies at Vienna learned the news on March 13. They immediately declared the emperor an outlaw. The pact of Chaumont was renewed. Resumption of the war was certain, and new disasters probable for France. Talleyrand, the French representative at the Congress, was in a cruel position. Foreseeing the event, he associated himself with the allies in order at least to keep the conditions of the Treaty of Paris, and to prevent the next treaty from being made even more severe. It was easy afterwards to pillory this prudent decision, and to assert that the Bourbons had joined with the enemies of the French people. When those who had compromised themselves in the Hundred Days sought for an excuse, they used this treacherous argument.

DOWNFALL AND CAPTIVITY

Waterloo.—Napoleon had never held the illusion that the allies would permit him to reign, nor that he could reign, over a France reduced to its former boundaries. He was still subject to the law which had in the past driven him incessantly to battle. Outlawed by Europe, he prepared to fight. He could still command his followers, but the enthusiasm of the early days had evaporated and there were sinister forebodings. There were many abstentions from the plebiscite held, as before, to approve the supplementary Act to the constitution. The assembly of the *Champ de Mai* resuscitated as the festival of Federation, was gloomy. The spirit of the people was exhausted, their minds disturbed, and Napoleon's supporters uneasy. To prevent a new invasion, the Emperor left for Belgium on June 12 with the intention of separating Wellington and Bliicher, who had a hundred thousand men more than he, and defeating them successively. In spite of a success at Ligny, he failed to prevent the junction of the English and the Prussians. This was partly due to what is usually called ill-fortune, but is really the resultant of many forces. Grouchy, a second-rate general to whom Napoleon had given a command in reward for political services, blundered, and remained inactive during the great battle which took place on June 18 at Waterloo—the name of a disaster unparalleled since Trafalgar. On his return to Paris on June 20 no other course but a second abdication was open to Napoleon. All was over. The Napoleonic drama culminated in disaster,

It would appear that in order to strike the imagination of mankind a hero's life should end with a great misfortune. If he had died a natural death in his palace, or fallen on the field of battle, Napoleon would never have become to posterity the figure we know. Lives like his must end in martyrdom, which crowns them with the pity caused by human suffering and the respect due

NAPOLEON I



PHOTOGRAPHS, (1, 4) GIRAUDON, (3, 6) ALINARI, (5, 7) FROM SLOANE, "LIFE OF NAPOLEON" (CENTURY COMPANY AND MACWILLAN, LONDON1

NAPOLEON BONAPARTE

1. Death Mask of Napoleon, now in the Invalides, Paris
2. Upper left: miniature portrait of Napoleon in 1812, by Isabey. Upper right: miniature portrait of Josephine in 1813, by Isabey. Below: engraving by G. Fiesinger, after a miniature portrait of Napoleon by Guerin, deposited in the National Library, Paris, in 1799
3. "The Last Days of Napoleon," sculpture portrait by V. Vela; now at Versailles
4. "Napoleon I," statue by Philippe-Laurent Roland. In the Paris Institut
5. House in the Place Letizia, Ajaccio, Corsica, in which Napoleon Bonaparte was born. From the drawing by Eric Pape
6. "Napoleon Crossing the Alps," by J. L. David. At Versailles
7. "Longwood," Napoleon's residence at St. Helena. Drawing by Harry Pena, from a photograph belonging to L. C. Billings

to misfortune. Saint Helena idealised the emperor's memory, and his gaolers unwittingly prepared for him a sort of poetic immortality. Though his imprisonment in a distant island was a punishment relatively slight as compared with the torture of Joan of Arc, and though the man who placed the imperial crown upon his own head had little in common with the young girl who led her king to his crowning at Reims, there is some similarity in the moral effect and the historical renown of their death. The last phase of Napoleon's life may be regarded as his transfiguration.

After Waterloo, the energy which his presence had re-awakened relaxed. On his return to Paris he felt himself abandoned, The Chamber declared itself against him, and appointed an executive commission to govern with the ministers. He must either forcibly dissolve it, or abdicate. He decided to abdicate in favour of his son, the king of Rome, and made known his intention of going to the United States. The executive commission replied that two frigates, then in waiting at Rochefort, were at his disposal, and requested him to hasten his departure. He remained a week longer at Malmaison, then, as a last despairing throw of the dice, offered his sword against the invaders as a simple general. He then undertook to leave for America. His offer was refused. He left Malmaison on June 29 and arrived at Rochefort on July 3.

The two frigates were there, but the "Bellerophon" and other English ships were cruising before the harbour and blocked the outlet. One hope was left, to slip past and get out to sea. Napoleon would not run the risk of arrest as a fugitive. Thanking all those who offered to help him to escape, he decided on a plan he had had in mind several days, which seemed to him to be the most worthy of him as having an element of greatness, namely to demand asylum from the British government. Maitland, the commander of the "Bellerophon," had let him know that the request would be well received. Thus Napoleon wrote his famous letter to the prince regent:—

"Your Royal Highness, Exposed to the factions which distract my country and to the enmity of the greatest powers of Europe, I have ended my political career, and I come, like Themistocles, to appeal to the hospitality of the British people. I put myself under the protection of their laws, and beg your royal highness, as the most powerful, the most determined and the most generous of my enemies, to grant me this protection."

The allies at this moment were in agreement on only one point of their treatment of Napoleon. There must be no new return from Elba, and it would be perhaps even easier to return from America. The victors, to tell the truth, did not know what to do with him, and every solution presented difficulties. Their secret hope was that he would commit suicide, or perish on his way, the victim of a "White Terror." Or they would have liked Louis XVIII. on his return to Paris to have him summarily tried, condemned and executed. "We wish," wrote Lord Liverpool to Castlereagh, "that the king of France would have Bonaparte shot or hanged. It would be the best end to the business." But no one wished to take the responsibility, and Louis XVIII, less than anyone else. And Alexander I. and Wellington were working to save Napoleon's life. So the fate of the man regarded as an outlaw, "outside human society," *hostis generis humani*, had still to be decided. By his surrender to England the "Corsican ogre" laid on her the task of custody which Lord Liverpool would willingly have left to others.

Louis XVIII., who had returned to Paris on July 9, was anxious for the matter to be settled as quickly as possible, without taking the odium on himself. He ordered the prefect of Rochefort to keep the ex-emperor on the frigate La Saale, and to give him up to Commander Maitland, on the latter's requisition. Napoleon thought it more dignified to surrender without waiting for summons or arrest. On July 15 wearing the green coat of the *chasseurs* de la garde, and the small hat, his favourite uniform, and that in which he is always popularly represented he went on board the "Bellerophon."

One wonders if he deceived himself as to his fate and believed that the British government would allow him to go to America, or to remain at liberty in England, which had always welcomed exiles and was looked on as a political asylum. He may have remembered Paoli and Theodore, king of Corsica for a brief period, who had come to London, to die. Strangely enough there has been found among his papers a short literary exercise, an imaginary letter from Theodore asking Walpole for protection. In his school exercise books is also the phrase "Saint Helena, a little island."

The Voyage.—If Napoleon had hoped to remain at liberty he was undeceived when the "Bellerophon" arrived at Plymouth. Admiral Keith delivered to him, in the name of the British government a letter which informed "General Bonaparte" that in order to deprive him of further opportunities of disturbing the peace of Europe, it was necessary to restrain his personal liberty, and that to this end Saint Helena had been chosen as his future residence. He might take with him three companions, from among those who had accompanied him to England, and a surgeon. The emperor, on receipt of the letter, protested that he was the guest and not the prisoner of the British government, and that the rights of hospitality were being violated in his person. He then resigned himself, and set an example of stoicism to his followers. He did no more than put into writing the verbal protest which he had made to Admiral Keith.

Napoleon took with him into his captivity General Bertrand, a former grand marshal of the palace, Count Montholon, aide de camp, and General Gourgaud, and a civilian, the count de Las Cases. Countess Bertrand and Countess Montholon were of the party, as well as Las Cases the younger, and several servants. On Aug. 7 they embarked on the "Northumberland," commanded by Admiral Cockburn, and almost immediately set sail. The voyage lasted more than two months. Napoleon preserved his impassibility, even though the officers and crew had been ordered to refrain from paying him marks of respect, and he was addressed merely as "General." On arriving at Saint Helena Cockburn even said to General Bertrand, "I know of no emperor living in this island, nor of any person with a right to that position, having, as you say, travelled with me on the Northumberland."

Reading was Napoleon's chief distraction, during this long and monotonous voyage which was bearing him for ever from France and from his family. He had read to him from the Encyclopedia *Britannica* everything concerning Saint Helena and the countries near which the ship was passing. After a turn on deck he would lean against a gun, which the midshipmen soon called "the emperor's gun," and talk at length of his past life, telling stories of his career. Las Cases, who kept a journal was thus led to begin his Memorial of Saint Helena. Soon Napoleon himself decided to dictate his recollections, beginning with his Italian campaign.

Saint Helena.—On Sunday, Oct. 15 the "Northumberland" dropped anchor before Saint Helena. Napoleon looked through his glasses at the island which was to be his tomb, without, says Las Cases, showing the slightest emotion, and then worked as usual. They landed the next day. The dwelling intended for the prisoner was called Longwood, and, as it was in bad repair and not ready for his reception he stayed temporarily at the small house "The Briars," of which Las Cases says: "The Emperor Napoleon, who was once so powerful, and master of so many crowns, found himself reduced to a little hovel a few square feet in dimensions, with neither curtains, shutters, nor furniture. He had to sleep, dress, eat, work, live there, and if there was cleaning to be done he had to go out of doors." Napoleon protested more than once against this "infamous treatment," against the fact that he was treated as a prisoner of war, though he had himself taken refuge under the English flag, and against the prohibition of news of his wife and son. In December, Longwood was ready at last, and the little company moved there, together with Doctor O'Meara of the Northumberland who had asked to share Napoleon's exile, since no other doctor was available. He also has written an interesting account of the captivity.

Longwood, which had been a farm. was larger and a little more comfortable than "The Briars." Napoleon remained there till his death, spending his time in talking over his past career, dictating his reminiscences, reading, doing a little gardening, riding in the narrow limits permitted him, and even in learning English, which he read fairly fluently, but would never speak. His chief troubles were the prohibition of correspondence with his family, and the badness of the food. His imprisonment became still more rigorous when, in April 1816, Admiral Cockburn was replaced by Hudson Lowe. The new Governor, obsessed with the fear of losing his prisoner, and, seeing nothing but espionage and plans of escape, made himself detested. Under his petty persecution Napoleon remembered with regret the régime of Admiral Cockburn. First Las Cases, accused of having organised a correspondence with the outer world, was deported to the Cape; O'Meara, the next to go, was replaced by the Corsican doctor, Antommarchi. In 1818 Gourgaud, who could not agree with his companions, left Saint Helena. Only Bertrand and Montholon stayed till the end.

Napoleon's health was suffering. It is possible that the climate, the food and mental anguish assisted the tendency towards cancer which he inherited from his father. His strength rapidly declined. In March 1821, he took to his bed. In April he dictated his will. "It is my wish," he said "that my ashes shall be laid to rest on the banks of the Seine among the French people whom I have loved so well." He added "I am dying before my time, murdered by the English oligarchy and its hired assassin" (Hudson Lowe). He died on the morning of May 5 in his 52nd year. His body was dressed in his favourite uniform, that of the *chasseurs de la garde,* and covered with the cloak he had worn at Marengo. He was buried in a lonely spot near a spring shaded by two weeping willows. He had often walked there. "Here lies" was on the stone. No name.

The Napoleonic Legend.—He had said one day, "What a romance my life has been." Napoleon knew mankind too well, he was in fact too great an artist not to realise that his captivity and his martyrdom gave him a magnificent opportunity of impressing himself upon posterity. On that lonely rock he was seized by an idea as great as were his plans of campaign or the *Code civil.* He would prepare, if not for himself, at least for someone of his race, something better than a return from Elba. He foresaw the nineteenth century, and would catch its imagination. Two thousand leagues away from France he divined the medley of sentiment and emotion forming there:—Austerlitz and Waterloo, the triumph and humiliation of the tricolor, the Revolution of 1789 ending in the return of the Bourbons, all the longings for liberty and for glory which would torture the people of France. Buried desires would rise again, resuscitated by regret and the magic of remembrance. Napoleon had always known how to appeal to the French people. He had not lost the art.

So the *Memorial of Saint Helena* was to become the Gospel of Saint Helena. During the hundred days he had already allied himself with the Liberals and the Republicans. The great Carnot had wept on his shoulder after the second abdication. He spent his years of exile in reviving the Napoleonic legend, in confounding it with liberalism, in "changing the eagle's plumage." He dreamed sometimes that he was working for himself. and that the people aroused by his promises would drive out their Kings and come to deliver him. "We are martyrs to an immortal cause," he said. "We struggle against oppression and the voice of the nations is for us."

In the conversations which were published to the world by his companions in captivity, he made himself. the apostle of a new political doctrine, which, inspired by the principles of 1789, had the character and the fascination of a religion. It was a vast idealistic programme, a declaration of the rights and duties of the French people, a reshaping of Europe on the principles of liberty, equality, fraternity and justice. He identified his cause with that of universal freedom. The peoples must be set free, and a holy alliance of nations substituted for a holy alliance of Kings. "There are" he said "strivings for nationhood which must be satisfied sooner or later." No people should be left under the domination of another, and different sections of the same race, which wish to unite, ought not in the future to be separated. "Though they are scattered there are in Europe more than thirty million Frenchmen, fifteen million Spaniards, fifteen million Italians and thirty million Germans. I should like to have made each of these peoples a single united nation." He re-told his own story, giving it a humanitarian and idealistic bias. He represented his dictatorship as that of a liberal, or '.crowned Washington," a despot in spite of himself and for the world's good, waging war to found the United States of Europe. He called himself the Messiah of the Revolution whose name would be for the peoples "the emblem of their hopes."

This lofty incarnation triumphed. Popular imagination represented Napoleon at Saint Helena as on a sort of Mount Sinai. Béranger's songs, Victor Hugo's poems added to the glamour. In 1840 the government of Louis-Philippe obeyed the national will by sending the prince de Joinville to bring back the remains of the emperor. The "return of the ashes" was a historic day. Since then, Napoleon rests in the Invalides. Another poet. Lamartine, warned Louis-Philippe that this return foreshadowed another. And, indeed, thanks to the legend woven by his uncle. after the revolution of 1848, Louis Napoleon was elected president of the republic, and then restored the empire, accomplishing in foreign policy, by his support of Italian unity, the programme of nationalities, though the integration of Italy was not yet completed. Thus the Napoleon of Saint Helena survived.

THE NAPOLEONIC RECORD

The Soldier.—We must now briefly consider this man, whose personality was in every respect far above the mean, as a commander and as a legislator—as soldier and sovereign.

His master concepts may be gathered from his various sayings. "The art of war" he said "is simple and wholly executive. There is nothing ideological about it." And again "The whole art of war consists of a careful and nell-thought out defensive, together with a swift and bold offensive." Simplicity and rapidity are the dominating features both of his campaigns and his battles. "The art of war" he said at the beginning of his career "consists, with inferior forces, in always having larger forces than the enemy at the point of attack or defence" To do this rapidity of movement is required. "Energy, rapidity" was his constant admonition to subordinates. One must concentrate one's own forces, keep them together, lead the enemy to give battle in the most unfavourable conditions; then, when his last reserves are engaged, destroy him by a decisive attack and end the war as quickly as possible.

As Napoleon himself said, all these precepts could be compressed in a very small book. He had, in fact, a method. not a system. "One of the characteristic features of Napoleonic strategy," says Marshal Franchet d'Esperey, "is that, the goal once chosen and boldly chosen, the method does not vary, though, being supple, it adapts itself to circumstances." One might just as well say "the measure of the method is the commander's measure." Napoleon's power of rapidly summing up a situation and making his decision, explains his victories. As Clausewitz has well said: "On the field of battle everything depends on a decision made in a few minutes." Napoleon summed up everything, including himself, in the words: "No precise rules can be laid down. Everything depends on the character of the general, his abilities, his weakness, the quality of his troops, the range of their neapons, the weather and a thousand other circumstances which never repeat themselves." Hence before the battle his meticulous study of the position, of alternative suppositions, a keen examination of the psychology of his opponent, and the rigorous use of information, material and moral. The weak point was that everything depended on Napoleon. He saw everything, did everything, took account of the most insignificant details, himself directly gave all the orders. His lieutenants, having the habit of obedience, mere merely executants who took no initiative. Berthier. although he held the position of chief of staff,said that he counted for nothing with the army. Therefore, an indisposition of the emperor was sufficient to disorganize the machine.

Then, from 1812 onwards, the number of troops involved became too large, and the commander's vision no longer sufficiently sure. It was a war of armies, not of army corps. The Napoleonic system began to give less favourable results. An exaggerated belief in his "star" and his genius, and his heavy demands on an exhausted France, explain the final catastrophe. He had long profited from the concentration of power in his own person. He himself rejoiced in being almost the only great captain to hold absolute authority over a rich and populous country, and command its resources both of men and money. Yet in spite of his enormous intellectual energy he gave way in the end under the burden. He insisted on regulating the minutest details of his government. Thus the decree which still governs the *Theâtre Français* was signed at Moscow. Moreover his empire was precarious. Founded on victory and success, it could not survive defeat. Remembering after Waterloo Louis XIV. unshaken by misfortune, he said, "If I had been my own grandson, I could have retreated as far as the Pyrenees."

The Sovereign.—Yet he did more than win and lose battles. He gave to France laws which for the most part still endure. We have seen that when he became first consul, France had fallen practically into anarchy. The ancient laws, excessively complicated, because they differed from province to province and were customary and traditional, had been wiped out by the revolution. The new laws, so far as they existed at all, were too revolutionary in character and unadapted to normal society. The *code civil* united what in Roman law and in tradition was best suited to France under the conditions engendered by the Revolution. It may be said to be a systemization of good sense, at the same time logical and historical. Napoleon had no legal training, and his share in the work should not be exaggerated, but he intervened continually with the dominating idea that, though the work of the revolution must not be undone, order must be restored in France. Here again he profited by his lack of prejudice and his trained intelligence. He carried out the transition from old to new France. Probably he alone could have re-established the conditions necessary to settled government without being accused of relinquishing the "civil victories of the revolution." He was able to reimpose indirect taxation and in particular food taxes, the most unpopular of all, the abolition of which had made it impossible to place the finances of the Republic on a sound basis.

The council of state, the public accounts office, the courts of justice, the universities, the rights of the *Banque de France,* all these were established, counterbalancing the work of the revolutionary demagogues, and they serve to this day as restraining influences on the occasional over-violence of democracy. On the other side of the picture we see excessive centralization which stifled provincial life and local characteristics, cast the whole country in the same mould, and made the State supreme over the entire people—a system singularly favourable to "étatisme." Thus as a legislator, and as a legendary figure, Napoleon appeared as the restorer of order and authority and the embodiment of progress.

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(J. Bai.)

NAPOLEON II.: *see* Reichstadt, Napoleon Francis Joseph Charles, Duke of.

NAPOLEON III. [Charles Louis Napoleon Bonaparte] (1808–1873), emperor of the French, was born on April 20, 1808, in Paris at 8 rue Cerutti (now rue Laffitte), and not at the Tuileries, as the official historians state. He was the third son of Louis Bonaparte *(see* Bonaparte), brother of Napoleon I., and king of Holland (1806–10), and of Hortense de Beauharnais (*q.v.*). Of the two other sons of Louis Bonaparte and Hortense, the elder, Napoleon Charles (1802–1807), died in infancy; the second, Napoleon Louis (1804–1831), died in the insurrection of the Romagna, leaving no children.

Exile of **Hortense.**—After Waterloo, Hortense, suspected by the Bourbons of having arranged the return from Elba, had to go into exile. The ex-king Louis, who now lived at Florence, had compelled her by a scandalous law-suit to give up to him the elder of her two children. With her remaining child she wandered, under the name of duchesse de Saint-Leu, from Geneva to Aix, Carlsruhe and Augsburg. In 1817 she bought the castle of Arenenberg, in the canton of Thurgau, on a wooded hill looking over the Lake of Constance. Hortense supervised her son's education in person. The young prince also studied at the gymnasium at Augsburg, and there he acquired his slight German accent.

In 1823 he accompanied his mother to Italy, visiting his father at Florence, and his grandmother Letitia at Rome, and dreaming with Le Bas on the banks of the Rubicon. He returned to Arenenberg to complete his military education under Colonel Armandi and Colonel Dufour, who instructed him in artillery and military engineering. At the age of twenty he was a "Liberal," an enemy of the Bourbons and of the treaties of 1815; but he was dominated by the cult of the emperor, and for him the liberal ideal was confused with the Napoleonic.

Revolution of 1830.—The July revolution of 1830, of which he heard in Italy, roused all his young hopes. He could not return to France, for the law of 1816 banishing all his family had not been abrogated. But the liberal revolution knew no frontiers. Italy shared in the agitation. He had already met some of the conspirators at Arenenberg, and it is practically established that he now joined the associations of the Carbonari. Following the advice of his friend the Count Arese and of Menotti, he and his brother were among the revolutionaries who in February 1831 attempted a rising in Romagna and the expulsion of the pope from Rome. They distinguished themselves at Civita Castellana, a little town which they took; but the Austrians arrived in force, and during the retreat Napoleon Louis, the elder son, took cold, followed by measles, of which he died. Hortense hurried to the spot and took steps which enabled her to save her second son from the Austrian prisons. He escaped into France, where his mother, on the plea of his illness, obtained permission from Louis Philippe for him to stay in Paris. But he intrigued with the republicans, and Casimir-Périer insisted on the departure of both mother and son. In May 1831 they went to London, and afterwards returned to Arenenberg.

For a time he thought of responding to the appeal of some of the Polish revolutionaries, but Warsaw succumbed (September 1831) before he could set out. Moreover the plans of this young and visionary *enfant du siècle* were becoming more definite. The duke of Reichstadt died in 1832. His uncle, Joseph, and his father, Louis, showing no desire to claim the inheritance promised them by the constitution of the year XII., Louis Napoleon henceforth considered himself as the accredited representative of the family. He endeavoured to define his ideas, and in 1832 published his *Rêveries politiques, suivies d'un projet de constitution,* and *Considérations politiques et militaires sur la Suisse;* in 1836, as a captain, in the Swiss service, he published a *Manuel d'artillerie,* in order to win popularity with the French army.

Strasbourg Conspiracy.—With the aid of his friend Fialin and of Eléonore Gordon, a singer, and of certain officers, such as Colonel Vaudrey, an old soldier of the Empire, commanding the 4th regiment of artillery, and Lieutenant Laity, he tried to bring about a revolt of the garrison of Strasbourg (Oct. 30, 1836). The conspiracy was a failure, and Louis Philippe, fearing lest he might make the pretender popular either by the glory of an acquittal or the aureole of martyrdom, had him taken to Lorient and put on board a ship bound for America, while his accomplices were brought before the court of assizes and acquitted (February 1837). The prince was set free in New York in April; by the aid of a false passport he returned to Switzerland in August, in time to see his mother before her death on Oct. 3, 1837.

At any other time this attempt would have covered its author with ridicule. Such, at least, was the opinion of the whole of the family of Bonaparte. But his confidence was unshaken, and in the woods of Arenenberg the romantic-minded friends who remained faithful to him still honoured him as emperor. And now the government of Louis Philippe, by an evil inspiration, began to act in such a way as to make him popular. In 1838 it caused his partisan Lieutenant Laity to be condemned by the Court of Peers to five years' imprisonment for a pamphlet which he had written to justify the Strasbourg affair; then it demanded the expulsion of the prince from Switzerland, and when the Swiss government resisted, threatened war. Having allowed the July monarch to commit himself, Louis-Napoleon at the last moment left Switzerland voluntarily. All this served to encourage the mystical adventurer. In London, where he had taken up his abode, together with Arese, Fialin (says Persigny), Doctor Conneau and Vaudrey, he was at first well received in society, being on friendly terms with Count d'Orsay and Disraeli, and frequenting the *salon* of Lady Blessington. He was evolving his programme of government, and in 1839 wrote and published his book: *Des Idées napoléoniennes,* a curious mixture of Bonapartism, socialism and pacificism, which he represented as the tradition of the First Empire. He also noted the fluctuations of French opinion.

Boulogne Conspiracy.—The pretender, again thinking that the moment had come, formed a fresh conspiracy in 1840. With a little band of fifty-six followers he attempted to provoke a rising of the 42nd regiment of the line at Boulogne, hoping afterwards to draw General Magnan to Lille and march upon Paris. The attempt was made on Aug. 6, but failed; he saw several of his supporters fall on the shore of Boulogne, and was arrested together with Montholon, Persigny and Conneau. This time he was brought before the Court of Peers with his accomplices; he entrusted his defence to Berryer and Marie, and took advantage of his trial to appeal to the supremacy of the people, which he alleged, had been disregarded, even after 1830. He was condemned to detention for life in a fortress, his friend Aladenize being deported, and Montholon Parquin, Lombard and Fialin being each condemned to detention ior twenty years. On Dec. 15, the very day that Napoleon's ashes were deposited at the Invalides, he was taken to the fortress of Ham. On the whole the régime imposed upon him was mild. He corresponded with Louis Blanc, George Sand and Proudhon, and collaborated with the journalists of the Left, Degorge, Peauger and Souplet. For six years he worked very hard ('at his University of Ham," as he said. He wrote some *Fragments historiques,* studies on the sugar-question, on the construction of a canal through Nicaragua, and on the recruiting of the army, and finally, in the *Progrès du Pas-de-Calais,* a series of articles on social questions which were later embodied in his *Extinction du paupérisme* (1844). But the same persistent idea underlay all his efforts. On May 25, 1846, he escaped to London, giving as the reason for his decision the dangerous illness of his father. On July 27 his father died.

Return to France.—He was again well received in London and he "made up for his six years of isolation by a furious pursuit of pleasure." The duke of Brunswick and the banker Ferrère interested themselves in his future, and gave him money, as did also Miss Howard, whom he later made comtesse de Beauregard, after restoring to her several millions. At the first symptoms of revolutionary disturbance he returned to France; on Feb. 25, he offered his services to the Provisional Government, but, on being requested by it to depart at once, resigned himself to this course. But Persigny, Mocquard and all his friends devoted themselves to an energetic propaganda in the press, by pictures and by songs. After May 15 had already shaken the strength of the young republic, he was elected in June 1848 by four departments, Seine, Yonne, Charente-Inférieure and Corsica. In spite of the opposition of the executive committee, the Assembly ratified his election. But he had learnt to wait. He sent in his resignation from London, merely hazarding this appeal: "If the people impose duties on me, I shall know how to fulfil them." This time events worked in his favour; the industrial insurrection of June made the middle classes and the mass of the rural population look for a saviour, while it turned the industrial population towards Bonapartism, out of hatred for the republican *bourgeois.*

Presidency of the Republic.—On Sept. 26 he was re-elected by the same departments; on Oct. 11 the law decreeing the banishment of the Bonapartes was abrogated; on the 26th he made a speech in the Assembly defending his position as a pretender, and cut such a sorry figure that Antony Thouret contemptuously withdrew the amendment by which he had intended to bar him from rising to the presidency. Thus he was able to be a candidate for this formidable power. The former rebel of the Romagna, the Liberal *Carbonaro,* was henceforth to be the tool of the priests. In his very triumph appeared the ultimate cause of his downfall. On Dec. 10 he was elected president of the Republic by 5,434,226 votes against 1,448,107 given to Cavaignac. On Dec. 20, he took the oath "to remain faithful to the democratic Republic . . . to regard as enemies of the nation all those who may attempt by illegal means to change the form of the established government." From this time onward his history is inseparable from that of France. But, having attained to power, he still endeavoured to realize his cherished project. All his efforts (Dec. 10, 1848 to Dec. 2, 1852) tended towards the acquisition of absolute authority, which he wished to obtain, ostensibly from the people.

It was with this end in view that he co-operated with the party of order in the expedition to Rome for the destruction of the Roman republic and the restoration of the pope (March 31, 1849), and afterwards in all the reactionary measures against the press and the clubs, and for the destruction of the Reds. But in opposition to the party of order, he defined his own personal policy. "The name of Napoleon," he said on this occasion, "is in itself a programme; it stands for order, authority, religion and the welfare of the people in internal affairs, and in foreign affairs for the national dignity."

In spite of this alarming assertion of his personal policy, he still remained in harmony with the Assembly (the Legislative Assembly, elected on May 28, 1849) in order to carry out "a Roman expedition at home," *i.e.,* to clear the administration of all republicans, put down the press, suspend the right of holding meetings and, above all, to hand over education to the Church. But he knew where to stop and how to keep up a show of democracy. When the Assembly, by the law of May 31, 1850, restricted universal suffrage and reduced the number of the electors from g to 6 millions, he was able to throw upon it the whole responsibility for this *coup d'état bourgeois.*

In fact, while trying to compass the destruction of the republican movement of the Left, he was taking careful steps to win classes. At his side were his accomplices, men ready for anything, whose only hopes were bound up with his fortunes, such as Morny and Rouher; his paid publicists, such as Romieu, the originator of the "red spectre"; his cudgel-bearers, the "Ratapoils" immortalized by Daumier, who terrorized the republicans.

Coup **d'État.**—He next entered upon that struggle with the Assembly, now discredited, which was to reveal to all the necessity for a change, and a change in his favour. In January 1851 he deprived Changarnier of his command of the garrison of Paris. "The Empire has come," said Thiers. The pretender would have preferred, however, that it should be brought about legally, the first step being his re-election in 1852. The Constitution forbade his re-election; therefore the Constitution must be revised. On the 19th of July the Assembly threw out the proposal for revision, thus signing its own death-warrant, and the *coup d'état* was resolved upon. He prepared for it systematically. The cabinet of Oct. 26, 1851 gave the ministry for war to his creature Saint-Arnaud. All the conspirators were at their posts—Maupas at the prefecture of police, Magnan at the head of the troops in Paris. At the Elysée, Morny, adulterine son of Hortense, a hero of the Bourse and successful gambler, supported his half-brother by his energy and counsels. The ministry proposed to abrogate the electoral law of 1850, and restore universal suffrage; the Assembly by refusing made itself still more unpopular. By proposing to allow the president of the Assembly to call in armed force, the questors revealed the Assembly's plans for defence, and gave the Elysée a weapon against it ("donnent barre contre elle à l'Elysée"). The proposition was rejected (November 17), but Louis-Napoleon saw that it was time to act. On Dec. 2 he carried out his *coup d'état.*

Proclamation as Emperor—But affairs developed in a way which disappointed him. By dismissing the Assembly, by offering the people "a strong government," and re-establishing "a France regenerated by the Revolution of '89 and organized by the emperor," he had hoped for universal applause. But both in Paris and the provinces he met with the resistance of the Republicans, who had reorganized in view of the elections of 1852. He struck at them by mixed commissions, deportations and the whole range of police measures. The *décrets-lois* of the year 1852 enabled him to prepare the way for the new institutions. On Dec. 2, 1852 he became in name what he was already in deed, and was proclaimed Emperor of the French.

The aim which the emperor had in view was, by a concentration of power which should make him "the beneficent motive force of the whole social order" (constitution of the 14th of January 1852; administrative centralization; subordination of the elected assemblies; control of the machinery of universal suffrage) to unite all classes in "one great national party" attached to the dynasty. His success, from 1852 to 1856, was almost complete. The nation was submissive, and a few scattered plots alone showed that republican ideas persisted among the masses. As "restorer of the overthrown altars," he won over the "men in black," among them Veuillot, editor-in-chief of *l'Univers,* and allowed them to get the University into their hands. By the aid of former Orleanists, such as Billault, Fould and Morny, and Saint-Simonians such as Talabot and the Pereires, he satisfied the industrial classes, extended credit, developed means of communication, and gave a strong impetus to the business of the nation. By various measures, such as subsidies, charitable gifts and foundations, he endeavoured to show that "the idea of improving the lot of those who suffer and struggle against the difficulties of life was constantly present in his mind." His was the government of cheap bread, great public works and holidays. The imperial court was brilliant. The emperor, having failed to obtain the hand of a Vasa or Hohenzollern, married, on Jan. 29, 1853, Eugénie de Montijo, comtesse de Teba, aged twenty-six and at the height of her beauty.

Foreign Policy. — France was "satisfied" in the midst of order, prosperity and peace. The foreign policy of the Catholic party, by the question of the Holy Places and the Crimean War (1853–1856), gave him the opportunity of winning the glory which he desired, and the British alliance enabled him to take advantage of it. In January 1856 he had the good fortune to win a diplomatic triumph over the new tsar, Alexander II. It was at Paris (February 25–March 30) that the conditions of peace were settled. The emperor was now at the height of his power. He appeared to the people as the avenger of 1840 and 1815, and the birth to him of a son, Eugène Louis Jean Joseph, on March 16, 1856, assured the future of the dynasty. It was then that, strong in "the esteem and admiration with which he was surrounded," and "foreseeing a future full of hope for France," he dreamed of realizing the Napoleonic ideal in its entirety. This disciple of the German philologists, this crowned *Carbonaro,* the friend of the archaeologists and historians who were to help him to write the *Histoire de César,* dreamed of developing the policy of nationalism, and of assisting the peoples of all countries to enfranchise themselves.

From 1856 to 1858 he devoted his attention to the Rumanian nationality, and supported Alexander Cuza. But it was above all the deliverance of Italy which haunted his imagination. But the Catholics feared that the Italian national movement, when once started, would entail the downfall of the papacy; and in opposition to the emperor's Italian advisers, Arese and Prince Jerome Napoleon, they pitted the empress, who was frivolous and capricious, but an ardent Catholic. Napoleon III. was under his wife's influence, and could not openly combat her resistance. It was the Italian Orsini who, by attempting to assassinate him as a traitor to the Italian nation on Jan. 14, 1858, gave him an opportunity to impose his will indirectly by convincing his wife that in the interests of his own security he must "do something for Italy." Events followed each other in quick succession, and now began the difficulties in which the Empire was to be irrevocably involved. Not only did the Italian enterprise lead to strained relations with Great Britain, the alliance with whom had been the emperor's chief support in Europe, and compromised its credit; but the claims of parties and classes again began to be heard at home.

The Italian war aroused the opposition of the Catholics. After Magenta (June 4, 1859), it was the fears of the Catholics and the messages of the empress which, even more than the threats of Prussia, checked him in his triumph and forced him into the armistice of Villafranca (July 11, 1859). But the spread of the Italian revolution and the movement for annexation forced him again to intervene. He appealed to the Left against the Catholics by the amnesty of April 17, 1859. His consent to the annexation of the Central Italian states, in exchange for Savoy and Nice (Treaty of Turin, March 24, 1860) exposed him to violent attacks on the part of the ultramontanes, whose slave he had practically been since 1848. At the same time, the free-trade treaty with Great Britain (January 5, 1860) aroused a movement against him among the industrial *bourgeoisie.*

From this time onward, in face of a growing opposition, anxiety for the future of his régime paralysed his initiative. Placed between his Italian counsellors and the empress, he was ever of two minds. His plans for remodelling Europe had a certain generosity and grandeur; but internal difficulties forced him into endless manoeuvre and temporization, which led to his ruin. Thus in October 1862, after Garibaldi's attack on Rome, the clerical coterie of the Tuileries triumphed. But the replacing of M. Thouvenel by M. Drouin de Lhuys did not satisfy the more violent Catholics, who in May 1863 joined the united opposition. Thirty-five opposers of the government were appointed, Republicans, Orleanists, Legitimists or Catholics. The emperor dismissed Persigny, and summoned moderate reformers such as Duruy and Béhic. But he was still possessed with the idea of settling his throne on a firm basis, and uniting all France in some glorious enterprise which should appeal to all parties equally, and "group them under the mantle of imperial glory." From January to June 1863 he sought this appearance of glory in Poland, but only succeeded in embroiling himself with Russia. Then, after Syria and China, it was the "great inspiration of his reign," the establishment of a Catholic and Latin empire in Mexico, enthusiasm for which he tried in vain from 1863 to 1867 to communicate to the French.

But while the strength of France was wasting away at Puebla in Mexico, Bismarck was founding German unity. In August 1864 the emperor, held back by French public opinion, which was favourable to Prussia, and by his idea of nationality, allowed Prussia and Austria to seize the duchies of Schleswig and Holstein. After his failure in Poland and Mexico and in face of the alarming presence of Germany, only one alliance remained possible for Napoleon III., namely with Italy. He obtained this by the convention of the 15th of September 1864 (involving the withdrawal of the French troops from Rome). But the Catholic party redoubled its violence, and the pope sent out the encyclical *Quanta Cura* and the *Syllabus,* especially directed against France. In vain the emperor sought in German affairs a definitive solution of the Italian question. At Biarrite he prepared with Bismarck the Franco-Prussian alliance of April 1866; and hoped to become arbiter in the tremendous conflict which was about to begin. But Koniggratz came as a bolt from the blue to ruin his hopes. French interests called for an immediate intervention. But he resigned himself to the annexation by Prussia of northern Germany. "Now," said M. Drouin de Lhuys, "we have nothing left but to weep."

The Third Party. — Henceforth the brilliant dream, a moment realized, the realization of which he had thought durable, was at an end. The Empire had still an uncertain and troubled brilliancy at the Exhibition of 1867. But Berezowski's pistol shot, which accentuated the estrangement from the tsar, and the news of the death of Maximilian at Queretaro, cast a gloom over the later fêtes. In the interior the industrial and socialist movement, born of the new industrial development, added fresh strength to the Republican and Liberal opposition. The moderate Imperialists felt that some concessions must be made to public opinion. In opposition to the absolutist "vice-emperor" Rouher, whose influence over Napoleon had become stronger and stronger since the death of Morny, Émile Ollivier grouped the Third Party, Anxious, changeable and distraught, the emperor made the Liberal concessions of Jan. 19, 1867 (right of interpellation), and then, when Ollivier thought that his triumph was near, he exalted Rouher (July) and did not grant the promised laws concerning the press and public meetings till 1868. The opposition gave him no credit for these tardy concessions. There was an epidemic of violent attacks on the emperor; the publication of the *Lanterne* and the Baudin trial, conducted by Gambetta, were so many death-blows to the régime. The *Internationale* developed its propaganda. The election of May 1869 resulted in 4,438,000 votes given for the government, and 3,355,000 for the opposition, who also gained 90 representatives. The emperor, disappointed and hesitating, was slow to return to a parliamentary régime. It was not till December that he instructed Ollivier to "form a homogeneous cabinet representing the majority of the Corps Législatif" (ministry of the 2nd of January 1870). But, embarrassed between the *Arcadiens*, the partisans of the absolute régime, and the republicans, Ollivier was unable to guide the Empire in a constitutional course. At the Tuileries Rouher's counsel still triumphed. It was he who inspired the ill and wearied emperor, now without confidence or energy, with the idea of resorting to the *plébiscite*.

"To do away with the risk of a revolution," "to place order and liberty upon a firm footing," "to ensure the transmission of the crown to his son," Napoleon III again sought the approbation of the nation. He obtained it with brilliant success, for the last time, by 7,358,786 votes against 1,571,939, and his work now seemed to be consolidated.

War With **Prussia.**—A few weeks later it crumbled irrevocably. Since 1866 he had been pursuing an elusive appearance of glory. Since 1866 France was calling for "revenge." He felt that he could only rally the people to him by procuring them the satisfaction of their national pride. Hence the mishaps and imprudences of which Bismarck made such an insulting use. Hence the negotiations of Nikolsburg, the "note d'aubergiste" (innkeeper's bill) claiming the left bank of the Rhine, which was so scornfully rejected; hence the plan for the invasion of Belgium (August 1866), the Luxemburg affair (March 1867), from which M. de Moustier's diplomacy effected such a skilful retreat; hence the final folly which led his government into the war with Prussia (July 1870).

The war was from the first doomed to disaster. It might perhaps have been averted if France had had any allies. But Austria, a possible ally, could only join France if satisfied as regards Italy; and since Garibaldi had threatened Rome (Mentana, 1867), Napoleon III, yielding to the anger of the Catholics, had again sent troops to Rome. Negotiations had taken place in 1869. The emperor, bound by the Catholics, had refused to withdraw his troops. It was as a distant but inevitable consequence of his agreement of December 1848 with the Catholic party that in 1870 the emperor found himself without an ally.

His energy was now completely exhausted. Successive attacks of stone in the bladder had ruined his physique; while his hesitation and timidity increased with age. The influence of the empress over him became supreme. On leaving the council in which the war was decided upon the emperor threw himself, weeping, into the arms of Princess Mathilde. The empress was delighted at this war, which she thought would secure her son's inheritance.

Deposition. — On July 28 father and son set out for the army. They found it in a state of utter disorder, and added to the difficulties by their presence. The emperor was suffering from stone and could hardly sit his horse. After the defeat of Reichshoffen, when Bazaine was thrown back upon Metz, he wished to retreat upon Paris. But the empress represented to him that if he retreated it would mean a revolution. An advance was decided upon which ended in Sedan. On Sept. 2 Napoleon III surrendered with 80,000 men, and on the 4th of September the Empire fell. He was taken as a prisoner to the castle of Wilhelmshohe, near Cassel, where he stayed till the end of the war. After the intrigues of Bazaine, of Bismarck, and of the empress, the Germans having held negotiations with the Republic, he was de facto deposed.

On March 1, the assembly of Bordeaux confirmed this deposition, and declared him "responsible for the ruin, invasion and dismemberment of France."

Restored to liberty, he retired with his wife and son to Chislehurst in England. Unwilling even now to despair of the future, he still sought to rally his friends for a fresh propaganda. He had at his service publicists such as Cassagnac, J. Amigues and Hugelmann. He himself also wrote unsigned pamphlets justifying the campaign of 1870. It may be noted that, true to his ideas, he did not attempt to throw upon others the responsibility which he had always claimed for himself. He dreamed of his son's future. But he no longer occupied himself with any definite plans. He interested himself in pensions for workmen and economical stoves.

At the end of 1872 his disease became more acute, and a surgical operation became necessary. He died on Jan. 9, 1873, leaving his son in the charge of the empress and of Rouher.

The young prince was educated at Woolwich from 1872 to 1875, and in 1879 took part in the English expedition against the Zulus in South Africa, in which he was killed. By his death vanished all hope of renewing the extraordinary fortune which for twenty years placed the nephew of the great emperor, the *Carbonaro* and dreamer, at once obstinate and yet hesitating, on the throne of France.

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NAPOLEON, a round game of cards (known colloquially as "nap"). Any number may play. The cards rank as at whist, and five are dealt to each player. The deal being completed, the player to the dealer's left looks at his hand and declares how many tricks he would play to win against all the rest, the usual rule being that more than one must be declared; in default of declaring he says "I pass." and the next player has a similar option of either declaring to make more tricks or passing, and so on all round. A declaration of five tricks is called "going nap."

The player who declares to make most has to try to make them, and the others. but without consultation, to prevent him. The declaring hand has the first lead, and the first card he leads makes the trump suit. The players, in rotation, must follow suit if able.

If the declarer succeeds in making at least the number of tricks he stood for he wins whatever stakes are played for; if not he loses. If the player declaring nap wins he receives double stakes all round; if he loses he only pays single stakes all round.

Sometimes, however, a player is allowed to go "Wellington" over "nap." and even "Blücher" over "Wellington." In these cases the caller of "Wellington" wins four times the stake and loses twice the stake, the caller of "Blücher" receives six times and loses three times the stake.

Sometimes a player is allowed to declare *misère, i.e.,* no tricks. This ranks, as a declaration, between three and four, but the player pays a double stake on three, if he wins a trick, and receives a single on three if he takes none.

NAPOLEONIC CAMPAIGNS. The era of the Revolutionary and Napoleonic Wars falls into two main divisions, the first of which (1792–1801) is dealt with under the heading FRENCH REVOLUTIONARY WARS. In the present article are described the campaigns in central and eastern Europe, directed by Napoleon — no longer one amongst many French generals. nor even a simple *primus inter pares,* but "Emperor" in the fullest sense — between the years 1805 and 1814. Napoleon's short

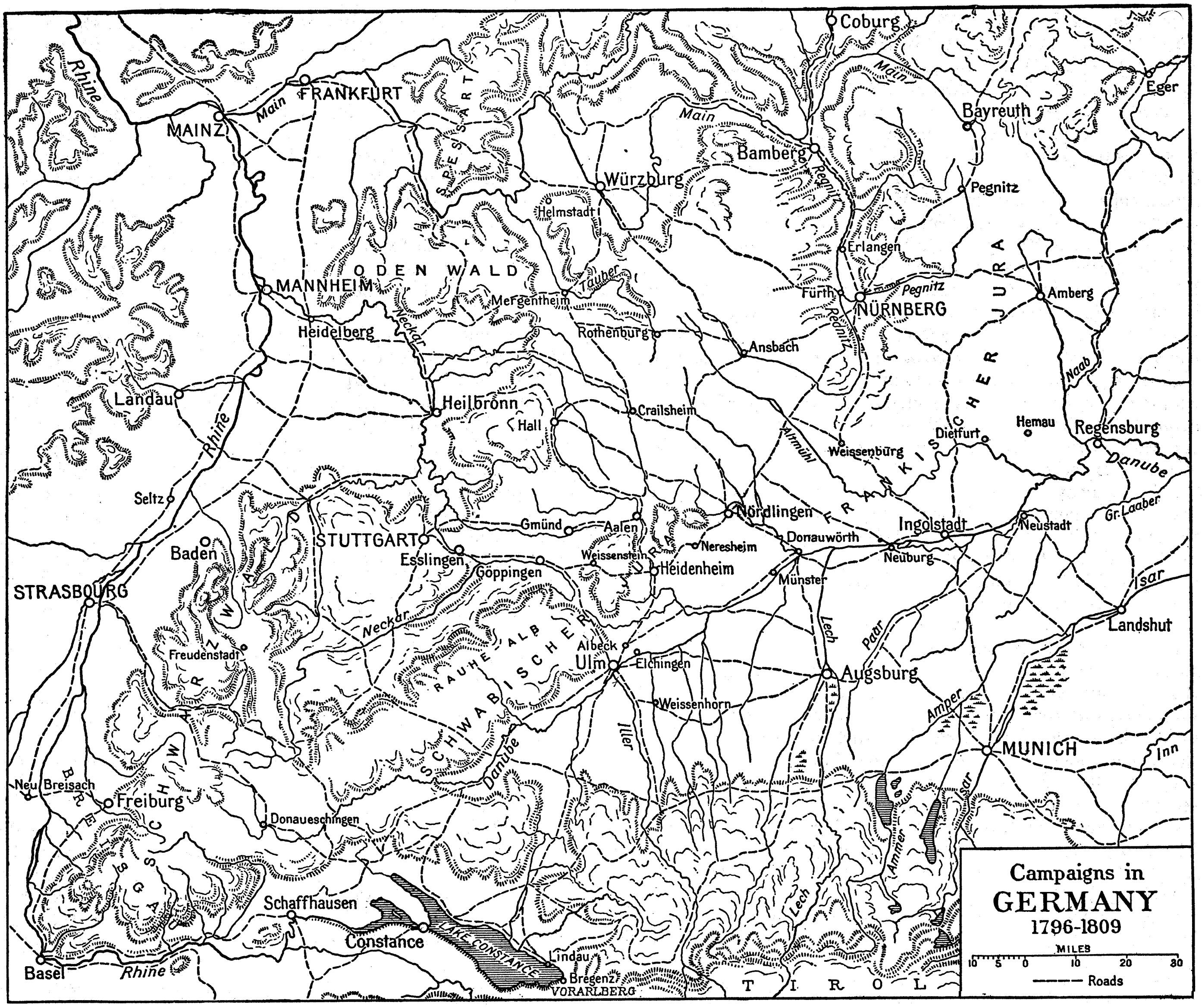

FIG. 1

Spanish Campaign of 1809 is dealt with under PENINSULAR WAR (this article covering the campaigns in Spain, Portugal and southern France 1808–1814), and for a discussion of the events that led to the final drama of Waterloo the reader is referred to WATERLOO CAMPAIGN, 1815.

The campaigns described below are therefore—

(a) The Austrian War of 1805 (Ulm and Austerlitz).

(*b*) The Conquest of Prussia and the Polish Campaign (Jena, Auerstadt, Eylau and Friedland).

(c) The Austrian war of 1809 (Eckmühl, Aspern and Wagram).

The Russian War of 1812 (Borodino and the retreat from Moscow).

(*e*) The German "War of Liberation," culminating in the Battle of the Nations around Leipzig.

(f) The last campaign in France, 1814.

The naval history of 1803–1815 includes the culmination and the sequel of the struggle for command of the sea which began in 1793 and continued for more than a decade with results increasingly disappointing to the ambitions of Napoleon, finally reaching a decisive climax on the day of Trafalgar.

THE CAMPAIGN OF 1805

This may be regarded as a measure of self-defence forced upon Napoleon by the alliance of Russia (April 11), Austria (August g) and other powers with Great Britain. The possibility had long been before the emperor, and his intention in that event to march straight on Vienna by the valley of the Danube is clearly indicated in his reply (November 27, 1803) to a Prussian proposal for the neutralization of the South German states. In this he says, "It is on the road from Strasbourg to Vienna that the French must force peace on Austria, and it is this road which you wish us to renounce." When, therefore, on Aug. 25, 1805, he learnt definitely that Villeneuve (see *Naval* Operations below) had failed in his purpose of securing the command of the Channel, which was the necessary preliminary to the invasion of England, it was but the affair of a few hours to dictate the dispositions necessary to transfer his whole army to the Rhine frontier as the first step in the march which he had determined to make to the Danube. On the date of this decision the army actually lay in the following positions:—

I.	Corps	Bernadotte	Hanover (Göttingen)
II.	"	Marmont	Holland
III.	"	Davout	Camp of Boulogne and other points on the English Channel
IV.	"	Soult	
V.	"	Lannes	
VI.	"	Ney	
VII.	"	Augereau	
Guard		Bessières	Paris

The corps were, however, by no means fit for immediate service. Bernadotte's corps in Hanover was almost in the position of a beleaguered garrison, and the marshal could only obtain his transport by giving out that he was ordered to withdraw to France. Marmont and Davout were deficient in horses for cavalry and artillery, and the troops in Boulogne, having been drawn together for the invasion of England, had hardly any transport at all, as it was considered this want could be readily supplied on landing. The composition of the army, however, was excellent, The generals were in the prime of life, had not yet learnt to distrust one another, and were accustomed to work under the emperor and with one another. The regimental officers had all acquired their rank before the enemy and knew how to manage their men, and of the men themselves nearly two-thirds had seen active service. The strength of the army lay in its infantry, for both cavalry and artillery were short of horses, and the latter had not yet acquired mobility and skill in manoeuvring. Napoleon's determination to undertake the invasion of England has often been disputed, but it is hard to imagine what other operation he contemplated, for the outbreak of hostilities with his continental enemies found him ill-supplied with intelligence as to the resources of the country he had then to traverse. To remedy this, Murat and other general officers as well as minor agents were sent ahead and instructed to travel through South Germany in plain clothes with a view to collecting information and mastering the topography. The emperor was, moreover, imperfectly acquainted with the degree of preparation of his adversaries' designs, and when he dictated his preliminary orders he was still unaware of the direction that the allies' advance would assume. On Aug. 26, however, he learnt that 100,000 Russians were about to enter Bohemia thence to unite with an Austrian army of 80,000 near the junction of the Inn and Danube, and this information drove him to alter the general direction of his advance so as to traverse the defiles of the Black Forest north of the Neckar, cavalry only observing the passes to the south.

Austrian Army.—The Austrians after the defeats of 1800 had endeavoured to reorganize their forces on the French model, but they were soon to learn that in matters of organization the spirit is everything, the letter very little. They had copied the organization of the French corps, but could find no corps commanders fit to assume the responsibility for these commands. As always in such conditions, the actual control of the smallest movements was still centralized in the hands of the army commanders, and thus the rate of marching was incredibly slow. They had decided that in future their troops in the field should live by requisition, and had handed over to the artillery, which needed them badly, a large number of horses thus set free from the transport service, but they had not realized that men accustomed to a regular distribution of rations cannot be transformed into successful marauders and pillagers by a stroke of the pen; and they had sent away the bulk of their army, 120,000 under their best general, the archduke Charles, into Italy, leaving Mack von Leiberich in Germany, nominally as chief of the staff to the young Prince Ferdinand, but virtually in command, to meet the onset of Napoleon at the head of his veterans. Mack had the distinction of having risen from the ranks in the most casteridden army in Europe.

The March on Ulm.—The outbreak of the campaign was hastened by the desire of the Austrian government to feed their own army and leave a bare country for Napoleon by securing the resources of Bavaria. It was also hoped that the Bavarians with their army of 25,000 men would join the allies. In the latter hope they were deceived, and the Bavarians under General Wrede slipped away to Bamberg in time. In the former, however, they were successful, and the destitution they left in their wake almost wrecked Napoleon's subsequent combinations. Mack's march to Ulm was therefore a necessity of the situation, and his continuance in this exposed position, if foolhardy against such an adversary, was at any rate the outcome of the high resolve that even if beaten he would inflict crippling losses upon the enemy. Mack knew that the Russians would be late at the rendezvous on the Inn. By constructing an entrenched camp at Ulm and concentrating all the available food within it, he expected to compel Napoleon to invest and besiege him. and he anticipated that in the devastated country his adversary would be compelled to separate and thus fall an easy prey to the Russians. For that blow he had determined to make his own army the anvil. But these views obviously could not be published in army orders, hence the discontent and opposition he was destined to encounter.

Movements of the French.—It was on Sept. 21 that Napoleon learnt of Mack's presence in Ulm. On that date his army had crossed the Rhine and was entering the defiles of the Black Forest. It was already beginning to suffer. Boots were worn out, greatcoats deficient, transport almost unattainable and, according to modern ideas, the army would have been considered incapable of action.

On Sept. 26 its deployment beyond the mountains was complete, and as Napoleon did not know of Mack's intention to stay at Ulm and had learned that the Russian advance had been delayed, he directed his columns by the following roads on the Danube, between Donauworth and Ingolstadt, so as to be in a position to intervene between the Austrians and the Russians and beat both in detail.

	Sept. 28	Oct. 6	Oct. 9	Oct. 16
Bernadotte	Würzburg	Anspach	Nürnberg	Regensburg
Marmont	Würzburg	Anspach	Nürnberg	Regensburg
Davout	Mannheim	Mergentheim	Anspach	Dietfurt
Ney	Selz	Crailsheim	Weissenburg	Ingolstadt
Lannes	Strassburg	Gmünd	Nordlingen	Neuburg
Soult	Landau	Aalen	Donauworth	

On Oct. 7 this movement was completed—the Austrians abandoned the Danube bridges after a show of resistance, retreating westward—and Napoleon, leaving Murat in command of the V. and VI. corps and cavalry to observe the Austrians, pressed on to Augsburg with the others so as to be ready to deal with the Russians. Learning, however, that these were still beyond striking radius, he determined to deal with Mack's army first, having formed the fixed conviction that a threat at the latter's communications would compel him to endeavour to retreat southwards towards Tirol. Bernadotte in his turn became an army of observation, and Napoleon joining Murat with the main body marched rapidly westward from the Lech towards the Iller.

Austrian Plans.—Mack's intentions were not what Napoleon supposed. He had meanwhile received (false) information of a British landing at Boulogne, and he was seriously deceived as to the numbers of Napoleon's forces. He was also aware that the exactions of the French had produced deep indignation throughout Germany and especially in Prussia whose neutrality had been violated. All this, and the almost mutinous discontent of his generals and his enemies of the court circle, shook his resolution of acting as anvil for the Russians, of whose delay also he was aware, and about Oct. 8 he determined to march out north-eastward across the French lines of communication and save his sovereign's army by taking refuge if necessary in Saxony. Believing implicitly in the rumours of a descent on Boulogne and of risings in France which also reached him, and knowing the destitution he had left behind him in his movement to Ulm, when he heard of the westward march of French columns from the Lech he told his army, apparently in all good faith, that the French were in full march for their own country.

Actually the French at this moment were suffering the most terrible distress—up to the Danube they had still found sufficient food for existence, but south of it, in the track of the Austrians, they found nothing. All march discipline disappeared, the men dissolved into hordes of marauders and even the sternest of the marshals wrote piteous appeals to the emperor for supplies, and for permission to shoot some of their stragglers. But to all these Berthier in the emperor's name sent the stereotyped reply—"The emperor has ordered you to carry four days' provisions, therefore you can expect nothing further—you know the emperor's method of conducting war."

Action of Albeck or Haslach.—Meanwhile Murat, before the emperor joined him, had given Mack the desired opening. The VI. corps (Ney) should have remained on the left bank of the

Danube to close the Austrian exit on that side, but by mistake only Dupont's division had been left at Albeck, the rest being brought over the river. Mack on the 8th had determined to commence his withdrawal, but fortune now favoured the French. The weather during the whole of October had been unusually wet, the swollen Danube overflowed the low ground and the roads had become quagmires. On the south bank, owing to better natural drainage and a drier subsoil, movement was fairly easy, but the Austrians found it almost impossible. On Oct. 11, when they began their march, the road along the Danube was swept into the river, carrying with it several guns and teams, and hours were consumed in passing the shortest distances. At length in the afternoon they suddenly fell upon Dupont's isolated division at Albeck, which was completely surprised and severely handled. The road now lay completely open, but the Austrian columns had so opened out owing to the state of the roads that the leading troops could not pursue their advantage — Dupont rallied and the Austrians had actually to fall back towards Ulm to procure food.

Elchingen.—For three more days Mack struggled with an unwilling staff and despondent men to arrange a further advance. During these very three days, through a succession of staff blunders, the French failed to close the gap, and on the morning of Oct. 14 the armies, each renewing its advance, came in contact at the bridge of Elchingen. This bridge, all but a few road-bearers, had been destroyed, but now the French gave an example of that individual gallantry which was characteristic of the old revolutionary armies. Running along the beams under a close fire a few gallant men forced their way across. The floor of the bridge was rapidly relaid, and presently the whole of the VI. corps was deploying with unexampled rapidity on the farther side. The Austrians, still in their quagmire, could not push up reinforcements fast enough, and though Mack subsequently alleged deliberate obstruction and disobedience on the part of his subordinates, the state of the roads alone suffices to explain their defeat. Only the right column of the Austrians was, however, involved; the left under General Werneck, to whom some cavalry and the archduke Ferdinand attached themselves, did indeed succeed in getting away, but without trains or supplies. They continued their march, famished but unmolested, until near Heidenheim they suddenly found themselves confronted by what from the diversity of uniforms they took to be an overwhelming force; at the same time the French cavalry sent in pursuit appeared in their rear. Utterly exhausted by fatigue, Werneck with his infantry, some 8,000 strong, surrendered to what was really a force of dismounted dragoons and foot-sore stragglers improvised by the commanding officer on the spot to protect the French treasure chests, which at that moment lay actually in the path of the Austrians. The young archduke with some cavalry escaped.

Mack Surrounded. — The defeat at Elchingen on Oct. 14 sealed the fate of the Austrians, though Mack was still determined to endure a siege. As the French columns coming up from the south and west gradually surrounded him, he drew in his troops under shelter of the fortress and its improvised entrenched camp, and on the 15th he found himself completely surrounded. On the 16th the French field-guns fired into the town, and Mack realized that his troops were no longer under sufficient control to endure a siege. When, therefore, next morning, negotiations were opened by the French, Mack, still feeling certain that the Russians were at hand, agreed to an armistice and undertook to lay down his arms if within the next twenty-one days no relief should arrive. To this Napoleon consented, but hardly had the agreement been signed when he succeeded in introducing a number of individual French soldiers into the fortress, who began rioting with the Austrian soldiery. Then, sending in armed parties to restore order and protect the inhabitants, he caused the guards at the gates to be overpowered, and Mack was thus forced into an unconditional surrender.

On Oct. 22, the day after Trafalgar, the remnant of the Austrian army, 23,000 strong, laid down its arms. About 5,000 men under Jellachich had escaped to Tirol, 2,000 cuirassiers with Prince Ferdinand to Eger in Bohemia, and about 10,000 men under Werneck had surrendered at Heidenheim. The losses in battle having been insignificant, there remain some 30,000 to account for — most of whom probably escaped individually by the help of the inhabitants, who were bitterly hostile to the French. Napoleon now hastened to rejoin the group of corps he had left under Bernadotte in observation towards the Russians, for the latter were nearer at hand than even Mack had assumed. But hearing of his misfortune they retreated before Napoleon's advance along the right bank of the Danube to Krems, where they crossed the river and withdrew to an entrenched camp near Olmiitz to pick up fresh Austrian reinforcements. The severe actions of Diirrenstein (near Krems) on Nov. 11, and of Hollabriinn on Nov. 16, in which Napoleon's marshals learned the tenacity of their new opponents, and the surprise of the Vienna bridge (November 14) by the French, were the chief incidents of this period in the campaign.

Campaign of **Austerlitz.**—Napoleon continued down the right bank to Vienna, where he was compelled by the condition of his troops to call a halt to refit his army. After this was done he continued his movement to Briinn. Thither he succeeded in bringing only 55,000 men. He was again forced to give his army rest and shelter, under cover of Murat's cavalry. The allies now confronted him with upwards of 86,000 men, including 16,000 cavalry. About Nov. 20 this force commenced its advance, and Napoleon concentrated in such a manner that within three days he could bring over 80,000 French troops into action around Brunn, besides 17,000 or more Bavarians under Wrede. On the 28th Murat was driven in by the allied columns. That night orders were despatched for a concentration on Brunn in expectation of a collision on the following day; but hearing that the whole allied force was moving towards him he decided to concentrate south-east of Briinn, covering his front by cavalry on the Pratzen heights. Meanwhile he had also prepared a fresh line of retreat towards Bohemia, and, certain now of having his men in hand far the coming battle, he quietly awaited events.

The allies were aware of his position, and still adhering to the old "linear" system, marched to turn his right flank *(see* AUSTERLITZ). As soon as their strategic purpose of cutting him off from Vienna became apparent, the emperor moved his troops into position, and in the afternoon issued his famous proclamation to his troops, pointing out the enemy's mistakes and his plan for defeating them. At the same time he issued his orders for his first great battle as a supreme commander. The battle of Austerlitz began early next morning and closed in the evening with the thorough and decisive defeat of the allies.

PRUSSIAN AND POLISH CAMPAIGNS

Around the Prussian army, and particularly the cavalry, the prestige of Frederick the Great's glory still lingered; but the younger generation had little experience of actual warfare, and the higher commanders were quite unable to grasp the changes in tactics and in the conduct of operations which had grown out of the necessities of the French Revolution. The individual officers of the executive staff were the most highly trained in Europe, but there was no great leader to co-ordinate their energies. The total number of men assigned to the field army was 110,000 Prussians and Saxons. They were organized in corps, but their leaders were corps commanders only in name, for none were allowed any latitude for individual initiative. Ill-judged economies had undermined the whole efficiency of the Prussian army. Two-thirds of the infantry and one-half of the cavalry were allowed furlough for from ten to eleven months in the year. The men were unprovided with greatcoats. Most of the muskets had actually seen service in the Seven Years' War, and their barrels had worn so thin with constant polishing that the use of full charges at target practice had been forbidden. Above all, the army had drifted entirely out of touch with the civil population. The latter, ground down by feudal tradition and law, and at the same time permeated by the political doctrines of the late 18th century, believed that war concerned the governments only, and formed no part of the business of the "honest citizen." In this idea they were supported by the law itself, which protected the civilian against the soldier, and forbade even in war-time the requisitioning of horses, provisions and transport, without payment. Up to the night of the battle of Jena itself, the Prussian troops lay starving in the midst of plenty, whilst the French everywhere took what they wanted. This alone was a sufficient cause for all the misfortunes which followed.

During the campaign of Austerlitz Prussia, furious at the violation of her territory of Anspach, had mobilized, and had sent Haugwitz as ambassador to Napoleon's headquarters. He arrived on Nov. 30, and Napoleon, pleading business, put off his official reception till after the battle of Austerlitz. Of course the ultimatum was never presented, as may be imagined; Haugwitz returned and the king of Prussia demobilized at once. But Napoleon, well knowing the man he had to deal with, had determined to force a quarrel upon Prussia at the earliest convenient opportunity. His troops therefore, when withdrawn from Austria, were cantoned in south Germany in such a way that, whilst suspicion was not aroused in minds unacquainted with Napoleonic methods, they could be concentrated by a few marches behind the Thuringian forest and the upper waters of the Main. Here the Grande Armée was left to itself to recuperate and assimilate its recruits, and it is characteristic of the man and his methods that he did not trouble his corps commanders with a single order during the whole of the spring and summer.

As the diplomatic crisis approached, spies were sent into Prussia, and simultaneously with the orders for preliminary concentration the marshals received private instructions, the pith of which cannot be better expressed than in the following two quotations from Napoleon's correspondence:—

"Man intention est de concentrer toutes mes forces sur l'extrémité de ma droite en laissant tout l'espace entre le Rhin et Bamberg entièrement dégarni, de manière à avoir près de 200.000 hommes réunis sur un même champ de bataille; mes premières march'es menacent le coeur de la monarchie prussienne" (No. 10,920). "Avec cette immense supériorité de forces réunis sur un espace si Ctroit, vous sentez que je suis dans la volonté de ne rien hasarder et d'attaquer l'ennemi partout oh il voudra tenir. Vous pensez bien que ce serait une belle affaire que de se porter sur cette place (Dresden) en *un bataillon carré de 200,000 hommes*" (Soult, No. 10,941).

Advance of the Grande Armée.—On Oct. 7 the Grande *Armée* lay in three parallel columns along the roads leading over the mountains to Hof, Schleiz and Kronach; on the right lay the IV. corps (Soult) about Bayreuth, with his cavalry in rear, and behind these the VI. corps (Ney) at Pegnitz; in the centre, Bernadotte's I. corps from Nordhalben, with the III. corps (Davout) Lichtenfels; Guard and headquarters, Bamberg. The left column was composed of the V. (Lannes) at Hemmendorf, with the VII. (Augereau) extending south to the Main at Burgebrach.

Napoleon's .object being surprise, all the cavalry except a few vedettes were kept back behind the leading infantry columns and these latter were ordered to advance, on the signal being given, in "masses of manoeuvre," so as to crush at once any outpost resistance which was calculated upon the time required for the deployment of ordinary marching columns. This order has never since found an imitator, but deserves attentive study as a masterpiece (see H. Bonnal, *Manoeuvre d'Iéna*).

To meet the impending blow the Prussians had been extended in a cordon along the great road leading from Mainz to Dresden, Blucher was at Erfurt, Rüchel at Gotha, Hohenlohe at Weimar, Saxons in Dresden. with outposts along the frontier. An offensive move into Franconia was under discussion, and for this purpose the Prussian staff had commenced a lateral concentration about Weimar, Jena and Naumburg when the storm burst upon them. The emperor gathered little from the confused reports of their purposeless manoeuvres, but, secure in the midst of his "battalion square" of 200.000 men, he remained quite indifferent, well knowing that an advance straight on Berlin must force his enemy to concentrate and fight, and as they would bring at most 127,000 men on to the battlefield the result could hardly be doubtful. On Oct. g the cloud burst. Out of the forests which clothe the northern slopes of the Thuringer Wald the French streamed forth, easily overpowering the resistance of the Prussian outposts on the upper Saale, and once the open country was reached the cavalry under Murat trotted to the front, closely followed by Bernadotte's corps as "general advance guard." The result of the cavalry scouting was, however, unsatisfactory. On the night of the 10th, the emperor was still unaware of the position of his principal foe, and Murat with Bernadotte behind him was directed on Gera for the 11th, the remainder of the army continuing along the roads previously assigned to them.

In the meanwhile, however, the Saxons had been moving from Naumburg through Gera on Jena, Hohenlohe was near Weimar, and all the other divisions of the Prussian army had closed in a march eastwards, the idea of an offensive to the southward which Napoleon had himself attributed to them having already disappeared.

Reaching Gera at 9 A.M. Murat reported the movement of the Saxons on the previous day, but omitted to send a strong detachment in pursuit. The traces of the Saxons were lost, and Napoleon, little satisfied with his cavalry, authorized Lasalle to offer up to 6,000 frs. reward for information of the Prussian point of concentration. At 1 A.M. of the 12th Napoleon issued his orders: Murat and Bernadotte via Zeitz to Naumburg; Davout (III. corps and a dragoon division) also to Naumburg; Lannes to Jena, Augereau following; Soult to Gera.

In the meantime the Prussians were effecting their concentration. Ruchel, who with 15,000 men had been sent into the mountains as an advance guard for the projected offensive, was recalled to Weimar, which he reached on the 13th. The main body were between Weimar and Apolda during the 12th, and the Saxons duly effected their junction with Hohenlohe in the vicinity of Vierzehnheiligen, whilst the latter had withdrawn his troops, all but some outposts from Jena, to the plateau about Capellendorf, some 4m. to the N.W. The whole army, of over 120,000 men, could therefore have been concentrated against Lannes and Augereau by the afternoon of the 13th, whilst Soult could

FIG. 2.—JENA CAMPAIGN

only have intervened very late in the day, and Davout and Bernadotte were still too distant to reach the battlefield before the 14th. All the French corps, moreover, were so exhausted by their rapid marches over bad roads that the emperor actually ordered (at 1 A.M. on the 13th) a day of rest for all except Davout, Bernadotte, Lannes and Murat.

The Prussian headquarters, however, spent the 12th and 13th in idle discussion, whilst the troop commanders exerted themselves to obtain some alleviation for the suffering of their starving men. The defeats undergone by their outpost detachment had profoundly affected the nerves of the troops, and on the afternoon of the 11th, on the false alarm of a French approach, a panic broke out in the streets of Jena, and it took all the energy of Hohenlohe and his staff to restore order. On the morning of the 12th the Saxon commanding officers approached Hohenlohe with a statement of the famishing condition of their men, and threatened to withdraw them again to Saxony. Hohenlohe pointed out that the Prussians were equally badly off, but promised to do his best to help his allies. Urgent messages were sent off to the Commissary von Goethe (the poet), at Weimar for permission to requisition food and firewood. These requests, however, remained unanswered, and the Prussians and Saxons spent the night before the battle shivering in their miserable bivouacs.

The 13th of October.—During the early morning of the 13th the reports brought to Napoleon at Gera partially cleared up the situation, though the real truth was very different from what he supposed. However, it was evident that the bulk of the Prussians lay to his left, and instructions were at once despatched to Davout to turn westward from Naumburg towards Kosen and to bring Bernadotte with him if the two were still together. The letter, however, ended with the words "but I hope he is already on his way to Dornburg." Now Bernadotte had neglected to keep the emperor informed as to his whereabouts. He was still with Davout, but, concluding that he had missed an order directing him to Dornburg, he thought to conceal his error by assuming the receipt of the order evidently alluded to in the last words, and as a result he marched towards Dornburg, and his whole corps was lost to the emperor at the crisis of the next day's battle.

On the road from Gera to Jena Napoleon was met by intelligence from Lannes announcing his occupation of Jena and the discovery of Prussian troops to the northward. Knowing the emperor's methods, he wisely restrained the ardour of his subordinates and asked for instructions whether to attack or wait. The emperor rode forward rapidly, reached Jena about 3 P.M., and with Lannes proceeded to the Landgrafenberg to reconnoitre. From this point his view was, however, restricted to the immediate foreground, and he only saw the camps of Hohenlohe's left wing. At this moment the Prussians were actually on parade and ready to move off to attack, but just then the "evil genius" of the Prussian army, Massenbach, an officer of the Headquarters Staff, rode up and claiming to speak with the authority of the king and commander-in-chief, induced Hohenlohe to order his troops back to camp. Of all this Napoleon saw nothing, but from all reports he came to the conclusion that the whole Prussian army was actually in front of him, and at once issued orders for his whole army to concentrate towards Jena, marching all night if need be. Six hours earlier his conclusion would have been correct, but early that morning the Prussian headquarters, alarmed for the safety of their line of retreat on Berlin by the presence of the French in Naumburg, decided to leave Hohenlohe and Rüchel to act as rear-guard, and with the main body to commence their retreat towards the river Unstrutt and the Eckhardtsberge where Massenbach had previously reconnoitred an "ideal" battlefield. This belief in positions was the cardinal principle of Prussian strategy in those days. The troops had accordingly commenced their march on the morning cf the 13th, and now at 3 P.M. were settling down into bivouac; they were still but a short march from the decisive field.

Battle of **Jena.**—On the French side, Lannes' men were working their hardest, under Napoleon's personal supervision, to make a practicable road up to the Landgrafenberg, and all night long the remaining corps struggled through darkness towards the rendezvous. By daybreak on the 14th, the anniversary of Elchingen, upwards of 60,000 men stood densely packed on the narrow plateau of the mountain, whilst, below in the ravines on either flank, Soult on the right, and Augereau on the left, were getting into position. Fortunately a dense fog hid the helpless masses on the Landgrafenberg from sight of the Prussian gunners. Hohenlohe had determined to drive the French into the ravine at daybreak, but had no idea as to the numbers in front of him. For want of room, only a few Prussian battalions were sent forward, and these, delaying their advance till the fog had sufficiently lifted, were met by French skirmishers, and small columns, who rapidly overlapped their flanks and drove them back in confusion. Hohenlohe now brought up the remainder of his command, but in the meanwhile the French had poured across the neck between the Landgrafenberg and the main plateau, and the troops of Soult and Augereau were working up the ravines on either hand. In view of these troops the Prussian line, which had advanced faultlessly as if on parade, halted to prepare its bayonet attack by fire, and, once halted, it was found impossible to get them to go on again. The French, who had thrown themselves into houses, copses, etc., picked off the officers, and the flanks of the long Prussian lines swayed and got into confusion. The rival artilleries held each other too thoroughly to be able to spare attention to the infantry, whilst the Prussian cavalry, which had forgotten how to charge in masses of eighty or more squadrons, frittered away their strength in isolated efforts. By 10 A.M. the fourteen battalions which had initiated this attack were outnumbered by three to one, and drifted away from the battlefield. Their places were taken by a fresh body, but this was soon outnumbered and ourflanked in its turn. By 2 P.M. the psychological moment had come, and Napoleon launched his guards and cavalry to complete the victory and initiate pursuit. Rüchel's division now arrived and made a most gallant effort to cover the retreat, but their order being broken by the torrent of fugitives, they were soon overwhelmed by the tide of the French victory and all organized resistance had ceased by 4 P.M.

Briefly summarized, the battle came to this—in four successive efforts the Prussians failed because they were locally outnumbered. This was the fault of their leaders solely, for, except for the last attack, local superiority was in each case attainable. Organization and tactics did not affect the issue directly, for the conduct of the men and their junior officers gave abundant proof that in the hands of a competent leader the "linear" principle of delivering one shattering blow would have proved superior to that of a gradual attrition of the enemy here, as on the battlefields of the Peninsula and at Waterloo, and this in spite of other defects in the training of the Prussian infantry which simultaneously caused its defeat on the neighbouring field of Auerstadt.

Battle of **Auerstädt.**—Here the superiority of French mobility showed its value most conclusively. Davout in obedience to his orders of the previous morning was marching over the Saale at Kosen, when his advanced guard and that of the Prussian main army came unexpectedly in contact. The latter with at least 50,000 men was marching in two columns, and ought therefore to have delivered its men into line of battle twice as fast as the French, who had to deploy from a single issue, and whose columns had opened out in the passage of the Kosen defile and the long ascent of the plateau above. But the Prussians attacked at the old regulation speed of seventy-five paces to the minute, and the French manoeuvred at the quick or double of 120 or 150. The consequence was that the French always succeeded in reinforcing their fighting line in time to avert disaster. Nevertheless by mid-day their strength was well-nigh exhausted, whilst the Prussian reserve, eighteen battalions of guards under Kalckreuth, stood intact and ready to engage. But at the critical moment the duke of Brunswick fell mortally wounded, and Scharnhorst, his chief of the staff, was at the time absent on another part of the field. Meanwhile rumours from the battlefield at Jena, magnified as usual, began to reach the staff, and these may possibly have influenced Kalckreuth, for when called upon to attack with his eighteen battalions and win the day, he declined to move without the direct order of the commander-in-chief to do so, alleging that it was the duty of a reserve to cover the retreat and he considered himself personally responsible to the king for the guards entrusted to his care. Even then the day might possibly have been saved had Bliicher been able to find even twenty squadrons accustomed to gallop together, but the Prussian cavalry had been dispersed amongst the infantry commands, and at the critical moment it proved impossible for them to deliver a united and decisive attack

Seeing further efforts hopeless, Scharnhorst in the duke's name initiated the retreat and the troops withdrew north-west towards Buttelstedt. almost unmolested by the French, who this day had put forth all that was in them, and withstood victoriously the highest average punishment any troops of the new age of warfare had as yet endured. So desperate had been their resistance that the Prussians unanimously stated Davout's strength at double the actual figure. Probably no man but Davout could have got so much out of his men, but why was he left unsupported?

Bernadotte, we have seen, had marched to Dornburg, or rather to a point overlooking the ford across the Saale at the village of

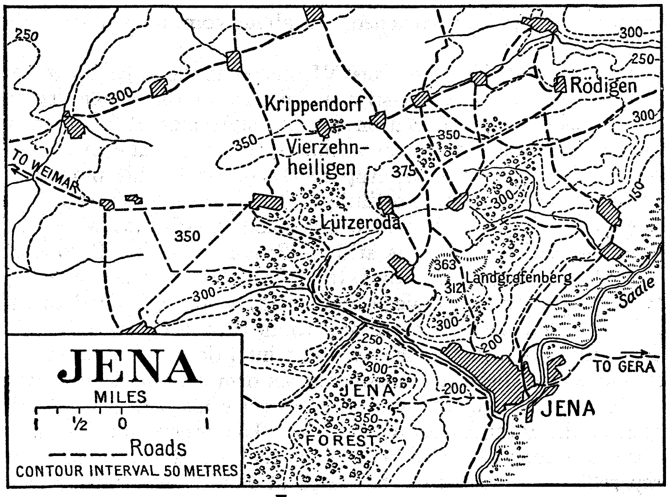

FIG. 3.—JENA

that name, and reached there in ample time to intervene on either field. But with the struggle raging before him he remained undecided, until at Jena the decision had clearly fallen, and then he crossed the river and arrived with fresh troops too late for their services to be required.

Prussian Retreat.—During the night the Prussians continued their retreat, the bulk of the main body to Sommerda, Hohenlohe's corps towards Nordhausen. The troops had got much mixed up, but as the French did not immediately press the pursuit home, order was soon re-established and a combined retreat was begun towards the mouth of the Elbe and Liibeck. Here help was expected to arrive from England, and the tide might ultimately have turned, for the Russian armies were gathering in the east. It was now that the results of a divorce of the army from the nation began to be felt. Instead of seizing all provisions and burning what they could not remove, the Prussian generals enforced on their men the utmost forbearance towards the inhabitants, and the fact that they were obeyed, in spite of the inhumanity the people showed to their sick and wounded countrymen, proves that discipline was by no means so far gone as has generally been believed. The French marching in pursuit were received with open arms, the people even turning their own wounded out of doors to make room for their French guests. Their servility awakened the bitterest contempt of their conquerors and forms the best excuse for the unparalleled severity of the French yoke. On Oct. 26 Davout reached Berlin, having marched 166m. in twelve days including two sharp rearguard actions, Bernadotte with his fresh troops having fallen behind. The inhabitants of Berlin, headed by their mayor, came out to meet him, and the newspapers lavished adulation on the victors and abuse-on the beaten army. On the 28th Murat's cavalry overtook the remnant of Prince Hohenlohe's army near Prenzlau (north of Berlin) and invited its capitulation. Unfortunately the prince sent Massenbach to discuss the situation, and the latter completely lost his head. Murat boasted that he had 100,000 men behind him, and on his return Massenbach implored his chief to submit to an unconditional surrender, advice which the prince accepted, though as a fact Murat's horses were completely exhausted and he had no infantry whatever within call. Only Bliicher now remained in the field, and he too was driven at length into Lubeck with his back to the sea where he capitulated Nov. 7.

Campaigns in Poland and East **Prussia.**—Hitherto the French had been operating in a rich country, untouched for half a century past by the ravages of war, but as the necessity for a campaign against the Russians confronted the emperor, he realized that his whole supply and transport service must be put on a different footing. After the wants of the cavalry and artillery had been provided for, there remained but little material for transport work. Exhaustive orders to organize the necessary trains were duly issued, but the emperor seems to have had little conception of the difficulties the tracks—there were no metalled roads—of Poland were about to present to him. Moreover, it was one thing to issue orders, but quite another to ensure that they were obeyed, for they entailed a complete transformation in the mental attitude of the French soldier towards all that he had been taught to consider his duties in the field. Experience only can teach the art of packing wagons and the care of draught animals, and throughout the campaign the small ponies of Poland and East Prussia broke down by thousands from over loading and unskilful packing.

The Russian Army formed the most complete contrast to the French that it is possible to imagine. Though clad, armed and organized in European fashion, the soldiers retained in a marked degree the traditions of their Mongolian forerunners, their transport wagons were in type the survival of ages of experience, and their care for their animals equally the result of hereditary habit. The intelligence of the men and regimental officers was very low, but on the other hand service was practically for life, and the regiment the only home the great majority had ever known. Hence obedience was instinctive and initiative almost undreamt of. Moreover, they were essentially a war-trained army, for even in peace time their long marches to and fro within the empire had most thoroughly inured them to hardship and privation. Napoleon might have remembered his own saying, "La misère est l'école du bon soldat." Their artillery was numerous and for the most part of heavy calibre—18- and 24-pounders were common—but the strength of the army lay in its infantry, with its incomparable tenacity in defence and its blind confidence in the bayonet in attack. The traditions of Suvarov and his victories in Italy (see FRENCH REVOLUTIONARY WARS) were still fresh, but there was no longer a Suvarov to lead them.

Advance **to the Vistula.**—Napoleon had from the first been aware of the secret alliance between Prussia and Russia, sworn

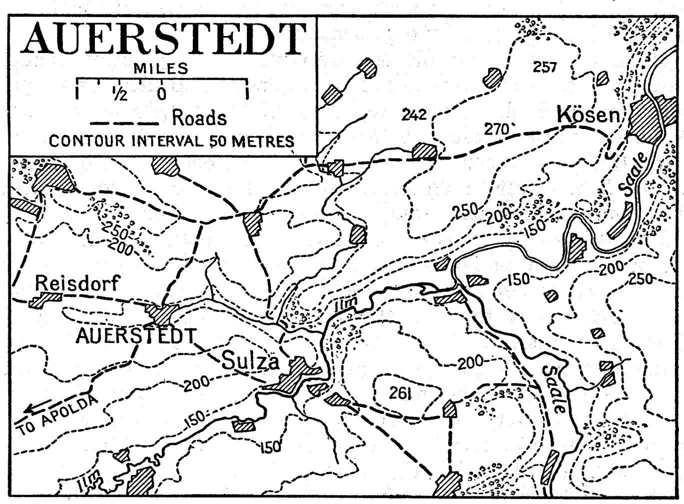

FIG. 4.—AUERSTEDT

by their respective sovereigns over the grave of Frederick the Great, and this knowledge had been his principal reason for precipitating hostilities with the former. He remained, however, in complete ignorance of the degree of preparation attained on the Russian side, and as the seizure of Warsaw together with the control of the resources of Poland in men and material its occupation would afford, was the chief factor in his calculation, he turned at once to the eastward as soon as all further organized resistance in Prussia was ended by the surrender of Prenzlau and Lübeck. Scarcely leaving his troops time to restore their worn-out foot gear, or for the cavalry to replace their jaded horses from captured Prussian resources, he set Davout in motion towards Warsaw on Nov. 2, and the remainder of the army followed in successive echelon's as rapidly as they could be despatched.

The cavalry, moving well in advance, dispersed the Prussian depots and captured their horses, as far as the line of the Vistula, where at last they encountered organized resistance from the

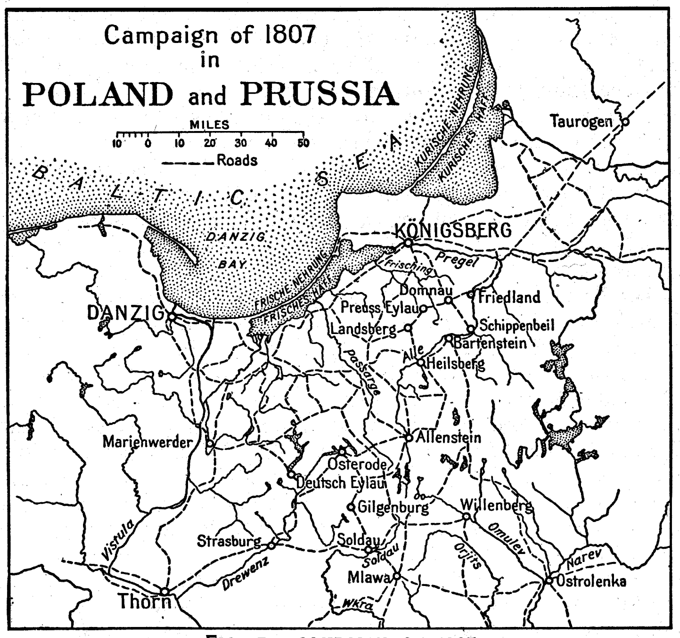

FIG. 5.—CAMPAIGN OF 1807

outposts of Lestocq's little corps of 15,000 men—all that was left of Frederick the Great's army. These, however, gave way before the threat of the advancing French and, after a few trifling skirmishes, Davout entered Warsaw on Nov. 30, being followed by the V., IV., and Guard corps during the succeeding fortnight, whilst the VI. and VII. were echeloned to their left, and the VIII. (Mortier) and IX. (Jerome Napoleon) and X. (Lefebvre), all new formations since the outbreak of the war, followed some marches in the rear. Jerome's corps was composed of the Bavarians, Wiirttembergers and Badensers.

Behind these all Prussia was overrun by newly formed units, (3rd and 4th battalions) raised from depot companies, conscripts for 1807, and old soldiers rejoining after sickness or wounds. Napoleon caused these to be despatched to the front immediately after their formation. He had much territory to occupy, and on the long march of on an average 85 days, he considered that they could be organized, equipped and drilled en route.

Pultusk.—The Russians meanwhile had been moving slowly forward in two bodies, one under Bennigsen (50,000), the other under Buxhowden (25,000), and the French being at this time in Warsaw, they took up threatening positions about Pultusk, Plock and Prassnitz. From this triangle they harried the French communications with Berlin, and to secure a winter's rest for his men Napoleon determined to bring them to action. On Dec. 23 operations were commenced, but the difficulties of securing information and maintaining communication between the respective columns, so unlike what any of the French had previously encountered, led to a very partial success. The idea had been to induce the Russians to concentrate about Pultusk and, turning their position from its left, ultimately to cut them off from Russia, and if possible to surround them. But in this new and difficult country the emperor found it impossible to time his marches. The troops arrived late at their appointed positions, and after a stubborn rearguard action at Pultusk itself and undecisive fighting elsewhere (Golymin and Soldau) the Russians succeeded in retreating beyond the jaws of the French attack, and Napoleon for the first time found that he had exceeded the limit of endurance of his men. Indeed, the rank and file bluntly told him as much as he rode with the marching columns. Yielding to the inevitable, but not forgetting to announce a brilliant victory in a bulletin, he sent his troops into winter quarters along the Passarge and down the Baltic, enjoining on his corps commanders most strictly to do nothing to disturb their adversary.

Campaign **of Eylau.**—Bennigsen, now commanding the whole Russian army which with Lestocq's Prussians amounted to 100,000, also moved into winter quarters in the area Deutsch Eylau-Osterode-Allenstein, and had every intention of remaining there, for a fresh army was already gathering in Russia, the first corps of which had reached Nur about 50m. distant from the French right.

Unfortunately, Ney with his VI. corps about Gilgenberg had received the most poverty-stricken district in the whole region, and to secure some alleviation for the sufferings of his men he incautiously extended his cantonments. till they came in contact with the Russian outposts. Apparently seeing in this movement a recommencement of hostilities, Bennigsen concentrated his troops towards his right and commenced an advance westwards towards Danzig, which was still in Prussian hands. Before his advance both Ney and Bernadotte (the latter, between Ney and the Baltic, covering the siege of Danzig) were compelled to fall back. It then became necessary to disturb the repose of the whole army to counter the enemy's intentions. The latter by this movement, however, uncovered his own communication with Russia, and the emperor was quick to seize his opportunity. He received the information on Jan. 28. His orders were at once issued and complied with so rapidly that by the 31st he stood prepared to advance with the corps of Soult, Ney, Davout and Augereau, the Guard and the reserve cavalry (80,000 men on a front of 60m.) from Myszienec through Willenberg to Gilgenberg; whilst Lannes on his right towards Ostrolenka and Lefebvre (X.) at Thorn covered his outer flanks.

Bernadotte, however, was missing, and this time through no fault of his own. His orders and the despatch conveying Napoleon's instructions fell into the hands of the Cossacks, and just in time Bennigsen's eyes were opened. Rapidly renouncing his previous intentions, he issued orders to concentrate on Allenstein; but this point was chosen too far in advance 'and he was anticipated by Murat and Soult at that place on Feb 2. He then determined to unite his forces at Joukendorf, but again he was too late. Soult and Murat attacked his rearguard on the 3rd, and Bennigsen, learning from his Cossacks that the French corps were designing to swing round and enclose him, he withdrew by a night march and ultimately succeeded in getting his whole army, with the exception of Lestocq's Prussians, together in the strong position along the Alle, the centre of which is marked by Preussisch-Eylau. The opportunity for this concentration Bennigsen owed to the time gained for him by his rearguard at Joukendorf, for this had stood just long enough to induce the French columns to swing in to surround it, and the next day was thus lost to the emperor as his corps had to extend again to their manoeuvring intervals. The truth is that the days were too short and the roads too bad for Napoleon to carry out the full purpose his "general advance guard" was intended to fulfil. It was designed to hold the enemy in position by the vigour of its attack, thus neutralizing his independent will power and compelling him to expend his reserves in the effort to rescue the troops engaged. But in forests and snowdrifts the French made such slow progress that no sufficient deployment could be made until darkness put a stop to the fighting. Thus, when late on Feb. 7, 1807 Murat and Soult found the enemy's rearguard near Eylau (*q.v.*) the fighting was severe but not prolonged. This time, however, Bennigsen, with over 60,000 men in position and 15,000 Prussians expected to arrive next morning, had no desire to avoid a battle, and deployed for action.

During the night Augereau and the Guards had arrived, and Ney and Davout were expected on either flank in the forenoon. This time the emperor was determined that his enemy should not escape him, and about 8 A.M. ordered Soult and Augereau on the left and right respectively to assail the enemy, Murat and the Guards remaining in the centre as reserve. Napoleon's own forces thus became the "general advance guard" for Ney and

Davout, who were to close in on either side and deliver the decisive stroke. But here too the weather and the state of the roads operated adversely, for Ney came up too late, while Davout, in the full tide of his victorious advance, was checked by the arrival of Lestocq, whose corps Ney had failed to intercept, and the attack of Augereau's corps (VII), made in a blinding snowstorm, failed with appalling loss. Bennigsen, however, drew off on Ney's arrival, and the French were too much exhausted to pursue him. Again the emperor had to admit that his troops could do no more, and, bowing to necessity, he distributed them into winter quarters, where, however, the enterprise of the Cossacks, who were no strangers to snow and to forests, left the outposts but little repose. A protracted period of rest followed, during which the emperor exerted himself unremittingly to re-equip, reinforce and supply his troops. Hitherto he had been based on the entrenched camp of Warsaw, but he had already taken steps to organize a new line of supply and retreat via Thorn, and this was now completed. At the same time Lefebvre was ordered to press the siege of Danzig with all vigour, and on May 5, after a most gallant resistance, Kalckreuth, who redeemed here his failure of Auerstadt, surrendered. English assistance came too late. By the beginning of June the French had more than made good their losses and 210,000 men were available for field service.

Heilsberg and Friedland.—Meanwhile Bennigsen had prepared for a fresh undertaking, and leaving Lestocq with 20,000 Prussians and Russians to contain Bernadotte, who lay between Braunsberg and Spandau on the Passarge, he moved southward on June 2, and on June 3 and 4 he fell upon Ney, driving him back toward Guttstadt, while with the bulk of his force he moved toward Heilsberg, where he threw up an entrenched position. It was not till June 5 that Napoleon received tidings of his advance, and for the moment these were so vague that he contented himself by warning the remainder of his forces to be prepared to move on June 6. Next day, however, all doubts were set at rest, and as the Russians advanced south of Heilsberg, he decided to wheel his whole force to the right, pivoting on the III corps, and cut Bennigsen off from Konigsberg and the sea. On June 8 the VI, III, VIII and Guard corps, together with a new cavalry reserve corps under Lannes, in all 147,000, stood ready for the operation, and with Murat and Soult as general advanced guard the whole moved forward, driving the Russian outposts before them. Bernadotte, who was to have attacked Lestocq, again failed to receive his orders and took no part in the following operations.

Murat attacked the Russians, who had halted in their entrenched position, on June 11 and drove in their outposts, but did not discover the entrenchments. Meanwhile, Soult had followed with his infantry in close support, and, the emperor himself arriving, ordered him to attack at once. Now the Russians uncovered their entrenchments, and in the absence of artillery preparation Soult's leading troops received most severe punishment. Fresh troops arriving were sent in to his support, but these also proved insufficient, and darkness alone put an end to the struggle. which cost the French 12,000 killed and wounded.

Bennigsen, however, learning that his right was threatened by the III corps, and not having as yet completed his concentration, retreated in the night to Bartenstein, and the following day turned sharp right toward Schippenbeil. The emperor now pressed on toward Friedland, where he would completely control the Russian communications with Konigsberg, their immediate base of supply, but for once the Russians outmarched him and covered their movement so successfully that for the next three days he seems to have completely lost all knowledge of his enemy's whereabouts. Lestocq in the meantime had been forced northward toward Konigsberg, and Soult with Murat was in hot pursuit. The III, VI, VIII and Guard corps followed the main road toward Konigsberg, and the former had reached Mühlhausen and the remainder were about Preussich-Eylau, when Latour Maubourg's dragoons sent in intelligence which pointed to the presence of Bennigsen about Friedland. This was indeed the case. The Russians after passing Schippenbeil had suddenly turned northward, and on the evening of June 13 were taking up a strong position on the river Alle with Friedland as a centre.

What followed presents perhaps the finest instance of the Napoleonic method. The enemy lay directly to his right, and Murat, the IV and III corps had well overshot the mark. Lannes's reserve corps (cavalry), to whom Latour Maubourg reported, lay at Domnau about 10 mi. to the right. The latter at once assumed the role of advanced guard cavalry and was ordered to observe the enemy at Friedland, Ney following in close support. Davout was turned about and directed on the enemy's right, and the VIII corps (Mortier), the Guards and the reserve cavalry followed as main body. On June 14 (the anniversary of Marengo) Lannes carried out his role of fighting advanced guard or screen, the emperor's main body gradually came up, and the battle of Friedland (*q.v.*), notable chiefly for the first display of the new artillery tactics of the French, ended with a general attack about 5 P.M. and the retreat of the Russians, after severe losses, over the Alle. Lestocq was, meanwhile, driven through Konigsberg (which surrendered on June 15) on Tilsit, and now that he was no longer supported by the Russians, the Prussian commander gave up the struggle.

THE AUSTRIAN WAR OF 1809

Ever since Austerlitz the Austrian officers had been labouring to reconstitute and reform their army. Much had been done to create an efficient staff, but though the idea of the army corps command was now no new thing, the senior generals entrusted with these commands were far from having acquired the independence and initiative of their French opponents. Hence the extraordinary slowness of their manoeuvres, not because the Austrian infantrymen were bad marchers, but because the preparation and circulation of orders were still far behind the French standard. The infantry adopted the highly manoeuvrable formations of the French—skirmishers and columns—but it was easier to adopt the formations than to acquire the initiative which gave these their vital energy. The light cavalry had been much improved and the heavy cavalry on the whole proved a fair match for their opponents.

After the peace of Tilsit the *Grande Armke* was gradually withdrawn behind the Rhine, leaving only three commands, totalling 63,000 men, under Davout in Prussia, Oudinot in west central Germany and Lefebvre in Bavaria, to assist the princes of the Confederation of the Rhine in the maintenance of order and the enforcement of the French law of conscription, which was rigorously insisted on in all the states comprised in this new federation. In exchange for the subsistence of the French troops of occupation, a corresponding number of these new levies were moved to the south of France, where they commenced to arrive at the moment when the situation in Spain became acute. The Peninsular War (*q.v.*) called for large forces of the old *Grande Armée* and for a brief period Napoleon directed operations in person; and the Austrians took advantage of the dissemination and weakness of the French forces in Germany to push forward their own preparations with renewed energy.

But they reckoned without the resourcefulness of Napoleon. The moment news of their activity reached him, while still in pursuit of Sir John Moore, he dispatched letters to all the members of the confederation warning them that their contingents might soon be required, and at the same time issued a series of decrees to General Clarke, his war minister, authorizing him to call up the contingent of 1810 in advance, and directing him in detail to proceed with the formation of 4th and 5th battalions for all the regiments across the Rhine. By these means Davout's, Oudinot's and Lefebvre's commands were augmented, while in February and March new corps were formed and rapidly pushed toward the front.

On his return from Spain, seeing war imminent, he issued a series of march orders (which deserve the closest study in detail) by which on April 15 his whole army was to be concentrated for manoeuvres between Regensburg, Landshut, Augsburg and Donauwörth, and sending on the Guard in wagons to Strasbourg, he despatched Berthier to act as commander in chief until his own arrival.

Austrian Offensive.—The position of assembly was excellently chosen, but unfortunately the Austrians took the initiative. On April g their main body of six corps crossed the Inn between Braunau and Passau and simultaneously two additional corps moved from Pilsen in Bohemia on Regensburg. At this moment Davout was entering Regensburg with his leading troops, the remainder still some marches in rear, and it was evident that the whole concentration could no longer be carried out before the Austrians would be in a position to intervene. Berthier received the news while still on his way to the front, and quite failed to grasp the situation. Reaching Donauworth at 8 P.M. on April 13, he ordered Davout and Oudinot to remain at Regensburg, whilst Lefebvre and Wrede (Bavarians) who had fallen back before the Austrians were directed to reoccupy Landshut. This was in direct contradiction to the instructions Napoleon had given on March 28 in view of this very emergency. Davout obeyed, but remonstrated. On the 16th Berthier went on to Augsburg, where he learned that Lefebvre's advanced troops had been driven out of Landshut, thus opening a great gap seventy-six miles wide between the two wings of the French army. Meanwhile Napoleon, who had left Paris at 4 A.M. on April 13, was hastening towards the front, but remained still in ignorance of Berthier's doings until on the 16th at Stuttgart he received a letter from the Marshal dated the 13th, which threw him into consternation. In reply he immediately wrote: "You do not inform me what has rendered necessary such an extraordinary measure which weakens and divides my troops"—and—"I cannot quite grasp the meaning of your letter yet, I should have preferred to see my army concentrated between Ingolstadt and Augsburg, the Bavarians in the first line, with the duke of Danzig in his old position, until we know what the enemy is going to do. Everything would be excellent if the duke of Auerstädt had been at Ingolstadt and the duke of Rivoli with the Wiirttembergers and Oudinot's corps at Augsburg, . . . so that just the opposite of what should have been done has been done" (C. N. to Berthier, Ludwigsburg, 16th April).

Napoleon Takes Command.—Having despatched this severe reprimand he hastened on to Donauworth, where he arrived at 4 A.M. on the 17th, hoping to find Berthier, but the latter was at Augsburg. Nevertheless, at 10 A.M. he ordered Davout and Oudinot to withdraw at once to Ingolstadt; and Lefebvre and Wrede on the right to support the movement. About noon Berthier returned and after hearing his explanation MassCna received orders to move from Augsburg toward Ingolstadt. "To-morrow will be a day of preparation spent in drawing closer together, and I expect to be able by Wednesday to manoeuvre against the enemy's columns according to circumstances."

Meanwhile the Austrians had approached so near that by a single day's march it would have been possible to fall upon and crush by superior numbers either wing of the French army, but though the Austrian light cavalry successfully covered the operations of the following troops they had not yet risen to a conception of their reconnoitring mission, and the archduke, in ignorance of his opportunity and possessed, moreover, with the preconceived idea of uniting at Regensburg with the two corps coming from Bohemia, moved the bulk of his forces in that direction, leaving only a covering body against Davout altogether insufficient to retain him. Davout, however, had left a garrison of 1,800 men in Regensburg, who delayed the junction of the Austrian wings until the 20th inst., and on the same day the emperor, having now reunited his whole right wing and centre, overwhelmed the covering detachments facing him in a long, series of disconnected engagements lasting forty-eight hours, and the archduke now found himself in danger of being forced back into the Danube. But with the Bohemian reinforcements he had still four corps in hand, and Napoleon, whose intelligence service in the difficult and intersected country had lamentably failed him, had weakened his army by detaching a portion of his force in pursuit of the beaten right wing, and against the archduke's communications.

Eckmühl.—When, therefore, the latter, on the 22nd, marched southward to reopen his communications by the defeat of the enemy's army, he actually reached the neighbourhood of Eckmiihl with a sufficient numerical superority had he only been prompt enough to seize his opportunity. But the French had been beforehand with him. Napoleon, who had personally taken part in the fighting of the previous day, and followed the pursuit as far as Landshut, whence he had despatched MassCna to follow the retreating Austrians along the Isar, seems to have realized about

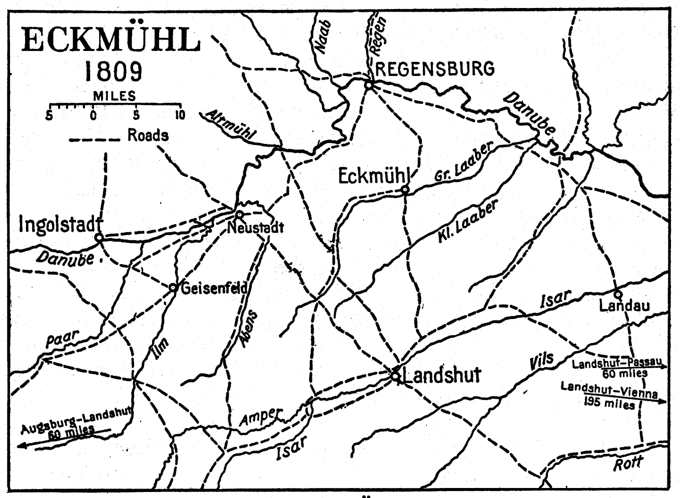

FIG. 6.—ECKMÜHL, 1809

3 A.M. in the morning that 'it was not the main body of the enemy he had had before him, but only its left wing, and that the main body itself must still be northward towards Regensburg. Issuing orders to Davout, Oudinot and his cavalry to concentrate with all speed towards Eckmiihl, he himself rode back along the Regensburg road and reached the battle-field just as the engagement between the advance troops had commenced. Had the Austrians possessed mobility equal to that of the French the latter should have been overwhelmed in detail, but whilst the French covered 17 and 19m. the Austrians only marched 10, and, owing to their defective assimilation of the new tactical training the troops actually on the ground could not hold out long enough for their reserves to arrive. The retreat of the front lines involved the following ones in confusion, and presently the whole mass was driven back in considerable disorder. It seemed as if nothing could save the Austrians from complete disaster, but at the critical moment the emperor, yielding to the protestations of his corps commanders, who represented the excessive fatigue of their troops, stopped the pursuit, and the archduke made the most of his opportunity to restore order amongst his demoralized men and crossed to the north bank of the Danube during the night.

On the following morning the French reached Regensburg and at once proceeded to assault its mediaeval walls, but the Austrian garrison bravely defended it till the last of the stragglers was safely across on the north bank. It was here that, for the only time in his career, Napoleon was slightly wounded. Then, leaving Davout to observe the archduke's retreat, the emperor himself rode after MassCna, who with the major portion of the French army was following the Austrian weaker wing under Hiller. The latter was not so shaken as Napoleon believed, and turning at bay at Ebelsberg inflicted a severe check on its pursuers. Thus covered by his rearguard Hiller gained space and time to pass his troops over to the north bank of the Danube and remove all boats on the river. This left the direct road to Vienna open, and Napoleon, hoping to find peace in the enemy's capital, pushed the whole of his army down the right bank, and with Murat's cavalry entered the city on May 12, after somewhat severe resistance lasting three days. Meanwhile the archduke and Hiller, both now unmolested, effected their junction in the vicinity of Wagram, picketing the whole line of the Danube with their outposts and collecting all the boats.

Aspern and Wagram.—The reconnaissance of the river was at once taken in hand by the French upon their arrival in Vienna, and a point opposite the island of Lobau selected for the crossing.

Thanks to the Austrian precautions it took four days to collect the necessary material to span the main branch of the river, here some 2,000yd. across, and though Napoleon personally spurred on all to activity nearly four days more were required for its construction. It was not till the night of May 19 that orders for the passage were finally issued, and during the night the troops commenced to occupy the island of Lobau. Surprise, of course, was out of the question, but the Austrians did not attempt to dispute the passage, their object being to allow as many French as they felt they could deal with to pass over and then to fall on them. Thus on May 21 the battle of Aspern (*q.v.*) or Essling began. It ended on the night of the 22nd with the defeat of Napoleon, the first ever inflicted upon him. The French retreated into the island of Lobau. By nightfall upwards of 100,000 men, encumbered with at least 20,000 wounded, were crowded together on the little island scarcely a mile square, short of provisions and entirely destitute of course of all hospital accessories. The question then arose whether the retreat was to be continued across the main stream or not, and for the second time in his career Napoleon assembled his generals to take their opinion. They counselled retreat, but having heard them all he replied, in substance: "If we leave here at all we may as well retire to Strassburg, for unless the enemy is held by the threat of further operations he will be free to strike at our communications and has a shorter distance to go. We must remain here and renew operations as soon as possible."

Immediate orders were despatched to summon every available body of troops to concentrate for the decisive stroke. Practically the lines of communication along the Danube were denuded of combatants, even Bernadotte being called up from Passau, and the viceroy of Italy, who driving the archduke Johann before him (action of Raab) had brought up 56,000 men through Tirol, was disposed towards Pressburg within easy call. The arsenal of Vienna was ransacked for guns, stores and appliances, and preparations in the island pushed on as fast as possible. By the end of June 200,000 troops were stationed within call, and on July 4 the French began to cross over to the left bank of the Danube. The events which followed are described under WAGRAM. The great battle at this place, fought on July 5 and 6, ended in the retirement of the Austrians. The only other event which occurred before peace was made was an unimportant action at Znaym on July 11.

THE RUSSIAN WAR OF 1812

Whilst the campaign of 1809 had shaken the faith of the marshals and the higher ranks in the infallibility of the emperor's judgment, and the slaughter of the troops at Aspern and Wagram had still further accentuated the opposition of the French people to conscription, the result on the fighting discipline of the army had, on the whole, been for good. The panics of Wagram had taught men and officers alike a salutary lesson. Aware of the growing feeling against war in France, Napoleon had determined to make his allies not only bear the expenses of the coming campaign, but find the men as well, and he was so far master of Europe that of the 363,000 who on June 24 crossed the Niemen no less than two-thirds were Germans, Austrians, Poles or Italians. But though the battlefield discipline of the men was better, the discipline in camp and on the march was worse, for the troops were no longer eager to reach the battlefield, and marched because they were compelled, not of their own goodwill. The result was apparent in a sudden diminution in mobility, and a general want of punctuality which seriously influenced the course of the campaign. On the other hand, the Russians, once their fatherland was invaded, became dominated by an ever-growing spirit of fanaticism, and they were by nature too obedient to their natural leaders, and too well inured to the hardships of campaigning, to lose their courage in a retreat.

By the middle of June 1812 the emperor had assembled his army along the line of the Niemen. On the extreme right stood the Austrian contingent under Schwarzenberg (34,000 men). Next, centring about Warsaw, a group of three corps (70,000 men) under the chief command of Napoleon's brother Jerome. Then the main army under Napoleon in person (220,000 men: with 80,000 more under the viceroy of Italy on his right rear); and on the extreme left at Tilsit a flanking corps, comprising the Prussian auxiliary corps and other Germans (in all 40,000 strong). The whole army was particularly strong in cavalry; out of the 450,000, 80,000 belonged to that arm, and Napoleon, mindful of the lessons of 1807, had issued the most minute and detailed orders for the supply service in all its branches, and the forwarding of reinforcements, no less than 100,000 men being destined for that purpose in due course of time.

Information about the Russians was very indifferent; it was only known that Prince Bagration (with 43,000 men) lay grouped about Wolkowysk; Barclay de Tolly (who had about 130,000) about Vilna; and on the Austrian frontier lay a small corps under Tormassov (40,000) in process of formation, while far away on the Turkish frontiers hostilities with the sultan retained Tschitschagov with 50,000 more. Of the enemy's plans Napoleon knew nothing, but, in accordance with his usual practice, the dispositions he had chosen met all immediate possible moves.

Opening of the Campaign.—On June 24 the passage of the Niemen began in torrid heat which lasted for a few days. The main army, with the emperor in person, covered by Murat and the cavalry, moved on Vilna, whilst Jerome on his right rear at once threatened Bagration and covered the emperor's outer flank. From the very first, however, the inherent weakness of the vast army, and the vicious choice of time for the beginning of the advance, began to make themselves felt. With crops still green, and nothing else available as forage for the horses, an epidemic of colic broke out amongst them, and in ten days the mounted arms had lost upwards of one-third of their strength; men died of sunstroke in numbers, and serious straggling began. Still everything pointed to the concentration of the Russians at Vilna, and Jerome, who on July 5 had reached Grodno, was ordered to push on. But Jerome proved quite inadequate to his position, listening to the complaints of his subordinates as to want of supplies and even of pay; he spent four whole days in absolute inertia, notwithstanding the emperor's reprimands. Meanwhile the Russians covered by stubborn rearguards made good their retreat—Barclay towards the entrenched camp of Drissa on the Dvina, Bagration towards Mohilev.

The emperor's first great coup thus failed. Jerome was replaced by Davout, and the army resumed its march, this time in the hope of surrounding and overwhelming Barclay, whilst Davout dealt with Bagration. The want of mobility, particularly in the cavalry,

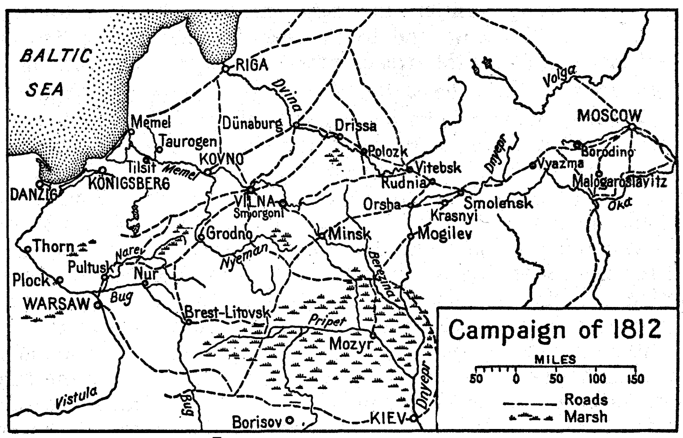

FIG. 7.—CAMPAIGN OF 1812

now began to tell against the French. With horses only just recovering from an epidemic, they proved quite unequal to the task of catching the Cossacks, who swarmed round them in every direction, never accepting an engagement but compelling a constant watchfulness for which nothing in their previous experience had sufficiently prepared the French.

Before their advance, however, the Russian armies steadily retired, Barclay from Vilna via Drissa to Vitebsk, Bagration—narrowly evading Davout—from Wolkowysk to Mohilev. Again arrangements were made for a Napoleonic battle; behind Murat's cavalry came the "general advanced guard" to attack and hold the enemy, whilst the main body and Davout were held available to swing in on his rear. Napoleon, however, failed to allow for the psychology of his opponents, who refused to be drawn into engagements and steadily withdrew from every position when the French gained touch with them. Thus the manoeuvre against Vitebsk again miscarried, and Napoleon found himself in a far worse position, numerically and mzterially, than at the outset of the campaign. Then he had stood with 420,000 men on a front of 160m., now he had only 229,000 men on a 135m. front; he had missed three great opportunities of destroying his enemy in detail, and in five weeks, during which time he had only traversed zoom., he had seen his troops reduced numerically at least one-third, and, worse still, his army was now far from being the fighting machine it had been at the outset.

Meanwhile the Russians had not lost a single gun and the *moral* of their men had been improved by the result of the many minor encounters with the enemy; further, the junction of Bagration and Barclay was now assured in the vicinity of Smolensk. Towards this place the French advance was now resumed, and the Russian generals at the head of a united force of 130,000 men marched forward towards Rudnia to meet them. Here, however, the inefficiency of the Russian staff actually saved them from the disaster which must certainly have overtaken them had they realized their intention of fighting the French. The Russians marched in two columns, which lost touch of one another, and as it was quite impossible for either to engage the French single-handed, they both retired again towards Smolensk, where with an advanced guard in the town itself—which possessed an old-fashioned brick *enceinte* not to be breached by field artillery alone—the two columns reunited and deployed for action behind the unfordable Dnieper.

Murat and Ney as "general advanced guard" attacked the town in the morning of Aug. 16, and the main body was swung round to place itself on the Russian rear astride the road to Moscow. The whole of the 17th was required to complete the movement, and as soon as its purpose was sufficiently revealed to the Russians the latter determined to retreat under cover of night. Their manoeuvre was carried out with complete success, and then began a series of rearguard actions and nocturnal retreats which completely accomplished their purpose of wearing down the French army. The Russian government, however, failed to see the matter in its true light, and Marshal Kutusov was sent to the front to assume the chief command. His intention was to occupy a strong position and fight one general action for the possession of Moscow, and to this end he selected the line of the Kalatscha where the stream intersects the great Moscow road.

Borodino.—Here he was overtaken by Murat and Ney, but the French columns had straggled so badly that four whole days elapsed before the emperor was able to concentrate his army for battle and then could only oppose 128,000 men to the Russians' 110,000. About 6 A.M. on Sept. 7 the battle *(see* BORODINO) began, but Napoleon was suffering from one of those attacks of illness and depression which henceforth became such an important factor in his fate. Till about midday he followed the course of the action with his usual alertness; then he appears to have been overcome by a kind of stupor and allowed his marshals to fight by themselves. There was no final decisive effort as at Wagram and the Guard was not even called on to move. Ultimately the sun went down on an undecided field on which 38,000 Russians and 25,000 French had fallen, but the moral reaction on the latter was far greater than on the former. Kutusov continued his retreat, and Murat with his now exhausted horsemen followed as best he might. Sebastiani, commanding the advanced guard, overtook the Russians in the act of evacuating Moscow, and agreed with the latter to observe a seven hours' armistice to allow the Russians to clear the town, for experience had shown the French that street fighting in wooden Russian townships always meant fire and the consequent destruction of much-needed shelter and provisions. Towards nightfall Napoleon reached the scene, and the Russians being now clear the troops began to enter, but already fires were observed in the farther part of the city. Napoleon passed the night in a house in the western suburb and next morning rode to the Kremlin, the troops moving to the quarters assigned to them, but in the afternoon a great fire began and, continuing for two days, drove the French out into the country again.

The emperor was now in the direst perplexity. Kutusov was hovering on the outskirts of the city, his main body at Kaluga, some marches to the south-west, where he was in full communication with the richest portion of the empire; and now news arrived that St. Cyr, who had relieved Macdonald on his extreme left, had only 17,000 men left under arms against upwards of 40,000 Russians under Witgenstein; and to the south Tschitschagov's army, being no longer detained on the Turkish frontier, where peace had been made, was marching to join Tormassov about Brest-Litovsk with forces which would bring the total of the two well over 100,000 men. Meanwhile Schwarzenberg's force opposing these had dwindled to a bare 30,000.

The disposition of the French forces was therefore untenable, and Napoleon's offers to treat for peace were ignored. Napoleon was considering a march on St. Petersburg with St. Cyr and Victor (the latter had about 30,000 men at Smolensk). Then, on Oct. 18, Murat, who had been sent to harass Kutusov, was attacked at Vinkovo, north of Tarutino, on the easterly road of the two roads leading south from Moscow to Kaluga.

Napoleon now resolved to retreat to Smolensk via Kaluga, hoping that, by taking the westerly road south from Moscow, he could bypass Kutusov and cut him off both from the provisions stored at Kaluga and from the Russian army facing Schwarzenberg at Brest. He left Moscow on Oct. 19, but Kutusov challenged him north of Kaluga, at Maloyaroslavets. The French after bitter fighting drove the Russians from the town (Oct. 24), but their strategy was frustrated and Napoleon turned to march for Smolensk without first taking Kaluga.

The Retreat from Moscow.—Then began the celebrated retreat. It has generally been forgotten that the utter want of march discipline in the French, and not the climatic conditions, was responsible for the appalling disasters which ensued. Actually the frost came later than usual that year, Oct. 27, and the weather was dry and bracing; not till Nov. 8 did the cold at night become sharp. Even when the Beresina was reached on Nov. 26, the cold was far from severe, for the slow and sluggish stream was not frozen over, as is proved by the fact that Eblé's pioneers worked in the water all through that terrible day. But the French army was already completely out of hand, and the degree to which the panic of a crowd can master even the strongest instinct of the individual is shown by the conduct of the fugitives who crowded over the bridges, treading hundreds under foot, whilst all the time the river was easily fordable and mounted men rode backwards and forwards across it.

To return to the actual sequence of events. Kutusov had been very slow in exploiting his success of the 24th and indeed had begun the pursuit in a false direction; but about Nov. 2, headquarters of the French being at Vyazma, the Cossacks became so threatening that the emperor ordered the army to march (as in Egypt) in hollow square. This order, however, appears only to have been obeyed by the Guards, with whom henceforward the emperor marched.

Kutusov had now overtaken the French, but fortunately for them he made no effort to close with them, but hung on their flank, molesting them with Cossacks and picking up stragglers. Thus the wreck of the *Grande Armée,* now not more than fifty thousand strong, reached Smolensk on the 9th and there rested till the 14th. The march was then resumed, the Guard leading and Ney commanding the rearguard. Near Krasnoi on the 16th the Russian advanced guard tried to head the column off. Napoleon halted a whole day to let the army close up; and then attacked with his old vigour and succeeded in clearing the road, but only at the cost of leaving Ney and the rearguard to its fate. By a night march of unexampled daring and difficulty Ney succeeded in breaking through the Russian cordon, but when he regained touch with the main body at Orcha only 800 of his 6,000 men were still with him (21st).

The **Beresina.**—From here Napoleon despatched orders to Victor to join him at Borisov on the Beresina. The cold now gave way and thaw set in, leaving the country a morass, and information came that Tschitschagov from the south had reached Borisov. He now selected Viesselovo as the point of passage and at 1 A.M. on the 23rd sert orders to Oudinot to march thither and construct bridges. In the execution of these orders Oudinot encountered the Russian advanced guard near Borisov and drove the latter back in confusion, though not before they had destroyed the existing bridge there. This sudden reassumption of the offensive threw Tschitschagov into confusion. Thus time was gained for Victor also to come up and for Oudinot to construct the bridges at Studienka near the above-mentioned place, but a spot in many respects better suited for the purpose. Thither therefore Napoleon sent his pontonniers under General Eblé, but on their arrival they found that no preparations had been made and much time was lost. Meanwhile Victor, in doubt as to the real point of passage, had left the road to Studienka open to Wittgenstein, who had followed hard on his heels.

By 4 P.M. on the 26th the bridges were finished and the passage began, but not without resistance by the Russians, who were gradually closing in. The crossing continued all night, though interrupted from time to time by failures of the bridges. All day during the 27th stragglers continued to cross, covered by such combatants as remained under sufficient discipline to be employed. At 8 A.M. on the 28th, however, Tschitschagov and Wittgenstein moved forward on both banks of the river to the attack, but were held off by the splendid self-sacrifice of the few remaining troops under Ney, Oudinot and Victor, until about 1 P.M. the last body of regular troops passed over the bridges, and only a few thousand stragglers remained beyond the river.

The number of troops engaged by the French that day cannot be given exactly. Oudinot's and Victor's men were relatively fresh and may have totalled 20,000, whilst Ney can hardly have had more than 6,000 of all corps fighting under him. How many were killed can never be known, but three days later the total number of men reported fit for duty had fallen to 8,800 only.

Final Operations.—Henceforward the retreat of the army became practically a headlong flight, and on Dec. 8, having reached Smorgoni and seeing that nothing further could be done by him at the front, the emperor handed over the command of what remained to Murat, and left for Paris to organize a fresh army for the following year. Travelling at the fullest speed, he reached the Tuileries on the 18th, after a journey of 312 hours. After the emperor's departure the cold set in with increased severity, the thermometer falling to 23°. On Dec. 8, Murat reached Vilna, whilst Ney with about 400 men and Wrede with 2,000 Bavarians still formed the rearguard; but it was quite impossible to carry out Napoleon's instructions to go into winter quarters about the town, so that the retreat was resumed on the 10th and ultimately Königsberg was attained on Dec. 19 by Murat with 400 Guards and 600 Guard cavalry dismounted. Meanwhile on the extreme French right Schwarzenberg and his Austrians had drifted away towards their own frontier, and the Prussian contingent, which under Yorck formed part of Macdonald's command about Riga, had entered into a convention with the Russians at Tauroggen (Dec. 30) which deprived the French of the last support upon their left. Konigsberg thus became untenable, and Murat fell back to Posen, where on Jan. 10 he handed over his command to Eugène Beauharnais and returned to Paris. The Russian pursuit practically ceased at the line of the Niemen, for the Russian troops also had suffered terrible hardships and a period of rest had become an absolute necessity.

The War of Liberation.—The Convention of Tauroggen became the starting-point of Prussia's regeneration. As the news of the destruction of the *Grande Armée* spread, and the appearance of countless stragglers convinced the Prussian people of the reality of the disaster, the spirit generated by years of French domination burst out. For the moment the king and his ministers were placed in a position of the greatest anxiety, for they knew the resources of France and the boundless versatility of their arch-enemy far too well to imagine that the end of their sufferings was yet in sight. To disavow the acts and desires of the army and of the secret societies for defence with which all north Germany was honeycombed would be to imperil the very existence of the monarchy, whilst an attack on the wreck of the *Grande Armée* meant the certainty of a terrible retribution from the new armies now rapidly forming on the Rhine.

But the Russians and the soldiers were resolved to continue the campaign, and working in collusion they put pressure on the not unwilling representatives of the civil power to facilitate the supply

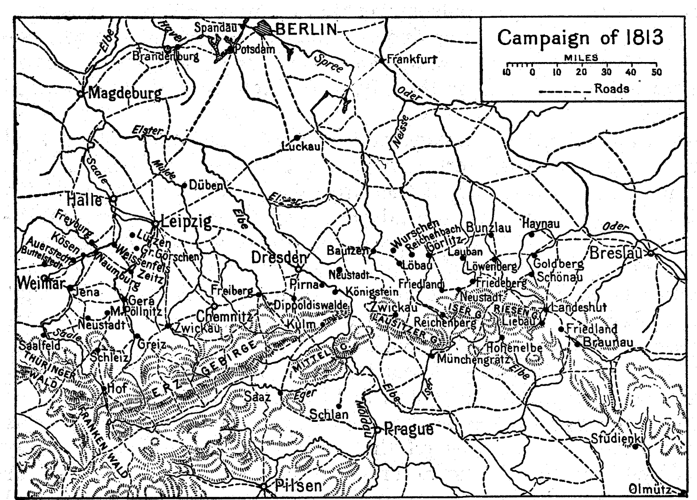

FIG. 8.—CAMPAIGN OF 1813

and equipment of such troops as were still in the field; they could not refuse food and shelter to their starving countrymen or their loyal allies, and thus by degrees the French garrisons scattered about the country either found themselves surrounded or were compelled to retire to avoid that fate. Thus it happened that the viceroy of Italy felt himself compelled to depart from the positive injunctions of the emperor to hold on at all costs to his advanced position at Posen, where about 14,000 men had gradually rallied around him, and to withdraw step by step to Magdeburg, where he met reinforcements and commanded the whole course of the lower Elbe.

Napoleon's Preparations.—Meanwhile the emperor in Paris had been organizing a fresh army for the reconquest of Prussia. Thanks to his having compelled his allies to fight his battles for him, he had not as yet drawn very heavily on the fighting resources of France, the actual percentage of men taken by the conscriptions during the years since 1806 being actually lower than that in force in continental armies of the early twentieth century. He had also created in 1811–12 a new National Guard, organized in "cohorts" to distinguish it from the regular army, and for home defence *only,* and these by a skilful appeal to their patriotism and judicious pressure applied through the prefects, became a useful reservoir of half-trained men for new battalions of the active army. Levies were also made with rigorous severity in the states of the Rhine Confederation, and even Italy was called on for fresh sacrifices. In this manner by the end of March upwards of 200,000 men were moving towards the Elbe,[1] and in the first fortnight of April they were duly concentrated in the angle formed by the Elbe and Saale, threatening on the one hand Berlin, on the other Dresden and the east.

The allies, aware of the gradual strengthening of their enemy's forces but themselves as yet unable to put more than 200,000 in the field, had left a small corps of observation opposite Madgeburg and along the Elbe to give timely notice of an advance towards Berlin; and with the bulk of their forces had taken up a position about Dresden, whence they had determined to march down the course of the Elbe and roll up the French from right to left. Both armies were very indifferently supplied with information, as both were without any reliable regular cavalry capable of piercing the screen of outposts with which each endeavoured to conceal his disposition, and Napoleon, operating in a most unfriendly cocntry, suffered more in this respect than his adversaries.

[1]Napoleon always gave their number as 300,000, but this was never attained.

On April 25 Napoleon reached Erfurt and assumed the chief command. On this day his troops stood in the following positions: Eugène, with Lauriston's, Macdonald's and Regnier's corps, on the lower Saale; Ney in front of Weimar, holding the defile of Kosen; the Guard at Erfurt, Marmont at Gotha, Bertrand at Saalfeld, and Oudinot at Coburg, and during the next few days the whole were set in motion towards Merseburg and Leipzig, in the now stereotyped Napoleonic order, a strong advanced guard of all arms leading, the remainder—about two-thirds of the whole—following as masse de manoeuvre, this time, owing to the cover afforded by the Elbe on the left, to the right rear of the advanced guard.

Meanwhile the Russians and Prussians had concentrated all available men and were moving on an almost parallel line, but somewhat to the south of the direction taken by the French. On May 1 Napoleon and the advance guard entered Liitzen. Wittgenstein, who now commanded the allies in place of Kutusov, hearing of his approach, had decided to attack the French advanced guard, which he took to be their whole force, on its right flank, and during the morning had drawn together the bulk of his forces on his right in the vicinity of Gross-Gorschen and Kaya.

Battle **of Lützen.**—About g A.M. on May 2 he began an attack on the French advance guard in Liitzen, whilst the remainder of his army was directed against Napoleon's right and rear. Just as the latter were moving off the heads of the French main body suddenly appeared, and at 11 A.M. Napoleon, then standing near the Gustavus Adolphus monument on the field of Liitzen, heard the roar of a heavy cannonade to his right rear. He realized the situation in a moment, galloped to the new scene of action, and at once grouped his forces for decisive action—the gift in which he was supreme. Leaving the leading troops to repulse as best they might the furious attack of both Russians and Prussians, and caring little whether they lost ground, he rapidly organized for his own control a battle-reserve. At length when both sides were exhausted by their efforts he sent forward nearly a hundred guns which tore asunder by their case-shot fire the enemy's line and marched his reserve right through the gap. Had he possessed an adequate cavalry force the victory would have been decisive. As it was, the allies made good their retreat and the French were too exhausted for infantry pursuit.

Perhaps no battle better exemplifies the inherent strength of the emperor's strategy, and in none was his grasp of the battlefield more brilliantly displayed, for, as he fully recognized, "These Prussians have at last learnt something—they are no longer the wooden toys of Frederick the Great," and, on the other hand, the relative inferiority of his own men as compared with his veterans of Austerlitz called for far more individual effort than on any previous day. He was everywhere, encouraging and compelling his men—it is a legend in the French army that the persuasion even of the imperial boot was used upon some of his reluctant conscripts, and in the result his system was fully justified, as it triumphed even against a great tactical surprise.

Bautzen.—As soon as possible the army pressed on in pursuit, Ney being sent across the Elbe to turn the position of the allies at Dresden. This threat forced the latter to evacuate the town and retire over the Elbe, before blowing up the stone bridge across the river. Napoleon entered the town hard on their heels, but the broken bridge caused a delay of four days, there being no pontoon trains with the army. Ultimately on May 18 the march was renewed, but the allies had continued their retreat in leisurely fashion, picking up reinforcements by the way. Arrived at the line of the Spree, they took up and fortified a very formidable position about Bautzen (*q.v.*). Here, on the 20th, they were attacked and fixed by Napoleon; but the intended decisive coup by which Ney was to arrive on their right rear on the 21st missed its mark owing to Ney's want of initiative and rigid adherence to the letter of his orders. As a result the allies were able to break off the action at their own time and retire in such good order that the emperor failed to capture a single trophy as proof of his victory. The enemy's escape annoyed him greatly, the absence of captured guns and prisoners reminded him too much of his Russian experiences, and he redoubled his demands on his corps commanders for greater vigour in the pursuit. This led the latter to push on without due regard to tactical precautions, and Bliicher took advantage of their carelessness when at Haynau (May 26), with some twenty squadrons of Landwehr cavalry, he surprised, rode over and almost destroyed Maison's division. The material loss inflicted on the French was not very great, but its effect in raising the moral of the raw Prussian cavalry and increasing their confidence in their old commander was enormous.

Still the allies continued their retreat and the French were unable to bring them to action. In view of the doubtful attitude of Austria, Napoleon became alarmed at the gradual lengthening of his lines of communication and opened negotiations. The enemy, having everything to gain and nothing to lose thereby, agreed finally to a six weeks' suspension of arms. This was perhaps the gravest military error of Napoleon's whole career, and his excuse for it, "want of adequate cavalry," was the strongest testimony as to the value of that arm.

As soon as a suspension of arms (to Aug. 15) had been agreed to, Napoleon hastened to withdraw his troops from the dangerous position they occupied with reference to the passes leading over the mountains from Bohemia, for he entertained no doubt now that Austria was also to be considered as an enemy. Finally he decided to group his corps round Görlitz and Bautzen whence they could either meet the enemy advancing from Breslau or fall on his flank over the mountains if he attempted to force his way into Saxony by the valley of the Elbe. This latter manoeuvre depended, however, on his maintenance of Dresden, and to this end he sent the I. Corps up the Elbe to Pirna and Konigstein to cover the fortifications of Dresden itself. His instructions on this point deserve the closest study, for he foresaw the inevitable attraction which a complete entrenched camp would exercise even upon himself, and, therefore, limited his engineers to the construction of a strong bridge head on the right bank and a continuous enceinte, broken only by gaps for counter attack, around the town itself.

Then he turned his attention to the plan for the coming campaign. Seeing clearly that his want of an efficient cavalry precluded all ideas of a resolute offensive in his old style, he determined to limit himself to a defence of the line of the Elbe, a position of waiting from which he could make a spring, of not more than a few days' duration, at any target the enemy might present.

Reinforcements had been coming up without ceasing and at the beginning of August he calculated that he would have 300,000 men available about Bautzen and 100,000 along the Elbe from Hamburg via Magdeburg to Torgau. With the latter he determined to strike the first blow, by a concentric advance on Berlin (which he calculated he would reach on the 4th or 5th day), the movement being continued thence to extricate the French garrisons in Kiistrin, Stettin and Danzig. The moral effect, he promised himself, would be prodigious, and there was neither room nor food for these 100,000 elsewhere. Towards the close of the armistice he learned the general situation of the allies. The crown prince of Sweden (Bernadotte), with his Swedes and various Prussian levies, 135,000 in all, lay in and around Berlin and Stettin; and knowing his former marshal well, Napoleon considered Oudinot a match for him. Bliicher with about 95,000 Russians and Prussians was about Breslau, and Schwarzenberg, with nearly 180,000 Austrians and Russians, lay in Bohemia. In his central position at Bautzen he felt himself equal to all his enemy's combinations.

Dresden.—The advance towards Berlin began punctually with the expiration of the armistice, but with the main army he himself waited to see more clearly his adversaries' plans. At length becoming impatient he advanced a portion of his army towards Bliicher, who fell back to draw him into a trap. Then the news reached him that Schwarzenberg was pressing down the valley of the Elbe, and, leaving Macdonald to observe Bliicher, he hurried back to Bautzen to dispose his troops to cross the Bohemian mountains in the general direction of Konigstein, a blow which would have had decisive results. But the news from Dresden, where the construction of the defences was still incomplete, was so alarming that at the last moment he changed his mind, and sending **Vandamme** alone over the mountains, he hurried with **his** whole army to the threatened point. This march remains one of the most extraordinary in history, for the bulk of his forces moved, mainly in mass and across country, gom. in 72 hours, entering Dresden on the morning of the 27th, only a few hours before the attack of the allies commenced. For the events which followed *see* DRESDEN: *Battle* of *Dresden.*

Dresden was the last great victory of the First Empire. By noon on Aug. 27 the Austrians and Russians were completely beaten and in full retreat, the French pressing hard behind them, but meanwhile Napoleon himself again succumbed to one of his unaccountable attacks of apparent intellectual paralysis. He seemed unaware of the vital importance of the moment, crouched shivering over a bivouac fire, and finally rode back to Dresden, leaving no specific orders for the further pursuit. The allies, however, continued to retreat, but unfortunately Vandamme, with his single corps and unsupported, issued out of the mountains on their iiank, threw himself across their line of retreat near Kulm, and was completely overwhelmed by sheer weight of numbers (29th). In spite of this misfortune, Napoleon could claim a brilliant success for himself, but almost at the same moment news reached him that Oudinot at Grossbeeren near Berlin, and Macdonald on the Katzbach opposed to Blucher, had both been severely defeated.

Napoleon's Movements.—During the next two days the emperor examined his situation and, after discussing on paper the respective hypotheses of a spring at Prague or at Berlin, summed up in favour of the second. But his consideration of this project was interrupted by news which indicated that the consequences of Macdonald's defeat had been far more serious to the moral of that command than he had imagined. He immediately rode over to establish order, and his manner and violence were so improper that Caulaincourt had the greatest difficulty in concealing the scandal. Blucher, however, hearing of his arrival, at once retreated and the emperor followed, thus uncovering the passes over the Bohemian mountains, a fact of which Schwarzenberg was quick to take advantage. Learning of his approach, Napoleon again withdrew to Bautzen. Then hearing that the Austrians had counter-marched and were again moving towards Dresden, he hastened back there, concentrated as many men as could conveniently be handled, and advanced beyond Pirna and Konigstein to meet him. But the Austrians had no intention of attacking him, for time was now working on their side and, leaving his men to starve in the exhausted district, the emperor again returned to Dresden, where for the rest of the month he remained in an extraordinary state of vacillation. On Oct. 4 he again drew up a review of the situation, in which he apparently contemplated giving up his communications with France and wintering in and around Dresden, though at the same time he was aware of the distress amongst his men for want of food.

Campaign of **Leipzig.**—In the meanwhile Blucher, Schwarzenberg and Bernadotte were working round his flanks. Ney, who had joined Oudinot after Grossbeeren, had been defeated at Dennewitz (Sept. 6), the victory, won by Prussian troops solely, giving the greatest encouragement to the enemy. Suddenly Napoleon's plans are again reviewed and completely changed. Calling up St. Cyr, whom he had already warned to remain at Dresden with his command, he decided to fall back towards Erfurt, and go into winter quarters between that place and Magdeburg, pointing out that Dresden was of no use to him as a base and that if he had a battle, he had much better have St. Cyr and his men with him than at Dresden. He then on Oct. 7 drew up a final plan, and this he immediately proceeded to put into execution, for he was now aware of the danger threatening his line of retreat from both Blucher and Schwarzenberg and the North Army; yet only a few hours afterwards the portion of the order relating to St. Cyr and Lobau was cancelled and the two were finally left behind at Dresden. From the 10th to the 13th Napoleon lay at Düben, again a prey to the most extraordinary irresolution, but on that day he thought he saw his opportunity. Blücher was reported near Wittenberg, and Schwarzenberg was moving slowly round to the south of Leipzig. The North Army under Bernadotte, unknown to Napoleon, lay on Blucher's left around Halle. The emperor decided to throw the bulk of his force on Bliicher, and, having routed him, turn south on Schwarzenberg and sever his communications with Bohemia. His concentration was effected with his usual sureness and celerity, but whilst the French moved on Wittenberg, Blucher was marching to his right, indifferent to his communications as all Prussia lay behind him. This move on the 14th brought him into touch with Bernadotte, and now a single march forward of all three armies would have absolutely isolated Napoleon from France; but Bernadotte's nerve failed him, for on hearing of Napoleon's threat against Wittenberg he decided to retreat northward, and not all the persuasions of Blucher and Gneisenau could move him. Thus if the French movement momentarily ended in a blow in the air, it was indirectly the cause of their ultimate salvation.

The "Battle of the Nations."—On the 15th Napoleon concentrated his forces to the east of Leipzig, with only a weak detachment to the west, and in the evening the allies were prepared to attack him. Schwarzenberg had 180,000 men available at once and 60,000 on the following day; Blucher had about 60,000, but Bernadotte now could not arrive before the 18th.

Napoleon prepared to throw the bulk of his force upon Schwarzenberg and massed his troops south-east of the town, whilst Schwarzenberg marched concentrically against him down the valleys of the Elster and Pleisse, the mass of his troops on the right bank of the latter and a strong column under Giulay on the left working round to join Blucher on the north. The fighting which followed was most obstinate, but the Austrians failed to make any impression on the French positions, and indeed Giulay felt himself compelled to withdraw to his former position. On the other hand, Blucher carried the village of Möckern and came within a mile of the gates of the town. During the 17th there was only indecisive skirmishing, Schwarzenberg waiting for his reinforcements coming up by the Dresden road, Blucher for Bernadotte to come in on his left, and by some extraordinary oversight Giulay was brought closer in to the Austrian centre, thus opening for the French their line of retreat towards Erfurt, and no information of this movement appears to have been conveyed to Blucher. The emperor when he became aware of the movement, sent the IV. corps to Lindenau to keep the road open. On the 18th the fighting was resumed and by about noon Bernadotte came up and closed the gap to the N.E. of the town between Blucher and the Austrians. At 2 P.M. the Saxons, who had remained faithful to Napoleon longer than his other German allies, went over to the enemy. All hope of saving the battle had now to be given up, but the French covered their retreat obstinately and by daybreak next morning one-half of the army was already filing out along the road to Erfurt which had so fortunately been left for them.

It took Bliicher time to extricate his troops from the confusion into which the battle had thrown them, and the garrison of Leipzig and the troops left on the right bank of the Elster still resisted obstinately—hence no direct pursuit could be initiated, and the French, still upwards of 100,000 strong, marching rapidly, soon gained distance enough to be reformed. Blucher followed by parallel and inferior roads on their northern flank, but Schwarzenberg knowing that the Bavarians also had forsaken the emperor and were marching under Wrede, 50,000 strong, to intercept his retreat, followed in a most leisurely fashion. Blucher did not succeed in overtaking the French, but the latter, near Hanau, found their way barred by Wrede with 50,000 men and over 100 guns in a strong position. To this fresh emergency Napoleon and his army responded in most brilliant fashion. As at Krasnoi in 1812, they went straight for their enemy and after one of the most brilliant series of artillery movements in history, directed by General Drouot, they marched right over their enemy, practically destroying his whole force. Henceforward their march was unmolested, and they reached Mainz on Nov. 5.

THE CAMPAIGN IN FRANCE IN 1814

When the last of the French troops had crossed to the western bank of the Rhine, divided counsels made their appearance at the headquarters of the allies. Everyone was weary of the war, **and** many felt that it would be unwise to push Napoleon and the French nation to extremes. Hence a prolonged halt arose, utilized by the troops in renewing their equipment and so forth, but ultimately the Young German party, led by Blucher and the principal fighting men of the army, triumphed, and on Jan. 1, 1814, the Silesian army (50,000) began its passage of the Rhine at Kaub. They were to be supported by Schwarzenberg with 200,000 men,

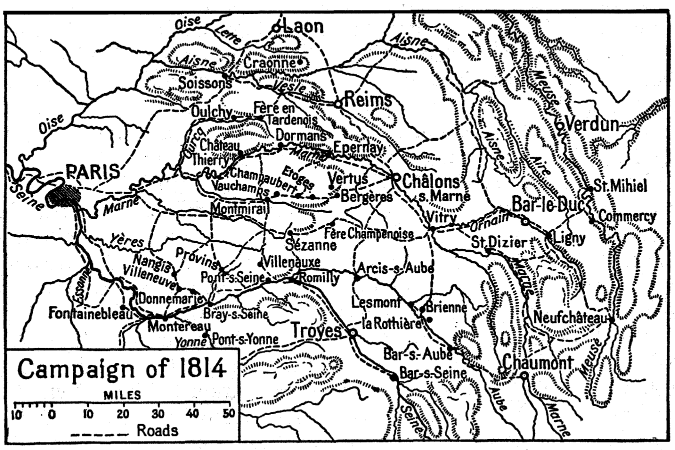

FIG. 9.—CAMPAIGN OF 1814

who was to advance by Basel and Neu Breisach to the south, and Bernadotte with the Northern army, about 120,000, was to move in support on the right flank through the Netherlands and Laon; this force was not yet ready and did not, in fact, reach the latter place till March. To meet these forces the emperor could not collect 200,000 men in all, of whom upwards of 100,000 were held by Wellington on the Spanish frontier, and 20,000 more were required to watch the debouches from the Alps. Hence less than 80,000 remained available for the east and north-eastern frontier. If, however, he was weak in numbers, he was now again operating in a friendly country, able to find food almost everywhere and practically indifferent as to his communications.

On Jan. 25 Blucher entered Nancy, and, moving rapidly up the valley of the Moselle, was in communication with the Austrian advanced guard near La Rothière on the afternoon of the 28th. Here his headquarters were surprised and he himself nearly captured by a sudden rush of French troops, and he learnt at the same time that the emperor in person was at hand. He accordingly fell back a few miles next morning to a strong position covering the exits from the Bar-sur-Aube defile. There he was joined by the Austrian advance guard, and together they decided to accept battle—indeed they had no alternative, as the roads in rear were so choked with traffic that retreat was out of the question. About noon Feb. 2 Napoleon attacked them, but the weather was terrible, and the ground so heavy that his favourite artillery, the mainstay of his whole system of warfare, was useless and in the drifts of snow which at intervals swept across the field, the columns lost their direction and many were severely handled by the Cossacks. At nightfall the fighting ceased and the emperor retired to Lesmont, and thence to Troyes, Marmont being left to observe the enemy.

Montmirail.—Owing to the state of the roads, more perhaps to the extraordinary lethargy which always characterized Schwarzenberg's headquarters, no pursuit was attempted. But on Feb. 4 Blucher, chafing at this inaction, obtained the permission of his own sovereign to transfer his line of operations to the valley of the Marne; Pahlen's corps of Cossacks were assigned to him to cover his left and maintain communication with the Austrians. Believing himself secure behind this screen, he advanced from Vitry along the roads leading down the valley of the Marne, with his columns widely separated for convenience of subsistence and shelter—the latter being almost essential in the terrible weather prevailing. Blucher himself on the night of the 7th was at Sézanne, on the exposed flank so as to be nearer to his sources of intelligence, and the rest of his army were distributed in four small corps at or near Épernay, Montrnirail and Étoges; reinforcements also were on their way to join him and were then about Vitry.

In the night his headquarters were again surprised, and he learnt that Napoleon himself with his main body was in full march to fall on his scattered detachments. At the same time he heard that Pahlen's Cossacks had been withdrawn forty-eight hours previously, thus completely exposing his flank. He himself retreated towards Étoges endeavouring to rally his scattered detachments, but Napoleon was too quick for him and in three successive days he defeated Sacken at Montmirail, Yorck at Champaubert and Blucher and his main body at Étoges, pursuing the latter towards Vertus. These disasters compelled the retreat of the whole Silesian army, and Napoleon, leaving Mortier and Marmont to deal with them, hurried back to Troyes with his main body to strike the flank of Schwarzenberg's army, which had meanwhile begun its leisurely advance, and again at Mormant on Feb. 17, Montereau the 18th and Méry the 21st, he inflicted such heavy punishment upon his adversaries that they fell back precipitately to Bar-sur-Aube.

In the meantime Blücher had rallied his scattered forces and was driving Marmont and Mortier before him. Napoleon, as soon as he had disembarrassed himself of Schwarzenberg, countermarched his main body and moving again by Sézanne, fell upon Blücher's left and drove him back upon Soissons. This place had been held by a French garrison, but had capitulated only twenty-four hours beforehand, a fact of which Napoleon was naturally unaware. The Silesian army was thus able to escape, and marching northwards combined with Bernadotte at Laon—this reinforcement bringing the forces at Bliicher's disposal up to over 100,000 men. On March 7 Napoleon fell upon the advance guard of this force at Craonne and drove it back upon Laon, where a battle took place on the 9th. Napoleon was here defeated, and with only 30,000 men at his back he was compelled to renounce all ideas of a further offensive, and he retired to rest his troops at Reims. Here he remained unmolested for a few days, for Blucher was struck down by sickness, and in his absence nothing was done. On March 14, however, Schwarzenberg, becoming aware of Napoleon's withdrawal to Reims, again began his advance and had reached Arcis-sur-Aube when the news of Napoleon's approach again induced him to retreat to Brienne.

The Allies March on Paris.—Thus after six weeks' fighting the allies were hardly more advanced than at the beginning. Now, however, they began to realize the weakness of their opponent, and, still more, the weakening of his political stability. Napoleon, coincidently, aware of the limitations of a strategy of continual parrying, was seized with the idea of a decisive coup against Schwarzenberg's communications. He determined to move eastward to St. Dizier, rally what garrisons he could find, and raise the whole country against the invaders, and had actually started on the execution of this plan when his instructions fell into the enemy's hands and his projects were exposed. The Czar Alexander called a council of war at which General Toll in opposition to his seniors, urged that instead of following Napoleon the allies should disregard the threat to their rear and advance by forced marches on Paris, whose people were reported to be "tired of the war and of Napoleon." His arguments for this moral objective won over the Czar and at his instigation the allies marched straight for the capital. Marmont and Mortier with what troops they could rally took up a position on Montmartre heights to oppose them, but seeing further resistance to be hopeless they gave way on March 31, just as Napoleon, with the wreck of the Guards and a mere handful of other detachments, was hurrying across the rear of the Austrians towards Fontainebleau to join them.

This was the end of the First Empire. The story of the WATERLOO CAMPAIGN, 1815, is told under its own heading.

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NAVAL OPERATIONS

The Peace of Amiens in 1802 was productive of but a brief truce. Napoleon's ambitions and actions were such as quickly to re-awaken European suspicions, and his refusal to evacuate the Netherlands was alone enough to arouse England and cause her to declare war on him as early as May 18, 1803. From then onwards, for over two years, the war took the form of a gigantic scheme, on the part of Napoleon, for an invasion of England—a scheme which led to the movements known as the Trafalgar Campaign which, in its turn, led to the Battle of Tiafalgar. Boulogne was chosen as the base for the French operations; along the coast on either side an army of some 150,000 men was encamped, and specially-constructed flat-bottomed boats for their transport were brought from all parts of France. The army was given constant practice in embarkation and disembarkation, and, in the meantime, it proved impossible for the British ships to do much damage to this armament owing to the shallow water on the coastline. In order, however, to carry through his scheme successfully, Napoleon had got to obtain at least a temporary control of the Channel, and this meant either defeating the British fleet on equal terms in action, or, by some means, causing the various parts of it to scatter on some wild-goose chase, so giving hitnself the chance to bring every available ship to the Channel and overwhelm the British fleet there by sheer weight of numbers. French fleets were stationed at Brest, Rochefort, L'Orient and Toulon; all of them were watched by British blockading squadrons. From the end of 1804, when Spain entered the war on his side, Napoleon was able to add to this total Spanish squadrons at Corunna, Ferrol, Cadiz and Cartagena, all of which the British blockaded. The total number of ships at Napoleon's command was about 60, the English had an approximately equal number employed in blockading them. His plan, then, took the form of attempting to elude these blockading squadrons and make them scatter to various parts of the world in search of his escaped squadrons which would, after concentrating at a given rendez-vous, return to the Channel to crush Cornwallis and the English Channel Fleet, if indeed that had not scattered too, after the presumed escape of the Brest Fleet which it was blockading. In either case Napoleon might hope to achieve his object—control of the Channel for long enough to enable him to take his troops across, while the British squadrons returned from the various parts of the world to which he seemed to think they might sail. The scheme was an exceedingly weak one, and postulated a gross ignorance of naval strategy on the part of that country that had been its greatest exponent. The British Admiralty upset it by a single order. The various blockading squadrons, if they were eluded by the squadrons they were blockading, were to fall back on Cornwallis. Thus if all the French squadrons united at the appointed rendez-vous (which was Martinique) and sailed for the Channel, they would merely find Cornwallis with an equally concentrated fleet, and the extent of the British concentration would depend on, and be equal to, that of the French.

The first move occurred in January 1805 when the Rochefort squadron of five ships escaped and sailed for the West Indies, but it proved an isolated effort. On March 30, however, Admiral Villeneuve used a gale to elude Nelson who was watching him off Toulon, and got clear away with eleven ships which he increased to eighteen by picking up the Cadiz Squadron, reaching Martinique on May 14. He was joined on June 1, by two ships from Rochefort, but no others put in an appearance. He should have waited until nearly the end of the month before sailing back to Europe to try and pick up those squadrons which failed to join him, preliminary to making for Brest, whence Admiral Gantheaume was trying unsuccessfully to emerge from time to time. Only a week later, however, information reached Villeneuve that Nelson was already in the West Indies in search of him, and he decided to make for European waters immediately. Nelson, after having been evaded off Toulon should, according to his orders, have fallen back on Cornwallis, but he preferred, not for the first time, to follow his own course. It has often been said that Villeneuve induced Nelson to follow him and that, in doing so, the latter was playing into Napoleon's hands. The foolishness of this can be seen in the fact that the mere information that Nelson was in the neighbourhood caused Villeneuve to make for home a considerable time before he was due to depart, and any hope of a West Indian concentration was thus lost. When Napoleon hoped that the English blockading squadrons would scatter, he meant to places where the French had not gone. Foiled by false information of his hope of catching Villeneuve, Nelson sent a fast brig home to warn the Admiralty of the former's return, and himself sailed for Gibraltar. The Admiralty despatched Sir Robert Calder to intercept Villeneuve; this he did, off Finisterre, and, in a not very satisfactory action, fought in a fog, deprived him of two Spanish battleships, but let him make Ferrol. Here the French Admiral received reinforcements, and his next move, according to his programme, should have been to make for the Channel in an attempt to unite with the Brest fleet. But he conceived, rightly, that Napoleon's scheme had already been foiled and that his task would be impossible; thus when he left Ferrol he made, not for the Channel, but for Cadiz. Here he was blockaded by Nelson and Collingwood. The Trafalgar Campaign, as a campaign, was over, and the invasion scheme was a failure. Napoleon broke up his camp and marched his troops against Austria. A natural corollary of the Trafalgar Campaign was the battle of Trafalgar, but it must be realised that it was the former that saved England from invasion. In the autumn Napoleon needed a fleet in the Mediterranean and ordered Villeneuve to proceed there. The latter, after a protest, attempted to comply, and was beaten, as all the world knows, on Oct. 21, 1805 with a loss of twenty ships.

The victory of Trafalgar, while it did not end the war, conferred upon England the complete command of the sea. Thereafter naval activity was most pronounced, and the British Navy was employed in numerous undertakings in all parts of the world, but it becomes impossible to trace out any broad policy. It only remains to point out some of the more prominent incidents. Napoleon's operations with Russia produced some naval, activity. England attempted to assist that country when in 1807 Napoleon was preparing a final blow against her, by forcing the Dardanelles — Turkey being then allied with France. Admiral Duckworth was selected for the operation, and he actually silenced the batteries in the Straits and appeared off Constantinople. There he was helpless for lack of bombships, and had to retire under a damaging fire. Later in the same year the third coalition against France came to a final end when Napoleon and the Tsar of Russia signed the Treaty of Tilsit, by which they agreed to cease war and both plot for England's overthrow. One scheme they hatched was to seize all the neutral fleets in Europe and employ them against their common enemy. The largest neutral navy was Denmark's, and Canning, having providentially heard of this peculiar arrangement, anticipated a Franco-Russian breach of Danish neutrality by sending Admiral Gambier to "borrow" this fleet for the duration of the war. Gambier bombarded Copenhagen and returned with 70 out of 72 of the Danes' fighting ships.

Napoleon's Berlin and Milan Decrees, by which he hoped to break England's merchant marine, and England's reply with the Orders in Council, also gave the British navy opportunities to show its command of the sea. Napoleon forbade continental countries to import British goods either in British or foreign ships. England in turn seized neutral ships that called at a continental port without also calling at a British port. The struggle forced England to open new markets in the east and South America, but several countries rebelled against Napoleon's system and England was always ready to help. The revolt of Portugal began in 1808 and produced the Peninsular War, which ought to be thought of as partly a naval operation, for the fleet took off the army after Corunna, was always behind the duke of Wellington's lines at Torres Vedras and finally followed, as nearly as possible, his victorious advance.

The revolt of Austria in 1809 produced the combined expedition against Antwerp, commanded by Admiral Strachan and Lord Chatham, which hoped to find some sympathy among the Netherlanders for their Austrian former rulers. Walcheren and Flushing were captured, but the expedition had to retreat after the collapse of Austria. Finally, England's resistance to Napoleon's decrees involved it in 1812 in war with the United States, which considered itself ill-treated in the matter of the seizure of ships.

The British lost many single-ship actions with the Americans, their only success being that of the "Shannon" over the "Chesapeake," but the United States let its very natural jubilation rather blind it to the fact that its coasts were blockaded without serious challenge.

This is but a small selection from the numerous incidents that make up the naval side of the Napoleonic War after Trafalgar. The main point is that British sea supremacy was unchallenged after that battle, and the royal navy remained Napoleon's worst enemy to the end, for it was the British "Bellerophon" which intercepted him when, after Waterloo, he sought to escape to the United States to carve out an empire in a new world.

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NAPOLEONITE, or CORSITE, a gabbro showing orbicular, or spherical, structure from Santa Lucia di Tallano, Corsica The rock when cut and polished makes a beautiful ornamental stone, examples of which are to be found in most petrographical museums. Although often referred to as a diorite, corsite in its mineral and chemical composition corresponds to a hornblende gabbro (*q.v.*). The orbicules, remarkable for their uniformity in structure, range from $\frac{3}{4}$ in. to 2 in. in diameter and are set in a matrix of variable grain size built up of green hornblende and cummingtonite ***(see*** AMPHIBOLE) and bytownite feldspar ***(see*** FELDSPAR: ***The*** *Plagioclases*).

The core of these structures consists of material mineralogically similar to the matrix but richer in feldspar; it is followed by a series of broad and narrow zones, respectively, of radiate plagioclase and green hornblende-cummingtonite intergrowths also radially arranged. Both the plagioclase of the core and of the broad zones is distinctly more calcic than that of the matrix. These relations are in accord with the concept that the orbicules developed in a crystallizing liquid and the structure itself has probably arisen by rhythmic crystallization.

Orbicular or spheroidal structures, though by no means common, have been found in the crystalline rocks of Sweden, Finland, the U.S.S.R. and America. They have been closely studied by the petrologists of Finland and are there known as esboites. The mutual relations in composition and structure of orbicule and matrix in some of these rocks, especially those of Finland, have led to the opinion that the structures are metamorphic in origin, the orbicules developing in a solid or quasi-solid matrix which has in part been converted into a migmatite by metasomatic replacement.

See P. Eskola, "*On* the Esboitic Crystallization of Orbicular Rocks," *J. Geol.*, vol. xlvi, pp. 448–485 (1938). (C. E. T.)

NAPRAPATHY is a system of manipulative drugless treatment founded in 1907 by Oakley Smith, based on a theory that connective tissue which has become shrunken as the result of injury is the basic cause of disease. A shrunken strand of connective tissue is called a ligatight and may occur in the spine, thorax, pelvis or elsewhere. It is claimed that such tissue can be corrected by naprapathic treatment, which aims at stretching the shrunken strands.

Study of a set of charts showing types of ligatights and manipulations to correct them are held to be an important part of the practitioner's training.

NÁPRAVNÍK, EDUARD (1839–1916), Czech conductor and composer, was born at Byšt in Bohemia on Aug. 24, 1839. In 1861 he went to St. Petersburg as conductor to Prince N. Yussipov. Through the influence of Anatol Liadov he obtained a post at the Maryinsky theatre and in 1869 succeeded him as first conductor there. He died Nov. 23, 1916.

Nápravník wrote several operas, including ***Francesca*** da ***Rimini*** (on Stephen Phillips's play); four symphonies; and orchestral, choral and piano pieces.

NAQUET. ALFRED JOSEPH (1834–1916), French chemist and politician, was born at Carpentras (Vaucluse) on Oct. 6, 1834. In 1863 he became professor of chemistry in Palermo and two years later of medicine in Paris. In 1867 he was imprisoned as a freemason and republican and in 1869 took refuge in Spain. Under the Third Republic he became an active politician. He was elected deputy for Vaucluse in 1871 and its senator in 1882, sitting on the extreme republican left. In 1888 he ardently supported Gen. Georges Boulanger and pressed for revision of the constitution. As a result of his efforts a law was passed facilitating divorce after three years of separation, on the demand of either party. He was prosecuted in the Panama affair but was acquitted in 1898. He thereafter retired into private life. He wrote several scientific works, including ***Principes de chimie*** *fondés sur les théories modernes* (1865), and such political works as La *République radicale* (1873) and ***Socialisme*** *collectiviste* et ***socialisme*** *libéral* (1890). (D. TN.)

NARA (sometimes called EAST NARA RIVER), an important water channel in West Pakistan, part of the bed of the "lost river of Sind," the Hakra ***(see*** INDIAN DESERT). It traverses the desert east of the lower Indus. A canal scheme utilizes the channel. (T. HER.)

NARA, a town of Japan, in the Nara prefecture, $25\frac{1}{2}$ mi. from Osaka by rail. Pop. (1955) 115,674 It lies on the slope of a range of picturesque hills, beautifully wooded with cryptomerias and evergreen oaks. Nara remained the metropolis during seven consecutive reigns (709 to 784), and its 75 years of favoured existence sufficed for the building and furnishing of several imposing shrines and temples, for the laying out of a noble park and for the casting of a colossal image of Buddha. In Nara and its environs there have been preserved important and beautiful remains of architecture dating back to the 7th and 8th centuries, such as parts of the Buddhist monasteries called Hōryūji, Yakushiji, Kōfukuji and Tōdaiji, together with remarkable examples of sculpture of similar age, notable among which are such celebrated Buddhist images as the Kudara Kwannon, the Chūgūji Kwannon, bronze Shaka trinity of A.D. 623 and many other distinguished works of art.

Many articles and ornaments used in the Nara palaces have been preserved for nearly 1,200 years in a storehouse. the Shōsō-in. They give a picture of the court life of those days and show evidence of cultural relations not only with China but with western Asia. The Shinto shrine of Kasuga, doubtless many times rebuilt, still preserves in its shape and decoration features of the primitive style of Japanese architecture. Nara has a fine park. and efforts are made to preserve the ancient characteristics of the town.

NARAYAN, JAYAPRAKASH (1902–), Indian political leader. founded and led the Socialist party (India) Born on Oct 11, 1902 in the province of Bihar, he was educated there and in the United States at the universities of California, Wisconsin, Iowa and Ohio State university, where he studied science and economics. During his stay in the United States he became a militant Marxist. A member of Mohandas K. Gandhi's civil disobedience movement, he was head of the Labour department of the Indian National congress in 1931, and was imprisoned with other congress leaders in 1932 for passive resistance to the setting up of special electorates for depressed classes. After his release Narayan organized and was founding secretary of a Socialist party within the congress in 1933. He also organized the All-India Railwaymen's federation, of which he was president from 1946 to 1952. He was imprisoned again in 1939 and 1942–43 in protest against the government's action of taking India into World War II without consulting congress leaders and against a new constitution offered by the British government. He left the congress in 1947 and later became active in the *Bhudan Yagna* (Land Gift) movement in Bihar; in 1954 he renounced political activity to work for *Bhudan Yagna.*

NARBADA (NERBUDDA), a river of central India. It is sometimes regarded as the boundary between Hindustan and the Deccan. It rises in the Maikala range in Madhya Pradesh and for the first 200 mi. of its course winds among the Mandla hills. Then at Jubbulpore, passing through the "Marble Rocks," it enters the structural trough between the Vindhya and Satpura ranges, and pursues a direct westerly course to the Gulf of Cambay. Its total course through Madhya Pradesh and northern Bombay state amounts to 801 mi., and it falls into the sea in the Bombay district of Broach. It receives the drainage of the northern slopes of the Satpuras, but not that of the Vindhya tableland, the streams from which flow into the Ganges and Jumna. After entering Bombay state, the river widens out in the fertile district of Broach, with an average breadth of ½ mi. to 1 mi. Below Broach city it forms an estuary which is 13 mi. broad where it enters the Gulf of Cambay.

The Narbada is nowhere utilized for irrigation, and navigation is confined to the lower section. In the rainy season boats of considerable size sail about 60 mi. above Broach city. In sanctity the Narbada ranks second to the Ganges among the rivers of India, and along its whole course are special places of pilgrimage. The most meritorious act that a pilgrim can perform is to walk from the sea to the source of the river and back along the opposite bank. The valley of the Narbada has always been an important routeway between the Arabian sea and the Ganges valley. Its middle section is followed by the main railway from Bombay to Jabalpur on its way to Allahabad.

NARBONNE, a city of France, capital of an *arrondissement* in the *département* of Aude, in a vine-growing plain 5 mi. from the Mediterranean, 37 mi. E. of Carcassonne. Pop. (1954) 27.896. Narbonne was the capital of the Volcae Tectosages. There the Romans in 118 B.C. founded their first colony in Gaul, named *Narbo Martius;* they built great works to protect the city from inundation and to improve its port, situated on a lake now filled up. The capital of Gallia Narbonensis, the seat of a proconsul and a station for the Roman fleet, Narbo Martius became the rival of Massilia. But the division of Gallia Narbonensis into two provinces lessened its importance. Alans, Suevi, Vandals, each held the city, and at last, in 413, it was occupied by the Visigoths, whose capital it afterward became. In 719, after a siege of two years, it was captured and extended by the Saracens Charles Martel, after the battle of Poitiers, and Pippin the Short. in 752, were both repulsed from its walls; but on a new attempt, after an investment of seven years, the Franks again forced their way into Narbonne. Charlemagne made the city the capital of the duchy of Gothia, and divided it into three lordships—one for the bishop, another for a Frankish lord and the third for the Jews. In the 13th century the archbishopric was seized by the pope's legate, Arnaud Amaury, who took the title of viscount of Narbonne. Simon de Montfort, however, deprived him of this dignity, receiving from Philip Augustus the duchy of Narbonne along with the county of Toulouse. By his expulsion of the Jews Philip the Fair hastened the decay of the city; and about the same period the Aude, which had formerly been diverted by the Romans, ceased to flow toward Narbonne and the harbour was silted up. United to the French crown in 1507, Narbonne was enclosed by a new line of walls under Francis I but had the last portions of its ramparts demolished in 1870. The archbishopric was founded about the middle of the 3rd century, its first holder being Sergius Paulus; it was suppressed in 1790. The Robine canal, a branch of the Canal du Midi, divides Narbonne into the *bourg* and the *cite'.* The former 13th-century cathedral (St. Just), consists only of a choir 130-ft. high and transept. The towers (194-ft. high) at each end of the transept date from 1480. The apse of the cathedral was formerly joined to the fortifications of the archiepiscopal palace, and the two buildings are still connected by a mutilated cloister of the 14th and 15th centuries. Part of the palace now serves as *hôtel de ville,* and the palace garden contains many fragments of Roman work; the Musée Lapidaire in the Lamourguier buildings has similar Roman remains. The church of St. Paul, though partly Romanesque, is for the south of France a rare example of a building of the early 13th century in the Gothic style of the north. It possesses some ancient Christian sarcophagi and fine Renaissance wood carving. It has a good trade in wine and spirituous liquors, salt, tartar, almonds and leather. The industries include cooperage, sulfur refining, brandy distilling and the manufacture of bricks and tiles.

NARCISSUS, in Greek mythology, son of the river-god Cephissus and the nymph Leiriope, distinguished for his beauty. The seer Teiresias told his mother that he would have a long life, provided he never looked upon his own features. His rejection of the love of the nymph Echo (*q.v.*) or of his lover Ameinias drew upon him the vengeance of the gods. Having fallen in love with his own reflection in the waters of a spring, he pined away (or killed himself), and the flower that bears his name sprang up where he died. According to Pausanias, Narcissus, to console himself for the death of a favourite twin sister, his exact counterpart, sat gazing into the spring to recall her features by his own.

It is a very plausible suggestion of Sir James Frazer in *The Golden Bough* that this story is to be connected with the widespread belief that it is unlucky, or even fatal, to see one's own reflection. This superstition existed in Greece.

Hence is derived the term narcissism, used in psychiatry, and especially psychoanalysis, for a morbid condition in which the subject is intensely interested in his own body.

NARCISSUS (d. A.D. 54) was a freedman of Claudius, and his secretary *ab epistulis.* Narcissus and Messallina between them exercised an unbounded influence over the emperor and arranged the execution or exile of their opponents almost at pleasure. Narcissus was sent to Britain to subdue the mutiny of the soldiers of A. Plautius. He was not well received, but the mutiny subsided. Narcissus was almost solely responsible for the ultimate downfall of Messallina in the Silius affair. It was he who made Claudius alarmed for his own safety, who succeeded in hardening him against Messallina's appeals and who finally gave the order for her execution when Claudius hesitated. For this he received the insignia of praetor. Eventually he made a false move over Claudius' second marriage, for which he supported Aetia Petina, and further antagonized Agrippina by backing the claims of Britannicus to the throne. As a result he was put to death on Nero's accession in A.D. 54. Narcissus' importance is an early example of the power of the freedmen-secretaries of the emperor's household and represented the first step toward the transformation of the emperor's personal staff into an imperial civil service.

See Sac. *Ann.* xi, xii, xiii, 1; Dio Cass. ix; Suet. *Claudius.*

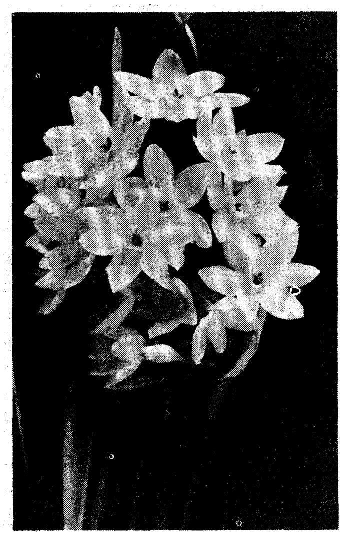
NARCISSUS, a genus of bulbous plants belonging to the amaryllis family (Amaryllidaceae), native of central Europe and the Mediterranean region; one species, *N. tazetta,* extends through Asia to Japan. From some of these, by cultivation and hybridization, have arisen the numerous modern varieties. The plants have long narrow leaves springing from the bulb and a central scape bearing one or more generally large, white or yellow, drooping or inclined flowers. The flowers are regular, with a perianth springing from above the ovary, tubular below, with spreading segments and a central corona; the six stamens are inserted within the tube. The most interesting feature botanically is the corona, or cup, which springs from the base of the flower segments and gives the special character to the flower. The classification of narcissuses adopted by the Royal Horticultural society in 1950 includes 11 groups or divisions; of these the following five are of chief interest to the gardener:

1. The hoop petticoat narcissuses are from 4 to 12 in. in height and have grassy foliage and yellow or white flowers. These have the corona in the centre of the flower—very large in proportion to the other parts and much expanded, like a hoop petticoat. They are all regarded as varieties or forms of the common hoop petticoat, *N. bulbocodium,* which has comparatively large bright-yellow flowers.

2. A second group is that of the pseudo narcissuses, of which the daffodil, N. *pseudo-narcissus,* is the type. The daffodil is common in woods and thickets in most parts of the north of Europe and is naturalized in the U.S. Its leaves are about 1 ft. in length and 1 in. in breadth and have a blunt central ridge and flat edges. The stem, which is 8 to 18 in. long, bears a single flower. The flowers are large, yellow, scented and a little drooping, with a corolla deeply cleft into six lobes, and a bell-shaped corona, which is crisped at the margin; they appear in early spring. In this species the corona is also very large and prominent. *(See* DAFFODIL.)

3. Another group, with coronas of medium size, includes the fine and numerous varieties of *N. incomparabilis,* one of which, with large, double flowers, is known as butter-and-eggs; N. *odorus,* known as the campernelle jonquil, has two to four uniform bright-yellow flowers and is considered a hybrid between N. *jonquilla* and *N. pseudo-narcissus* although it is found wild in France and Spain.

4. The polyanthus or bunch narcissuses form another well-marked group. whose peculiarity of producing many flowers on the stem is indicated by the name. In these the corona is small and shallow as compared with the perianth. *N. tazetta* is the type of this group. They are general favourites among spring flowers. The Chinese sacred lily, or joss flower, is a variety of N. *tazetta.* The jonquil, *N. jonquilla,* with yellow flowers, a native of south Europe and Algeria, is also grown in pots for early flowering but does well outside in a warm border.



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PAPER-WHITE NARCISSUS (NARCISSUS TAZETTA ALBA), **ONE OF THE POLYANTHUS NARCISSUSES**

5. In the poet's or pheasant's-eye narcissuses *(N. poeticus)* the perianth is large, spreading and conspicuous and the corona very small and shallow. These pheasant's-eye narcissuses, of which there are several well-marked varieties, blossom in succession from earlv to midspring, and all do well in-the open borders as permanent hardy bulbs.

About 65 species of *Narcissus* are under cultivation. Narcissuses are best displayed in naturalized plantings but are effective in more formal arrangements. Bulbs, available in early fall, should be planted as soon as they are received, so that they may root before cold weather arrives. They should be covered by soil as deep as one and one-half times their height. Narcissuses will thrive in a loamy soil enriched with rotted manure or bone meal, which should not touch the bulbs. After the plants flower, the leaves should be allowed to wither naturally; the bulbs depend upon the foliage for the manufacture of food materials necessary for the resumption of growth next season.

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NARCOTICS, a general term for substances which produce lethargy or stupor and the relief of pain. In a restricted sense, the term applies to opium (*q.v.*) or coca leaves or any compound, manufacture, salt or preparation thereof, even though their action is not narcotic. Prescriptions for these substances in most countries require that the prescribing physician be registered with the proper governmental agency (department of internal revenue in the U.S.) and comply with the regulations furnished by that agency. *(See* DRUG ADDICTION.) (F. L. A.)

NARDI, JACOPO (1476–1563), Florentine statesman and historian, whose history of his native city throws light on contemporary events and personalities, was born in Florence in 1476. A republican and supporter of Savonorola, he occupied various official positions after the expulsion of the Medici in 1494. He continued in the public service after their return, but joined in the movement for their second expulsion in 1527 and was instrumental in defeating the Medicean troops under Cardinal Silvio Passerini. On the family's final reinstatement in 1530, Nardi was exiled. He lived most of the rest of his life in Venice. He died in March 1563.

Nardi's chief literary work was his *Istorie della Citta di Firenze,* published posthumously (1582). Based on the diary of Biagio Buonaccorsi, a companion of Macchiavelli, it covers the period 1498 to 1538. It reflects Nardi's republican zeal, and his admiration for the religious ideals of Savonorola, and its style is sometimes heightened by sincere feeling. He mas also the author of two comedies, and of a life of Antonio Giacomini (1567).

See L. Arbib's complete edition of Nardi's *Istorie* (1838–41); A. Pieralli, *La vita e le opere di Jacopo Nardi* (1901).

NARDINI, PIETRO (1722–1793), Italian violinist and composer, mas born at Fibiana in Tuscany in 1722. He studied violin and composition at Leghorn and later became a pupil of Giuseppe Tartini at Padua.

For 15 years he held an appointment at the court of Stuttgart as solo violinist. In 1767 he settled at Leghorn and was with Tartini in his last illness. He became music director to the duke of Tuscany in 1770 and enjoyed great fame as a performer and composer. He died at Florence on May 7, 1793. Nardini is remembered as Tartini's most famous pupil, and as the composer of many graceful compositions for the violin. His music is melodious and eminently playable, and has an educational value in respect of technique. Modem reprints of the sonatas are found in Alard's *Maîtres classiques,* in David's *Hohe Schule des Violinspiels* and in Jensen's *Classische Violinmusik.*

NARES, SIR GEORGE STRONG (1831–1915). English arctic explorer and commander of the "Challenger." mas educated at the Royal Naval college at New Cross and entered the navy in 1845 He served on the Australian station was mate of the "Resolute" in the arctic expedition of 1852 and then served in the Crimea. He was then employed in surveying work on the north-east coast of Australia and in the Mediterranean. While in command of the "Challenger" (1872–74), in the famous voyage of deep-sea exploration round the world, he was ordered home to take command of the arctic expedition which set sail in the spring of 1875 in the ships "Alert" and "Discovery." For his services he was made Knight Commander of the Bath (1876). Two years later he was sent in command of the "Alert" to survey Magellan strait. He retired from active service in 1886, and became a vice-admiral in 1892. He died at Surbiton, Surrey. on Jan. 15, 1915.

He published *Reports on Ocean Soundings and Temperature* (1874–75); and *Narrative of a Voyage to the Polar Sea during 1875–76,* 2 vol. (1878)

NARES, JAMES (1715–1783), English organist and composer, mas born at Stanwell, Middlesex, in 1715.

In 1734 Nares was appointed organist of York cathedral. Named organist and composer to the king in 1756, he became in 1757 master of the children at Chapel Royal. succeeding his former teacher, Bernard Gates. The Catch club, founded in London in 1761 to encourage the composition and performance of vocal music, awarded him a prize in 1770 for his glee "To all Lovers of Harmony." In July 1780 he resigned from his post at Chapel Royal, and on Feb. 10, 1783, he died in London.

Nares's works include three collections of harpsichord lessons (1748, 1758, 1759); two treatises on singing; *Il Principio, or, A Regular Introduction to Playing on the Harpsichord or Organ* (1759); *The Royal Pastoral* (1767), a dramatic ode; a collection of catches and glees (*c.* 1780); six organ fugues; 20 anthems (1778); and a number of services, canons. and rounds.

NARESUAN (PHRA NARET), popularly known as the Black Prince, was king of Siam from 1590 to 1605. In his youth, his country was invaded and conquered by Burma and was exposed to repeated invasions from Cambodia. In 1571, when only 16 years of age, Prince Naresuan was made governor of the northern province of P'itsanulok. His rule was a chronicle of constant fighting, during which he displayed reckless courage and extraordinary military skill. In 1584 he renounced allegiance to Burma. He successfully defended the capital city of Ayuthia, and defeated the besieging Burmese forces by a combination of scorched earth and daring guerrilla tactics. He also drove out the Cambodians and thus had reassured Siamese independence by the time he mounted the throne. As king he devoted more time to the improvement of internal affairs. He conducted peaceful relations with Portuguese from Malacca and Spanish from Manila. Then he expanded his power over much of Burma and Malaya, and reduced Cambodia to vassalage. He re-established the prestige of Siam in the region between the Indian ocean and the borders of China. More than anyone else, the celebrated warrior hero was responsible for the greatness of Siam which dazzled the first East India merchants from the Netherlands and Elizabethan England.

(C. A. B.)

NAREW, BATTLES OF THE. The battles on the river Narew, northeast of Warsaw, in July and Aug. 1915, were a part of the great offensive planned by Falkenhayn against Russia. During May and June, Mackensen had driven the Russian armies in Galicia from Tarnów on the Dunajec to the east of Lemberg (*see* LEMBERG, BATTLES *OF*). In July the group of armies under his command was directed northeast toward Brest-Litovsk against the communications of the Russian forces which still held the Warsaw salient.

Hindenburg, who commanded the group of armies on the northern part of the eastern front. was now ordered to strike a blow on the north side of the salient. Falkenhayn hoped thus by driving in the flanks of the salient to cut off large numbers of Russians in its apex about Warsaw. The realization of this hope depended, of course, on the rapidity with which the flanks could be forced.

Rival German Plans.—The operation against the Narew line provoked a controversy between the two men who had most influence on German strategy during the war, Falkenhayn and Ludendorff The former was at this time chief of the German Great General staff, and thus responsible for the supreme direction of the war; the latter was chief of staff to Hindenburg. Ludendorff had long cherished the idea of a Napoleonic maneuver against the Russian rear by Kovno and Wilno on Minsk, and considered the proposed Narew offensive as timid and ineffectual; Falkenhayn, with heavier responsibilities on his shoulders, mistrusted both the feasibility and the expedience of the Wilno adventure. He could not afford to become so deeply involved in the Eastern theatre as to be unable to withdraw troops to meet the coming offensive in the west. After a discussion of the alternative plans held in the presence of the kaiser, Falkenhayn's views were approved; and Hindenburg was ordered to carry out the Narew attack.

A formidable water barrier protected Russian Poland against invasion from East Prussia, formed by the Niemen. the Bobr, the Narew and the lower course of the Bug, and thence the Vistula to the frontier. The Russians had fortified this river line. Besides the fortresses of Kovno and Grodno. Osoweic, Lomza and Nowa-Georgiewsk, there were fortified bridgeheads on the Narew at Ostroleka. Rozan, Pultusk and Zegrze. Though the river was fordable in the summer at many points, marshes along its length increased its effectiveness as an obstacle.

The German **Attack.**—Gallwitz's army, which was to make the attack, comprised six corps (14 divisions). Opposite to it, on the lower Vistula, lay the Russian 1st army (Litvinov) with three corps and a cavalry corps.

The tactical details of the fighting are not of any special interest. On July 13 Gallwitz delivered his first attack on the approximate line Przasnysz-Ciechanbw, aiming at Pultusk. The Russians, overneighted both in numbers and heavy artillery, at once fell back more than halfway to the Narew line. They were attacked again on July 15, and during July 18 and 19 withdrew across the river, the Russian 12th army on their right conforming to the movement. Reinforcements had now arrived and resistance stiffened. Though the Germans stormed the bridgeheads of Pultusk and Rozan on July 23, and secured crossings over the river, their further progress was limited by violent Russian counterattacks, and they were unable to reach the line Wyszków-Ostrów (on the lower Bug), at which they were aiming. An attempt to force a passage further east at Ostroleka on July 30 failed, and it was not until Aug. 4 that this bridgehead fell. Losses were heavy on both sides; but the Russians had secured time and space sufficient to evacuate the Warsaw salient without danger.

Hindenburg and Ludendorff naturally claimed that the result of the battle vindicated their opinion on the mistaken strategy of the Supreme command. Falkenhayn retorted that the operations would have had the desired effect of intercepting the Russian retreat had Hindenburg used the full force available and given Gallwitz 20 divisions instead of 14. It seems doubtful, however, whether the communications would have allowed the effective employment of so large a force.

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NARIÑO, southwesternmost department of the republic of Colombia, bounded by Ecuador on the south, the Pacific ocean on the west, and by the department of Cauca and the *comisaria* of Putumayo on the north and east. The *comisaria* of Putumayo was made a part of Nariño in 1953 and re-established as a *comisaria* in 1957. Area, 12,499 sq.mi. The population of Nariño (613,640 [1961 est.]) is principally concentrated in the volcanic Andean highlands above 5,000 ft. Indian physical and cultural characteristics predominate but Spanish is the universal language. The densely-settled *altiplano* of Túquerres-Ipiales on the Ecuador frontier is separated by the Patia river from that of Pasto, where Nariño's capital of that name is located. The economy of Nariiio is based almost entirely on agriculture. Wheat, barley, beans and potatoes are the principal highland crops. Bananas are exported from the port of Tumaco, which handles large ocean-going vessels. A railroad from Tumaco ascends the Patia valley for 70 mi. to El Diviso. (Js. J. P.)

NARNI (anc. Umbrian *Nequinum*, Rom. ***Narnia*),** a town and episcopal see of the province of Terni, region of Umbria, Italy, 65 mi. N. of Rome by rail. Pop. (1957 est.) 21,414 (commune). It is picturesquely situated on a lofty rock (787 ft.). The cathedral and the portico of S. Maria Impensole are Romanesque; the former has some good Renaissance sculptures. There are other interesting churches and some picturesque Gothic houses and palaces. There are factories of linoleum and calcium carbide.

The Umbrian Nequinum was taken by the Romans in 299 B.C., and a colony planted there against the Umbrians. It was situated on the Via Flaminia, and one of the finest bridges of antiquity crosses the river below the town. The original main road ran to Nuceria by Mevania; a branch by Interamna and Spoletium joined it at Forum Flaminii. According to some authors, the emperor Nerva was born at Narnia. The town played a considerable part in military history. In the middle ages Narni was under the papal power. It was the birthplace of the well-known condottiere Erasmo Gattamelata (d. 1443), whose statue by Donatello is at Padua.

See G. Eroli, *Miscellanea Storica Narnese* 2 vol. (1858–1862), and other works by the same author.

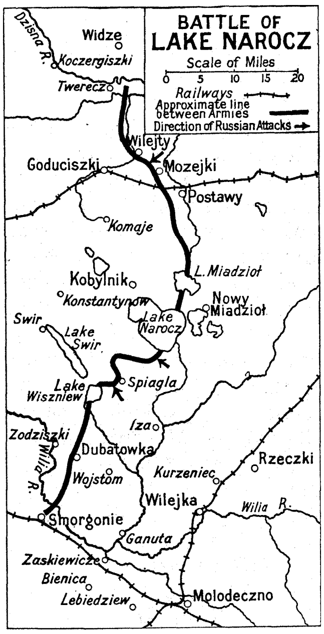
NAROCZ, BATTLE OF LAKE. Lake Narocz, in Belorussian S.S.R., U.S.S.R.. 62 mi. E.N.E. of Vilnius, gives its name to a great offensive by the Russian 2nd army in the spring of 1916. *(See* WORLD WAR *I: From Verdun to the Entry of America.)*

General Situation on the Eastern Front. — The river Pripet formed the dividing line between the German and Austrian commands. At the beginning of March there were 42 German and two Austrian divisions on the front north of the Pripet, the total length of which was about 250 miles. The Russians had organized their armies into three groups: the northern (12th and 5th armies) on the Dvina, the western (1st, 2nd, 10th, 4th and 3rd armies) extending to south of the Pinsk marshes and the southwestern (8th, 11th, 7th and 9th armies) up to the Rumanian border. Their main strength was concentrated on the northern and western fronts, where it had been decided that the principal efforts of the year should be made. The losses of 1915 in men and material had been made good; guns and munition were available on a larger scale than previously, though still insufficient for the requirements of trench warfare.

Plan of Operations. — The general idea of the battle was for the 2nd army to attack on either side of Lake Narocz, where the German line formed a slight salient; the two wings were eventually to join and to continue their advance westward to Panevežys (some 80 mi. N. of Wilno [Vilna] and 100 mi. W. of the original line), where the 5th army, which was to attack from the Jakobstadt bridgehead on the Dvina, was to join them. The operation seems to have been planned originally to take place later in the year, when all the Allies proposed to attack simultaneously. But on Feb. 21 the German assaults on Verdun began, and the Russians chivalrously hurried on their preparations and attacked to relieve the pressure on the French, at the worst possible time of the year—when the annual thaw, which renders all communications practically impossible for a period, might be expected at any moment.

Description of the Terrain. — Lake Narocz (8 mi. by 6 mi.) is the largest of a whole series of small lakes in which the tributaries of the Wilia and the Dzisna rise. It drains into the Narocz river, which flows south to join the Wilia east of Smorgonie. The greater part of the trench line between Dvinsk and Smorgonie (over 100 mi. in a straight line) was protected by lake, stream or marsh, and stretches of dry ground wide enough for a large scale offensive were few. On either side of Lake Narocz, however, mere gaps of four miles or so in the water line, where the terrain was comparatively favourable for attack, though communications were poor. The northern gap was ten miles to the north of Lake Narocz; the southern was between the lake itself and Lake Wiszniew.

Dispositions of the Opposing Forces. — The 2nd army was divided into three groups: the right group (under General Plyeshkov), opposite the northern gap, consisted of three corps and a cavalry corps; the centre group (under General Sirelius), of two corps; and the left group (under General Baluev), of three corps. Four corps were available behind these groups to exploit any success gained. The right and left groups were to attack the north and south faces of the salient respectively, while the centre group assisted by minor assaults and demonstrations. The army commander, Smirnov, fell sick just before the battle and his place was taken by General Ragoza



PLAN OF THE BATTLE OF LAKE NAROCZ, MARCH 18, 1916

The 2nd army was opposed by Von Eichhorn's 10th army on a front of some 85 mi.. comprising 11 divisions and two cavalry divisions. The Germans were aware of the Russian concentration.

The Russian Attacks. — A thaw set in on March 17, but the offensive was nevertheless begun on the 18th. After a bombardment of several hours, massed infantry attacks were made both by Plyeshkov's group north of Lake Narocz and by Baluev's group in the south. In the thickly wooded and enclosed terrain the insufficiently trained Russian infantry soon lost cohesion, and their assaults were ill-timed and disjointed. Though the German first-line trenches were in several cases occupied, they could not be held under the concentrated fire of the German artillery, which mas extremely skilfully handled. By nightfall the Russians were back in their original positions, having suffered very heavy casualties without result. After two days of further artillery preparation and minor attacks intended to mislead the enemy, renewed heavy assaults were made on the nights of March 19–20 and 20–21.

On Plyeshkov's front no ground was permanently gained in spite of terrible losses, but Baluev's group in the south made an advance of over a mile on a front of about 23 miles. The weather conditions were by now terrible; it thawed from the 17th to the 22nd. and the whole area of operations became a sea of mud. The battle was, however, continued till March, 27, when the Russians at last desisted from their fruitless and costly attacks. In April a German counterstroke retook all the ground gained by Baluev. Meanwhile the attacks of the 5th army from Jakobstadt, March 21–26, were equally unsuccessful and almost equally wasteful of life.

Results of the Operations. — The operations resulted in a complete and disastrous failure for the Russians. Their losses were over 100,000 and they accomplished nothing. The offensive did not cause the Germans to move a single man from the western front, and so brought no relief to the French. Both time and place were ill-chosen; the staff work was bad; and the artillery, in spite of a greater concentration of heavy guns on a narrow front and a more liberal expenditure of ammunition than ever before, failed to give proper support to the infantry, who, as usual, paid the price in terrible losses.

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NARRA or ASANÁ, the local names (Philippine dialect) applied to some of the best timber trees, *Pterocarpus indicus*, P. *echinatus* and *P. blancoi* (family Leguminosae) in the Philippine archipelago. The wood is commonly known as "Philippine mahogany," and is in great demand for cabinet work; it is usually of a beautiful red or rose colour, often variegated with yellow, and is hard and heavy. The trunk is surrounded (or, occasionally, supported) by huge buttresses extending outward and upward for 10 to 20 ft.; these are sometimes made into table tops, the pattern of the grain and the colouring being hardly equalled by any other timber. The wood cells contaig a peculiar substance: a minute chip placed in a bottle of water soon gives an opalescent colour to the liquid. Narra is known as Burmese rosewood, Andaman redwood and Kiabooca wood.

NARSES *(c.* 478–573), an important officer of Justinian. in the 6th century. He was a eunuch of Persamenia, and apparently born about 478. If the statement that he died at the age of ninety-five be correct, he was probably brought young to Constantinople, and attained a footing in the *officium* of the grand chamberlain. He rose to be one of the three *chartularii,* a position involving the custody of the archives of the household. Hence, probably in middle life, he became *praepositus sacri cubiculi.*

In 532 the insurrection known as the Nika broke out in Constantinople, when for several hours the throne of Justinian seemed doomed to overthrow. It mas saved partly by the courage of his nife, Theodora, and partly by the timely prodigality of Narses, who with large sums of money bribed the leaders of the "blue" faction, which uas formerly loyal to the emperor. to shout as of old "Justiniane Auguste tu vincas." He defeated Totila in 552, with whom fell the last hopes of the Gothic kingdom of Italy.

NARSIMHAPUR (NARSINGHPUR), is a town and district in the Jabalpur division of Madhya Pradesh, India. The town, headquarters of the district, lies on the Central railway 50 mi. W. of Jabalpur. Pop. (1951) 14,316. Once called Chhota Gadarwara, it was renamed Narsinghpur when a temple of Narsingh (the "man lion," an incarnation of Vishnu) was erected about 150 years ago. The river Singri divides the town into two parts, Kandeli on the east and Narsimhapur on the west. The chief trade is in timber.

NARSIMHAPUR DISTRICT (area 1,979 sq.mi.; pop. 1961,412,387) is a narrow strip of fertile black alluvium between the Narmada (Narbada) river and the Satpura ranges. The Narmada, which marks its northern border, receives many tributaries from the south whose ravines are an ever-growing problem. Much of the district is forested and the remainder is under cultivation. the main crops being wheat. cotton, *jowar* millet and *sesamum*.

Narsimhapur once formed part of the territory of the Mandla Gond kings of Chauragarh, 20 mi. S.W. of Narsimhapur town. Later, the Bundelas of Orchha conquered Chauragarh and in 1781 the Gond dynasty was overthrown by the Marathas who were ousted by the British in 1818. (S. M. A.)

NARTHEX, in architecture, a long, narrow porch, usually colonnaded or arcaded. at the entrance of a church. sometimes alone, sometimes as the side of the atrium (*q.v.*) adjacent to the church façade. In the early days of Christianity it was the only portion of the church to which catechumens and penitents were admitted. Occasionally an additional vestibule exists within the church building proper. In this case, the inner vestibule is called the narthex and the outer porch an exonarthex. The narthex is common in basilican, Byzantine and some Romanesque churches. particularly in Italy; in the Gothic period its use had almost disappeared, but during the Renaissance it was again found, although its ritual usage had entirely died out and it had become a simple porch or vestibule. *See* BASILICA; RELIGIOUS ARCHITECTCRE.

NARVA, a seaport of Estonian S.S.R., U.S.S.R., on the Narva river, 8 mi. above the entry into Narva bay on the Gulf of Finland. Pop. (1956 est.) 21,000. With it is associated Narva-Joesuu (Hungerburg) in the Narva estuary; pop. (1939) 2,600.

Founded by the Danes in 1223, Narva became 15 years later a fortress of the Teutonic Knights. At the end of the 13th century it was conquered for a few years by the Russian Novgorod republic. but changed hands again and remained a Teutonic stronghold until 1558. In that year it returned to Russia, but in 1581 it was taken by Sweden. In 1700 it was besieged by the Russians who on Nov. 20 suffered a defeat at the hands of Charles XII. king of Sweden. Four years later Tsar Peter I had his revenge and on Aug. 9, 1704, captured Narva by storm. It remained under Russian rule until Estonia obtained independence in 1918: it returned to Russia in 1940 when Estonia was annexed by the U.S.S.R. During World War II it was occupied by the Germans from Aug. 1;, 1941, to July 26. 1944. The town suffered much from artillery fire when it was recaptured by the Russians.

Narva is a port and an industrial centre. Before 1939 vessels of $15\frac{1}{2}$ to 16 ft. draught could load in its harbour. There are important textile mills.

See H. J. Hansen, *Geschichte der Stadt Narva* (1858).

NARVÁEZ, PÁNFILO (*c.* 1480–1528), Spanish adventurer. was born at Talladolid. He helped Diego Velásquez in the reduction of Cuba and was put at the head of the force sent to the Aztec coast to compel Hernan Cortes to renounce his command. He was defeated by his compatriot and made prisoner (1520). On his return to Spain he obtained from Charles V a grant of Florida as far as the River of Palms. Landing near Pensacola bay in April 1528, he struck inland with 300 of his followers and reached "Apalache" on June 25. Disillusioned in their hopes of fabulous wealth, they made for the coast, arriving in July at the Bahia de los Caballos. at or near St. Mark's. Having built rude boats, the much-reduced company sailed on Sept. 22 for Mexico. but the vessel which carried Narváez perished in the storm. His lieutenant. Cabeza de Vaca, and three others ultimately reached the Gulf of California by way of Texas. *See* FLORIDA.

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NARVÁEZ, RAMON MARÍA (1800–1868), Spanish soldier and statesman. was born at Loja. Granada, on Aug. 5, 1800. He served under Francisco Espoz y Mina (*q.v.*) in Catalonia in 1822. As one of the Conservative supporters of Isabella II he achieved great popularity by defeating Miguel Gómez, the Carlist general, near Arcos, in Nov 1836, and after clearing La Mancha of brigands in 1838 he mas appointed captain-general of Old Castile and commander in chief of the army of reserve. After taking part in the Seville insurrection (1840) against Baldomero Espartero and the Progresista party he fled to France and planned with Maria Cristina the expedition of 1843. which led to the overthrow of his adversary. Prime minister field marshal and duke of Valencia in 1844. his reactionary policy culminated in his having to quit office in Feb 1846 He became ambassador at Paris, but returned (1847) to govern Spain until 1851. despite misunderstandings with the court. His ministry succeeded Leopold O'Donnell's in 1856–57, Alejandro Mon's in 1864–65 and O'Donnell's in July 1866 He died in Madrid April 23, 1868.

NARVIK, an ice-free seaport on the Ofot fjord of the northnest coast of Norway in Nordland *fylke* (county), 68° 30' N. Pop. (1950) 11,023 (1959 est.) 12,842. The town dates from the construction, in 1903, of the Ofot railway, the most northerly in the world. Narvik is 167 mi. N.W. of Gallivare and 982 mi. N. of Stockholm by rail. From the Kiruna-Gallivare region of Sweden iron ore is transported across the mountains for shipment at Narvik. During World War II the Germans seized Narvik (April 9, 1940). Two naval battles were fought there on April 10 and 13, 1940. *See* WORLD WAR II.

NARWHAL, a cetacean (*Monodon monoceros*), characterized by the presence in the male of a long, hornlike tusk. In the adult of both sexes there are only two teeth, both in the upper jaw, which lie horizontally side by side, and in the female remain throughout life concealed in cavities of the bone. In the male the right tooth usually remains similarly concealed, but the left is immensely developed. attaining a length equal to nearly that of the entire animal. It projects forward from the head in the form of a cylindrical or slightly tapering, pointed tusk, composed of ivory nith a central cavity reaching almost to the apex. without enamel. and with the surface marked by grooves and ridges running in a left-handed spiral. Occasionally both left and right tusks are developed. In young animals several small additional teeth are present, but these generally disappear soon after birth

The head is short and rounded: the forelimbs or paddles are small and broad. and (as in the beluga) a dorsal fin is wanting. The general colour is dark gray, variously marbled and spotted with gray. The narwhal is an arctic whale rarely seen south of 65" N. Like most cetaceans it is gregarious and usually met nith in schools of 15 or 20. Its food appears to be cuttlefishes, small fishes and crustaceans. The purpose of the tusk is uncertain The narwhal is extremely playful, individuals frequently elevating their tusks and crossing them with each other as in fencing. They have never been known to charge and pierce the bottoms of ships with their weapons as the swordfish does The ivory of the tusk is of good quality but because of the central cavity is fitted only for the manufacture of objects of small size. The entire tusks are sometimes used for decorative purposes. *See* WHALE.

NASBY, PETROLEUM V., pen name of DAVID ROSS LOCKE (1833–1888), U S humorous satirist of the Civil War period He was born near Binghamton. N.Y., on Sept. 20, 1833. From an early age he worked for various newspapers in Nen York and Ohio. In 1861, as editor of the *Findlay* (Ohio) *Jeffersonian,* he published the first of many satirical letters purportedly written by one Petroleum Vesuvius Nasby. For over 20 years Locke contributed "Nasby Letters" to the *Toledo Blade,* which under his editorship gained national circulation. Many of the letters appeared also in book form

An ardent Unionist and foe of slavery. Locke vigorously supported the Northern cause. His chief weapon was a heavy irony. He let his character h'asby, a "Copperhead." argue in favour of the Southern position; but because Nasby is stupid, illiterate, coarse and vicious. he damns the cause he favours. His reasoning is absurd, his grammar and spelling atrocious. Used for a serious end, such verbal fooling delighted Northern readers, including President Lincoln. who occasionally read Xasby letters to his cabinet. But topical satire and humour date quickly. Among the many humourists who flourished during and immediately after the Civil War, Locke, perhaps the most influential of his time. is today one of the least readable. He died on Feb. 15, 1888.

See Cyril Clemens. *Petroleum V. Nasby* (1936) ; Walter Blair, *Horse Sense in American Humor* (1942). (L. T. D.)

NASCIMENTO, FRANCISCO MANOEL DO (pseudonym. FILINTO ELÍSIO) (1734–1819). the last of the Portuguese neoclassical poets. He was born in Lisbon on Dec. 23. 1734. of humble and probably adulterous origin. He was educated by the Jesuits and ordained in 1754. Sot long afterward he founded a literary society known as the *Grupo dn Ribriru das Naus.* In 1768 he became tutor to the daughters of the marquis of Alorna and fell in love with one of them, the "Maria" of his poems. Disapproving of the low-born poet's affection for his daughter. the marquis may have been ultimately responsible for Nascimento's being denounced to the Inquisition in June 1778. He succeeded in escaping to France, however. and there. except for some four years in The Hague during the revolutionary Terror. he remained. living by translations and by taking private pupils. But when he died, in Paris on Feb. 25, 1819, it was recognized that Portugal had lost its foremost poet.

The themes of Xascimento's poetry. which is usually in blank verse. polished. robust but often overladen with archaisms. range from denunciations of the tyranny of the aristocracy, the Inquisition and the hierarchy. coupled with praise of liberty and patriotism, to homely evocations of the joys of life in his native land and laments on the poverty and loneliness of exile. His demonstration of the flexibility and richness of the Portuguese language, his choice of themes and his translations of such works as Wieland's *Oberon* and Chateaubriand's *Les Martyrs* influenced the romantic writers.

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NASEBY, a village of Northamptonshire, Eng., 7 mi. S.S.W. of Market Harborough, famous as the scene of the battle of June 14, 1645, which decided the issue of the first Civil War (*see* CIVIL WAR, ENGLISH). The army of King Charles I was less than 10,000 strong, while the New Model army of the parliament, commanded by Sir Thomas Fairfax. numbered about 13,000. Yet it was not without considerable hopes of victory that the royalists drew up for battle, although Lieutenant General Cromwell had made the New Model cavalry formidable indeed, the royalist foot had become professionalized in several years of war, whereas the parliamentarian foot was newly organized and in part at least only half trained. Fairfax and Cromwell, however. were still more confident, and with better reason. The battlefield lies between Naseby and Sibbertoft (3 mi. N. of Naseby) and is an undulating ridge which. near the centre of England, forms the divide between the Avon and the Welland rivers. Across this ridge the two armies were drawn up, the New Model facing north and the king's army south, the horse on the flanks and the foot in the centre of each army. At the first shock the royal foot asserted its superiority over the opposing infantry, four out of five regiments in the first line were broken and Philip Skippon, the major general of the foot, was wounded. But Fairfax' regiment held its ground until the second line of infantry advanced and re-established the front. Meantime the royalist right wing of horse, led by Prince Rupert, had completely routed the horse of Col. Henry Ireton which opposed them. But the victors as usual indulged in a disorderly pursuit, and attempted to overpower the baggage guard of the enemy near Naseby village. Their incoherent attack was repulsed, and when Rupert, gathering as many of his. men as he could, returned to the battlefield, the decisive stroke had been delivered by Cromwell and 'the right wing of parliamentary horse. In front of him, in somewhat broken ground, was Sir Marmaduke Langdale's cavalry, which the lieutenant general with his own well-trained regiments scattered after a short, fierce encounter. Cromwell's "godly" troopers did not scatter in pursuit. A few squadrons were ordered to keep the fugitives on the run, and with the rest, and such of Ireton's broken troops as he could gather. Cromwell attacked the royalist centre in rear while Fairfax and his foot pressed it in front. Gradually the royalist infantry, inferior in numbers, was disintegrated into small groups, which surrendered one after the other. But one brigade. called the "Bluecoats." held out to the last, and mas finally broken by a combined charge of Fairfax' regiment of foot, led by Cromwell. and the general's personal escort, led by Fairfax himself, who captured a colour with his own hand. The remnant of the king's army. reformed by Rupert, stood inactive and irresolute while its infantry was being destroyed and then fled. The spoils included 100 standards and colours and the king's private papers. But more important than trophies was the practical annihilation of the last field army of which the king disposed.. Half the royalists were captured, and about 1.000 fell in the battle and the pursuit. In addition all the artillery and the muskets (to the number of 8,000) and ammunition without which the king could scarcely create a new army were lost.

NASH, PAUL (1889–1946), English painter appointed an official war artist in both World Wars I and II, was born in London on May 11, 1889, and studied at the Slade school, London. In 1914 he enlisted in the artists! rifles and his 1918 exhibition of paintings portrayed with abstract detachment shattered war landscapes, such as "Menin Road" (Imperial War museum, London). There followed seascapes ("Wall Against the Sea," Carnegie institute: Pittsburgh) and landscapes ("Oxenbridge," Birmingham art gallery, Eng.) of distinguished design and cool, vibrating colours. and book illustrations and wood engravings. In the 1930s his paintings developed freer design and richer colour. together with a symbolic. "fourth-dimensional" vision influenced by surrealism. One of his best-known paintings of World War II was "Totes Meer" ("Dead Sea," Tate gallery, London). Later paintings reveal his imaginative poetic symbolism; *e.g.,* "November Moon" (Fitzwilliam museum! Cambridge, Eng.) and "Solstice of the Sunflower" (National gallery, Ottawa). Kash died at Boscombe. Hampshire, on July 11, 1946.

See Paul Kash, *Outline* (1949) ; M. Eates (ed.), *Paul Nash* (1948). (M. T. N.)

NASH, RICHARD (1674–1761), English dandy, better known as "Beau Kash," was born at Swansea on Oct. 18, 1674. He was educated at Carmarthen grammar school and at Jesus college, Oxford. He obtained a commission in the army, mhich however, he soon exchanged for the study of law at the Temple. There among "wits and men of pleasure" he came to be accepted as an authority on dress. manners and style. When the members of the lnns of Court entertained William III after his accession, Nash conducted the pageant at the hliddle Temple. He was offered knighthood, but he declined the honour, unless accompanied by a pension. The pension was not given and Nash turned gamester. In 1705 he succeeded Captain Webster as master of the ceremonies at Bath. Under his regime Bath became the leading fashionable watering place. He drew up a new code of rules for the regulation of balls and assemblies, abolished the wearing of swords in places of public amusement and brought duelling into disrepute, induced gentlemen to adopt shoes and stockings in parades and assemblies instead of boots, reduced refractory chairmen to submission and civility and introduced a tariff for lodgings. Through his exertions a handsome assembly room was also erected, and the streets and public buildings were greatly improved. Nash adopted an outward state corresponding to his nominal dignity. He wore an immense white hat as a sign of office, and a dress adorned with rich embroidery, and drove in a chariot with six grays, laced lackeys and French horns. When the act of parliament against gambling was passed in 1745, he was deprived of an easy though uncertain means of subsistence, but the corporation afterward granted him a pension of 120 guineas a year, which, with the sale of his snuffboxes and other trinkets, enabled him to support a certain faded splendour till his death on Feb. 3, 1761. He was honoured with a public funeral at the expense of the town. He was a man of strong personality, and considerably more able than Beau Brummell. whose prototype he was.

See Oliver Goldsmith, *Life of Richard Nash* (1762); Lewis Melville, *Bath Under Beau Nash* (1908), with full list of authorities.

NASHE (NASH), **THOMAS** (1567–1601?), English pamphleteer, poet and dramatist, was born in 1567 at Lowestoft. Suffolk, the son of a Herefordshire minister. In 1581 or 1582 he matriculated at St. John's college, Cambridge. About 1588 he left Cambridge and went to London, where he became associated with Robert Greene and other professional authors. His first appearance in print was his preface to Greene's *Menaphon* (1589), though he probably wrote *The anatomie of absurditie* (1589) earlier. Both works reveal the recent university graduate: a fervid but traditional espousal of literary standards. violent hostility to popular literature, a conventional misogynic attitude and a style tainted by euphuism. The learning is pretentious and the tone often arrogant and sometimes coarse: "I will persecute those idiots and their heires unto the third generation, that have made Art bankerout of her ornaments, and sent Poetry a begging up and downe the Countrey."

In 1589 and 1590 he evidently became a paid hack of the episcopacy in the Marprelate controversy (*q.v.*), and matched wits with the unidentified. but enormously clever, "Martin." Almost all the replies to Martin have variously been assigned to Nashe, but the only one that has been convincingly attributed is *An Almond for a Parrat* (1590). He wrote the preface to Thomas Newman's unauthorized edition of Sir Philip Sidney's *Astrophel and Stella* (1591). Though Nashe penned an extravagant, servile dedication to Sidney's sister, the countess of Pembroke, the book was withdrawn and reissued in the same year without Nashe's foreword.

Pierce Penilesse his supplication to the divell (1592) revealed Nashe's artistic strengths and weaknesses. Purged of euphuistic affectations, his prose had become a combination of colloquial diction and idiosyncratic coined compounds ideal for controversy and for his eccentric discussion of the seven deadly sins. But verbal facility was frequently an end in itself; Nashe rambled, inserting whatever came to mind, and failed to impose a consistent structure upon his material. In a digression he attacked Richard Harvey and thus added to Greene's diatribe against the Harveys in *A quip for an upstart courtier* (1592) a passage which Greene deleted before his death on Sept. 3, 1592. After Gabriel Harvey (*q.v.*) had assailed both Greene and Nashe in *Four Letters and certaine sonnets* (1592), in *Strange newes* (1592), Nashe defended, but not too strenuously, the memory of his friend and heaped further abuse upon the Harvey family. Then, in the foreword to *Christs teares over Jerusalem* (1593), he indicated willingness to end the dispute, but when Harvey, who was probably unaware of the proposal, printed *Pierces supererogation* (1593), Nashe withdrew the preface in the second edition, and wittily burlesqued his opponent in *Have with you to Saffron-Walden* (1596). Thomas Middleton, writing in 1604, was probably most accurate when he termed this controversy "but the running a tilt of wits in booksellers' shops on both sides of John of Paul's churchyard." For in 1592 and 1593 Harvey was in the employ of John Wolfe, who printed his pamphlets, and, if Harvey is to be credited, Nashe was as early as 1593 a hack in the printing establishment of John Danter. The flyting was officially terminated in 1599, when the archbishop of Canterbury ordered "that all Nasshes bookes and Doctor Harveyes bookes be taken wheresoever they maye be found and that none of theire books bee ever printed hereafter."

Apparently Nashe wrote *Strange newes* while he was living in late 1592 and early 1593 at the home of Sir George Carey, who dramatically relieved for the moment his oppressive poverty. *Christs teares over Jerusalem* and *The Terrors of the Night* (1593) were dedicated to members of the Carey family. In the former Nashe ominously warned his countrymen during one of the worst plagues that unless they reformed London would suffer the fate of Jerusalem, and so strenuously condemned the greed of London merchants that he was forced to cancel the offending passage. *The Terrors of the Night* was a discursive, sometimes bewildering, attack on demonology. Both works were medieval in their attitudes and almost puritanical in their moral indictments.

Pierce Penilesse excepted, Nashe's most successful works were his masque, *Summers last Will and Testament* (1592, publ. 1600), his novel *The unfortunate traveller, or, The life of Jacke Wilton* (1594) and *Nashes lenten stuffe* (1599). *The unfortunate traveller* has brilliant sections, including the romance of the earl of Surrey and Geraldine, but it is marred by Nashe's lack of artistic control and by his repellent fascination with cruelty and violence. *Lenten stuffe,* purportedly a panegyric of red herrings, contained a charming description of Yarmouth, Norfolk, and a serio-comic treatment of Hero and Leander.

By his share in a lost stage comedy entitled *The Isle of Dogs* (1597) and labeled seditious, Nashe offended the authorities. Exactly what punishment he received is unknown, but Ben Jonson and others were temporarily imprisoned. In the remaining years of his life Nashe apparently retired from London to Yarmouth. He died in 1600 or 1601. Nashe was the first of the English prose eccentrics, an extraordinary inventer of verbal hybrids, and, according to C. S. Lewis, "the supreme master of literary *sansculottisme.*" (C. S. Lewis, *English Literature in the Sixteenth Century,* Oxford University Press, London, 1954.) Unfortunately he neither had time because of financial need nor the temperament necessary to realize fully his undoubted talents.

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NASHUA, a city of New Hampshire, U.S., is located on the Merrimack and Nashua rivers 40 mi. N.W. of Boston, Mass.; the seat of Hillsboro county, It has extensive manufacturing. With the post-World War II withdrawal of textiles the city developed a diversified industrial base through the Nashua-New Hampshire foundation, which includes shoes, paper products, electronics, chemicals, office equipment, millwork, plastics, greeting cards, asbestos products and machinery for the manufacture of plastic and paper.

The site was originally part of Massachusetts province but the 1741 settlement of the Massachusetts-New Hampshire boundary led to local resentment and a five-year delay in applying for a charter as Dunstable, N H. In 1803 the village of Indian Head, across the Nashua river, took the name of Nashua (believed to have been derived from a local Indian tribe, the Nashuas). The two settlements joined in 1837 as Nashua. The northern section uithdrew, as Nashville. in 1842 over a dispute in locating the town hall. They were reunited under a city charter in 1853.

Nashua is the site of Rivier, a Roman Catholic college for women, founded in 1933. The city early attracted Irish immigrants to the textile mills, followed by large numbers of French Canadians. The latter still form the major ethnic group, although Lithuanian, Polish and Greek immigrants subsequently contributed to the cosmopolitan character of the community. For comparative population figures *see* table in NEW HAMPSHIRE: *Population.* (L. F. R.)

NASHVILLE, capital city of Tennessee, U.S., and seat of Davidson county, is situated on the Cumberland river in the north central portion of the middle Tennessee basin. Pop. (1960) city 170,874; standard metropolitan statistical area (Davidson county) 399,743. (For comparative population figures *see* table in TENNESSEE: *Population.)*

History. — The first English settlement in Tennessee west of the Allegheny mountains, the city was founded in 1779 by settlers from eastern Tennessee under the leadership of James Robertson and John Donelson. The site of the city had been occupied much earlier by French traders, who operated a trading post near the present downtown area, and before that by the Shawnee Indians. It was originally named Fort Nashborough, for Gen. Francis Nash of North Carolina, and in 1784 took its present name.

One of the prime movers behind the settlement of Fort Nashborough was Richard Henderson, a North Carolina jurist, who in 1775 acquired most of middle Tennessee and Kentucky in the famous Transylvania purchase from the Cherokee Indians. He also is credited with having written the Cumberland Compact, the articles of self-government adopted by the settlers, which contained the first known provision in the United States for recall of elected officials (see TENNESSEE: History). Henderson's settlement was under frequent Indian attack in its early years and for a while these attacks seemed likely to destroy the infant colony. But with the end of the American Revolution many new settlers arrived increasing the population and treaties of peace were soon signed with the formerly hostile Indians.

The city grew rapidly in the first half of the 19th century and soon became a thriving trade centre for the entire middle Tennessee area. Radiating from the city like the spokes of a wheel was an extensive system of turnpikes over which the produce of the surrounding area was brought to the city's Cumberland river docks. Nashville's commercial importance was further enhanced in the 1850s when it acquired railroad connections with major commercial cities to the north and south. The city also became a political centre of the state. In 1826, just two years before Andrew Jackson became president of the United States, Nashville was selected as temporary capital of the state; in 1843 it became the permanent capital.

Its transportation facilities and strategic location made Nashville an important city in the campaigns of the American Civil War. It was occupied by Federal troops in Feb. 1862, shortly after the capture of Ft. Donelson, the Confederacy's key defense position on the Cumberland river. Nashville was under Federal military control for the remainder of the war and from March 3, 1862, to April 1865 it was the seat of government for Military Governor Andrew Johnson. It also was a major supply base for Federal operations in the lower south. Its warehouses and railroads played an important part in Gen. William T. Sherman's 1864 campaign against Atlanta.

The last major battle of the Civil War took place at Nashville a few months after the fall of Atlanta. Confederate Gen. John B. Hood moved back into Tennessee in an effort to cut Sherman's supply lines and perhaps threaten Cincinnati and other northern cities. After suffering heavy losses in the battle of Franklin (Nov. 30, 1864), Hood advanced to the southern outskirts of Nashville, about 15 mi. N. of Franklin and there established defensive lines across the railroad tracks leading south. On Dec. 15, 1864, the Union army, commanded by Gen. George H. Thomas, marched out against Hood and overwhelmingly defeated the badly outnumbered Confederates. On the following day the Union victory was made complete and the Confederate army retreated in near disorder into Alabama.

Since Nashville had been occupied early in the war and without a fight, the city suffered less physical destruction than most occupied southern cities. Union warehousing and supply operations were not without economic benefit to the city and the many Federal soldiers who remained in Nashville after the war helped promote its economic recovery. Nashville resumed and improved its position as a leading investment and commercial centre and by the turn of the century was also becoming an important manufacturing centre in the state. Its continuing industrial development was greatly accelerated in the 20th century by the availability of cheap electric power from the Tennessee Valley authority and from the Cumberland river dams of the U.S. army corps of engineers.

Population and Government.—Nashville in the 1960s had a metropolitan area of more than 500 sq.mi. with almost one-half of the population residing outside the city limits. About one-fifth of the metropolitan population and one-third of the city population was Negro. Government of the city was by a mayor and council, while most residents of the metropolitan area outside of the city were governed by a county judge and county court. A few areas in the suburbs were incorporated as separate cities under varying forms of city government.

As was the case with other Tennessee cities, Nashville in the 1960s was grossly underrepresented in the state legislature, which still retained the rural dominance of the state's last reapportionment in 1907. The city frequently found less than a sympathetic understanding of urban problems among legislators from the rural areas. Slowness of the city to expand its boundaries with its population presented a major problem in government, and civic and political leaders were sharply divided on the question of annexation as against formation of a metropolitan government combining features of both county and city government. The city meanwhile engaged in ambitious and progressive programs of urban renewal, slum clearance, improved street lighting, expansion of airport facilities and other civic improvements.

Commerce, Industry and Transportation.—Nashville has a well diversified economy. Investment firms and insurance firms are both important. There are more than 500 manufacturing plants but no single one is a dominant element in the city's economy. The largest industrial plant is one producing dacron and cellophane at Old Hickory, a suburban industrial city built as an explosives centre during World War I. Other major industries produce shoes, major parts for airplanes, vacuum bottles and lunch kits, river transport equipment and paper bags. Important additions to the city's industrial development include a glass plant and a rubber plant.

Nashville is widely known as a religious centre. It is the site of the national headquarters of several boards and agencies of the Methodist Church, the Sunday school board of the Southern Baptist convention and the international headquarters of the Disciples of Christ Historical society. The Methodist Publishing House is said to be the largest religious publishing house in the world and is one of the few major publishers that operates its own printing plant; its interdenominational magazine The Upper *Room* is claimed to be the world's most widely used devotional guide, being printed in over 30 languages. This publishing house is only one of a large number that make printing and publishing one of the city's major industries. The Southern Baptist convention also operates a publishing house.

During the second quarter of the 20th century the city became widely known as an entertainment centre, largely through its "country music" industry, Regular radio broadcasts of the "Grand Ole Opry" began in 1925 and national network broadcasts in 1939; it consistently attracted capacity audiences to its performances in historic Ryman auditorium. Country music is also the mainstay of a very large recording industry.

Nashville is served by several airlines, two railroads and more than 40 motor-freight lines, several of which have their home offices in the city. It is the major river port on the Cumberland.

Education.—Vanderbilt, a private university founded in 1873, ranks as one of the nation's leading universities; it has schools of liberal arts, medicine, law, religion, engineering, nursing and graduate studies. On adjoining campuses are George Peabody College for Teachers (private), founded as Davidson academy in 1785, and Scarritt College for Christian Workers, a Methodist senior college and graduate school chartered in 1924. Nearby is Belmont college, established in 1951 by the Tennessee Baptist convention on the historic property formerly occupied by Ward-Belmont college, now defunct; farther south is David Lipscomb college, founded in 1891 and affiliated with the Churches of Christ. In the west portion of the city are Fisk university, established in 1865 and affiliated with the American Missionary association, and, on an adjoining campus, Meharry Medical college (Methodist), founded in 1876. Still farther west is Tennessee Agricultural and Industrial State university, established in 1912. The city also has two highly regarded private preparatory schools, Harpeth Hall (for girls) and Montgomery Bell academy (for boys). Well-known private schools in nearby outlying towns are Battle Ground academy in Franklin, Castle Heights Military academy in Lebanon and Columbia Military academy in Columbia, all for boys.

Parks and Recreation.—Nashville's park system includes more than 30 city parks. The best known is Centennial park, which occupies 132 ac. of the state centennial exposition grounds and features the world's only full-scale reproduction of the Parthenon. Edwin Warner park and Percy Warner park, adjoining each other in the southwestern portion of the county near the city's Fine Arts Center and Botanical Gardens, contain 2,665 ac. of hilly land of great natural beauty. These parks contain scenic roads, picnic and play areas, hiking and riding trails and a municipal golf course. Old Hickory lake, a 22,500-ac. impoundment of the Cumberland river, is another major recreational area.

The area's best-known historic site is The Hermitage, the home of Andrew Jackson. It annually attracts thousands of visitors, many of whom also visit Belle Meade, a famous 19th-century plantation home and thoroughbred nursery; Traveler's Rest the home of Jackson's close friend and business associate, John Overton; and Ft. Nashborough, a reconstruction of the fort around which the city developed. (W. T. A.)

NASI, JOSEPH (? –1579), Jewish statesman and financier, was born in Portugal of a Jewish (Marrano) family. Emigrating from his native land, he founded a banking house in Antwerp. Despite his financial and social prosperity there, he felt it irksome to be compelled to wear the guise of Catholicism, and determined to settle in a Mohammedan land. After two troubled years in Venice, Nasi betook himself to Constantinople. There he proclaimed his Judaism, and married his beautiful cousin Reyna. He rapidly rose to favour, the sultans Soliman (Suleiman) and Selim promoting him to high office. He founded a Jewish colony at Tiberias which was to be an asylum for the Jews of the Roman Campagna. In 1566 when Selim ascended the throne, Kasi was made duke of Naxos. He had deserved well of Turkey, for he had conquered Cyprus for the sultan. Kasi's influence was so great that foreign powers often negotiated through him for concessions they sought from the sultan; the Holy Roman emperor Maximilian II corresponded with Nasi; William of Orange and Sigismund II Augustus. king of Poland. conferred with him. On the death of Selim in 1574, Nasi receded from his political position, but retained his wealth and offices and passed the rest of his life at Belvedere (Constantinople). He died in 1579. (I. A.; X.)

NASIK, a city, with taluka (administrative subdivision), and a district of Bombay state, India. The city is on the Godavari river 6 mi. W. by road of Nasik Road station on the Central railmay, 97 mi. K.E. of Bombay city. Pop. (1951): city 97,042, taluka (52 j sq.mi.) 254,076. It is a place of Hindu pilgrimage, being associated with the hero-god Rama. Shrines and temples line the riverbanks. and in the vicinity are Buddhist caves of the 3rd century B.C to the 6th century A D., with many inscriptions. Nasik manufactures brassware and copperware. It is the seat of an undergraduate college of Poona university and of an Anglican bishop.

NASIK DISTRICT has an area of 6,021 sq.mi. Save a few villages in the west, the district is on a tableland, 1,300–2,000 ft. above sea level. The western part is hilly and intersected by ravines. The eastern tract is open, fertile and well cultivated. The Sahyadri range stretches from north to south; the watershed is formed by the Chandor range, running east and west, All the streams south of this range are tributaries of the eastward-flowing Godavari. North of the watershed the Girna and its tributary the Mosam flow through fertile valleys into the westward-flowing Tapti. The Kadwa canal (opened 1874), the Girna left-bank canal (1909) and Godavari right- and left-bank canals (1911) irrigate about 87,000 ac. At Gangapur, 8 mi. W. of Nasik, an earthen dam. built in 1949–54, irrigates about 45,000 ac. The population in 1951 was 1,429,916. The principal crops are millet, wheat, pulses and oilseeds; cotton and fine grapes and vegetables are grown. There is trade in copperware and brassware, and in sugar cane. At Ravalgaon (pop. 7,495) there is a sugar factory producing about 10,000 tons a year. There are railway workshops at Igatpuri (14,100) and Manmad (18,350). Other than these and Nasik city, the most important towns are Malegaon (55,022), 62 mi. N.E.; and Deolali (26,885), a large military station 4 mi. S.

NASIR-I KHUSRAU (1004–1088), Persian poet, theologian and religious propagandist, whose later life and work were influenced by his conversion to Ismailism, was born near Balkh (in Afghan Turkestan) of a Shiite family. He served in the Saljuq government of Khorasan before resigning to make the pilgrimage to Mecca. Continuing his journey into Palestine and Egypt, he was impressed by the splendour of Fatimid rule in Cairo and it was as an ardent Ismaili convert that he returned to Balkh in 1053. His vigorous advocacy of that heresy obliged him soon to flee to the mountains of Badakhshan (northwest Hindu Kush), where he ended his days. His poems of a didactic and devotional character consist mainly of long odes considered to be of high literary quality; he is also credited with two moralizing sequences, the *Sa'adat-nama* and the *Raushana'i-nama*. His most celebrated prose work is the *Safar-nama*, a diary describing his journey. It is a most valuable record of the scenes and events which he witnessed. He also wrote more than a dozen treatises expounding the doctrines of the Ismailis, among them the *Jami' al-hikmatain*, in which he attempted a harmony between theology and philosophy. Nasir-i Khusrau's style is straightforward and vigorous. In his verse he displays great technical virtuosity, while his prose is remarkable for the richness of its philosophical vocabulary.

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NASMYTH, ALEXANDER (1758–1840), Scottish portrait and landscape painter, was born in Edinburgh on Sept. 9. 1758. His work attracted the attention of the portrait painter Allan Ramsay, uho took him to London and employed him upon the subordinate portions of his portraits. Nasmyth returned to Edinburgh in 1778. and was soon largely patronized as a portrait painter. He also assisted Patrick Miller of Dalswinton, as draftsman, in his mechanical researches and experiments. Miller advanced him money to go to Italy in 1782 where he remained two years. On his return he painted the portrait of Burns now in the Scottish National Portrait gallery. Although they are little known, some of his portraits. and in particular the conversation pieces he executed in the 1780s and 1790s, are of considerable interest Nasmyth's pronounced Liberal opinions gave offense to many of his aristocratic patrons, and led to the diminution of his practice as a portraitist. In his later years. accordingly, he worked mainly at landscapes. His subjects are carefully finished and coloured, but are wanting in boldness and freedom. He also designed sets for the theatre and worked as an architect. He invented the "bow-and-string" bridge and is known for his designs for the Dean bridge. Edinburgh, and the graceful circular temple covering St. Bernard's well.

Nasmyth died in Edinburgh on April 10, 1840.

His youngest son, James Nasmyth. was an engineer. His eldest son, PATRICK NASMYTH (1787–1831), called in his time the "British Hobbema," achieved a reputation as a landscape painter.

For an account of the Nasmyth family, *see* S. Smiles (ed.), *James Nasmyth, Engineer: an Autobiography (1883).*

NASMYTH, JAMES (1808–1890), Scottish engineer, inventor of the steam hammer, was born in Edinburgh on Aug. 19, 1808, and was the youngest son of Alexander Nasmyth, the "father of Scottish landscape art." He started business in Manchester on his own account in 1834, and in a few years he was at the head of the prosperous Bridgewater foundry at Patricroft, from which he was able to retire in 1856 with a fortune. The invention of the steam hammer, with which his name is associated, was actually made in 1839, a drawing of the device appearing in his notebook. or "scheme-book." as he called it. with the date Nov. 24 of that year. It was designed to meet the difficulty experienced by the builders of the "Great Britain" steamship in finding a firm that would undertake to forge the large paddle-wheel shaft required for that vessel, but no machine of the kind was constructed till 1842. In that year Nasmyth discovered one in Schneiders' Creuzot works, and he found that the design was his own and had been copied from his "scheme-book." Apparently, however, he was anticipated in the idea by James Watt. Nasmyth did much for the improvement of machine tools, and his inventive genius devised many new appliances—a planing machine ("Nasmyth steam-arm"), a nut-shaping machine, steam pile driver, hydraulic machinery for various purposes, etc. On his retirement he lived at Penshurst in Kent. and amused himself with the study of astronomy, and especially of the moon, on which he published a work, The *Moon Considered as a Planet, a World and a Satellite,* in conjunction with James Carpenter in 1874. He died in London on May 7. 1890.

NASR-ED-DIN [NÁṢIRU'D-DIN] (1829–1896). shah of Persia, was born on April 4, 1829. His mother, a capable princess of the Kajar family, persuaded Shah Mohammed, his father, to appoint him heir apparent, in preference to his elder brothers; and he was accordingly made governor of Azerbaijan. His succession to the throne, Oct. 13, 1848, was vigorously disputed, especially by the followers of the reformer El Bab, upon whom he wreaked terrible vengeance. In 1855 he re-established friendly relations with France and, coming under the influence of Russia, signed a treaty of amity on Dec. 17 with that power, but remained neutral during the Crimean War. In 1856 he seized Herat, but a British army under Outram landed in the Persian gulf, defeated his forces and compelled him to evacuate the territory. The treaty of peace was signed at Paris on March 4, 1857, and to the end of his reign he treated Great Britain and Russia with equal friendship. In 1866 the shah authorized the passage of the telegraph to India through his dominions and reminted his currency in the European fashion. In 1873 and again in 1889 he visited England in the course of his journeys to Europe. Nasr-ed-din was assassinated at Teheran on May 1, 1896, by a member of the Babi faction and was succeeded by his son Muzaffar-ed-din.

NASRIDES, THE, of Granada, were the last of the Mohammedan dynasties in Spain. They ruled from 1232 to 1492. The dynasty was of remote Arabic origin, but its immediate source was the mountain range of the Alpujarra, and the founder was Yusuf (or Yahia) l'Nasr, a chief engaged in conflict with the family of Beni-Hud, once kings at Saragossa, who held the fortress of Granada. Yusuf's nephew (or son) Mohammed completed the defeat of the Beni-Hud largely by the help of the king of Castile, to whom he did homage and paid tribute. From Mohammed I, called el Ghalib, *i.e.*, the Conqueror (1238–73), to Mohammed XI, called Boabdil, and also the little king, "El Rey Chico," by the Christians, who lost Granada in 1492, there are counted 29 reigns of the Nasrides, but several of them were expelled and restored two or three times. There were also contemporary reigns in different parts, and tribal or local rivalries between plain and hill, and the chief towns, Granada, Málaga and Guadix. The dissensions of the Nasrides reached their greatest pitch during the very years in which the Catholic sovereigns were conquering their territory piecemeal, 1482–92.

NASSAU, the capital of the Bahamas, is a port on the north-eastern coast of New Providence Island. Founded on the village of Charles Towne, it was not until 1690 that it took its present name and not until 1729 that the city was laid out. (*See* also BAHAMAS.) Pop. (1957 est.) 46,920.

The temperate climate (average temperature Nov.–May, 74° F., June–Oct., 82° F.), beautiful scenery and fine beaches make Nassau one of the chief pleasure resorts of the world. The city proper covers a comparatively small area but the residential districts extend for a considerable distance along the coast. From Bennett's hill, a ridge south of the city, there is a view not only of the city and harbour but also of almost the whole island. The water tower, a conspicuous landmark on the ridge, is the source of the city's water supply. Below the tower is Ft. Fincastle (1793), one of several built during the 18th century when Nassau was fortified. On Mt. Fitzwilliam above the city is the imposing white building of Government house; in the middle of a long flight of steps in front of it stands a statue of Christopher Columbus. In George street, which leads downhill to the town, stands Christ Church Anglican cathedral. The city's centre is Rawson square with the law courts and chief government buildings; Christ Church cathedral and the public library are nearby. The main shopping and business street is Bay street, which also has the public market (1901). Bay street runs parallel with the harbour front. Offshore, at the eastern end of the harbour, are the marine gardens where glass-bottomed boats are available for sight-seeing. The natural vegetation of Nassau is exceedingly beautiful, the scarlet poinciana tree flowering from May to September and the poinsettia at Christmastime, and the purple bougainvillaea growing profusely along the hedgerows. In the Ardastra gardens along Bay street to the west of the city are many rare tropical plants.

The harbour, which is sheltered by Hog Island, accommodates vessels of 24 ft. draft. There are no important industries on the island but products including sisal, sponges, citrus fruits, tomatoes and pineapples are exported.

Nassau is easily reached by sea or air. From the airport at Oakes field, 1 mi. from the town's centre, there are regular services to airports in the U.S., Great Britain and elsewhere. There are local services to other islands in the Bahamas.

See W. W. Cartwright (ed.), *Pocket Guide to Nassau, 8th* ed. (Nassau, 1954); *Historic Forts of Nassau* (Nassau, 1932).

NASSAU, formerly a territory of Germany forming the bulk of the government district of Wiesbaden, in the Prussian province of Hesse-Nassau. After World War II it was made part of the Land (state) of Hesse of the German Federal Republic. Until 1866 it was an independent and sovereign duchy of Germany consisting of a territory 1,830 sq.mi. in area divided into two nearly equal parts by the Lahn river and bounded on the south and west by the Main and Rhine, on the north by Westphalia and on the east by Hesse. The southern half of the area is almost entirely occupied by the Taunus mountains, while to the north of the Lahn is barren Westerwald. The valleys and low-lying districts are very fertile, producing an abundance of grain, flax, hemp and fruit, but by far the most valuable product is wine. Nassau is one of the most thickly wooded regions in Germany. There are over 100 mineral springs in the district; the best known are those of Wiesbaden and Ems. Minerals include iron, lead, copper, building stone, coal, slate, a little silver and a bed of malachite.

History.—During the Roman period the district was occupied by the Mattiaci and later by the Alamanni. The latter were subdued by the Franks under Clovis, and at the partition of Verdun in 843 the country became part of the East Frankish or German kingdom. Christianity seems to have been introduced in the 4th century. The founder of the house of Nassau is usually regarded as a certain Drutwin (d. 1076), who built a castle on a hill overlooking the Lahn, near the town of Nassau. Drutwin's descendant Walram (d. 1198) took the title of count of Nassau. In 1255 Walram's grandsons, Walram and Otto, divided between them their paternal inheritance; Walram took the part of Nassau lying on the left bank of the Lahn and Otto took the part on the right bank. The brothers thus founded the two branches of the house of Nassau.

The fortunes of the Ottonian or younger line belong mainly to the history of the Netherlands. William the Silent and his descendants were called princes of Orange-Nassau, and this line became extinct when the English king William III died in 1702. The descendants of Count John, his brother, remained rulers of Nassau until 1806, when the reigning prince, William VI, was deprived of his lands because he refused to join the Confederation of the Rhine. Some of them were given in 1815 to the line of the family descended from Count Walram. In 1815 William VI became king of the Netherlands as William I, and was compensated for that loss by the grant of parts of Luxembourg. When in 1890 William's male line died out, Luxembourg, like Nassau, passed to the descendants of Count Walram.

The territories possessed by the elder line of the house of Nassau were partitioned several times. In 1816 the whole of Nassau was united under the rule of Frederick William of Nassau-Weilburg as duke of Nassau. In 1866 Duke Adolph espoused the cause of Austria, but was soon a fugitive before the Prussian troops. On Oct. 3, 1866, Nassau was formally incorporated with the kingdom of Prussia.

NASSER, GAMAL ABDEL (1918–), Egyptian army officer, Arab political leader and first president of the United Arab Republic, was born in Beni Mor, upper Egypt, on Jan. 15, 1918. He attended secondary school in Cairo and in 1937 was accepted at the military college, where he was appointed lecturer in Nov. 1942. Soon afterward he founded the secret Free Officers' movement, which by 1952 had about 700 members known only to Nasser. The military coup d'état of July 23, 1952, forced King Farouk to abdicate and made Maj. Gen. Mohammed Naguib head of state and later premier and president of the republic.

Relations between Naguib and Nasser became embittered, however; after becoming premier in 1954, Nasser removed Naguib from the presidency in November. In June 1956 Nasser, the only candidate, was elected Egypt's president for six years. Nasser's nationalization of the Suez Canal company in July 1956 led to the Suez conflict *(see* Suez Canal). In Feb. 1958 Nasser nas proclaimed the first president of the union of Egypt and Syria in the new Cnited Arab Republic.

NAST, THOMAS (1840–1902) U S. cartoonist. best known for his attack on the political machine of William M Tweed (*q.v.*) in New York city in the 1870s, was born in Landau Ger., on Sept. 27, 1840. He was brought to New Tork city by his mother in 1846. He studied art there with Theodore Kaufmann and at the National Academy of Design. at the age of 15 became a draftsman for *Frank Leslie's Illustrated Newspaper,* at 19 for *Harper's Weekly,* at 20 went to England for the *New York Illustrated News,* and in the same year went to Italy to cover Garibaldi for *The Illustrated London News* and C S publications. His cartoon. "After the Battle" (1862). attacked Northerners opposed to pushing the Civil War vigorously. This and other cartoons published in *Harper's Weekly* during the Civil War led President Lincoln to call him "our best recruiting sergeant." Nast's cartoon campaign against Tweed was climaxed when a caricature of him led to his identification and arrest in Vigo, Spain in 1876. Originally a Republican, Nast turned first to the Mugwumps because of his advocacy of civil service reform and his distrust of James G. Blaine and in 1884 to the Democrats; in 1892 he returned to the Republicans. Having lost nearly all his money in the failure of the brokerage house of Grant and Ward in 1884. he was appointed consul general at Guayaquil. Ecuador, by Pres. Theodore Roosevelt in 1902, and he died there on Dec. 7 of the same year.

Nast did some painting in oil and book illustrations, but his fame rests on his caricatures and political cartoons. From his pen came the Democratic party's donkey. the Republican party's elephant. and Tammany's tiger.

See A. B. Paine, *Thomas Nast: His Period and His Pictures* (1904).
(D. H. W.)

NASTURTIUM or Indian Cress. *Tropaeolum majus,* a perennial climber, native of Peru, but in cultivation treated as a hardy annual. It climbs by means of the long stalk of the peltate leaf which is sensitive to contact like a tendril. The irregular flowers have five sepals united at the base, the dorsal one produced into a spur; of the five petals the two upper are slightly different and stand rather apart from the lower three; the eight stamens are unequal and the pistil consists of three carpels which form a fleshy fruit. The pungent leaves are sometimes eaten in salads, and the young green fruits are pickled in vinegar as a substitute for capers. The dwarf form known as Tom Thumb (*T. m. nanum*), is an excellent bedding or border flower, growing about 1 ft. high. Other fine annual tropaeolums are *T. peltophorum* with long spurred orange flowers and numerous varieties; and *T. minus,* a kind of miniature *T. majus* with yellow, scarlet and crimson varieties.

The genus *Tropaeolum* (family Tropaeolaceae). native to South America and Mexico, includes about 50 species of generally climbing annual and perennial herbs with orange. yellow, rarely purple or blue, irregular flowers; *T. peregrinum* is the well-known canary-bird flower. A fine nasturtium with brilliant scarlet blossoms is *T. speciosum* from Chile; it has tuberous roots. as have also such perennials as *T. polyphyllum* and *T. pentaphyllum.*

The *Nasturtium* of botanists is a genus of plants of the family Cruciferae; *N. officinale* is the water cress (*q.v.*).

NATAL, a province of the Republic of South Africa, is bounded by the Indian ocean, by the Cmtamvuna and Cmzimkulu rivers, which divide it from the Griqualand East division of Cape Province, by the Drakensberg. which separates it from Basutoland, the Orange Free State and part of the Transvaal, and by the Pongola river, the Lebombo range and, for a short distance, a line of latitude, nhich mark it off from the Transvaal Swaziland and Mozambique. Natal, in this extended and official sense includes Zululand and Amatongaland. The northern boundary of Natal proper for part of the way is the Tugela. The seaboard from the mouth of the Umtamvuna to the mouth of the Tugela is 166 mi., and from the Tugela to the Portuguese border near Ore point. 210 mi. Its total area is 33,578 sq.mi., or 7.47% of the Republic, while it carries a little more than 20% of the Republic's population. The area of Natal proper is 23,216 sq.mi.

Geologically. the country consists of a monoclinal fold affecting Karroo rocks. Along the axis. which runs more or less north and south, these have been eroded and the underlying rocks of the Swaziland system (granite, schists, etc.) have been exposed along a fairly continuous belt. which can be followed from a point. 5 or 6 mi. inland from Port Shepstone. through Inchanga. the Valley of a Thousand Hills, and on into Zululand. n-here their area broadens out. A great part of the country is formed of horizontal. or gently inclined. shales and sandstones among which numerous sills of dolerite are intercalated. Erosion attacking these beds has produced a distinctly terraced topography. The hills are often steep sided and flat topped.

Usually, three zones are distinguished: (1) the coast belt below 1,000 ft., n-hich is about 20 mi. wide behind Durban and n-hich narron-s southward and widens considerably when followed northward and into Zululnnd: (2) the midlands, between 2,000 and 4,000 ft.; (3) the highlands from 4,000 ft. to the foot of the Drakensberg. This classification is oversimplified. but may serve as a rough indication of the build of the country. The rivers: as a result of rejuvenation. have cut deep valleys in their lower courses. with the result that the topography of the coast belt and part of the midlands is very broken. In their middle. and in part of their upper courses, the rivers flow in broad: open valleys. Because of their high average gradient and the numerous waterfalls caused by the outcropping of hard beds of sandstone and dolerite, and also their low winter level. they are all unnavigable except for stretches of three or four miles at the mouths of the Cmkomaas and Umzimkulu. The dominant topographical feature is the great barrier of the Drakensberg (*q.v.*), which rises to more than 10,000 ft.. and from which several secondary ranges run out toward the coast. The Lebombo range in the north runs from north to south. and is caused by the outcrop of resistant lavas. Rivers such as the Usutu and the Pongola cut across this escarpment in great *poorts.*

Climate, Vegetation, Fauna.—These are described under South Africa, Union of. Because of the range of altitude from sea level to 5,000 or 6.000 ft. at the foot of the Drakensberg. there is a wide range of climate. which is further complicated by the varied topography. Always, however, the subtropical coast belt stands out as a distinct natural region. with its humid heat. small temperature ranges and its subtropical vegetation and production. Inland, the winter drought becomes more clearly marked and frosts more frequent and severe during the winter nights. The chief rain-bearing wind is from the southeast. A very characteristic feature of the Natal climate is the "hot winds." which are usually most frequent in spring and summer. They appear to be caused by the flow of air being drawn toward depressions passing southward along the coast. They blow from the northwest and are heated by compression as they descend the escarpments. The temperature often rises above go" and the relative humidity may fall to 30°. A hot wind may blow for a few hours. or for two or three days. It causes great clouds of dust. and all doors and windows in the houses have to be closed. Usually these winds change suddenly. or are replaced by a cool, moist wind from the southwest. which often brings greatly appreciated rain, or sometimes, in the higher districts, snow.

In addition to the trees. shrubs and grasses, described elsewhere, mention may be made of the flowers, which are often beautiful. Some of these, like the red bush lily. grow in the shade of the patches of bush. Others are more tolerant of light and are to be found in the open. Among these are the fire lily, which blooms in the early spring before the grasses have grown beyond a few inches, the agapanthus. the arum lily along the streams, the gladioli. etc. . A very common grassland flower, and one that blooms late. when the grasses are tall, is the leonotis, which attains a height of five or six feet and has terra-cotta to orange-coloured flowers. Many a hillside in early spring is enlivened by the flowers of the aloes, in various shades of red. The delightfully rich crimson of the Kaffir boom blossoms is peculiarly characteristic of much of Natal.

Some of the smaller buck have increased in numbers because of the cover afforded them by the large wattle plantations. Jackals are undesirably numerous in some of the upland districts, and they often destroy many lambs. Otters occur in some of the rivers. Snakes are common. The chief sporting birds are the quail, partridge and guinea fowl. About 450 sq.mi. of country were set aside as game reserves. in nhich no animals may be killed at any time. There are several such reserves, one near Giant's Castle. to protect the surviving eland. and one on the Mkuze, in Zululand. where the inyala (buck) still survives. as well as impala, the Zululand suni. etc. Reserves have been established in the Klip river and the Umgeni districts. In addition. several animals and birds have been declared royal game, and cannot be shot or captured. They include the white, or square-lipped, rhinoceros. which is still found in Zululand. the elephant. female eland, the impala, inyala. roan antelope, springbuck, sassaby; crested crane, Stanley crane. etc. (R. U. S.; X.)

HISTORY

Natal Before the British Settlement.— In 1497 the Portuguese Vasco da Gama, on his voyage to India, sighted the bluff at the entrance to the present harbour of Durban on Christmas day and named the country Terra Natalis. Neither then nor subsequently did the Portuguese settle or claim Natal. The nearest Portuguese settlement was 296 mi. farther north at Delagoa bay which offered safer anchorage and a more convenient entrepbt for trade.. It was, then. from shipwrecked mariners that the first tales of the Natal coast reached Portugal. King Sebastian of Portugal in 1575 commissioned Manuel Perestrelo to survey the South African coast and mark points for safe anchorage in storms, for these had already taken heavy toll of the merchantmen. In 1j93 the wreck of the Portuguese "Santo Alberto" north of the Great Kei river left a party of 28j stranded on the shore. This group, instead of pushing north along the coast to Delagoa bay, a route already notorious for its perils, used compass and sextant to "navigate" an inland route which took them through the heart of Natal Zululand and Tongaland to Lourenço Marques. These were the first Europeans known to have penetrated to the interior of Natal.

By the 17th century English, French and Dutch challenged the Portuguese monopoly of the Indian ocean; but for Natal the story was still one of wrecks and disasters rather than of trade and settlement. In 1685 the survivors of the English slaver "Good Hope" left a small company complete with guns in a shanty fort on the bluff. The following year the Dutch trader "Stavenisse" was wrecked farther south. The survivors were joined by English from the bluff and from another English vessel, the "Bonaventura." They built a boat and sailed with a cargo of ivory to Cape Town. In 1689 Simon van der Stel dispatched thence the "Noord" to open up trade in ivory and secure the bay of Natal. The bay was duly purchased, but the wreck of the "Noord" on the return voyage and the repudiation of the sale by the natives made the venture abortive. In 1721 another venture was made by Gov. Maurits Pasques de Chavonnes to place a settlement during the Dutch attempt to hold Delagoa bay. Both moves were abandoned in 1730. The coast was difficult and for practical purposes the hinterland of Natal was terra incognita. There was no obvious source of wealth to be tapped. For yet another century Natal was to lie off the beaten track of European adventurers. (See also Cape of Good Hope.)

Within Natal the Nguni branch of the Bantu seems to have settled early in the 16th century, Zulu (reputed dates 1627–1jog) being but the least of many founders of tribes. A. T. Bryant estimated that about 50 separate clans inhabited Natal proper at the opening of the 19th century and hazarded the calculation that at least 78,000 and probably 100,000 natives were technically aboriginals in Natal. North of the borders of modern Natal, the Tembu-Tongas seem to have acted as middlemen between the Portuguese traders and the natives in Zululand and Natal. They are credited with introducing maize, yams, the groundnut and, legend has it, the cat into Natal. Throughout the hinterland, which of course had as yet no political boundaries, there were the petty wars about land and cattle common to all primitive societies, but no major cataclysms. The first attempt at a paramountcy was made by Dingiswayo (1795–1818). He was chief of the Mtetwa, south of the Umfolosi river. He opened up trade with Delagoa bay by exchanging oxen and tusks for blankets and beads. Until his defeat and death at the hands of Zwide the Ndwandwe in 1818 he established a rough suzerainty which Shaka (Chaka) of the Zulus was to usurp (see Zululand). Already before Shaka crossed the Tugela in 1818. refugee tribes from Zululand headed by the Tembus and Cunus had hacked a way through the coastal tribes of Natal. Thereafter the Zulu impis first of Shaka and then of Dingaan (Dingane) completed the dispersal and destruction which was to mislead both Boer and Briton into thinking Natal was uninhabited. Those who had not been murdered or conscripted either hid or fled. From 1821 onward all the area between the Cmzimkulu and the Umzimvubu was in chaos. Ncapaai of the ama Baca (1826–44) forged some of the exiled tribes into a massive army of about 3,000 warriors. He defied both the pressure from Natal to the north and from Pondoland to the south until his destruction by Faku the Pondo in 1844. Three prime factors, then. provide clues to the policy of early European settlement in Natal: fear of Zulu military power; the myth that Xatal was uninhabited; and the chaos beyond the Umzimkulu n·hich threatened both Natal and Cape Province.

The First British Settlement, 1824.—One consequence of the occupation of the Cape by Britain in 1806 was the attempt to map the east coast for naval purposes. Throughout 1822 and 1823 Capt. W. F. On-en. R.N.. laboured at this task. Merchants and traders, already speculating in the coastal trade. follon-ed in his track. Two former naval lieutenants, F. G. Farewell and J. S. King. arranged with Owen to survey the port of Natal and St. Lucia bay which Owen had not completed. Farewell and King failed to land at St. Lucia bay. but a renewed attempt farther south brought them triumphantly across the bar of what is now Durban harbour. The following year Farewell with H. F. Fynn and others returned to the port of Natal to found a trading station and open up negotiations with Shaka at his Bulawayo (Zululand) kraal. Chiefly due to the courage, tact and medical skill of Fynn. Shaka rewarded Farewell's party by signing a treaty (Aug. 1824) ceding the port of Natal and about jo mi. of coast line to a depth of 100 mi. inland. This was never revoked. but Shaka seems to have regarded the traders as in some sort his vassals or subchieftains for in 1826 they were virtually conscripted into Shaka's war with the Ndwandwes. Both Shaka and Dingaan protested against shelter given to refugees from royal wrath. Shaka did not hesitate to make peremptory demands. as for instance in 1828 when he was infuriated because his ambassadors to George IV had returned empty handed from Port Elizabeth: equally because they had forgotten the Macassar oil he ordered. John Cane was compelled to set out for the Cape to purchase the oil and dared not defy. While the Cape authorities blamed the traders without warrant for the tribal upheavals, the traders themselves led a precarious existence. King died of dysentery in 1828. Farewell was murdered by Nqueto and the Quabas in 1829 in no man's land. In 1831 Fynn and his group narrowly escaped with their lives when Dingaan raided Port Natal, and the following year Fynn withdrem to Grahamstown.

It seems clear that both Shaka and, more particularly, Dingaan and their indunas were perturbed by European diffusion. especially after the opening of the land route through Pondoland. Jacob the interpreter, a Kaffir former convict (shot in 1832), combined distorted pictures of European power and greed with the self-claimed power to prophesy that the coming of traders and white missionaries spelled doom to the natives, and it is inconceivable that Matiwane. who was murdered by Dingaan in 1829, can have failed to report his disastrous encounter with Col. H. Somerset at Baziya hlount. In 1832 Andrew Smith arrived from the Cape to report on Natal. In 1833 a commissie trek arrived from the Eastern province directed by Piet Uys. They made contact with the Zulus by shouting across the Tugela and reported that Satal was vacant and available for settlement.

The European settlers at Port Natal reiterated the demand first made by King in 1826 that Natal should be taken over as a colony. In 1834 the merchants at Cape Town petitioned to the same end, while in Britain there was some mercantile support for the move. In Natal the settlers backed their demands by laying out a municipality which in 183j they called Durban after the then governor of the Cape, Sir Benjamin D'Urban. But in the Cape the renewal of frontier war and in Britain the reluctance of the colonial office to undertake wider commitments militated against intervention. One step was essayed. Capt. A. F. Gardiner had gone to Natal as a missionary and had secured from Dingaan (May 1835) a treaty ceding the southern half of Natal, on condition that refugees were handed back to Dingaan. He also secured the appointment of the Rev. F. Owen at Dingaan's kraal at Umgungundhlovu. With this behind him he secured in 1837 magisterial authority at Durban from the Cape. But without troops or police, he had no effective control in Natal where the traders, hunters and gunrunners wanted protection without control. For this reason the traders welcomed Piet Retief, the advance envoy of the trekkers who had crossed the passes of the northern Drakensberg in the late summer of 1837.

The Voortrekkers in Natal.—The settlers welcomed Retief and guided him to Dingaan's court. Dingaan promised Retief virtually the whole of Natal provided he first recovered cattle stolen from the Zulus by Sikonyela in Basutoland. This Retief rapidly achieved by a mixture of subterfuge and force so expeditious that together with the news of the defeat of Mzilikazi his kinsman at the Marico river (Nov. 183;) it alarmed Dingaan and the indunas. The deed of cession was duly signed and witnessed but it was sealed with Retief's blood, Piet Retief and more than 60 followers who were all unarmed being massacred on the spot (Feb. 1838). From Umgungundhlovu Zulu impis sped to exterminate the scattered laagers along the Bushman's and Blaauwkrantz rivers. Loss of life was appalling. The English from Durban hastened to the rescue with their native levies but were overwhelmed. Save for a few stalwarts the survivors embarked from Natal on the brig "Comet."

Undeterred by the murder of Retief and the death of Gert Maritz the following September, the trekkers. reinforced by timely supplies brought up by Andries Pretorius from Graaff-Reinet. simultaneously pursued two ends. viz.. the defeat of Zulu military dominance and the organization of a government in Natal in touch with trekkers west of the Drakensberg. In Dec. 1838 the Boers under the supreme command of Pretorius defeated the Zulus at the battle of the Blood river and destroyed more than 3,000 of Dingaan's army. H. Jervis, the British agent, mediated a peace in May 1839, but it was broken by both sides and Dingaan was finally defeated by the trekkers in alliance with his brother Mpande (Panda) at Magongo in Jan. 1840 and fled to his death in Swaziland. Mpande made valuable concessions to the allies of his treachery. He ceded a coastal belt from the Black Umfolosi to the entrance to St. Lucia bay, undertook to withdraw behind the Tugela and rule in the newly defined Zululand as the vassal of the new republic with its capital at Pietermaritzburg. Even before the territorial position had been secured, a constitution had been drafted. The volksraad (elected legislature) u-as to meet four times a year at the capital. leaving a *commissie* raad (committee) to function during the long recesses. Landdrosts (magistrates) were appointed at Pietermaritzburg, Weenen and Congella and 12 field cornets were elected. Financial stringency, acute after Capt. T. C. Smith (see below) took control of the port, lack of permanent trained officials, personal quarrels between the leaders, the difficulty of keeping touch with the adjunct raads at Winburg and Potchefstroom. all made progress toward effective administration difficult, but not necessarily impossible. What sabotaged the structure of the republic was the influx of natives returning to Natal to resettle the lands they had abandoned to the Zulus. The attempt of the trekkers to meet the crisis by their subjection and expulsion probably decided the British to intervene.

British Annexation of Natal, 1843.—Even before the trek, various groups in Britain and in the Cape had pressed for the annexation of the port of Natal. By 1838 there were clear grounds for decisive action. There were signs of coal in Natal which made Durban, in the days of steamships, a possible coaling point; there was anxiety about French colonial projects when it was discovered that J. A. Smellekamp, self-appointed political agent who visited the new republic in 1842, was financed in Paris; there was official as well as humanitarian concern that the "apprentices" scheduled for release at the end of 1838 should in fact be released; there was the ambiguity caused by the claim of jurisdiction to latitude 25° in the Cape of Good Hope Punishment act, together with the British refusal to admit that allegiance and therefore obedience could be discarded; there was above all the growing realization that disturbances in the Cape were in part the consequence of upheavals in Natal. At first British policy was dangerous by reason of its uncertainty. The Whig government was on its last legs by 1839 and fell in Sept. 1841. Between Jan. 1839 and Jan. 1846 there were five different secretaries of state for war and colonies. Though permanent officials like James Stephen exercised great influence, decisions at cabinet level had always to reckon with parliament. The slowly forming convictions as to what was the right policy were tempered by practical politics and the already heavy drain on Britain's financial resources. In the circumstances, with changing fronts in South Africa and changing fronts at Whitehall, it was difficult for policy to crystallize. Between Dec. 1838 and Dec. 1839 Durban had been reoccupied and held. Captain Jervis. the British agent, had actually patched up a truce (May 1839) between Dingaan and Pretorius. The military crisis over, the order came to withdraw the British forces from Durban in Dec. 1839. The republican flag was thereupon hoisted. But at the end of 1840 the Natalians sent a commando against Ncapaai, who with his Bushmen allies had raided republican cattle. This disturbed local opinion because of the scale of the plunder. which included "apprentices" taken in defiance of the Punishment act. It also alarmed Faku the Pondo, to reassure whom. in Jan. 1841, Captain Smith was sent with a small force to the Umgazi river. Hitherto the colonial office had toyed with the proposal of Pretorius that the republic should be officially recognized. But in Dec. 1841 came the news that in August the raad, harrassed by the unceasing flow of native refugees. had decided to evict them and settle them in the disputed territories between the Umtamvuna and the Cmzimvubu, the tinderbox of conflict. To avert this, in May 1842 Smith was ordered to reoccupy Durban. His leisurely advance gave the republicans time to organize, and Smith was besieged so closely at the port that only the heroic ride of Dick King to Grahamstown for reinforcements averted disaster. Col. A. J. Cloete rushed up reinforcements by sea and resistance collapsed. In June the republicans submitted. One year later Henry Cloete arrived as special commissioner and thenceforward though the raad, shorn of its more virile members. continued to function until Oct. 1845, in theory the administration was British, the land settlement liable to revision and the principle of legal equality pronounced. In Aug. 1843 Mpande, all claim to European suzerainty being tacitly dropped by Britain, accepted the Tugela as his frontier and confirmed the cession of St. Lucia bay. This fixed the northern boundary of Natal. To the south, the Cmzimkulu mas fixed as the boundary and beyond it Faku the Pondo, having disposed of Ncapaai. was given treaty status and recognized as ruler betneen the Umzimkulu and the Umtata. When it is recalled that in Dec 1843 similar treaty status had been given to Adam Kok and Moshesh across the Orange river, the annexation of Natal to the Cape appears not merely as it obviously was, in part a commercial in part a humanitarian, move but also as part of a constructive. if abortive, effort to give new stability to frontiers distorted by the Great Trek. On the maintenance of stability combined with flexibility, the well-being of all in southern Africa depended.

In the event. nhen the War of the Axe broke out in the Cape in 1846 the annexation proved to have been a wise insurance. Partly because, theoretically, the colonial office would allow no distinction between black and white. and pendant on that a revision of the land settlement was considered necessary, many trekkers withdrew from Natal. It is estimated that by the beginning of 1847 the number of Boer families had shrunk to less than 100. The largest immigration project was that launched by N. Byrne uho during 1849–51 brought out 2,500 emigrants from Britain.

From Annexation to Responsible Government in 1893.—Though from 1845 onward Natal had a local administration, until

1856 it mas substantially an adjunct of the Cape. In 1856 it was given its own legislative council of 4 official members and 12 elected representatives. As the settlers increased. they sought to establish control over the executive by securing more complete control over the revenue. There were two chief bones of contention. In 18j6 the crown stipulated that £5,000 annually should be set aside for native development. This was challenged on the constitutional ground that the legislature had incomplete control over expenditure. Secondly, Theophilus Shepstone (*q.v.*), first as diplomatic agent, then as secretary of native affairs, was a permanent official and tended to move without consultation with either government or legislature. Overemphasis on the niceties oi constitutional theory reached their climax during the depression which coincided with the lieutenant governorship of R. W. Keate (1867–72). Economic crisis. constitutional deadlock, uneasiness in the native areas, the threatened repercussions of the Langalibalele affair (see below) resulted in the dramatic intervention of the colonial office which sent out Sir (later Lord) Garnet Wolseley (*q.v.*) in April 1875 to stiffen official control. By dint of "drowning the constitution in champagne and sherry" he added. for a five-year period, eight more official members to the legislature. Between 1845 and 1875 Shepstone built up the Natal pattern of native administration. His influence was at its height when. in 1849. by ordinance, the lieutenant governor was made supreme chief and Shepstone his chief induna. Natal mas geographically isolated from the rest of South Africa. the European population was small and its resources slight. Across the Tugela was the powerful Zulu monarchy and within Natal the Europeans were hopelessly outnumbered. Merely to have preserved peace during the crucial period of Natal's growth was a major development. When in 1849 a hut tax oi 7*s.* was imposed on the natives. Shepstone supervised its collection. For years the hut tax was the most stable revenue of the colony. During 1851–54 Shepstone sought leave to draw off the natives to districts south of the Umzimkulu and to create, as J. Dunn was to do in Zululand. a quasi monarchy. This was vetoed by the colonial office. Instead, he settled about 80,000 natives in fixed locations in Natal, leaving about 50,000 as squatters on crownlands or on private property. In 1864. largely at his instigation, the Native Land trust was created with control over more than 2,000,000 ac, of land. In the same year provision was made for educated natives to apply for exemption from native 1 Little attempt was made nor indeed. with deficiency of men and money, could be made. to civilize the natives, though by the end of the century 188 mission schools were subsidized. Measure of Shepstone's achievement was given when. in 1873. Langalibalele, chief of the Hlubi tribe. settled at the foot of the Drakensberg and rebelled rather than hand in for registration the firearms his young men had earned in Kimberley. In the existing state of tension in South Africa, the revolt was probably intended to touch off a general rising. Its prompt suppression by Sir Benjamin Pine without a ripple of revolt in the rest of Natal is comment enough on the effectiveness of the Shepstone system at that stage of Natal's economic development.

As the European population of Natal in the 1870s was little more than 20,000, the Natalians sought not so much more land as a reliable labour supply. Various crops had been sampled: tobacco, indigo, cotton and tea in addition to staple farm products had been tried and found wanting. The future of the colony seemed to turn on the coastal belt which in the late 1850s was found suitable for sugar cane. Many natives, acclimatized to the uplands, could not adapt themselves to the malaria-ridden coastal belt. Most had all they needed without work. In 1860, therefore, and, save for the period 1866–74, without interruption until 1911, coolie labour was recruited in India on a five-year indenture with the option of settling on the expiration of the contract. At the same time free immigrants began to arrive in numbers.

The prosperity of the Natal sugar industry as also the development of market gardening was substantially due to Indian labour. On the eve of the union in 1910 there were 65,917 free Indians and 42,777 were still under indenture.

Until the 1870s Natal remained relatively isolated from the rest of South Africa. The Drakensberg, though not insurmountable. was a formidable barrier Across the Tugela lay Zululand and to the south (though Alfred county beyond the Umzimkulu was added to Natal in 1865) lay Pondoland and Griqualand East, both potential storm centres. Communications by sea were not easy Repeated attempts to make the harbour safe had failed and the coast mas often a coast of wrecks until the harbour mouth was narrowed and dredged. Economic impetus was, though, sharply felt in the 1870s and 1880s. The opening of the Kimberley diamond fields (1870) made transport riding profitable. The coming of railways facilitated the development of the Natal coal fields and railways in their turn were indebted to the development of the coal mines as well as to the opening of the Witwatersrand gold fields in 1886. By the 1890s Natal had a key role to play in the making of a new South Africa.

From 18; j to 1880, moreover, Natal had been the hub of political crisis. The annexation of the Transvaal (q v.) by Shepstone on the instruction of the earl of Carnarvon, secretary of state for colonies, in 1877 and the Zulu War of 1879 (see ZULULAND) were prelude to the first Transvaal war of 1881 which was fought out and extinguished in the Laing's Nek pass and over the Drakensberg at Majuba (Feb. 1881). The crisis made the Natalians acutely aware oi the South African position as a whole and H. Escombe and J. Robinson began to press for responsible government Robinson in particular pressed for a federal union, nhich, Carnarvon's project having ended so disastrously, he argued should next originate nith South Africa. Zululand, after abortive experiments. was annexed to the crown in 1887 and the sensitivity of the foreign office as well as the colonial office to the vulnerability of the South African coast line was shown in the sealing off of the coast by annexation. In 1884 St. Lucia bay was annexed, in 1886 Port St. Johns. in 1885 Galekaland and Bomvanaland, in 1894 Pondoland and in 189j Tongaland.

Economic development and greater security necessarily reacted on internal politics. The retirement of Shepstone in 187j had seen the beginning of a transitional phase in native policy. In 1875 a native high court of three judges was established thus separating the judicial from the administrative powers of the secretary for native affairs A commission was appointed to draw up a code of native law (1878). but in practice magistrates in each district had a wide margin of discretion There was a groning interest in native administration not altogether now divorced from land hunger and desire to tap more effectively the labour and fiscal potentialities of the natives. Native affairs mere more exposed to the exigencies of politics. Codification of native law tended to give rigidity to a tribal structure that economic changes were beginning to undermine.

In 1893 the increase in European colonization and settled development, greater prosperity and, it seems, conviction that the economic prosperity of Natal turned on forging links with the Transvaal, brought to a successful conclusion the demands for responsible government in Natal. The first prime minister was Sir John Robinson (1893–97). He had been a member of the legislative council since 1863 and had represented Natal at the London conference on federation (1876) and at the jubilee celebrations of 1887. In 1888 he had represented Natal at the South African customs conference and had declined to commit Natal to agreements which would have sacrificed the advantages of its geographical proximity to the Rand. In the three years that followed the customs agreement between the Cape and the Orange Free State and the extension of the Cape railway system to Pretoria, 'Natal revenues shrank by 50% and the colony was crippled by £250,000 interest charges on debt incurred to improve railways and harbours. Natalians tended unwarrantably to blame a nonresponsible administration for failure to press Natal's economic interest. The popular response to Robinson's renened agitation for responsible government was due to popular conviction that the future oi the colony depended on the exploitation of the Rand market which mas only 130 mi. from the Natal border. It was believed that one reason why, though the Natal railway system had reached Charlestown in 1891, the Transvaal nevertheless refused to allow the extension of it was that Natal was still a crown colony, so that obliquely the railway was a "crown" railway Certainly the conclusion of a railway agreement with the Transvaal (Feb 1894) followed hard on the heels of the establishment of responsible government. In Oct 1895 the new line was completed to Pretoria

Economic forces had proven a basic community of interests between the South African states. a conclusion endorsed in Natal when belatedly in 1898 Natal concluded customs agreements with the Cape and Orange Free State In the same way the native problem was even more clearly an Interstate problem once the mines at the Rand became dependent on migratory native labour Two things ruptured the approach to a common South African point of view. One was the cultural revival of Afrikander nationalism which fixed its political hopes on the republics; the other was the gross and inexcusable blunder of the Jameson raid (Dec 1895; see TRANSVAAL) Thus, though in 1897 Natal, as befitted its new status, assumed responsibility for Tongaland and Zululand, the necessary readjustments had hardly been made when in Oct. 1899, the South African War struck at the foundations of South African co-operation Natal was invaded by the Boers but the defense of Ladysmith, as well as the reinforcements hurried from overseas through the port of Durban, prevented the colony from being overrun. Natalians played an important part both in the civil and the military organization of the war. On its conclusion the districts of Vryheid, Utrecht and parts of Wakkerstroom were reattached to Natal Utrecht, settled and founded by Boers in 1848, had been enlarged by agreements with Mpande in 1861. While in 1884, also at the expense of Zululand. Vryheid had been founded and, with frontiers cut off from the sea by the British annexation of St. Lucia bay, had, to the exasperation of Natal, been recognized faute de *mieux* by Britain in 1884. Natal had made considerable efforts and sacrifices during the war and though it is arguable that as a colony its interests had on occasion either been ignored or even subordinated to those of the Cape and to the shifting trends of British colonial policy, its territory had been doubled since 1897 and now coincided with the boundaries envisaged by the trekkers.

Peace of Vereeniging to the Union of South Africa, 1910.—The peace of Vereeniging which ended the South African War was followed by the grant first of representative and then of responsible government in the Transvaal and the Orange River colony. This made the problem of evolving some kind of economic and political co-ordination as urgent as it had been before the war. Natal statesmen played a prominent part in the intercolonial conferences which preceded the union. In 1906 the Bambata rebellion was a sharp reminder that more was at stake than railway rates and customs. Responsible government in Natal had brought with it a tendency to subordinate native affairs to the exigencies of party politics while the rapid development of commerce and industry brought natives more sharply up against European notions of contract reflected in the Masters and Servants regulations. The migration of native labourers first to Kimberley, then to the Rand or, nearer home, to the coal fields of Natal was unsettling. First locusts, then rinderpest, then war had dislocated agriculture. Squatters' rents had gone up, the cost of living, even at Zulu levels, was rising and the poll tax of £1 a head imposed on all males, native and European, over the age of 18 was. though theoretically it treated all races equally, resented by the natives on whom it placed a disproportionate burden. There had been, too, much anti-white agitation. When, therefore, the attempt to collect the tax led to the killing of two European policemen at Byrnetown, there were signs and fears of a general rising. The arrested natives were tried and sentenced by court-martial, but Lord Elgin, secretary of state in the Campbell-Bannerman ministry. ordered stay of execution. The Natal protest that this was a violation of the rights of self-governing colonies received commonwealth support and Lord Elgin gave way. More serious was the threatened spread of the revolt through the attempt of Bambata to rouse Zululand. In less than six months the revolt was isolated and suppressed, but isolated events convinced Natalians that Dinizulu was implicated. He was arrested in Dec. 1907 and thanks to the skilled advocacy of W. P. Schreiner he was acquitted of most of the charges levied against him. The revolt had been promptly handled and Natal had received the active support of the other South African colonies. It is to the credit of Natal that the revolt caused some heart searching. A special commission was appointed in Aug 1906 to inquire into the whole position and more than 5,500 natives attended and 901 native statements were recorded in the schedule attached to the report Its analysis recognized the defects in native administration. in particular the loss of personal contact, the increased and often confusing regulations (there had been 48 new regulations since 1893) and the subordination of native affairs to political pressures One sentence in particular was long to be pertinent. "As we can neither assimilate nor destroy them, political forethought and commonsense alike call for a settlement of the question on a broad. enlightened permanent basis." It seems fairly certain that Natal's approach to the union was coloured by the experiences of 1906. The need for union on economic grounds was clear. The advantage of a strong front in view alike of the Indian and the native question was also clear, but Natal was sceptical of Cape liberalism quite as much as of Transvaal nationalism and strove vainly in the National convention which preceded union to substitute federation for an incorporating union. Natal was the only colony which held a referendum on the question of union. It was accepted by 11,121 votes to 3,701.

Natal After the Union.—By the South Africa act Natal like the other colonies suffered diminution of constitutional status in the interest of South Africa as a whole and became a province of the newly constituted union. Natal like the Orange Free State (subject to periodical distribution of seats) returned 17 members to the house of assembly, as against 51 in the Cape and 36 in the Transvaal. All provinces had equal representation in the senate and the provincial quota of eight senators, in Natal as elsewhere, was to be elected by the provincial councillors. The administrator of the province (in terms of the South Africa act) is appointed by the governor general for five years The provincial council of 25 is elected by the normal parliamentary electorate, and the council in its turn elects by proportional representation an executive committee which, like the council, holds office for three years.

Provincial administration in Natal has been traditionally vigorous and sound in a province where in 1946 74% of the European population was English speaking. Natal has tended to cling to its provincial powers. For instance, where the three other provinces handed over responsibility for poor relief and charitable institutions to the department of social welfare in 1940, Natal did not do so till 1950. During the constitutional crisis of 1952 *(see* SOUTH AFRICA. UNION OF) there was a marked revival of provincial liberalism, never entirely lacking from the Natal point of view. When the general election of 1953 confirmed the majority of the Nationalist party in the Union house of assembly. the provincial council passed a resolution demanding that if the government were to introduce a republic, a referendum should first be held. In May 1953 Sen. Heaton Nicholls of Natal launched a new Federal party to reassert the letter and the spirit of constitutional government and ultimately to relate South Africa to a greater Africa federation under the crown. In the provincial election of 1954 the Federal party failed to secure a single seat in the provincial council and Senator Nicholls resigned from the senate.

Economic and social factors have tended to militate against the political and cultural traditions of Natal. Economic development has increasingly integrated Natal with the structure of the Union. The *mariage de convenance* has become increasingly binding. Durban became the busiest port in the Union. In 1960 it was the third largest town in the Republic, the population being 655,-370 (all races). The great extension of secondary and tertiary industries where improved techniques have made for the simplification of operative movements has resulted in a great increase in the use of non-European labour in industry. Thus the economic structure has changed and has reacted on the racial pattern. In 1961 Natal had the densest population in the Republic with an average of 87.4 per square mile. Of the total provincial population of 2,933,447 only 340.293 were European.

Though the land shortage in the reserves was less acute in Zululand where the population density in 1961 was 52.5 per square mile as against 102.9 per square mile in the rest of Natal, it was inescapable that there was congestion in all the reserves where much of the land was not and never could be arable. Some effort was made under the Native Land and Trust act, 1936, to recondition parts of the locations, but it was doubtful whether this fragmentary approach could ease the position as a whole. Much of the native labour outside the reserves is traditionally that of migrant males who return periodically to their tribes, wherever locations are not near enough to municipal areas for more settled habits. In Natal for historical reasons (see above) the tribal structure is more intact than elsewhere in the Republic but the employment of natives in industry (which increased by 171% in a single decade) has made the maintenance of the tribal structure more precarious and less desirable to many of the Zulus, just as overcrowding in the reserves has made it less tolerable. Migrant labour in a period of industrial revolution has elsewhere always tended to check efficiency and to diffuse discontent; historical and sociological parallels. if drawn, would be disturbing. Though the majority of the Zulus are by European standards backward, there is a highly intelligent minority and the Zulu journal Ilanga lase Natal maintains a good standard of journalism.

The Representation of Natives act (1936), which put the Cape natives onto a separate electoral roll, set up the short-lived Natives' Representative council (1936–51) in which Natal natives were represented by one nominated and three elected representatives. By the same act. Natal natives were empowered to elect one of the four senators allotted to the four native constituencies in terms of the act. This latter privilege was not abrogated in 1951 when the Natives' Representative council was abolished. In 1951. by the Bantu Authorities act, in place of the Representative council new regional and territorial authorities, part tribal, part conciliar, were created with defined powers. The Natal natives were then not totally unrepresented, but they were not in a position to exert any electoral pressure on the ordinary course of democratic government. Though the Bantu Education act (1953) transferred education from the provinces to the department of native affairs. and justified Bantu medium and tempered education on sociological grounds, its minimum effect when implemented was expected to show a decrease in illiteracy in the Bantu languages.

The Asiatic population of Natal forms about 80% of the Republic's total Asiatic population, and in Natal it outnumbers the European population. By the Provincial ordinance of 1924. Natal thenceforward excluded Indians from the municipal franchise and tacitly accepted the policy of the Union government with regard to franchise, land tenure and immigration of Asiatics. In 1946 the Electoral Consolidation act provided that Natal and Transvaal Indians together should elect three European members to the house of assembly. In the senate, one additional senator was to be elected by them, one nominated by the government. By the same act the Indians were empowered to elect two additional representatives to the Natal provincial council. Indian refusal to accept the procedure led to the repeal of the act. Indian males who have passed standard vi and have an annual income of £84 or property worth £250 may vote. The Asiatic Land Tenure act of 1946 (amended 1949 and 1950) prevented the purchase of land by Asiatics save in insignificant exempted areas and was intended to peg the status quo. The Immigrants Regulation act (1953) restricted and, after 1956 prohibited the immigration of Indian women and children hitherto admitted to join relatives domiciled in the Union. As the number of males domiciled in the Union very greatly exceeded the number of females, this act was strongly resented.

Though on more than one occasion, as for instance in 1932, 1949 and 1953, there have been racial riots in Durban between natives and Indians, there has been some attempt to build a common front since common grievances give common ground. At the same time many interesting experiments to ease racial tension have been made as, for example, the founding of the International club in Durban. The University of Natal (which began as a constituent college of the University of South Africa and received a separate charter in 1949) has developed a large non-European section and at Wentworth has developed a training school for non-European medical students. (W. A. Ml.)

POPULATION

The total population of Natal in 1960 was 2,933,447. The natives (see Zululand; Cape of Good Hope) numbered in 1960 2,155,824, or nearly 75% of the total population. About half of them live under tribal conditions on locations, which are saturated with population, under 20th-century conditions of skill and methods of exploitation. The other half live on farms owned by Europeans, on crownlands or in the towns. In 1960 the Asiatics were numbered at 394,237. They were largely concentrated in the coastal belt. Originally imported as indentured labourers for the sugar plantations, many of these Indians have become small market gardeners, or have taken employment in hotels and domestic service or industry, where they supply much of the unskilled and semiskilled labour. The European population numbered 340.293. The northern districts, Utrecht and Vryheid, are chiefly inhabited by Afrikaans-speaking people of Dutch origin. In recent years the percentage of Europeans of non-British origin in the total population has probably increased, as a result of the considerable numbers employed in the government services. In 1951 the home language of the Natal European population was reported as follows: English 201,567, Afrikaans 60,150, English and Afrikaans 3,417, other languages 9,106. The German group is centred about New Hanover. Scandinavian settlers about the Umzimkulu, and in Durban, especially connected with the whaling industry, contribute a very valuable element to the population. There is also an appreciable French element, which originally migrated to Natal, largely from Mauritius, in connection with the sugar industry, though it is no longer confined to that industry. The number of coloured people in Natal is quite small, the "mixed and others" in 1960 numbered 43,093.

Towns. — Apart from Pietermaritzburg, the capital, and Durban (*qq.v.*), the only port and the largest centre, the towns of Natal are quite small. Only six, in addition to the two just mentioned, had a white population of more than 2,000, according to the 1960 census. These include Ladysmith (whites 7,260, total 22,997), which is now a railway centre of some importance; and Vryheid (whites 4.920, total 10,753); Glencoe (whites 2.482, total 8,317), a railway junction near the coal fields; and Newcastle (whites 3,212, total 17,418). Vryheid and Newcastle are also near coal mines, and Newcastle is developing an iron and steel industry.

Education. — For higher education see South Africa, Union of. The direction of public education. other than higher education, rests with the provincial education department, subject to the control of the provincial administration. At its head is the director of education. The department has direct management of primary and of some secondary schools, and makes grants to various private schools, which maintain the same standard as the government schools. Fees are charged for pupils in the secondary schools. Special schools are provided for native, coloured and Indian children. Attendance is compulsory for European children between 7 and 15 who live within three miles of a school. A government training college for teachers is situated in Durban and in Pietermaritzburg in conjunction with Natal university.

There are in Natal six training colleges for natives, Sastri college and four training classes for Indians and one training centre for coloured teachers. In addition to the government schools, there are several good schools in the province, both for boys and girls, which are modelled on the English public school. An agricultural college, connected with a government experimental farm, was opened in 1906 at Cedara, 14 mi. from Pietermaritzburg. To meet some of the requirements of the non-European population, there were, in 1958, 1,492 government and aided schools which catered for 309,679 pupils.

Agriculture. — The coast belt is sharply marked off from the rest of the country. It produces sugar, bananas, pineapples, citrus fruit, etc. Formerly, practically all the cane grown was of the Uba variety, but extensive research was undertaken with a view to the development of new mosaic-free varieties superior to Uba. In 1951 there were 386,669 ac. under cane, and in the same year 5,073,615 tons of cane were reaped by Europeans, and 434.048 tons by non-Europeans. The industry now satisfies the requirements of the South African market and has a surplus for export.

Among the by-products are molasses, used for cattle feeding and also exported, motor spirit produced from the molasses, methylated spirits, ether and wax. The cultivation of tea was abandoned in 1949. The rest of Natal is devoted to mixed farming, with increasing stress being laid on dairying. Maize thrives particularly well in the midlands, but little of this grain is exported because it is often sold by the white farmers to the natives, whose own food production is insufficient. Between 2,000 and 6,000 ft. above sea level the Australian black wattle is grown, especially in the mist belts along the escarpments. From the bark an extract is made which is used in tanning. The poles supply the mines with pit props and the towns with much of their domestic fuel. There is a wattle belt, fairly well defined, in the midlands of Natal, and wattle extract is exported. Cotton growing appears to have passed the experimental stage. It is being grown in some of the northern and eastern districts of Natal and in Zululand. The growing of tobacco was stimulated by the introduction of a preferential tariff for empire tobacco in Great Britain in 1925.

The chief mineral produced in the country is coal. The chief coal field is in the Klip river and Newcastle districts, centring about Dundee. Mines are also active in the Vryheid and Utrecht districts. The expense of the long railway journey to the coast, on the average about 240 mi., is partially counterbalanced by the nearness of the coal to the surface. At Waschbank the following by-products are produced: tar. sulphate of ammonia, light creosote oil and naphtha. Tar is also made.

Communications. — Railway construction has been greatly handicapped by the varied topography. The main line from Durban to the Transvaal climbs to 1,808 ft. at Krantzkloof (23 mi.), 3,006 ft. at Thornville Junction (61 mi.), drops to 2,218 at Pietermaritzburg (73 mi.), rises to 3,702 at Hilton Road (84 mi.), to 4,807 at Nottingham Road (116 mi.), drops to 3,280 ft. at Colenso (185 mi.) and rises again to 5,429 ft. at Van Reenen, just within the Orange Free State. Electrification of the whole Natal main line from Durban to Volksrust (323 mi.), begun in 1922, was completed in 1937. From the main system a line runs from Durban along the coast southward to Port Shepstone, and northward as far as Pongola in Zululand to serve the sugar-cane area. From Pietermaritzburg a line with two short branches was constructed to Kranskop through the wattle belt. Another runs southwestward across the grain of the country to open up Griqualand East; from Glencoe junction a line running through Dundee and Vryheid carries large quantities of coal. (R. U. S.; X.)

NATAL, chief city and capital of the state of Rio Grande do Norte, Brazil. It is located a little more than 5° S. of the equator, on the right bank of the Rio Potengi about 2 mi. above the river's mouth. Pop. (1950) 94,812. Natal is connected by rail with the interior of the state and southward to João Pessoa, Recife and Maceió. Its chief overland connections, however, are by all-weather gravel highways which reach all the major points in the northeast of Brazil and extend southward to R o de Janeiro. Natal is of major importance as a centre of air travel. About 8 mi. S.S.W. of the city is the transatlantic airport of Parnamirim, a major stop on all the airlines connecting Europe and South America south of the equator. From Natal to Dakar in Africa is 1.900 mi. and to Freetown is 1,800 mi. During World War II, Natal was a stage in the ferry route over which planes from the U.S. were flown to Africa and southeast Asia. Natal is also the port through which the products of the state are sent to other parts of Brazil. The chief products are cotton, sugar, salt and hides. In the city there are plants for the manufacture of cotton textiles and for the refining of salt. The city was founded by the Portuguese in 1599. (P. E. J.)

NATCHEZ, a Muskogian-speaking tribe formerly living in nine villages on the east side of lower Mississippi river between the Yazoo and Pearl rivers, near the site of the present city of Natchez, Miss. Early in the 18th century when the French first established themselves in what was later called the Natchez district, the tribe numbered perhaps 6,000. Relations with the French were at first friendly, and under Jean Baptiste Lemoyne, sieur de Bienville, governor of Louisiana, Ft. Rosalie was built on the site of the present city of Natchez. In 1723 the Natchez were nearly conquered by the French, and an unsuccessful uprising of the Natchez in 1728 was follo ed in Nov. 1729 by the massacre of more than 200 Frenchmen and the destruction of Ft. Rosalie. In the war that followed the French enlisted the aid of the Choctaw tribe, drove the Natchez from their villages and scattered them. More than 400 Natchez were captured and sold into the West Indian slave trade; the remainder took refuge with the Chickasaw, and later with the Creek and Cherokee. A few Natchez lived in northeastern Oklahoma in the second half of the 20th century.

The Natchez, allied in general culture to other Muskogian tribes, were primarily agricultural, highly developed in the arts, and exerted considerable influence on neighbouring tribes before their dispersal. They had developed a sun worship with which was related a perpetual fire of oak bark in a temple. The fire, as well as all fires in the villages, was allowed to die once a year on the eve of the harvest festival and was renewed at dawn on the festival day by a high priest who made fire by rubbing two sticks together. All the village fires were then made anew from this fire. The women then bore in the first maize, some of which was offered at the temple and some of which was ground and baked into bread for a ceremony at sunset. The ceremony was followed by general feasting.

The remarkable Natchez caste system was divided into "suns," nobles, "honoured" people and commoners or "stinkards." The tribal chief ("Great Sun") and heads of the villages claimed descent from the sun; there were both male and female "suns," each supposedly descended from a male and female who had come out of the sun. The system was matrilineal and exogamic. Male and female "suns" could not intermarry. Male "suns" married "stinkard" wives and their children were "honoured." "Sun" women married "stinkard" husbands and their children were "suns." The "Great Sun" had power of life and death over all the others and was followed in death by his spouses, attendants and voluntary victims. The succeeding "Great Sun" was the son of his sister or of the closest female relation.

See also MUSKOGIAN INDIANS.

NATCHEZ, a city of Mississippi, U.S., is located on the Mississippi river near the southern boundary of the state; the seat of Adams county. Founded by France as an outpost bastion of empire, Natchez has been part of the struggle for colonial mastery in North America and is symbolic of the south with its rich ante-bellum cotton culture, post-Civil War decline and modern industrialization.

The oldest settlement on the Mississippi river, the site was selected in 1700 as one of a series of military posts designed to halt British westward penetration, with actual settlement occurring in 1716. Surviving a massacre by Natchez Indians in 1729, one of the bloodiest in U.S. history, the settlement passed into British possession in 1763 at the conclusion of the French and Indian War. Becoming Great Britain's chief outpost on the Mississippi, Natchez was a haven for Loyalists driven from the revolting colonies during the early stages of the American Revolution until, in 1779, the town was captured by Spain. Spanish cession occurred in 1795, and with occupation by the United States in 1798 Natchez became the first incorporated town (1803) and the first capital of the Territory (1798–1802) of Mississippi. It was also the southern terminus of the famed Natchez Trace, the overland link between Natchez and Nashville, Tenn. As the old southwest was settled, Natchez burgeoned as the commercial and cultural centre of a vast and rich cotton-producing area. At the outbreak of the American Civil War it was the largest and wealthiest city in Mississippi.

Following a decline after the Civil War, modern Natchez has capitalized upon its natural resources, industrial potential, and historic legacy to become again one of Mississippi's leading cities. Transportation facilities include river, railway (nonpassenger), highway and airline systems. A $40,000,000 bridge spans the Mississippi at Natchez. Timber, petroleum and natural gas reserves have attracted major manufacturers of rubber, wood, paper and textile products as well as producers of petroleum and natural gas.

Possessing a legacy of the cotton barons' magnificent homes, sunken roads, an infamous though long extirpated river front section named "Natchez-Under-the-Hill" and a culture ranging from the supreme elegance of the "Cotton kingdom" to the lawlessness of the early river front. Natchez has become the stereotype of the ante-bellum south. The annual Natchez pilgrimage held during March and featuring homes and pageants of those days, attracts visitors from throughout the United States. Many novels and motion pictures have their setting in the city.

The city contains several parks. the largest of which was once part of Auburn and Sunnyside plantations; also three hospitals the Fisk public library and Natchez college, a Baptist junior college opened in 1885 For comparative population figures *see* table in MISSISSIPPI: *Population.* (P. F WA.)

NATHAN, GEORGE JEAN (1882–1958). U S author editor and drama critic, of whom, at the time of his death. the *New York Times* reported ". . . no other American critic of the period had so greatly raised the standards of play producers or so determinedly elevated the tastes of play goers." He was born Feb 14, 1882, in Fort Wayne, Ind., son of Charles and Ella (Nirdlinger) Nathan. He graduated from Cornell university Ithaca. N Y., in 1904 and joined the staff of the *New York Herald* Beginning in 1906. he was at various times drama critic for numerous magazines and newspapers, but his name is particularly associated with *Smart Set,* of which he was co-editor (1914–23) nith H L Mencken, and with the *American Mercury,* which also with Mencken, he helped to found (1924) As a critic Nathan championed the plays of Ibsen Strindberg. Shaw. Eugene O'Neill Sean O'Casey and William Saroyan He published his *Theatre Book of the Year* annually from 1943 through 1931. as well as more than 30 volumes of lively essays on theatrical and other subjects

Nathan married the actress Julie Haydon in 1955. He died in New York city on April 8, 1958. (B. HT.)

NATHANAEL, one of the first disciples of Christ, "an Israelite . . in whom there is no guile" (John i, 47) He was an inhabitant of Cana in Galilee (John xxi, 2), but is otherwise unknown Though Nathanael was one of the first disciples, his name does not appear in the apostle lists. A 9th-century Syrian tradition identified him with Bartholomew — so Isho'dad of Merv. Elias of Damascus and others. (See BARTHOLOMEW, SAINT.) This identification was adopted by Rupert of Deutz in the 12th century and became common from that time on in the Western church; it is commonly accepted by modern biblical scholars. The name means "God has given." (J. A. FI)

NATHANYA (NETANYA), a town of Israel situated on the coastal plain of Sharon 25 mi. N. of Tel Aviv-Jaffa. Founded in 1923 as an agricultural village of smallholders, it was named after Nathan Straus. a well-known C.S. philanthropist. Pop (1961) 40 907 It became a popular bathing resort for the region, and British forces had a big rest camp there in World War II. Many diamond cutters and polishers from the Netherlands and Belgium were settled in a suburb to carry on the diamond industry, and other important industries (textiles. chemicals paper products, food processing) have been developed. The Goldmunz Museum of Modern Art is in the southern part of the town. The park by the sea includes an open-air theatre. There is good road and railway communication with Tel Aviv-Jaffa. (No. B.)

NATICK, a city of Massachusetts, U S.. 18 mi W.S W. of Boston is situated on the southeast end of Lake Cochituate The area was granted to John Eliot (*q.v.*) in 1650 as a plantation where he could carry on his mission nork and establish a school of higher education for the most capable Indian converts; Natick was its original Indian name. Eliot published his Indian Bible in 1658, a copy of which the town possesses. The Indians held the land in common until 1719 and prevailed until 1762, at nhich time Natick became an English district. Incorporation as a town took place in 1781. Modern Natick serves in a dual capacity as a suburban residential community and as a growing industrial ton-n Of special interest is the research plant of the quartermaster research and development command, located on the lake. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (M E L)

NATION, CARRY AMELIA (*née* **MOORE)** (1846–1911), U.S. temperance advocate, was born in Garrard county, Ky.. Nov. 25, 1846 In 1867 she married a drunkard; their brief unhappy life together prompted her later career of saloon-smashing in Kansas. With a few hymn-singing women, or alone she nould march into a saloon. sing pray, hurl vituperations at all "rummies" present and smash the fixtures and the stock with hatchets. This crusade, most violent in the 1890s. led to scattered temporary efforts at law enforcement. After this period of "hatchetation" of "joints"—her nords — she lectured in many states. in Canada and Great Britain. usually under her own management For a nhile she also spoke between acts of carnivals and burlesque shoas

The fact that her first husband had been an active member of a fraternal order as well as a drunkard led her to fight such organizations along with saloons, and she added to her list of things to be destroyed tobacco. foreign foods, corsets skirts of improper length and paintings of the sort often found in barrooms. She was an advocate of women's suffrage, but neither the national movement for suffrage nor that for temperance gave her much support. Her second husband. David Nation, divorced her in 1901 on grounds of desertion after a marriage of 23 years. She died June 9, 1911. Her autobiography *The Use and Seed of the Life of Carry A. Nation* (1904), is a hodgepodge of disorder. (G. BN.)

NATIONAL ANTHEMS. The official patriotic songs of some countries, used on various national and other festive occasions and as greetings to the sovereign in countries under a crowned head, are known as national anthems, although the word anthem has a special ecclesiastical connotation that is not strictly suited to such songs, nhich would be better called national hymns. The following are or have been the national anthems of various countries:

Abyssinia: "Etiopia hoy, des yibalish," tune by M. K. Salbadian (1925), words by a group of Ethiopian scholars (1930). *Argentina:* "Oid, mortales, el grito sagrado Libertad." words by V. Lopez y Planes, tune by J. Bias Parera (1813). *Australia:* "God Save the Queen" (see *Great Britain,* below); also used unofficially: "Advance, Australia Fair," words and tune by P. Dodd McCormick, and "Australia Will Be There," words and tune by W. W. Francis. *Austria:* After World War II: "Land der Berge, Land am Strome," tune by Mozart ("Bruder, reicht die Hand zum Bunde," from the Masonic cantata, K. 623. 1791), words by Paula Preradovic (1946). Under the empire: "Gott erhalte, Gott beschutze. unsern Kaiser, unser Land." words by L. L. Haschka, tune by Haydn (1797). After World War I: "Deutsch-Oesterreich. du herrliches Land," words by Karl Renner, tune by Wilhelm Kienzl (1920). After 1933: "Oesterreichische Bundeshymne" ("Sei gesegnet ohne Ende"), nords by Ottokar Kernstock, to Haydn's tune. *Belgium:* "La Brabançonne" ("Après des siècles d'esclavage"), original words by H. L. A. Dechet (Jenneval), tune by F. van Campenhout (1830). In 1951 the tune was revised by a specially appointed commission and a fourth verse was added. A Flemish version was also prepared, with words by M. Herreman, which replaced "De Vlaamsche Leeutv," words by H. van Peene, tune by K. Miry (1845). *Brazil:* "Ouviram do Ypiranga as margens plácidas," words by J. O. Duque Estrada, tune by F. M. da Silva. *Bulgaria:* From 1950: "Bulgario mila, zemya na gheroi," words by Nikola Furnadzhiev, M. Isaev and Elisaveta Bagriana, tune by G. Dimitrov G. Zlatev-Cherkin and S Obretenov. Until 1946: "Shumi Slaritsa." words by Marachek, tune by Gabriel Shebek; later version of words by N. Zhivkov. *Canada:* "God Save the Queen" (see *Great Britain,* below); also used unofficially: "The Maple Leaf Forever." words and tune by A Muir (186;); French-Canadians, "O Canada! terre de nos aïeux," words by Sir A. B. Routhier. tune by C. Lavallée (*c.* 1880). *Chile:* "Dulce patria, recibe los votos," original words by B. de Vera y Pintado (1819), modified by E. Lillo (1847). tune by R. Carnicer (1828). *Chzna:* Under the people's republic. interim anthem, tune by Niel Eel. After the 1912 revolution: "Tsung Kuoh hiung." words and tune anonymous (*c.* 1912). Later Kuomintang party song. "The Song of the Kuomintang." words from an address by Sun Yat-sen, tune by Ch'eng Mao-yün (1928). *Colombia:* "Oh! gloria inmarcesible." words by R. Núñez. tune by

O. Sindici (c. 1905). Cuba: "Himno Bayamés" ("Al combate corred Bayameses"), words and tune by P. Figueredo (1868). Czechoslovakia: Czech, "Kde domov můj," words by J. K. Tyl, tune by F. Škroup (1834); Slovak, "Nad Tatrou sa blyska." words by J. Matuška (1844), tune traditional. (These were combined in 1919.) Denmark: Danish royal anthem: "Kong Kristian stod ved højen mast," words by J. Ewald, tune probably adapted by J. E. Hartmann from D. L. Rogert (1779). Danish national anthem: "Der er et yndigt Land," words by A. Oehlenschlager, tune by H. E. Krøyer (c. 1819). Also used unofficially, "Den gang jeg drog afsted," words by F. Faber, tune by J. O. E. Horneman. Dominican Republic: "Quisqueyanos valientes, alcemos," words by E. Prud'homme, tune by R. Reyes (1883, adopted 1900). Two others before that, including "Himno de Capotillo," tune by I. M. Caldéron (1865). Ecuador: "Salve! O patria!" words by J. L. Mera, tune by A. Neumann (1866). Egypt: Instrumental march by Verdi (c. 1872), words added by Arabic Music institution (1940s). Estonia: "Mu isamaa, mu dnn ja rõõm," words by J. Jannsen (1865, adopted c. 1917), tune by F. Pacius (1848, Finnish national anthem). Finland: "Maamme laulu" ("Oi maamme Suomi synnyinmaa"), words by J. L. Runeberg (1846), tune by F. Pacius (1848). France: "La Marseillaise" (*q.v.*), words and tune by Rouget de Lisle (1792). During the reign of Napoleon III: "Partant pour la Syrie," words by A. de La Borde, tune attributed to Queen Hortense of Holland, but probably by L. Drouet. Germany: German Federal Republic: "Einigkeit und Recht und Freiheit" (verse three of "Deutschland, Deutschland uber alles"), tune by Haydn (see below) (adopted 1950). German Democratic Republic: "Auferstanden aus Ruinen und der Zukunft zugewandt," words by J. R. Becher, tune by H. Eisler (adopted 1949). The first German national anthem was "Heil dir im Siegerkranz," words by H. Harries (1790), modified by B. G. Schumacher (1793), tune "God Save the Queen" (see Great Britain, below) (adopted 1796). After World War I: "Deutschland, Deutschland uber alles," tune by Haydn ("Gott erhalte," see Austria), words by A. H. Hoffmann von Fallersleben (1841, adopted 1922). Great Britain: "God Save the Queen," words and tune anonymous, first sung semiofficially at Drury Lane and Covent Garden theatres in London, arranged by T. A. Arne and Charles Burney respectively, after Sept. 28, 1745, when the defeat of the Jacobite rebellion was announced. It was then merely an expression of party loyalty to George II, and the words (*e.g.,* "confound their politics") referred to the Jacobites, not to some enemy of the country as a whole. The tune has been traced back, unconvincingly, as far as John Bull (1619) and its opening phrase, to the words "God save the King," appears in a catch by Henry Purcell (1685) as though quoted from a song already familiar, which may, however, be a coincidence. The later claims made 'for Henry Carey and James Oswald rest on no solid foundations. The words became slightly altered when the song came into use as the British national anthem and "Queen" was first substituted for "King" in Queen Victoria's reign. Greece: "Se gnorizo apo tin kopsi," words by D. Solomos (1823), tune by N. Mantzaros (adopted 1863). Hungary: "Isten áldd még a magyart," words by F. Kolcsey (1823), tune by F. Erkel (1845). Iceland: "O Gud vors land," words by M. Jochumsson, tune by S. Sveinbjørnsson (1874). India: "Jana Gana Mana," words by R. Tagore, tune attributed to him but probably traditional (adopted 1950). Iraq: "Iraq Royal Salute," no words; composed by A. R. Murray and adopted in 1923. Ireland, Republic of: "The Soldier's Song" ("We'll sing a song"), words by P. Kearney. tune by P. Heaney (c. 1917, adopted 1937). *Israel:* "Hatikvah," words in Hebrew by N. H. Imber, English by Nina Salaman, tune based on traditional Hebrew melodies (adopted by the Zionist movement in 1907, by Israel in 1948). Italy: "Inno di Mameli" ("Fratelli d'Italia"), words by G. Mameli, tune by M. Novaro (1847, adopted 1946). From the foundation of the kingdom of Italy (1861): "Marcia Reale." *Japan:* "Kimi ga yo," words 9th century, tune by H. Hirokami, revised by F. Eckert (1880). Latvia: "Dievs, sveti Latviju," words and tune by K. Baumanis. Lithuania: "Lietuva, tévyné mūsu," words and music by V. Kudirka (1918). Mexico: "Mexicanos, al grito de guerra," words by F. Gonzalez Bocanegra, tune by J. Nun6 (1854). Netherlands: "Wilhelmus van Nassouwe," words attributed to Philip van Marnix heer van St. Xldegonde (c. 1590), tune anonymous (first published, 1626). New *Zealand:* "God Defend New Zealand," words by Thomas Bracken, tune by John J. Woods (adopted 1940); but "God Save the Queen" continues to be used. Nicaragua, Republic of: "Salve a ti Nicaragua," words by Sálomon Ibarra Mayorga (written 1917), tune anonymous. *Norway:* "Ja, vi elsker dette landet," words by B. Bjørnson (1869), tune by R. Nordraak (1863–64). Paraguay: "Paraguayos, República 6 muerte," words by F. Acuna de Figueroa, tune by Francés Dupuy. Persia: "Shāhanshāh i mā Zandah bādā," words by S. Afsar, tune by N. Moghaddam (adopted c. 1934). Peru: "Somos libres, seámos lo siempre," words by J. de la Torre Ugarte, tune by J. B. Alzedo (1821), tune rewritten by C. Rebagliati (1912). Poland: "Jeszcze Polska nie zginęła," words by J. Wybicki (1797), tune traditional (c. 1795, adopted 1927, altered 1948, harmonized by K. Sikorski). Portugal: "Herois do mar," words by L. de Mendonça, tune by A. Keil (1890, adopted 1910). Before the republic: "O patria, O rei, O povo," words and tune by Pedro IV (Pedro I of Brazil). Rumania: "Te slăvim, Romània, pământ părintesc," adopted on Aug. 23, 1953, words by E. Frunza and D. Deşir, tune by M. Socor. Before 1947: "Trăească Regele in pace si onor," words by B. Alexandri, tune by E. A. Hübsch (1861). South Africa: "Die Stem van Suid-Afrika," words by C. J. Langehoven (1936), tune by M. L. de Villiers (adopted 1938), official English translation, 1952. Spain: "hfarcha de Granaderos." Under the republic: "Himno de Riego." Sweden: "Du gamla, du fria, du fjallhoga Nord," words by R. Dybeck, tune traditional (adopted 1844). Switzerland: "Rufst du, mein Vaterland," words by J. H. Wyss (1811), tune, "God Save the Queen" (see Great Britain, above). Syria: "Humatal diyári 'alaikum salám," words by Khalil Mardam Bey, tune by the brothers Fulayfel (adopted 1939). *Thailand:* "Taurasben Barami," words and tune anonymous. Turkey: "Istiklal marsi," words by Mehmed Akif Ersoy, tune by Osman Zeki Ungor (adopted 1921). United States of America: "The Star-Spangled Banner," words by F. S. Key (1814), to the tune of J. Stafford Smith's song "To Anacreon in Heaven" (adopted 1931). Earlier, "My Country, 'Tis of Thee," words by S. F. Smith. tune "God Save the Queen" (see Great Britain, above) (1832); "Hail Columbia!" words by J. Hopkinson (1798), tune by P. Fyls (c. 1800). U.S.S.R.: "Gimn Sovietskogo Soyuza" (or "Song of Stalin"), original words by B. Lebedev-Kumakh (1942), rewritten by S. Mikhalkov and I. Registan (1944), tune by A. V. Alexandrov (1942). Used earlier by the U.S.S.R.: "L'Internationale," words (originally French) by E. Pottier (1871), tune by P. Degeyter. Tsarist Russia: "Bozhe Tsarya khrani," words by V. A. Zhukovsky, tune by A. Lvov (1833). *Uruguay:* "Orientales, la patria 6 la tumba," words and tune by J. Coppetti. *Venezuela:* "Gloria al bravo pueblo," words by V. Salias, tune by J. Landaeta (c. 1810). Yugoslavia: Since 194j: "Hej Slaveni," words anonymous, tune traditional (the Polish national tune). Earlier: A composite of three songs: "Bože pravde ti Sto spase" (Serbian), words by J. Djordje, tune by D. Jenko (1872), "Lijepa naša domovino" (Croatian), words by A. Mihanović, tune by J. Runjanin (1846) and "Naprej zastava slave" (Slovene), words by S. Jenko, tune by D. Jenko. (E. W. Bm.)

NATIONAL ARBITRATION TRIBUNAL: see Industrial Court.

NATIONAL ARCHIVES, U.S. The national archives and records service. part of the General Services administration, consists of the national archives, the office of records management, the Federal Register division, the Franklin D. Roosevelt library at Hyde Park. N.Y., and the Harry S. Truman library at Independence, Mo. It is headed by the archivist of the United States, who is also chairman of the national historical publications commission.

The national archives selects, preserves. describes and services federal records retained because of their enduring value. It holds the nation's most important records dating from about 1774 through World War II. They include the original laws, executive orders and proclamations, treaties, records of the congress and virtually all records over 50 years old of federal executive agencies.

The holdings, most of which are freely open for research, are described in finding aids published from time to time. Records of high research value are available to scholars and research institutions through the agency's microfilm publication program.

The Declaration of Independence, the constitution of the United States, the Bill of Rights and many other historical documents are on display in the National Archives building.

The primary objective of the office of records management is to reduce the quantity and cost of federal records and improve their quality. It develops and promotes in federal agencies efficient, economical methods for creating, maintaining and retiring records. Economical storage for noncurrent records, pending their ultimate disposition, is provided in ten federal record centres.

The Federal Register division publishes the daily *Federal Register*, the *Code of Federal Regulations*, the *United States Statutes* and the *United States Government Organization Manual*, all obtainable through the government printing office.

In the Franklin D. Roosevelt and Harry S. Truman libraries are housed the papers of these presidents and some of their associates. These collections are among the most important bodies of source materials for the study of modern U S. history.

The national historical publications commission promotes and participates in documentary publication programs of public and private agencies. Projects for publishing papers of such men as Benjamin Franklin, John and John Quincy Adams, Alexander Hamilton and James Madison have been set up under private sponsorship. The commission itself is preparing documentary histories of the ratification of the federal constitution and the Bill of Rights and of the first federal congress. (W. C. G.)

NATIONAL ASSOCIATION FOR THE ADVANCEMENT OF COLORED PEOPLE, a U.S. voluntary interracial organization founded to combat racism, stamp out lynching and lynch law, eliminate racial discrimination and segregation and assure Negroes their constitutional rights. In response to a call issued by 60 Negro and white educators, clergymen and other leaders on Feb. 12, 1909, the centennial of the birth of Abraham Lincoln, a national conference on the Negro was held in New York city on May 30–June 1 of that year. The conference idea had been conceived by William English Walling, a journalist. and nurtured by two social workers — Mary White Ovington and Henry Moskowitz — together with Oswald Garrison Villard. grandson of William Lloyd Garrison. Out of this conference the National Association for the Advancement of Colored People (N.A.A C P.) was born.

Since its founding, the N.A.A.C.P has sought its goal through legal action to protect the rights of Negro citizens, nonpartisan political action to secure enactment of civil rights laws and a program of education and public information designed to win popular support. By the second half of the 20th centnry the N.A.A.C.P. had become a nationwide association of more than 400,000 members in 1,200 local units in 45 states and the District of Columbia. Headquarters were maintained in New York city with a bureau in Washington and regional offices in Atlanta, Dallas and San Francisco. Its monthly organ, *The Crisis*, had a circulation of more than 80,000. *See* also NEGRO, AMERICAN.

For current history *see* the *Britannica Book of the Year*, American edition. (Ro. C. W.)

NATIONAL ASSOCIATION OF MANUFACTURERS (U.S.) : *see* TRADE ORGANIZATION.

NATIONAL CITY, a city of California, U.S., on the southeast shore of San Diego bay adjoining the city of San Diego (*q.v.*), it is on the site of the Mexican land grant Rancho de la Nación. The mild and equable climate attracted pioneer Frank A. Kimball. who purchased the ranch and founded the city in 1868. It was incorporated in 1887. National City enjoys an exceptionally favourable location for industrial development; it is served by railroads and also has ready access to deepwater channels. The majority of its residents work in its expanding industries, retail centres, vegetable-packing houses and in the U.S. navy's repair base. For comparative population figures see table in CALIFORNIA; *Population*. (K. J. *R.)*

NATIONAL CONVENTION. National conventions of the Democratic and Republican parties are held at four-year intervals to nominate the party candidates for president and vice-president of the United States. The conventions, as the representative organs of the parties, also adopt party platforms, elect the party national committees and may adopt rules governing the national organization of the parties and their work between national conventions. In practice, the conventions also act as campaign rallies for the presidential election campaigns that follow. Disagreements within the parties often lead to heated argument at the conventions but also usually to reconciliation and greater cohesion as each party unites behind an existing or newly chosen leadership. The public image of the parties on the eve of the presidential election is in large measure the product of the conventions and their activities.

Early History. — The conventions originated during the presidency of Andrew Jackson (1829–37), after years of growing dissatisfaction over nominating procedures. The first president, George Washington, was so clearly the outstanding national leader of his time that no formal action was necessary to identify him as a candidate before his election. But when it became necessary to choose a successor among several candidates, it became apparent that somehow the field of choice must be narrowed as a preliminary step, if the electoral arrangements of the constitution were to operate effectively. By the election of 1796, the beginnings of party organization in congress were able to solve the problem; presidential nominations were then made mainly in informal congressional party caucuses until 1816, when James Monroe was nominated and elected.

Monroe's administration was marked by a virtual disappearance of such organized political parties as had previously existed in congress. In 1820, Monroe required no nomination for a re-election that was almost by unanimous consent; but in 1824, the popular vote was divided among four candidates who had come to public notice in one way or another. No candidate had a majority, and the presidential election was thrown into the house of representatives for settlement. John Quincy Adams was chosen president, although Andrew Jackson had been a leading candidate.

Jackson was promptly called upon by the legislature of Tennessee to run again in 1828, and agreed to do so. By that year, the Jackson men were so strongly organized that no formal action was needed to identify their candidate, although there had been talk of calling a national convention. Jackson won the presidency in 1828 without difficulty. A clarification of party lines followed in congress, but the congressional party caucus was too discredited for restoration as a nominating agency.

The opposition parties of the time held the first recognized national party conventions in preparation for the elections of 1832. The Antimasonic party met at Baltimore, Md., in Sept. 1831, with 116 delegates from 13 states and chose William Wirt. The National Republican party, generally identified as a predecessor of the Whig party and the present Republican party, held a convention at Baltimore in Dec. 1831, at which it nominated Henry Clay. The Jacksonians met at Baltimore in May 1832 as the "Democratic-Republican National convention." hailed Jackson as their chief and nominated Martin Van Buren for vice-president. This was the first national convention of the present Democratic party, which held such meetings regularly after that time.

The National Republicans held no convention in 1836 and were replaced in 1840 by the Whigs, who held national conventions through 1852. After that year the Whig party disintegrated over the issues of slavery. It was succeeded mainly by the Republican party. which held national conventions in preparation for every presidential election after 1856. Third parties and minor parties also held national political conventions; but as generally used, the term refers to the conventions of the two major parties that have alternated in winning presidential elections since 1832: the Democrats on the one hand, and the Republican party and its predecessors on the other.

Nominating Patterns.——Of the 65 presidential nominations in major party national conventions through 1960, 33 were made by the party currently in power in the White House. Of these 33, 17 were renominations of an incumbent president, usually without much of a contest. Franklin Pierce, defeated for renomination in 1856, was the only elected president who tried and failed to win a second nomination from the national convention of his own party. But others of the period declined the effort. James K. Polk had announced himself as a one-term president; and James Buchanan, who replaced Pierce, thought better of any second-term attempt.

After the turn of the century, it was generally expected that an incumbent first-term president would seek renomination and achieve it easily. The "Bull Moose" drive to prevent the renomination of William Howard Taft in 1912 was the main exception; and Taft was renominated in the end, although he lost the election. Franklin D. Roosevelt won a third-term nomination in 1940 with relatively little difficulty, and a fourth in 1944 with none at all. But under the 22nd amendment to the constitution, adopted in 1951, further third-term nominations were prohibited, except for a vice-president who becomes president with less than two years to serve in his first term.

All of the seven vice-presidents who succeeded to the higher officethrough death of the president through 1945 sought nominations to succeed themselves. The four who made the effort during the 19th century—John Tyler, Millard Fillmore, Andrew Johnson and Chester A. Arthur—were uniformly rejected Three in the 20th century—Theodore Roosevelt, Calvin Coolidge and Harry S. Truman—all won renomination and election.

Nominations in the party out of power have only rarely resulted in the renomination of a previous candidate. After Van Buren's failure to secure a third nomination in 1844, and Clay's final nomination in that same year, no "titular leader" of a defeated party was seriously considered for renomination until Grover Cleveland's third nomination and second election in 1892. William Jennings Bryan was nominated in 1896, 1900 and 1908, but lost the elections that followed in each case. A period followed in which defeated candidates again took themselves out of further nominating consideration; but Alfred E. Smith sought a second Democratic nomination unsuccessfully in 1932, and Wendell Willkie sought a second Republican nomination unsuccessfully in 1944. In 1948, Thomas E. Dewey became the first defeated Republican to receive a second nomination, but was again defeated; in 1956, Adlai E. Stevenson was renominated by the Democrats, and was also defeated.

The conventions have nominated occasionally with little or no contest even when no president or titular leader was available. Instances of this kind have included a few rare nominations that were akin to inheritance as a means for acquiring party leadership: Van Buren's first presidential nomination, in 1836; Taft, 1908; Herbert Hoover, 1928; Richard M. Nixon, 1960. Other instances have included the designation of an already obvious party choice: Clay in 1832 and 1844, Smith in 1928 (Smith had previously been involved in the lengthy Democratic contests of 1920 and 1924, but in 1928 his previous major opponent, William G. McAdoo, had declined the race).

A few other nominations have involved enough agreement among the inner groups of party leaders to make the work of the conventions relatively simple. Among the Democrats, such nominations have included those of Lewis Cass, 1848; George McClellan, 1864; Horace Greeley, 1872; Winfield S. Hancock, 1880; Cleveland's first nomination, 1884; Alton B. Parker, 1904. Republican nominations of this type have included those of John C. Frémont, 1856; Ulysses S. Grant, 1868; Charles Evans Hughes, 1916; and Alfred M. Landon, 1936. Inner-group selections of the kind just noted have rarely won elections—many were made in years of party weakness—and were more common in the early decades of the party system than in later periods.

New leadership was selected after a vigorous contest in 26 of the 65 major party conventions through 1960. Each of these contests involved at least two and often three or four leading candidates for the presidential nomination of the party concerned. In 19 cases, the prize was captured by one of the major contestants; 7 of these cases involved the succession in the party in power, 12 the nomination in the party out of power; 9 occurred in the period from 1832 through 1892, 10 in that from 1896 through 1960. indicating that there has been no diminution in the frequency of these occurrences in the American party system.

In the other seven cases of contest, compromise or "dark horse" candidates were selected after rejection of all the leading candidates. These include the cases of Polk, 1844; Pierce, 1852; Horatio Seymour, 1868; Rutherford B. Hayes, 1876; James A. Garfield, 1880; Warren G. Harding, 1920; and John W. Davis, 1924. In addition, Benjamin Harrison (1888) and Bryan (1896) have sometimes been regarded as "dark horse" candidates, but were in no sense the result of interfactional stalemate and compromise. Harrison was a secondary candidate of the James G. Blaine faction, and Bryan of the silver faction in their respective parties. Willkie (1940) has also been considered a "dark horse" candidate, but was conspicuously in the running before the convention opened and was not a compromise.

After the 1920s, the factors producing the "dark horse" candidacies of the past disappeared or changed considerably. In 1936, the Democratic party abandoned its century-old rule requiring a two-thirds vote of the convention to nominate. Under a regime of majority voting in both party conventions; with increasingly open campaigning before the conventions by willing candidates; and with the clarification of preconvention campaigns and candidate status that takes place through public opinion polls, preconvention primaries and modern processes of communication, national conventions can usually reach their decisions quickly when they finally come to the nominations—unlike the Democratic convention of 1924, which required 16 days and 103 ballots under the two-thirds rule to nominate a candidate who lost the election.

Sources of Candidates.—Candidates for the nominations have usually been persons with extensive political experience; although in rare instances others have been considered and nominated, as in the case of Willkie (1940), and even elected, as in the case of Dwight D. Eisenhower (1952). United States senators have provided the largest single category of contestants for both the presidential and vice-presidential nominations. Nominations for the lesser office were won by senators with increasing frequency from 1928 through 1956; but from the nomination of Stephen A. Douglas (1860) to 1956, Harding (1920) was the only incumbent senator to win a major party presidential nomination. In 1960, however, Sen. John F. Kennedy became the nominee of the Democratic party.

Governors have long been highly important as a source of aspirants for the nominations, and particularly as the category of officialdom from which the choice is most likely to be made in a situation of contest. Disregarding three presidential nominees who had succeeded to the presidency from the vice-presidency (two of whom were ex-governors), 8 of the 19 first-time presidential nominees from 1896 to 1960 were incumbent governors. Among the Democrats, they included Woodrow Wilson, James M. Cox, Smith, Roosevelt and Stevenson; among the Republicans, William McKinley, Landon and Dewey. Three first-time nominees, Bryan, Davis and Willkie. held no governmental position at (or immediately prior to) the time of their nomination; two, Taft and Hoover, were cabinet members; two, Parker and Hughes, were high court judges; two, Harding and Kennedy were senators; one, Eisenhower, was a regular army general; and one, Nixon was vice-president.

With so many sources from which candidates for the nominations may come, the conventions occupy a critical place in the career aspirations of the political and other leaders of the Cnited States. A final convention vote on a contested presidential nomination usually inserts a full stop in the development of a number of political careers; while creating a new political celebrity, and providing the basis for a new constellation of personal and power relationships. The career development and preconvention campaign activities that lead up to these final decisions tend to involve all elements of the U.S. social order. The presidential nominating process, consisting of the never-ending actions and activities that take place in anticipation of future convention decisions, is one of the main organizing features of U.S. life and politics.

Preconvention Campaigns.—When an open nominating situation is in prospect in one party or the other. willing candidates may announce as early as October or November of the preceding year, as Robert A. Taft did in 1947 and 1951 and Stevenson in 1955. Early candidates incur the hazards of the "front-runner," but the filing requirements for the presidential primary elections in several important states require action by December or January for a successful race in the primaries that follow.

Preconvention campaigning was dominated by the so-called presidential primary elections after World War II, although they were held in fewer than half of the states. The states holding presidential primaries have experimented with such widely different systems since 1904, when they originated, that no easy summary is possible; but in most of these states, the state delegates to the respective party national conventions are chosen in a public election at which the adherents of the respective parties may vote. The voters may also be given an opportunity, directly or indirectly, to express a preference among two or more of the candidates for a presidential nomination. The chronology of the presidential primaries in a typical presidential year begins with New Hampshire in March; includes Wisconsin, Illinois, New Jersey, Pennsylvania and Massachusetts in April; the District of Columbia, Maryland, Indiana, Ohio, Alabama, West Virginia, Nebraska, Oregon and Florida in May; and California, New York and South Dakota in June.

Something is usually known concerning the presidential candidate preferences of the would-be delegates, even in the states where there is no provision for putting such information on the ballot. In many of the primary states, would-be delegates can indicate their candidate preference on the ballot if the candidate gives consent; and in a few states, notably New Hampshire, Oregon and Florida, they can do so without the necessity of securing candidate consent. Generally when there is an active contest for the nomination of one party or the other, opposing presidential candidates of national stature can be expected to campaign vigorously in at least three or four of the presidential primary states. These state campaigns and elections usually have the effect of committing state delegations to the candidates winning in the respective states. They also attract national attention and clearly affect the estimates of the candidates that are held by the voters, as well as those held by the prospective delegates, even those from states where no primaries are held. In these states, delegates are usually selected by state and district party conventions.

Time, Place, Composition. — The national conventions meet at a time and place previously determined by the respective party national committees. Formerly the conventions were usually held in June, but in 1952 and 1960 both were held in July, and in 1956 in August. There is no policy on which party meets first. Chicago has been chosen as the convention city most frequently in the 20th century, with Philadelphia second. Baltimore was the favourite meeting place from 1832 to 1872. For most of a century, voting strength in both conventions was apportioned among the states in accordance with their electoral college vote, usually two convention votes for each of the state's senators and representatives in congress; and this was still a major factor in the apportionment in 1956. In preparation for its 1916 and later conventions, however, the Republican party adopted rules curtailing the representation of congressional districts (mainly in the south) where the Republican vote was light. Both parties later adopted the practice of giving "bonus" votes to the states carried by the party in a previous election, which had the effect of inflating total convention voting strength to more than 1,300 votes in each party in 1956. In Republican conventions, state delegations usually were restricted to their authorized size, with one vote for each delegate; but the Democratic party repeatedly authorized the election of additional delegates on a half-vote basis and frequently seated delegates who held less than half a vote, with resultant confusion of voting procedures. In 1960, the Democratic party put all delegates on a half-vote basis and increased the total number of votes to 1,521.

Proceedings. — Each convention is opened by the chairman of the national party committee, and usually elects a temporary chairman on the first day. The temporary chairman may give the keynote address and usually presides until the organization of the convention has been completed. Senators have often served as temporary chairmen, but governors have done so increasingly in the 20th century. The permanent chairman usually takes over on the second or third day of the convention and presides during the adoption of the party platform and the balloting on presidential and vice-presidential nominations. During the 19th century, state and local party leaders usually served as permanent chairmen; from 1896 to 1956, the post was filled, with the exception of the Republican convention of 1924, by an incumbent senator or representative in congress. Senators held the post more commonly during the early decades of the century; but from 1948 through 1956 both parties uniformly chose their party leader in the house of representatives as permanent convention chairman. In 1960, the Republican party did so again, but the Democrats chose a governor.

Party platforms are prepared in committees designated for the purpose. Platform issues have been hotly fought, with divided votes, in many Democratic conventions, including notably those of 1924 and 1948; but no platform issue came to a divided vote on the floor of a Republican convention between 1936 and 1960.

Nominations are the work of the convention as a whole and have not directly involved any prior committee action since 1840. Candidates are placed in nomination with nominating and seconding speeches, demonstrations are held, and eventually the convention votes. The roll of the states is called alphabetically and the vote of each state delegation is reported by its chairman; if necessary the delegation is polled. Many contests are settled on the first or second ballot, but even in the 1940s and 1950s, several ballots were sometimes necessary. The Willkie nomination of 1940 required six ballots; the Dewey nomination of 1948, three; the Stevenson nomination of 1952, three.

Vice-presidential nominations follow the presidential. Frequently the vice-presidential choice has been determined by the presidential nominee in consultation with other party leaders, after which other candidates for the lesser nomination have withdrawn and the convention has ratified the choice without a contest. But in 1956, Stevenson followed the example of Bryan in 1896—an example that Bryan never again followed himself—in insisting that the convention itself make the choice. Sen. Estes Kefauver won the nomination on the second ballot after an extremely close contest with Sen. John F. Kennedy.

Throughout the 19th century, the candidates usually remained at their homes while the conventions were in session; and committees were sent. often weeks later, to advise the successful candidates officially of the convention action. In the 20th century, willing candidates began to be present at the convention city oftener but rarely appeared in the convention itself before 1932. In that year, however, Franklin D. Roosevelt appeared in person at the end of the Democratic convention to accept its nomination. After that time. major candidates were usually present in the convention city during the proceedings, and appearance of the nominees to make acceptance speeches at the final session became customary.

Reform Proposals. — Throughout their history, the conventions have been among the most criticized of political institutions, perhaps because they provide so many opportunities for the organization, manipulation and display of political power. Throughout the 20th century, a favourite reform proposal has been to replace the conventions with a national presidential primary. to be provided either by a constitutional amendment or by federal law encouraging uniform state action. Public reaction to the conventions of 1952, the first to receive full television broadcasting over nationwide networks, was interpreted by some observers as giving great impetus to the movement for a national presidential primary. But that impetus failed to show itself in congress, except in the adoption of a presidential primary law for the District of Columbia.

State legislatures also were slow to register any notable desire to install primaries in states where they did not already exist. Florida revised its previous statute along lines recommended by a group of political scientists and claimed credit for developing a model presidential primary system.

At mid-20th century the conventions undoubtedly had become the object of a greater amount of professional and scientific research activity than at any previous time in their history. While such research mainly added to the store of knowledge concerning the complexities of the presidential nominating process, it also produced many suggestions for changes in procedures. It seemed that these might eventually have a significant cumulative effect without changing the fundamental nature of the convention institution, which seemed to be firmly established as a part of the U.S. political system.

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NATIONAL COUNCIL OF CHURCHES. The National Council of the Churches of Christ in the U.S.A. was formed in Dec. 1950 by a merger of 12 national interdenominational agencies, several of which had been organized as early as 1908. Its purpose is to provide an organization through which the member churches can express their common faith and co-operate with one another on programs to which the bodies themselves consent or which they initiate. The council has no authority over its constituent bodies. Among its objectives and functions, as stated in its constitution, are to encourage fellowship and counsel concerning the spiritual life and religious activities of the churches; to promote co-operation among local churches and the development of state and local councils of churches; to encourage study of the Bible; to do for the churches such common services as are desired; and to provide a medium of consultation, research and joint planning.

By 1960 there were 33 Protestant and Orthodox bodies constituent to the council, of which 26 were Protestant denominations. Almost 40 other denominations or agencies of denominations cooperated in one or more of the council's programs. In the constituency of the council at that time were approximately 144,000 local congregations with about 107,000 ministers. In these were almost 40,000,000 individual members, of which more than 35,000,000 were in the Protestant bodies.

The council also co-operated with about 900 local and state councils of churches which were responsible to their own state and local churches.

The council carries out many of its activities through four divisions. Through the Division of Christian Life and Work there is encouragement of study and action in international affairs; education among groups and individuals to apply Christian principles to economic life and racial and cultural relations; counsel and guidance to the ministries in hospitals and prisons; and co-ordination of activities in furtherance of religious liberty, social welfare and stewardship. The Division of Home Missions maintains a consultation service on church building; administers a co-operative migrant ministry for seasonal farm workers; and encourages broad planning to meet the special needs of rural and urban churches and of home missions institutions. The Division of Foreign Missions co-ordinates, counsels and interprets the co-operative phases of the overseas work of participating foreign mission boards and denominations; supplies medical services to foreign missionaries; and conducts a literacy program in about 200 languages. The Division of Christian Education helps the churches to develop guidance materials for local work in religious education; gives leadership in the improvement of administration of Sunday school programs; and administers about 600 leadership schools annually. It encourages weekday religious education and vacation schools and co-ordinates the educational work of the denominations with respect to church-related colleges.

Among other units of the council, Church World Service, a department of the council, is a channel through which many denominations carry on a world-wide program of relief and rehabilitation to needy and suffering persons abroad. These are largely programs of emergency aid to victims of natural disasters and political upheaval. It has administered services resulting in the resettlement of more than 100,000 refugees in the United States and has shipped overseas as much as 346,000,000 lb. of materials, mainly food, in one year. An activity of the Department of Evangelism is a co-operative ministry in the national parks that provides religious services to visitors. United Church Women participates in activities of local interdenominational councils of churchwomen; encourages observance of the annual World Day of Prayer; and encourages various programs in missions, family life, race relations and civil liberties. United Church Men aids in the development of co-operative programs among local groups of laymen and encourages their interest in such subjects as Christian missions and education. The Broadcasting and Film commission presents radio and television messages; develops films and film strips; and provides training for both clergymen and laymen on the use of radio and television. The Bureau of Research and Survey carries on various research projects; promotes research by other agencies; and maintains a centre of information on church statistics. It edits the *Yearbook of American Churches,* which presents official information from all faiths.

The General Assembly of the council, triennial, and the general board, meeting between sessions of the assembly, on occasion issues policy statements. Among them are: the council stands opposed to racial segregation in the churches and community life; believes in and supports the right of both employers and employees to engage in collective bargaining; believes in and supports the procedures of the United Nations; advocates broad international trade and the foreign-aid program of the United States; is unalterably opposed to communism and stands against the evils, violence and violations of human rights by communist and other tyrannies.

The Council's general board consists of both clergymen (almost two-thirds) and lay persons, elected or appointed by the constituent bodies. On the committees supervising the program units there are about as many lay people as clergymen. Of the council's net budget, more than half comes from church bodies; the remainder is made up of proceeds from sales of materials. gifts of individuals, foundations and corporations and proceeds from investments. Headquarters of the National council, shared with a number of other organizations, is located in the Interchurch centre at 745 Riverside drive, New York city.

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NATIONAL DEBT: *see* DEBT, PUBLIC.

NATIONAL DEPOSIT FRIENDLY SOCIETY: see FRIENDLY SOCIETY.

NATIONAL FINANCE: *see* FINANCE.

NATIONAL GEOGRAPHIC SOCIETY, a U.S. scientific society founded in Washington, D.C., in 1888, "for the increase and diffusion of geographic knowledge." From a small local organization founded by eminent explorers and scientists it had grown to become the largest scientific and educational society in the world, with an international membership of 3,000,000 (1962) in the second half of the 20th century. All members receive the society's monthly journal, the *National Geographic Magazine,* and many maps issued as supplements. Annual membership dues support all of the society's activities, which have included more than 200 major scientific projects and expeditions.

From the expeditions of Walter Wellman and Robert E. Peary to Richard E. Byrd and Paul A. Siple, the society has supported and encouraged arctic and antarctic exploration and published firsthand accounts of explorers. In the early 1930s its giant stratosphere balloons. launched jointly with the U.S. army air corps, pioneered in scientific exploration of the upper air and attained the greatest elevation reached by man up to that time (13.71 mi.). National Geographic expeditions, often cosponsdred with the Smithsonian and other institutions, have studied volcanic eruptions and earthquakes, excavated Machu Picchu, lost city of the Incas on a Peruvian mountain top, and discovered in Mexico the oldest dated work of man in the new world.

The society helped explore and bring into the C.S. national park system such national treasures as the Valley of Ten Thousand Smokes in Alaska. Carlsbad caverns and Pueblo Bonito in New Mexico and the giant sequoias of California. In 1958 the society presented Russell cave, Alabama—in which was uncovered a record of 9.000 years of North American prehistory—to the national park service. *(See* also ALABAMA: *History.)* In 1949–56 the society and the California Institute of Technology, working with the Palomar observatory telescopes. produced for world distribution a Sky *Atlas* of unprecedented scope. More recent activities have included archaeological examination of the vast. long-forgotten capital of Maya civilization, Dzibilchaltun, in Yucatbn, in co-operation with Tulane university, and anthropological research by Dr. and Mrs. L. S. B. Leakey in east Africa that has produced fossil remains of hominids of record antiquity.

Besides its expeditions. its magazine and its maps, the society fulfills the purpose for which it was organized—through its school service which issues weekly bulletins to educators. librarians and students in the Cnited States; a news service which issues daily releases on world events for press. radio and television; its illustrated books presenting scientific information in readily understandable form; globes, atlases, educational television; and occasional scientific monographs by its expedition leaders.

Melville Bell Grosvenor, son. grandson and great-grandson of presidents of the society, became its president and editor in 1957. *See* also GROSVENOR. GILBERT HOVEY. (M. B. G.)

NATIONAL GUARD is the name applied in the United States to a volunteer organization composed of individuals from all walks of life who devote part of their time each week to train as members of military units. Older than the nation it serves. it has the longest continuous history of any military organization in the United States. As an outgrowth of the early militia concept which provided for the common defense, its origin can be traced back to the early years of the 17th century when the colonists, in order to protect their lives and property, banded together to form militia companies (*see* MILITIA). These companies were equipped and trained according to the needs of the time. As the nation grew, the national guard grew, and as towns sprang up and states were added to the union, additional guard units were formed for local and national protection.

The distinction of being the oldest national guard units in the United States with unbroken lineages is shared by the 101st engineer battalion and the 182nd infantry regiment. Rlassachusetts national guard. These units trace their history back to Oct. 7, 1636, when the general court at Boston ordered that all military men in the area were to be formed into militia regiments. Two of these, the north regiment and the east regiment, both of which fought in the Revolutionary War, later became the 182nd infantry and the 101st engineers.

Throughout the Colonies, similar militia organizations were formed, and in 1775 the committee of safety of the second continental congress organized them into an over-all defense force. These militia provided approximately 165,000 of the 396,000 troops raised for George Washington's continental army. It was during the period 1776–90 that specific militia laws were first passed by the states for the purpose of regulating the militia and causing the enrollment of all free males between certain ages as a proper. natural and safe defense of a free state. These laws were based on the Declaration of Independence and the articles of confederation, which declared that a well-regulated militia was necessary but should not be superior to the civil power nor assume the role of a standing army in time of peace. From these laws arose the concept of the national guard as state-supported organizations of local volunteers.

After the Colonies had won their independence, the principle of the citizen-soldier was considered so important by Washington and the first congress that it was written into the constitution of the United States. Section 8. article I of the constitution empowered congress to provide for calling forth the militia to execute the laws of the union, suppress insurrections and repel invasions. and for organizing, arming and disciplining the militia. reserving to the states the appointing of officers and the training of the militia according to the discipline prescribed by congress. The second amendment to the constitution (article II of the Bill of Rights) recognized the right of the citizen-soldier, in the interests of "a well-regulated militia," to keep and bear arms. Ultimately, this basic authority was to result in the establishment of the national guard in its present form.

Although President Washington constantly pressed congress to prepare "a uniform and well-digested plan" for the militia, no action was taken, and militia were separately formed and trained by each state. By the act of Feb. 28, 1795, congress gave the president authority to call out the militia in cases of invasion and other emergency, but federal use of state militia depended on the individual state's acceptance or rejection of the president's request. A step toward a uniform militia and an eventual national guard was taken by congress in 1808. when legislation provided for specific federal aid-to be paid annually to the states to support their militia, although these forces still remained under state control.

The name "national guard" was first applied to a state militia on Xug. 16. 1824, when New York's 7th regiment (now the 107th infantry regiment, New York national guard), acting as an honour guard for the Marquis de Lafayette during his visit to the United States. adopted the name in tribute to his service during the Revolutionary War and in honour of his command of the Garde Nationale in Paris in 1789. By 1896 most states had adopted the title, although this change in name did not change the essential character of the guard as a state organization.

Throughout the 19th century, the militia remained a generally unwieldy and sprawling force, although it played an important part in providing troops and units in each of the four wars (1812, Mexican, Civil and Spanish-American Wars) in which the United States engaged during this period. In 1903 congress enacted laws whereby the federal government assumed a more direct and active part in organizing. training and equipping the militia under the same standards as those prescribed for the regular army. It was not until enactment of the National Defense act of June 3, 1916, however, that the organized militia was officially recognized as the national guard and made to conform to regular army organization. As such, it became a component of the nation's organized peace establishment and. when called into active federal service, a part of the army of the United States..

In 1916 approximately 151,000 guardsmen were called into federal service. of which 110,000 served on the Mexican border. During World War I. the national guard supplied more than 380,000 soldiers for the American expeditionary force. Seventeen guard divisions were sent overseas, of which eleven saw actual combat. Of the eight U.S. divisions rated excellent or superior by the German high command. six were national guard divisions.

The general demobilization of units and the discharge of individuals from federal service after World War I made it necessary to rebuild the national defense force, including the national guard. Under postwar amendments to the National Defense act of 1916, the national guard was reorganized to consist of the same guard divisions that had served during the war. This act, in setting forth a completely new military policy for the United States, established an "Army of the Cnited States" which consisted of the regular army, the organized reserve corps. and the national guard when called into federal service. The national guard remained a state force under the command of state authorities. The new act also provided for increased federal assistance for the national guard: when units reached certain minimum standards of strength, equipment and skill; they were formally recognized as eligible for federal support.

The act of June 15, 1933, created a new component of the army known as the "National Guard of the United States." This component. while identical in personnel and organization to the national guard of the several states. was a part of the army at all times and could be ordered into active federal service by the president whenever congress declared a national emergency without the necessity of being called through the governors of the states.

In August 1940 the president ordered the national guard of the United States to active military service. Between Sept. 16, 1940, and Oct. 1, 1941, the national guard brought into federal service more than 300.000 men in 18 combat divisions and numerous non-divisional units, including 29 air observation squadrons. These troops immediately doubled the strength of the standing army. Guardsmen supplied trained leaders for the expanding army. with an estimated 82,000 enlisted guardsmen later becoming officers. Nine divisions crossed the Atlantic to Europe and Africa and nine went to the far reaches of the Pacific.

Following World War II, national guard units were demobilized and their personnel separated from federal service and returned directly to civilian life. For a short period, there actually was no national guard. On Oct. 13, 1945, the secretary of war approved the policies relating to the organization of the postwar national guard, and on June 30, 1946, the first reorganized national guard unit was federally recognized. In 1947 the air units of the national guard mere organized separately from the army units and designated the air national guard. Since that time the national guard has consisted of the army national guard and the air national guard.

During the Korean war, more than 183,000 guardsmen in 8 infantry divisions. 22 wings and many other units of the army and air national guard were ordered into active federal service. Four divisions and 1; wings were stationed in the United States, 2 divisions and 3 wings served in Europe, and 2 divisions (the 40th and 45th) and 2 wings (the 116th and 136th) fought in Korea.

The national guard of the early 1950s was organized under regular army and air force tables of organization and equipment. The basic establishment of the army national guard was 21 infantry and 6 armoured divisions, 9 regimental combat teams, g armoured cavalry regiments, 123 antiaircraft and 80 field artillery battalions, and nearly 2,000 additional combat, combat support and service units of company or detachment size. The air national guard consisted of 27 combat wings with 87 tactical squadrons, plus a number of support groups, squadrons and other types of units. On Feb. 28, 1958. the strength of the army and air national guard was 476,061 officers and enlisted men organized into 5,952 federally recognized units located in more than 2,600 cities and toans throughout the United States including some of the territories and possessions.

The national guard has a dual status and mission. Each federally recognized unit is simultaneously a part of the national guard of its own state and of the national guard of the Cnited States. The function of the national guard of the several states is to provide organizations in each state, so trained and equipped as to enable them to function efficiently at existing strength in the protection of life and property and the preservation of peace, order and public safety under competent orders of the state authorities. The duty of the national guard of the United States is to provide units of the reserve components of the army and air force, adequately organized, trained and equipped, available for mobilization in the event of war or national emergency and capable of combat operations in support of war plans of the department of defense.

In addition to its basic duties, the national guard also became actively engaged in the defense of the United States. In the first peacetime duty assigned to it, the army national guard in March 1954 began active participation in the antiaircraft defense of the continental United States.

On Aug. 15, 1954. the air national guard began active participation in the air defense augmentation plan of the air defense command. Under this plan. 17 squadrons operated combat-ready aircraft from their air national guard bases in a five-minute runway alert status.

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NATIONAL INCOME. The traditional purpose of national income studies is to furnish measures. of the production of the nation. Beginning approximately with the 1930s, and quite explicitly since World War II, their purpose has come to be conceived more broadly as that of providing a systematic account of the economic activity of the nation. Inasmuch as production is a major feature of economic activity the two aims are closely interrelated.

National Output.—Terminology has not become standardized; the terms "national output," "income," "product" and "expenditure" are often used interchangeably. In the following discussion national output will. in general, be employed to designate the common concept. National output is the total of final or end products produced by the nation during a specified period, such as the calendar year. That is to say. it is the sum of products available for consumption or for additions to the stock of capital. Ran materials and semifinished products used up in production are not counted separately. For instance, if flour is baked into bread, only the bread is counted. National output is expressed in monetary values. since these provide a common unit for summing the wide variety of goods (commodities and services) produced.

The bulk of the production covered by measures of national output consists of items that are intended for sale in the market. Goods provided outside the market place are usually excluded, even though they may resemble items that are included by virtue of the market criterion. For instance, the services of housewives are usually excluded while services rendered by domestics are included. However, monetary values are generally imputed to wages paid in kind, to food and fuel produced on farms for home consumption, to the services which owner-occupants derive from their homes, and sometimes also to certain services, such as the handling of bank deposits, which financial institutions render free of charge to individuals. The treatment of nonmonetary items raises difficult problems in the measurement of the output of industrially undeveloped countries, where many types of productive activity that are channeled through the market in western countries are performed within the confines of the individual household.

The above explanation of national output has been in terms of product flows. because such an approach makes clear that the goal is to measure goods available for the satisfaction of human wants. Honever, inasmuch as the production of goods gives rise to a simultaneous flow of incomes—wages. profits, etc.—national output may also be envisaged as a sum of income flows. In practice, national output measures are prepared both by summing product flows and by summing income flows.

The relationship between these two types of measures is basic to the understanding of the entire structure of national income statistics. Accordingly, a somewhat more exact explanation of it will be given by reference to the operations of a typical business enterprise. (The bulk of national output originates in such enterprises. although certain services—mainly those of household and government employees—also are counted as part of national output.)

The typical business enterprise produces goods which it either sells or adds to its inventories. Chargeable to this production are purchases of raw materials and other intermediate products from other enterprises (but not purchases of fixed plant and equipment); wages, salaries and other incomes paid out in production; indirect business taxes, such as sales, excise and property taxes; and depreciation and kindred allowances for fixed capital used up. A residual item of profit or loss equalizes the expenses chargeable to production with its value.

Expenses chargeable to production and profits	Production
Purchases of intermediate products Wages and other incomes chargeable to production Indirect taxes Capital consumption allowances Profits	Sales Inventory change

If a statement of this type is prepared for the business system as a whole, those sales of enterprises that represent purchases of intermediate products by other enterprises cancel one another. Thus purchases of intermediate products disappear from the left-hand side of the statement and sales on the right-hand side are correspondingly reduced. Matching the noncanceling final products there remains a numerically equivalent total consisting of income streams (including profits), indirect taxes and capital consumption allowances. (Inasmuch as the income aggregate reflects current production, capital gains and losses are not included.)

Variant Measures. — All measures of national output are net in the sense that intermediate products used up in production are not counted separately, but only as part of the value of the final products in which they are embodied. The definitions, however, vary significantly in other respects. Three points of differences may be noted.

1. Mainly because it is difficult to estimate how much fixed capital is used up in production during a given period, many national output measures are defined on a "gross" basis; *i.e.,* before deduction of capital consumption allowances. This definition is adopted even though in principle the using up of fixed capital is similar to that of intermediate goods. However, "net" measures allowing for the use of fixed capital are just as common. even though the allowances usually fall short of being meaningful from the standpoint of indicating the true net change in the capital stock.

2. Measures of national output are sometimes valued in terms of market prices and thus reflect indirect taxes, which are part of market price. Alternatively, national output may be defined net of these taxes (in technical terms, at factor prices or costs).

As is suggested by the previous demonstration of the equivalence of the product flow and income flow measures, net national output at factor prices is equivalent to the sum of incomes generated in production — wages and salaries, interest, rents and profits. These are measured before deduction of direct taxes — mainly taxes on individual or business earnings. .(For a further discussion of the factor price and market price measures see the concluding section of this article.)

3. Measures of national output may refer to the output produced within the confines of a nation. or to the output to which residents of a nation have a claim. The two definitions differ because earnings derived from abroad provide residents of one nation with claims on output produced in others.

Differences between the gross and net and the market price and factor price measures are usually substantial. In the United States, for instance, the gross market price measure (gross national product) exceeds the net factor price measure (national income) by about one-fifth, with capital consumption allowances and indirect taxes contributing about equally to the spread. Differences between output measures due to variant treatments of international claims may also be significant.

It is necessary to distinguish between genuine output measures and various related aggregates that are not strictly measures of output. A widely used aggregate of the latter type (personal income, in the commonly accepted terminology) measures the sum of incomes received by individuals. Although the bulk of this aggregate arises in the production of national output, it cannot be regarded as a measure of the latter, since. on the one hand, it excludes some forms of income arising in production (such as undistributed profits) and. on the other, it includes incomes that do not reflect current productive activity (for instance, relief payments).

Adjustment for Price Change. — Measures of national output are usually expressed in terms of the prices current in the period to which the measures refer. Accordingly, changes over time in similarly defined output magnitudes reflect both changes in the quantity of goods produced and in the level of prices at which these goods are valued. For many purposes it is useful to have measures which separate the effect of the "real" (*i.e.,* quantity) change from that of the price change. They are obtained by expressing the goods produced in different time periods in terms of constant prices. These are usually the market prices that actually prevailed in one year, or in an average of years, during the period for which the measure is constructed. The approach to the comparison of real outputs produced in different countries is similar to that just outlined for time comparisons.

Output Breakdowns. — Measures of national output are usually accompanied by breakdowns of the totals that provide significant information on various aspects of the economy. The following are the breakdowns most frequently used.

1. The value of national output is shown in terms of the economic character of the products — essentially consumption and additions to capital stock. with further subdivisions of these two basic categories. It is also shonn in the same statement in terms of the sales of these products to major purchaser groups, usually consumers, business enterprises, government and foreign nations. The exact manner in which the type-of-product and the type-of-purchaser classifications are reconciled is not uniform. The aggregate broken down in this way is usually valued at market prices.

2. The value of national output is shown in terms of the various types of incomes — wages and salaries, interest, rents and profits — originating in production. This classification is usually of the aggregate expressed net at factor prices Sometimes, however, capital consumption allowances and indirect taxes are included, and a breakdown of the entire value of national output gross at market prices is thus provided.

3. The value of national output may be classified to show the portions of it originating in the various industries, such as agriculture, manufacturing and trade. This classification is generally given in terms of the income rather than the product flow measure. Industry breakdowns of output vary as regards the output definition (net or gross, market or factor price, etc.) that is used.

4. National output may be shown allocated to the various regions of a nation. To sidestep some of the special problems involved in such an allocation, the total is often not strictly a measure of national output, but the related aggregate of individual income receipts.

5. Some variant of this aggregate also most frequently underlies statements in which income is classified by the size of the unit income, the unit being usually the family or the single individual living separately. Such size distributions show the number of consumer units and the total income in successive income brackets.

National Income Accounting. — It is apparent that the output breakdowns listed shed a great deal of light on the structure of the economy. However. the facets of the economy so illuminated remain separate, and no fully coherent picture of the whole in terms of its component parts emerges. The technique of national income accounting (social accounting. national accounting, etc.—terminology varies) has been designed to overcome this shortcoming. It helps to envisage the precise relation to one another of the various facets of the economy on which information has been obtained, and it provides a framework for the actual preparation of coherent statistical pictures of the economy.

In essence, the economy is regarded as consisting of transactors, such as enterprises, households and governmental units. each such entity recording its transactions in a consistent set of accounts. For each transactor, three types of accounts are usually distinguished conforming to certain basic and distinct economic functions. The first account records its transactions as a producer —along the lines sketched above in the explanation of the equivalence between the product and income flow measures. The second shows its transactions as a recipient of net income (from its own production as well as from other. sources) and as a consumer, and includes a residual item of saving. The third account summarizes its transactions as a saver and investor. showing the disposition of its total saving among financial and tangible investment. To show interrelationships clearly, each transaction would be identified twice in an ideal scheme. For instance, purchases made by one transactor unit in its capacity as consumer would be shown as sales of another unit in its capacity as producer.

Many problems are encountered in drawing up the specifications of this accounting scheme. Some of these arise because the basic types of accounts distinguished are not applicable to all types of transactors with equal ease. For instance. the essential features of the production account for enterprises can be envisaged by reference to the operating statement of a typical business firm. But there is no similar guide to set the pattern for the production accounts of households and governments. and experts are not unanimous in their choice among several alternatives.

As to the detail in which transactors might be classified, there is no limit in principle. In the extreme, the economy might be depicted in terms of a separate set of accounts for each transactor. In practice, information is insufficient to implement such a scheme; moreover, so detailed a picture would be of no use, because in it one would not see the forest for the trees. Accordingly, statistical pictures of the economy in terms of interrelated accounts are confined to broad consolidations of the ultimate detail. Essential information on aspects of the economy which these consolidations do not bring out is shown in supporting tables.

Many types of consolidations are possible; one deserves mention because closely related variants of it underlie the national income presentations of many countries. In this consolidation, the accounts showing the productive activities of enterprises and other economic transactors are summed to yield twin measures of the national output—one in terms of product flows, the other in terms of income flows. Accounts showing transactors as recipients of income—including transfers, such as relief payments and taxes—and as consumers of output are usually distinguished for two broad groups, households and government; a consolidated receipt and expenditure account is provided for each of these groups. (The corresponding accounts for enterprise transactors are often merged with the production accounts.) Next, the saving-investment accounts for all transactors are consolidated to show such an account for the nation as a whole. Finally, an external account is provided to show transactions with foreign countries.

This particular consolidation of the underlying accounting scheme is selected for statistical implementation for pragmatic reasons. It contains measures of total output. which is the focus of national income statistics; it shows explicitly the transactions of households and governments, and saving-investment transactions per se, which are important for understanding the functioning of the economy; and it suppresses distinctions that are of lesser significance or that cannot generally be quantified because statistical information is lacking.

Related Systems.—The term national income statistics is usually confined to the measures of national output and of its breakdowns, and to the summary descriptions of the economy that have been described. There are three bodies of statistical information, not covered by the conventional use of the term. that can be seen to be closely related to national income estimates if the national income accounting approach is adopted.

1. Interindustry relation (input-output) studies aim at a depiction of the economic process which focuses on product flows among industries. They provide a full accounting for these flows, including intermediate goods, which are excluded from conventional national income statistics because the latter are concerned with final output.

At a high level of abstraction which omits many detailed points of comparison that are of importance in the actual use of the data, the relationship of input-output to national income statistics may be grasped by reference to the detailed accounting scheme for individual units that has been shown to underlie the latter. Input-output tables can be regarded as an alternative manner of summarizing this scheme; in essence, transactors are grouped on an industry basis.

2. Moneyflow systems trace, in addition to the flows accounted for in national income statistics, financial transactions such as transfers of deposits and lending and borrowing. These are not reflected in conventional national income estimates because the latter provide only one consolidated saving-investment account for the nation as a whole in which domestic financial transactions cancel. These transactions could be introduced into national income statistics by providing separate saving-investment accounts for appropriate groups of transactors. Again. this is only a general sketch of the relationship between the two systems.

Input-output and moneyflow data have been developed less extensively than national income estimates narrowly defined, partly because they require additional primary statistical information that is difficult to obtain. The extent to which they have been integrated with the national income accounts varies from country to country.

3. Statistics of national wealth are usually distinguished from those of national income, but inasmuch as wealth is largely the result of saving and investment. which are part of the national income estimates. the close relationship between the two sets of figures is apparent.

Uses of National Income Statistics.—National income data are a tool for evaluating the performance of the economy, mainly in terms of the total amount and the Eomposition of goods provided, and their distribution among various groups of the community. They are also an aid in understanding the functioning of the economy; *e.g.*, the nature of business fluctuations. the regularities in the distribution of income and the tendencies for long-term economic growth or retardation. They foster such understanding essentially because they provide quantifications of many of the key magnitudes with which economic reasoning on these matters deals.

Among the practical uses of the data, those concerned with public policy have been most prominent. National income estimates have been used, for instance. in formulating policy recommendations relating to economic mobilization during war, to the stabilization of business activity and to economic reconstruction and development. Intelligent policy decisions in these and other matters involve the assessment of the probable course of future events. For instance. anti-inflatlonary measures are in order, not if inflation has prevailed in the past, but if it is believed that it will prevail in the future. National income categories have been used to furnish a set of concepts in terms of which the future is viewed, and the record of recent and past developments provided by the statistics has been studied to yield clues as to the probable course of future events.

The extent to which these economic forecasts have been elaborated has varied. Often policy recommendations have involved only implicit forecasts of selected aspects of the economy. Sometimes they have been based explicitly upon complete descriptions ("models") of the anticipated course of the economy as a whole. While the latter approach has not·been more successful, it will be outlined because it exhibits some of the logic and limitations that characterize also the more eclectic variant.

In problems relating to wartime economic mobilization. for instance. the broad technique is to estimate the total national output that can be produced under given assumptions relating to the availability of labour and other resources and probable trends in productivity. This total is then allocated among the conflicting military and civilian requirements. Next, the money demands for civilian output that would be generated at the projected level of national income are estimated. Finally. if these demands are found to differ from supplies at existing prices, the tax. monetary, allocation and other measures needed to bring them into equality at reasonably stable prices are determined.

The phase of this analysis that deals with the probable magnitude of private demands at the projected level of national income usually relies heavily on past regularities in economic behaviour, such as past relations between income and market demand. These relations are also used in gauging the effects on demand of tax measures. such as specified changes in tax rates. But relations that have obtained in the past are often modified in projecting the future, to take into account the expected effects of altered circumstances. Other techniques, such as surveys of spending intentions, can also be used to help in forecasting.

Similar techniques are applied to problems of peacetime stabilization. The demand for national output is forecast on the basis of foreseeable future developments. If this demand is found to deviate from a level of output that is satisfactory from the standpoint of the stabilization goal, the fiscal. monetary and other measures necessary to stimulate or restrict demand are gauged. Projection of past relationships and surveys of spending intentions are the mainstays of this analysis also.

Use of national income data in problems of economic reconstruction and development involves a similar confrontation of the projected national output with the demands upon it and adjustment of the two to each other by means of the policy actions available to the government. In many instances an analysis of the role of international trade, aid and investment is essential in working out a solution.

Even though national income statistics are used widely in formulating public policy recommendations, the precise nature and significance of their role is not clearly established. In only a few countries have the methods reviewed been used intensively even on a technical level. Moreover, the weight which policymakers have given to recommendations based on these methods has been limited by other considerations that influence practical policies, as well as by the admitted shortcomings of the methods themselves.

The conclusions these methods suggest are uncertain partly because national income data are subject to considerable error but mainly because our knowledge of the future behaviour of the economic system is imperfect. National income estimates provide only a record of past events, and there is no guarantee that regularities disclosed by them will persist in the future. Nor will plans indicated in surveys of spending intentions necessarily materialize. While improvements in the statistics and in economic knowledge can be expected, it would be unrealistic to be overly hopeful about the extent to which economic forecasts can be made more firm. The interplay of economic forces is so complex, and their connections with noneconomic factors so numerous and close, that the odds against predicting economic events with a great deal of certainty seem overnhelming.

Nongovernmental uses of national income statistics also have become prominent. In particular, businessmen use the estimates to gauge the general economic climate in which their enterprises will operate. The over-all magnitudes embodied in these forecasts are used also to infer future market conditions for particular goods in which individual firms are interested, either as purchasers or sellers. These evaluations aid in the formulation of investment, production, price and other policies.

In addition to these and other applications, which have made national income statistics a widely used tool for practical orientation in the economic world, the data have been employed increasingly in academic studies. to test and develop hypotheses of economic theory. The problems encountered have to a large extent coincided with those confronted in the practical use of the data.

Sources and Methods of Compilation. — Existing programs of primary data collection are not designed specifically to measure national output, its components and the other entries in the national accounts. Instead, these magnitudes must be estimated by utilizing information prepared largely for other purposes. Prominent among this information are census enumerations and sample surveys, and statistics that are by-products of various governmental activities such as the administration of social security systems, tax laws and expenditure programs. Many other sources, too varied to summarize, are also used. The basic data often depart definitionally and in coverage from the items in the national income accounts. Estimation of these items involves, accordingly, the integration of all the available — and sometimes conflicting — information, and the filling of data gaps by resort to partial and indirect evidence.

National income figures are thus subject to error not only because of inaccuracies in the basic data but also because of imperfections in the estimating methods. Moreover, their margin of error cannot be precisely quantified, because the usual mathematical techniques for measuring error are not applicable to this complex case. Estimates of the margin of error which occasionally accompany national income figures fall short of definitional precision and incorporate a great deal of subjective judgment.

The reliability of national income statistics depends on the adequacy of the primary information and the effectiveness of the estimating techniques. It varies greatly from country to country, and within each country among the several entries in the accounts and according to the time period covered. Reliability is likely to be vastly higher for advanced industrial countries than for countries in which industrial processes have not developed. This situation is so mainly because industrial economies are characterized by transactions that lend themselves to registration in statistical form, and because the problems confronting such economies are likely to induce extensive data collection.

Other things being equal, relative errors in broad aggregates are likely to be smaller than those in its separately estimated components, because of offsetting error. For any given series, estimates referring to the remote past and to very recent periods are likely to be less accurate than estimates for intervening dates. This situation is so because the primary data diminish rapidly as one explores further into the past, and because estimates for recent periods are usually made before all the source material is at hand. Similarly, quarterly and monthly series are likely to be less accurate than annual estimates.

In an intensive use of the data it will be necessary to go beyond these generalizations and, mainly by an examination of the methodology underlying the estimates, form a judgment as to the order of their reliability. Thus, not only the preparation of national income statistics but also their use requires skill.

Availability of National Income Statistics. — National income estimates were prepared (in England) as early as the 17th century. But workmanlike estimates covering a span of years and built up from detailed components are largely a product of the 20th century. The economic problems associated with the depression of the 1930s and World War II made, it vitally important to understand the economy and gave further impetus to the development of the statistics. largely under governmental aegis. In the postwar period, problems of economic reconstruction and development have had similar effects.

Originally indigenous to western industrial countries, national income estimates are now available for a large number of others, differing widely as to needs. resources, technologies and institutional structure. The United Nations and other organizations have been active in promoting international comparability, both by developing standard accounting systems and by preparing compilations in which reported series are adjusted to uniform definitions.

Other noteworthy tendencies are the preparation of estimates on a less than annual basis and a speed-up in their publication schedules. This emphasis on recency reflects the active use of the data in current business analysis.

Unsettled Problems. — In conclusion, some outstanding unsolved problems relating to the design of national income statistics will be sketched.

1. As noted earlier, measures of national output are confined largely to output intended for sale, but marginal departures from this rule are made by imputing values to certain nonmarket items. These imputations are a source of irritation logically, because they do not flow from any general definition of output that can be specified. Moreover, the treatment of nonmarket production constitutes an acute practical problem in the analysis of economic conditions in countries whose market economies are undeveloped and also in international comparisons. Accordingly. much thought has been devoted to nonmarket output. Some progress has been made through the proposal of international conventions for its treatment, and *ad hoc* solutions may be found to serve the needs of specific analyses. But it seems doubtful whether an operational definition of national output not anchored to the market criterion ever can be devised.

2. There has been a persistent tendency to advance either market or factor price as the sole basis for valuing output, to the exclusion of the other method. On the whole, the market price valuation has gained in acceptance. It expresses goods in terms of the prices at which they are actually exchanged. and hence is the more realistic, easily understood and statistically convenient method.

The major justification of factor price series is that they are the best available measures of the services rendered by the ultimate agents of production, such as labour and capital, and that they provide a tool for the investigation of problems involving the allocation of these productive resources among alternative uses. Indirect business taxes must be excluded. it is maintained, because they do not reflect the services of productive agents as does the sum of wages, profits and other incomes originating in production.

The main objection to this argument is that it is based upon an assumption of circumstances — mainly stable and competitive business conditions — that do not obtain in practice. If these are absent, national output aggregates cannot be used to gauge resource allocation even if indirect taxes are excluded. For instance, the productive contribution of capital resources will not be reflected adequately in the national income totals in times of reduced economic activity when profits are depressed and in some instances even negative; similarly, monopolistic practices in an industry may give rise to incomes that give an exaggerated notion of the proportion of procedure resources actually engaged there.

3. Questions have been raised as to the proper distinction between final output and intermediate products. Specifically, it has been urged that not all of the output purchased by government be considered final, as is commonly done. Some of it should be excluded from the national output total, it is said, as are intermediate products. Somewhat more tentatively, it has been suggested that not all output bought by consumers be regarded as final either. No clear-cut proposals have been made, but the general idea appears to be to distinguish purchases that are direct causes of final human satisfaction from those that are only indirect conditions of it. and to exclude the latter. Opponents of the idea have argued that the proposed distinction cannot in fact be drawn; and they have not been refuted, either in logic or through the presentation of a viable classjfication that implements the proposed narrowing of the final product concept.

4. For some of the uses that are made of the data, it would be desirable to extend the definition of capital formation beyond its core, tangible capital formation by business, to intangible items, such as expenditures for industrial research, and to capital formation by government and consumers. Little has been done to recognize intangible capital, but capital expenditures by government have increasingly been taken into account, instead of being treated like current consumption.

The acquisition of residences is the only consumer purchase that is generally recognized as capital formation. There are sound reasons for extending this treatment to other consumer durables, inasmuch as these also outlast the normal accounting period and thus constitute additions to wealth. However, the extent to which capital accounting has been applied to them in actual national income estimates has been limited.

Measurement of capital formation on a gross basis, *i.e.,* before deduction of capital consumption allowances. raises problems because it is difficult to frame a uniform definition. For instance, it is hard to draw a systematic line which will either exclude or include repair and maintenance expenditures. In addition. the gross measure is insufficient because it does not show net additions to the capital stock. However, it appears difficult also to obtain a net capital formation measure that is meaningful for output measurement.

The conventional capital consumption allowances made by business are inadequate to serve as subtrahends from gross capital formation for this purpose. To an increasing extent they are affectedand made noncomparable over time by changes in tax laws. In addition, they are usually stated in terms of the original cost of the capital goods, and hence cannot be deducted from gross capital formation, which is expressed in current prices, to obtain a meaningful indication of the net change in capital stock. The realism of the methods used to allocate capital consumption charges over the lifetime of the assets is also often in doubt. It is not easy. however, to devise alternative, more meaningful measures of capital consumption.

The task of offsetting capital equipment used up against capital equipment produced is made difficult by changes in the character of the equipment, and by inadequate knowledge of the actual life span of capital goods and the time pattern according to which they are consumed.

5. Difficulties (additional to those involved in the accounting for nonmarket production) are encountered in comparing outputs produced in situations that differ radically as to needs, resources, technologies and institutional organization. These difficulties arise because in these circumstances the composition and the types of goods produced are likely to be very different. If, for instance. output of commodity A in one country is double that in another while output of commodity B is one-half, it is not possible to make an unambiguous comparison of the outputs of A and B combined. The result depends on the relative value that is attached to each commodity. Again, if in one time period output of transportation equipment consists of horse-drawn carriages, and in another of automobiles, it is not really possible to make a quantitative comparison between the two. As long as differences in composition and kind are moderate, the methods for calculating real national output described earlier will yield useful results. But little significance attaches to. the precise outcome of comparisons when these differences are substantial.

6. Apart from problems involving the definition of output, many others have arisen concerning accounting design: what are the economic groups whose activities should be separately shown? What types of accounts should be established? How should the transactions registered in the accounts be classified? What part of the information should be presented in interrelated accounts, and what part in supporting tables? While many of these issues are largely presentational, some have broader significance. For instance. the finances of unincorporated business are usually intermingled with the household finances of their owners, and one of the important problems of accounting design is to find a satisfactory place for unincorporated enterprise among business and household transactors.

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NATIONALISM, a state of mind, in which the supreme loyalty of the individual is felt to be due to the nation-state. Though attachment to the native soil, to parental traditions and to established territorial authorities have been known throughout history, it was only at the end of the 18th century that nationalism began to become a generally recognized sentiment molding public and private life and one of the great, if not the greatest, single determining factors of history. Thus nationalism is a modern movement, but, in the short span of its existence as a dominant element of societal life and organization, it has shown such a dynamic vitality and such an all-pervading character that the mistake has frequently been made of regarding nationalism as a permanent, or at least very ancient, factor of history. In reality, nationalism arose as a dominant force in the 18th century in western Europe and in North America; the American and the French revolutions may be regarded as its first powerful manifestations. From the western world, after having penetrated the new countries of Latin America, it spread in the early 19th century to central

Europe, thence, toward the middle of the century, to eastern and southeastern Europe, until. at the beginning of the 20th century. it put its stamp on the ancient lands of Asia and Africa. Thus nationalism has become a dominating force everywhere —so much so that the 19th century has been called "the age of nationalism" in Europe, while the 20th century has witnessed the rise and struggle of national movements throughout Asia.

Nationalism implies the identification of the state or nation with the people, or at least the desirability of determining the extent of the state according to ethnographic principles. In the age of nationalism, but only in the age of nationalism. the principle was generally recognized that each nationality should form a state, its state, and that the state should include the whole nationality. Formerly states, or territories under one administration, were not delineated by nationality; men's loyalty was not due to the nation-state, but to other, different forms of political organization: the city-state, the feudal fief and its lord, the dynastic state, the religious group or the sect. The nation-state was nonexistent during the greater part of history and for a very long time it was not even regarded as an ideal. In the first 15 centuries of the Christian era the ideal was the universal world-state, not loyalty to any separate political entity. The Roman empire had set the great example which survived not only in the Holy Roman empire of the middle ages, but also in the res *publica christiana* (Christian republic or community) and in its later secularized form of a united world civilization and world policy as it appeared in the aritings of the 17th century.

As political allegiance, before the age of nationalism, was-not determined by nationality. so civilization was not thought of as nationally determined. During the middle ages civilization was looked upon as determined religiously; for all the different nationalities of Christendom as well as for those of Islam there was but one civilization — Christian or Moslem — and but one language of culture — Latin (or Greek) or Arabic (or Persian). Later in the periods of the Renaissance and of classicism, it was the ancient Greek and Roman civilizations which became a universal norm. valid for all people and all times. Still later French civilization was accepted throughout Europe as a valid civilization for educated people of all nationalities. It was only at the end of the 18th century that, for the first time, civilization was considered to be determined by nationality and the principle was put forward that a man can be educated only in his own mother tongue, not in languages of other civilizations and other times. be they classical languages or the literary creations of other peoples who had reached a high degree of civilization. From the end of the 18th century on, the nationalization of education and national life went hand in hand with the nationalization of states and political loyalties. In many cases poets and scholars emphasized cultural nationalism first. They reformed the national language, eievated it to the rank of a literary language and delved deep into the national past, thus preparing the foundations for the political claims for national statehood soon to be raised by people in whom they had kindled the spirit of nationalism.

National feeling was evident in certain groups at certain periods, especially periods of stress and conflict, before the 18th century. Its rise was prepared by a number of complex events: the creation of large, centralized states by the absolute monarchs, who destroyed the feudal allegiances and thus made the integration of all loyalties in one centre possible; the secularization of life and education which fostered the development of the vernacular languages and weakened the ties of religious or sectarian loyalties; the growing economic interdependence which demanded larger territorial units, which would at the same time give the necessary scope to the dynamic spirit of the rising middle classes and their capitalistic enterprise. This large. unified territorial state with its political and economic centralization was filled in the 18th century with a new spirit — an emotional fervour, similar to that which in preceding periods characterized religious movements. Under the influence of the new theories of the sovereignty of the people and the rights of man, the people replaced the king as the centre of the nation. No longer was he the nation or the state; the state had become the people's state, a national state, a fatherland. Nation and state became identified, as civilization became identified with national civilization.

This was opposed to all the conceptions which had dominated political thought for the preceding 2,000 years. During that period man had commonly stressed the general and the universal and had seen in unity the desirable goal. Nationalism stressed the particular and parochial, the differences and the national individualities. These tendencies became more pronounced as nationalism developed. In the 17th and 18th centuries the common standards of western civilization, the regard for the universally human, the faith in reason, one and the same everywhere, and in common sense, the survival of the Christian and Stoic traditions were all too strong to allow nationalism to develop fully and to disrupt the society of man. Thus nationalism in its beginning was thought compatible with cosmopolitan convictions and with the general love of mankind. This was especially true in western Europe and North America.

The first full manifestation of modern nationalism occurred in 17th-century England, in the Puritan revolution. That century saw England the leading nation in the scientific spirit, in commercial enterprise, in political thought and activity. Swelled by an immense confidence in the new age, the English people felt upon their shoulders the mission of history, a sense that they were builders of destiny at a great turning point from which a new true reformation and a new liberty would start. In the English revolution an optimistic humanism and Calvinist ethics merged; the influence of the Old Testament gave form to the new nationalism by identifying the English people with ancient Israel. The new message, carried by the new people not only for England, but for all mankind, was expressed in the writings of John Milton in whose famous vision the idea of liberty was seen spreading from Britain, "celebrated for endless ages as a soil most genial to the growth of liberty" to all the corners of the earth. "Surrounded by congregated multitudes, I now imagine that I behold the nations of the earth recovering that liberty which they so long had lost; and that the people of this island are disseminating the blessings of civilization and freedom among cities, kingdoms and nations."

English nationalism was thus much nearer to its religious matrix than later nationalism which rose after secularization had made greater progress. The nationalism of the 18th century shared with it. however, the enthusiasm for liberty, the humanitarian character. the emphasis upon the individual and his rights and upon the human community beyond all national divisions. The rise of English nationalism coincided with the rise of the English trading middle classes; it found its final expression in Locke's political philosophy. It was in that form that it influenced American and French nationalism in the following century.

The rising nationalism of the settlers in British North America was influenced partly by the English traditions of the Puritan revolution and of Locke, and partly by the new rational interpretation given to English liberty by contemporary French philosophers. American nationalism became the typical product of the 18th century. The American settlers became a nation engaged in a fight for liberty and individual rights, basing that fight on current political thought, especially as expressed by Thomas Jefferson and Thomas Paine. This was a liberal and humanitarian nationalism. regarding America as the vanguard of mankind on its march to greater liberty, equality and happiness for all. The ideas of the 18th century found their first political realization in the Declaration of Independence and in the birth of the American nation. Their deep influence was felt in the French Revolution which enthroned French nationalism in place of French royalty.

Rousseau had prepared the soil for the growth of nationalism, not only by his stress on popular sovereignty and the general co-operation of all in forming the national will, but also by his regard for the common people as the true depository of civilization. Under his influence Herder gained a new understanding of art and civilization by emphasizing folklore, folk songs and primitive popular traditions as revealing the true creative forces of a nation. He went beyond Rousseau in his appeal to the past, often to the primitive past. He glorified the instinctive and irrational, and turned attention from the universally human and general to the peculiarities of each national tradition, regarding them as valuable sources of creative inspiration. Under Herder's influence German romantic nationalism later stressed these factors of irrationalism and of national peculiarities. The nationalism of the French Revolution, on the other hand, was the triumphant expression of a rational faith in common humanity and liberal progress. The famous slogan of "liberty, equality, fraternity" and the Declaration of the Rights of Man and of the Citizen were thought valid not only for the French people, but for all peoples. Individual liberty, human equality, fraternity of all peoples: these were the common cornerstones of all liberal and democratic nationalism. In their name the French nation constituted itself, overthrew the monarchy and soon began to spread the new gospel across Europe. Under their inspiration a new ritual was developed which partly took the place of the old religious ritual: festivals and flags, music and poetry, national holidays and patriotic sermons. In the most varied forms nationalism permeated all manifestations of life. Like the rise of American nationalism, the rise of the French produced a new phenomenon in the art of warfare: the nation in arms. In America and in France, citizen armies, untrained but filled with a new fervour, proved superior to professional armies which, though highly trained, fought without the incentive of nationalism. The revolutionary French nationalism stressed the element of will, of free individual decision, in the formation of nations. Nations were constituted by an act of self-determination on the part of their members. The plebiscite became the instrument whereby the will of the nation was expressed. In America as well as in revolutionary France, nationalism meant the adherence to an idea, a universal progressive idea, looking toward a common future of freedom and equality, not toward the past which had been characterized by authoritarianism and inequality.

Napoleon's armies spread this nationalism throughout Europe and even into the near east; on the other side of the Atlantic it aroused the Latin Americans. But Napoleon's yoke turned the newly awakened nationalism of the European peoples against France. In Germany, where the struggle was led by writers and intellectuals. it turned not only into a rejection of Napoleon's rule but of all the principles upon which the American and the French revolutions had been based and of the liberal and humanitarian form of nationalism. German nationalism began to stress instinct against reason; the power of historical tradition against rational attempts at progress and a more just order; the historical differences between nations against their common aspirations for the future. The French Revolution, liberalism and equality were regarded as a brief aberration, against which the eternal foundations of societal order would prevail. This interpretation was shown to be false by the development of the 19th century. Liberal nationalism reasserted itself, it permeated more and more peoples, the rising middle class and the new proletariat. The revolutionary wave of 1848, the year of "the spring of the peoples." seemed to realize the hopes of nationalists such as Mazzini, who had devoted his life to the unification of the Italian nation by democratic means and to the brotherhood of all free nations. Though his immediate hopes were disappointed, the 12 years from 1859 to 1871 brought the unification of Italy and Rumania, both with the help of Napoleon III, and of Germany; at the same time the 1860s saw everywhere great progress in liberalism, even in Russia and Spain. This victorious trend of liberal nationalism was, however, reversed in Germany by Bismarck. He unified Germany on a conservative and authoritarian basis and defeated German liberalism. The annexation of Alsace-Lorraine against the will of the inhabitants was contrary to the principle of nationalism based upon the free will of man. The people of Alsace-Lorraine were held to be German by objective factors, by race, independent of their will or of their allegiance to any nationality of their choice.

In the second half of the 19th century, nationalism disintegrated the supranational states of the Habsburgs and the Ottoman sultans, both of which were based upon prenational loyalties. In Russia the penetration of nationalism provoked a twofold attitude: some nationalists advocated an acculturation of Russia to the general progress of western mankind. They proposed a westernized Russia, following the common destiny of progressive society. Others stressed the distinctive character of Russia, its independent and different destiny, based upon its past of autocracy and orthodoxy. These Slavophiles, similar to and influenced by German romantic thinkers, saw Russia as a future saviour of a west undermined by liberalism and the heritage of the American and French revolutions.

As a result of World War I, nationalism triumphed in central and eastern Europe. The new nation-states emerging from the ruins of the Habsburg and Romanov empires were, however, subject themselves to the strains of internal nationality conflicts and territorial disputes with neighbouring states. World War I also stirred the masses in Asia into nationalist demands. In 1885 Indian nationalists had organized the Indian National Congress to promote a liberal nationalism, inspired by the English model. On the other hand, Japan, influenced by Bismarck's Prussia, made use of modern industrial techniques to strengthen a more authoritarian trend. After World War I the Asian peoples inaugurated their age of nationalism under the leadership of such powerful personalities as Kemal Ataturk in Turkey, Saad Zaghlul in Egypt, Ibn Sa'ud in the Arabian peninsula, Gandhi in India and Sun Yat-Sen in China. Ataturk succeeded in revitalizing and modernizing the formerly medieval structure of Turkey, replacing the Islamic monarchy by a secular republic. The demands of Arab nationalists for Arab unity were frustrated by French and British imperialism. Yet Britain showed a gift for accommodation with the new forces. It helped create an independent Egypt and Iraq, and displayed a similar spirit in India, where the Congress had become more radical after 1918. In China Sun Yat-Sen pleaded before his death (1925) for China's co-operation with communist Russia.

Lenin's triumph in Russia in Nov. 1917 meant the triumph of international communism over Russian nationalism. From the beginning, however, communism appealed to the new nationalist movements in Asia and Africa for support in its struggle against western capitalism. Fascism and National Socialism in the 1930s presented an unprecedented intensification of nationalism. In their turn they influenced the older totalitarian movement of communism. In World War II Russian nationalism and imperialism reasserted themselves under the communist dictatorship. After World War II the communist leaders tried to use nationalism everywhere for their own purposes.

On the other hand nationalism in communist-controlled countries turned against the Russian claim of centralized leadership throughout the communist world. With Tito setting an example in Yugoslavia, this so-called national communism became an important factor and helped inspire the liberation movements in Poland and Hungary in the fall of 1956.

The end of World War II also saw a mighty resurgence of nationalism throughout Asia and its first powerful manifestation in Africa. This new Asian-African nationalism, which dominated the conference of Asian and African peoples in Bandung, Indon., in 1955, made itself felt to a growing degree in the 1950s in the world community represented by the United Nations. A number of new nations arose, some in a peaceful way as a result of timely British and U.S. concessions—India. Pakistan, Ceylon, Burma, Malaya, the Philippines and Ghana. Others had to fight hard for their independence in bitter colonial wars, as in French Indochina (Vietnam. Laos and Cambodia) and French North Africa.

This progress to independence through nationalism from colonial status was in accord with the best traditions of western liberalism as embodied in the governing principles of the League of Nations and the United Nations. But conditions in the second half of the 20th century. with its rapid advances in communication, indicated, beyond the fragmentization of the world into nation-states. the need for international co-operation on a world-wide basis corresponding to the new reality of the growing common destiny of mankind.

See also IMPERIALISM; COLONY; SELF-DETERMINATION. For socialist and communist attitudes toward nationalism see SOCIALISM; COMMUNISM.

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NATIONALITY. As a legal concept, nationality is distinguishable from the popular use of the term to denote membership in a nation, meaning a people bound together by ethnic, religious or linguistic ties. *(See* NATIONALISM.) It is also distinguishable from citizenship (*q.v.*), a somewhat narrower term that is sometimes used to denote the status of those nationals who have full political privileges. Before an act of the U.S. congress made them citizens in the full sense of the word, for example, American Indians were sometimes referred to as "noncitizen nationals."

Not only individual human beings but also companies (corporations). ships and aircraft have nationality for the purposes of law. It is in reference to natural persons, however, that the term finds most frequent use. In general, nationality implies the duty of allegiance on the part of the person and the duty of protection on the part of the state. The UN Universal Declaration of Human Rights *(see* CIVIL LIBERTIES) in 1948 stated that "everyone has the right to a nationality" and that "no one shall be arbitrarily deprived of his nationality. . . ." Whether an individual possesses the nationality of a particular state may determine whether or not that state has a right to exercise jurisdiction over him in certain circumstances. If he is a national he may enjoy political and economic rights and privileges that he would not otherwise have. Wow one acquires nationality, how it may be lost, the possibility of statelessness and applications of the concept in international legal relations are matters of some practical importance.

The concept of nationality is found in both international law and national law. It is the nation-state which sets the criteria, through constitutional or statutory provisions, for determining who shall be its nationals. The right of a state to confer its nationality is, however, not unlimited, for otherwise it might impinge upon other states' rights to determine what persons shall be their nationals. By the *jus soli,* a person who is born within a state's territory and subject to its jurisdiction acquires that state's nationality by the fact of such birth. By the *jus sanguinis,* a person has a nationality as an inheritance from one or both of his parents. States vary in their use of these two principles. Some give priority to the *jus soli* but also rely to some extent on the *jus sanguinis;* others apply principally the *jus sanguinis,* but not all of these exclude the *jus soli.* When one state cedes territory to another, inhabitants of the region that is ceded commonly have. at the will of the acquiring state, an opportunity to acquire that state's nationality.

Practice, however, supports the idea that the individuals concerned should be allowed a free choice, with the understanding that those who choose to retain their old nationality may have to leave the territory. Still another method of acquiring nationality is through the process of naturalization.

An individual may lose his nationality through extinction of the state of which he has been a national. He may also lose it through naturalization in another state, but there is no universally binding law which requires that a state must recognize that one of its nationals, by reason of his being naturalized in a foreign state, has divested himself of his former nationality. There have been some treaties committing each signatory to recognize that its nationals who have migrated to the territory of another signatory and become naturalized there shall be regarded as having divested themselves of their original nationality.

The right of expatriation has not been universally recognized, however, and the possibility of dual or multiple nationality remains. Nor has the effort to eliminate statelessness been completely successful, although such an objective was considered by the Hague codification conference of 1930 under League of Nations auspices and by the International Law commission of the United Nations.

Under United States legislation of the 1950s, loss of nationality may be the result of treason, desertion from the armed forces, evasion of the military draft, service in the army of a foreign state or voting in an election in a foreign state. Naturalized citizens may in certain circumstances lose their acquired nationality by reason of long residence in some other state.

In the late 1940s there was a move in the British Commonwealth to continue, through parallel legislation, a common status of British subject or commonwealth citizen, while each of the states retained its own citizenship. *(See* COMMONWEALTH OF NATIONS: *Nationality and Citizenship.)* Such common status as was the result did not rest indefinitely upon a common allegiance, as some of the states concerned adopted the republican form of government.

One problem that has been dealt with in national legislation and in a projected international agreement is that of the nationality of married women. The trend has been away from the practice that allowed a woman's nationality to be changed by the mere fact of her marriage or by a change in her husband's nationality. The United Nations general assembly in 1957 approved a Convention on Nationality of Married Women that embodied the rule that a woman's nationality is not to be automatically changed by virtue of the celebration or dissolution of marriage.

In international legal relations nationality assumes significance in various circumstances. The fact that a person is a national of a state may be the basis for that state's exercising criminal jurisdiction over him, although his alleged crime may have been committed outside the state's territory. In making extradition treaties, states have often included clauses making it optional for them to surrender persons who are their own nationals. If a state desires to expel a person from its territory there is no international legal obligation for any state, other than the one of which the person is a national, to receive him.

A state's failure to afford reasonable protection to aliens may lead to claims by other states, the adjudication of which will require decision of questions concerning the nationality of claimants. The rule normally applied is that the claimant must be, for the purpose of a claim brought before an international claims commission, a national of the applicant state continuously from the time the cause of action has arisen to the time of the actual adjudication.

Legal questions may also arise in connection with legislation affecting alien enemies. Such persons may seek to avoid disabilities by becoming naturalized in a third state, but such efforts are not always successful. The International Court of Justice in the *Nottebohm Case* in 1955, for example, held that Guatemala was not bound to recognize the naturalization of a German national by Liechtenstein because the individual had not had a sufficiently close connection with the state concerned.

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NATIONALIZATION is one of a number of ways in which the state can alter or terminate the control or ownership of private property. Generally, in mature systems of law, the state or local government authorities possess the right to take private property for particular public purposes, such as the construction of roads, reservoirs or hospitals. In 1254 a power of this nature was granted by charter to the city of Copenhagen. Other examples may be found in the middle ages in German and Scandinavian law. The same principle was acknowledged in the French Declaration of the Rights of Man in 1789, as it was also in the fifth amendment to the constitution of the United States. The exercise of this right, which is normally accompanied by the payment of compensation, may be described as "expropriation" or as "eminent domain" (*q.v.*). By contrast, "nationalization" is historically a more recent development and differs both in motive and degree from "expropriation."

Nationalization is customarily, though not exclusively, associated with the implementation of communist or socialist theories of government This is certainly true both of the transfer of industrial, banking and insurance enterprises to the state in Russia in the period after the acquisition of power by the Soviet regime in 1918 and of similar developments in Bulgaria. Czechoslovakia, Hungary, Poland, Rumania and Yugoslavia after World War II. The same may be said also of the nationalization of the coal. electricity, gas and transport industries in the United Kingdom and France between 1945 and 1950. However, the conscious implementation of political and economic doctrine has on occasion become mixed with resentment at foreign control over industries upon which the state may be largely dependent. This was clearly a factor in the nationalization of the oil industries in Mexico in 1938 and in Iran in 1951, and in the nationalization of the Suez Canal company in Egypt in 1956. (See PERSIA: History; SUEZ CANAL.)

The process of nationalization may take various forms, especially in the case of industries owned primarily by companies. In some instances, the assets of the nationalized companies are transferred to the state; in others, the share capital is made the object of the transfer, leaving the company in existence to carry on its business under state control. But whatever the process employed, the result is ultimately that title to or control over the property is placed in the state itself or in a state-established and publicly controlled organ.

Questions of international law normally arise only when the property is owned either by aliens or by companies in which aliens have a large shareholding interest. It has become established as a matter of general principle that aliens carrying on activities or owning property in foreign states are entitled to treatment in accordance with a "minimum standard of international law" In particular. the arbitrary treatment of aliens is unlawful, as is discriminatory treatment directed toward them solely because they are aliens. In addition, as a result of a number of diplomatic episodes and international arbitrations, it is acknowledged, at least in relation to isolated takings of private property, that such taking is lawful only if accompanied by the payment of fair compensation. There are two leading decisions on this point. In the case of the Norwegian ships (Norway v. United States, 1925), the Permanent Court of Arbitration held that the United States was under an obligation to pay to Norwegian nationals, whose rights under certain shipbuilding contracts had been seized by the United States during World War I, a sum described as "fair compensation" for the loss which they had suffered. In assessing the amount payable, the court took into consideration such factors as the value of the contracts as between a willing buyer and a willing seller on the date of the seizure, the sum which the Norwegian nationals had actually expended and the amount of interest due if payment in respect of the seizures had been promptly made. The second case, that of the *Chorzów* factory, between Poland and Germany, decided by the Permanent Court of International Justice in 1927 and 1928, arose out of the seizure by the Polish authorities of certain German property in breach of the terms of the treaty of Versailles and of the Geneva convention of 1922. The case is notable for the distinction drawn by the court between lawful takings of alien property. for which fair compensation should be paid, and unlawful takings, for which not mere compensation, but true damages, assessed on the principle of *restitutio* in *integrum* (restoration of the original situation), should be paid. This principle requires that if the wrongdoer cannot discharge his primary obligation of restoring the injured party to his control of the property unlawfully seized, the injured party should be paid such sum as would notionally put him in the same position as if the wrong had not been committed. Although in this case the taking was unlawful because it involved a breach of a treaty, the judgment is also open to the interpretation that a taking may be unlawful if no genuine attempt is made to assess or pay fair compensation. A further important feature of the judgment is that, in relation to lawful taking, it identifies "fair compensation" with "the value of the undertaking at the moment of dispossession, plus interest to the day of payment," and thus establishes an objectively ascertainable standard of fair compensation.

It remains a matter of controversy whether these authorities apply with equal force when the scale of the taking of alien property is expanded from isolated expropriation to large-scale nationalization. On the one hand, emphasis is placed upon the continuing rights of the foreign investor. It is argued that these rights remain unaffected by any difference in degree between expropriation and nationalization; that there is no reason why the foreign investor should bear the cost of implementing local political policies; and that the alien suffers equal material loss in both cases. The right to nationalize alien property is, for these reasons, said to be conditional upon the payment of "prompt, adequate and effective compensation." On the other hand, stress is laid upon the sovereign right of every state to determine its own political, social and economic future. If need or theory require that the ownership of property should be vested in the state, its freedom of action should not be fettered by the fact that it is too poor to pay the fair market price for alien property. The foreign investor, it is argued, places his capital abroad in the hope of making profits, and he would not do so if he did not consider that the returns outweighed the risks. This contention is frequently coupled with the assertion that in many cases the value of the original investment of the alien had been fully returned to him in the shape of profits repatriated during the period of operation.

No international tribunal has yet been placed in a position to express an authoritative view on the controversy. The suggestion has been made that in case of true nationalization the solution lies in the payment of "partial compensation." It is doubtful, however, whether this formula is either sufficiently precise or adequately supported by authority for it to be accepted as representing existing law; though, admittedly, in practice, many disputes have been settled by agreement for amounts which have fallen short of the real value of the property involved. When the British claims against Mexico in respect of the expropriation of the oil properties were settled in 1947, the compensation secured probably did not amount to more than one-third of the value of the property seized. Nor was any higher standard of compensation achieved by the "lump sum" agreements relating to the nationalization measures of the eastern European states after World War II. Although this method of settlement normally leads to the certain payment of at least a proportion of the true value of the property, it has been estimated, for example, that under the agreements between the United Kingdom and Yugoslavia and Czechoslovakia the original owners can have received respectively no more than 45% and 25% of their claims. It is more difficult to assess the value of the settlements reached in the Anglo-Iranian oil company and Suez Canal company disputes. In the former, it was agreed in 1954, as part of a wider arrangement relating to the oil industry in Iran, that Iran should pay to the company the sum of £25,000,000 which represented a balance struck after taking into consideration various unspecified claims and counterclaims. In addition, the company became a 40% participant in the consortium of oil companies established to operate the oil industry on behalf of the Iranian government and is understood to have received certain payments from the other members of the consortium.

In the case of the Suez Canal company, the Egyptian government agreed in 1958 to pay to the company a sum of £E28,300,000 over a period of six years and to allow the company to retain all its assets situated outside Egypt.

However, despite the apparent generality of the practice of settling nationalization disputes by agreements providing for compensation which does not represent the full value of the property nationalized, there does not appear to be sufficient warrant for the view that customary international law now acknowledges the validity of nationalizations which are not accompanied by the payment of fair compensation. There is equally no adequate justification for the view that, because a number of states have nationalized foreign companies in breach of express undertakings to permit their operation for a fixed period of years, there is no rule of international law which protects specific contractual commitments. Nevertheless, as a means of reducing difficulties arising out of the uncertain content of the rules of customary international law relating to compensation, states whose nationals tend to be investors are placing increasing reliance upon specific treaty clauses providing for the protection of investments. The United States, in particular, has since the end of World War II entered into treaties of friendship, commerce and navigation which contain mutual undertakings on this point, coupled with clauses conferring compulsory jurisdiction upon the International Court of Justice.

For socialist and communist attitudes toward nationalization *see* COLLECTIVISM; COMMUNISM; SOCIALISM.

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NATIONAL PARKS AND NATURE RESERVES. For hundreds if not thousands of years and in many countries man has given some sort of protection to those wild animals he has used for food and sport. Before the 19th century he seldom had any other motives; it is only relatively recently that animals have been thought worthy of preservation for their own sakes and for the appreciation of future generations of mankind. Even more recently has man begun to realize that it is not only the so-called game animals that need to be preserved, but the forests, the water and the soil itself—in fact, the whole natural scene.

Whatever the motives for preservation, the means must nearly always include setting aside areas where restraints are enforced. Such restraints may be permanent or restricted to certain months of the year; they may give protection to all creatures or to one class only (for example, birds) or even to one particular species, or they may impose restrictions upon the use of certain natural resources, such as timber. The area may be tiny or very large, privately owned or in government hands.

Because there are so many kinds of areas of preservation and because they have been coming into being in many countries at the same time, it is hardly surprising that there has been little uniformity of terminology. A national park in the United States or Canada is intended to safeguard natural features and wildlife in a way that will contribute to public enjoyment. National parks in England and Wales are thinly inhabited regions where the natural scenery is safeguarded; animal and bird life in Britain is preserved in nature reserves. In Africa, generally, the chief purpose of a national park is the preservation of wildlife. A game reserve may be a place where a stock of game for shooting is maintained by game management or it may be a larger area designed to preserve wildlife that is rapidly disappearing elsewhere. Even within a single country where the legal status implied by a name is usually clear, the actual effect of restrictions may vary from being highly effective to being worse than useless. A game reserve that is small in area may be invaluable because it protects a rare species and is properly guarded; another enormous area without guards and with only nominal restrictions may be a happy hunting ground for lawbreakers. In some countries, also, the local people have not learned the economic and tourist potential in their wild animals and slaughter them indiscriminately, either for meat or for portions of the carcass, or destroy the essential habitat by overgrazing of domestic livestock or by using the lands for crops.

The paradox of national parks is that whereas they may depend on tourists for their existence by creating public interest in wildlife preservation, the animals themselves depend for their preservation on being unmolested. The best way of resolving this paradox would seem to be to restrict the movement of the visitor, as has been done in numerous parks, by setting aside an area within or near the national park where hotels, restaurants, parking places for cars, etc., can be provided, and by locating a limited number of roads within the park. A constructive partnership must, in fact, be established between those responsible for tourism and those responsible for the preservation of the natural features the park was established to safeguard.

In a comprehensive article such as this it is not possible to distinguish between the effectiveness of areas of preservation nominally enjoying the same status, a fact that should be kept in mind in using the tables in this article. (These tables are derived from *Derniers Refuges, Atlas Commente des Réserves Naturelles dans le Monde*, published in 1956 by the International Union for the Conservation of Nature and Natural Resources and parts i and ii of the United Nations' *List of National Parks and Equivalent Reserves*, 1961 and 1962. Permission to use them is gratefully acknowledged.) (C. L. BE.)

This article is divided into the following main sections:

I. United States
II. Canada
III. Africa
IV. Asia
V. Great Britain
VI. Europe
VII. Australasia
VIII. Central and South America

For bird and game protection and the protection of sea mammals and fish see WILDLIFE CONSERVATION.

I. UNITED STATES

The United States was long notoriously wasteful with its resources. In the brief span of three centuries verdant forests of vast regions were leveled, cover was torn from its soil, wildlife was pillaged and countless other offenses were committed against the natural fertility of the land. Fortunately, steps were taken early to prevent the exhaustion of natural resources. One early move in this direction was the transfer to the state of California, in 1864, of the Yosemite valley and the Mariposa grove of *Sequoia gigantea;* they were added to Yosemite National park in 1906. The concept of national parks under federal ownership originated in 1870, when the Doane-Washburn expedition investigated reports of the wonders of the Yellowstone. After some discussion of developing this region under the homestead laws, the matter was resolved when a member of the expedition, Cornelius Hedges, proposed that it should be the possession of all the people. Members of the expedition drafted legislation to that end, creating Yellowstone park, and it was signed by Pres. Ulysses S. Grant in 1872. Eighteen years passed before Yosemite, Sequoia and General Grant National parks were established in 1890. During this time the idea of protecting outstanding scenic and scientific resources, wildlife and vegetation, for their own sakes, and to ensure perpetuation of the aboriginal attributes of the American scene grew into a concept of national policy.

The national park system was expanded during the following decades, not only with the addition of vast natural areas, but also with the inclusion of places of especial significance in the human history of exploration of the continent and the development of American Indian culture. By the 1960s, the system included 192 areas encompassing 26,500,000 ac., of which 26,000,000 were in federal ownership.

Much of this land was originally part of the public domain, as was almost all of the land acquired by the new republic, beginning with western lands ceded by seven of the original thirteen states and continuing with later acquisitions such as the Louisiana Purchase. (For the disposition of this vast amount of territory *see* LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS: The *United States;* and LAND SYSTEM [U.S.].) From these public lands were reserved the national forests, most of the national park system and many other reservations. However, large tracts have been donated to the national park system by some of the states and some gifts have been made by individuals.

Kinds of Protected Areas.—National parks are established by congress; another act of congress is required to change boundaries or to modify the basic protection, unless boundary adjustment provisions were specifically stated in the original act. National parks have been defined as spacious land and water areas of nation-wide interest established as inviolate sanctuaries for the permanent preservation of scenery, wilderness, and natural vegetation and animal life in their natural condition. By the 1960s, there were 30 national parks. encompassing 13,500.000 ac., most of them quite large, 20 comprising more than 100,000 ac. each.

National monuments are established by specific acts of congress or under the Antiquities act of 1906 which authorizes the president to reserve, by proclamation, federal lands for 'the protection of objects of historic, prehistoric and scientific interest: the latter provision enables the president to act without delay to safeguard assets in danger of despoilment. Jurisdiction over national monuments was originally in the hands of several different federal agencies but in 1933 it was consolidated under the national park service.

By 1962 the system included 83 national monuments (9,148,908 ac.), 33 of which protect natural areas of scientific importance. Among the largest, Katmai, in Alaska, contains active volcanoes and the Valley of the Ten Thousand Smokes as well as extensive forested habitat of several species of bears and other wildlife; Glacier Bay National monument (*q.v.*), also in Alaska, contains some of the most impressive active tidewater glaciers on the continent, high mountains and abundant wildlife; Death valley (*q.v.*) in California-Nevada contains outstanding sonoran desert ecology.

Other monuments, ranging from a square mile to several hundred thousand acres, are notable for their canyons, caverns, natural arches and other geological features, or for botanical exhibits such as succulent cactus, Joshua trees, coastal redwoods, etc. Some have been established especially to safeguard particular species of wildlife. Remains of aboriginal Indian cultures are preserved in 20 national monuments; most of these are in the southwestern states but some are in other parts of the country. The remaining 30 relate to the history of the continent after the coming of the white man. Places notable in the colonial. Revolutionary and Civil War periods in the east, sites made famous in the settling of the west and landmarks in the careers of the nation's leaders are preserved and restored.

The national park service also administers national historical parks, military parks, battlefield parks and sites, and memorials commemorating principal engagements of the French and Indian War, the American Revolution and Civil War, and historic residences and sites not included in the system of national monuments. The value of this kind of preservation may be seen, for example, in the village of Appomattox Court House in Virginia, where Gen. Robert E. Lee surrendered to Gen. U. S. Grant on April 9, 1865, thus effectively terminating the Civil War. The village was at that time the seat of Appomattox county; later, when the county seat was moved elsewhere, it fell into decay and was in danger of total disappearance when its establishment as a national historical monument was authorized in 1935. It was thus established in 1940 and became a national historical park in 1954. It encompasses 972 ac.; the Wilmer McLean house, where the surrender took place, was restored, as were some other buildings.

There are three national parkways: the Blue Ridge parkway (to be 477 mi.), following the Appalachian ridges between Shenandoah and Great Smoky Mountains National parks; the Natchez Trace parkway, to follow the old Indian trail for 450 mi. between Nashville, Tenn., and Natchez, Miss.; and the George Washington Memorial parkway in Maryland and Virginia, 49 mi. when completed. Also included in the system are 10 Civil War cemeteries; the Cape Hatteras National Seashore Recreation area in North Carolina; the Theodore Roosevelt National Memorial park in the badlands of North Dakota; and the national capital parks in the District of Columbia, Maryland, Virginia and West Virginia. Public use of three large reclamation reservoirs is administered (as national recreation areas) by the park service: Lake Mead (1,951,928 ac.) in Arizona and Nevada, created by Hoover dam; Franklin D. Roosevelt lake (98,500 ac.). formed by Grand Coulee dam in Washington state; and Shadow mountain (18,240 ac) on the western edge of Rocky Mountain National park in Colorado.

Administration of the National Park System.—The national park service was established by an act of congress on Aug. 25, 1916, to administer the assigned areas "by such means and measures as conform to the fundamental purpose of said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." This directive protects the national park system (a generic term that includes all the areas the park service administers except reservoirs) from exploitation for profit or from any development that would contravene the primary objective, that of preserving natural or historical features.

Park service policy, based on this act and augmented by more detailed formulations issued by the secretary of the interior and the service itself, is applied equally to all the categories in the system, with minor adjustments that recognize their varied characters. Placing first emphasis on protection, with public use and enjoyment an essential corollary part of the objective, this concept of park administration has been adopted by many nations which later established national park systems of their own.

The system possesses natural resources attractive to interests that might profit from their exploitation, and from the beginning there have been repeated attempts to induce congress to weaken the rigid legal protection given one area or another. Yellowstone, Yosemite, Kings Canyon, Glacier, Grand Canyon and other areas include canyons where construction of hydroelectric or reclamation dams has been vigorously resisted; national controversies have raged over legislation that would have permitted Yellowstone lake to be dammed, Echo park in Dinosaur National monument to be flooded and other similar projects. Frequent efforts have been made to open individual parks and monuments, and even all of them. to mining; except within four areas (Mt. McKinley National park, Glacier Bay. Death Valley and Organ Pipe Cactus National monuments) in which mining is subject to regulation by the secretary of the interior, and a small section of Katmai National monument, mining was prohibited in the system.

On the principle that the native species should follow their natural behaviour patterns insofar as possible, hunting of all wildlife, including predators, is prohibited. In a few instances this policy, together with the fact that the aboriginal wildlife habitat lying beyond the park boundaries has been developed for human economic reasons, has resulted in overpopulations of certain large mammals so that the carrying capacity of the park ranges has been endangered, and the secretary of the interior has authority to reduce such species when scientific evidence demonstrates the need. The most notable case is that of the wapiti in Yellowstone, where thousands of these elk share insufficient ranges with bison, deer, bighorn sheep and antelope. Proposals to open the park to public hunting were rejected as violating the fundamental objective, and a program of elk reduction by deputized hunters in parts of nearby Grand Teton National park proved ineffectual.

Grazing of livestock is considered an activity not conforming to the purpose of the parks but occasionally there are demands that the grasslands in the system be made available to domestic animals. Grazing privileges in effect at the time lands are brought under park service jurisdiction are continued only through the lifetime of the permittee's immediate heirs, and grazing is gradually being reduced.

Overdevelopment, imperiling the assets the parks were established to safeguard, is probably the most difficult problem now confronting the administrating agency. Earlier, when most of the areas were remote and transportation slow and expensive, it was necessary to advertise them to arouse public interest in the national park program. Hotels and lodges were built in the parks, roads were provided to serve the infant tourist movement and dude ranching was developed. During the depression of the 1930s the modest appropriations provided by congress were sup-

Table I.—*A Partial List of Areas Administered by the United States National Park Service*

Name and location	Total gross acreage	Date established	Principal features
National Parks			
Acadia (Maine)	41,634	Part as Sieur de Monts National monument, 1916, and Lafayette National park, 1919; named Acadia, Jan. 19, 1929	Mount Desert Island and adjacent Atlantic coastal headlands; forests, mountains, sea birds
Big Bend (Texas)	708,221	June 12, 1944	Great bend of Rio Grande river; desert and mountain scenery; sonoran wildlife and botany
Bryce Canyon (Utah)	36,010	National monument, 1923; national park, Sept. 15, 1928	Vast eroded amphitheatres on Paunsagnnt plateau, with brilliantly colored spires, pinnacles and walls
Carlsbad Caverns (New Mexico)	49,448	National monument, 1923; national park, May 14, 1930	World's largest limestone caverns; calcite formations; hats; sonoran desert ecology
Crater Lake (Oregon)	160,290	May 22, 1902	Azure caldera 20 sq.mi. in area with multicolored 'walls 500 to 2,000 ft. high; conifer forests alpine tundra, abundknt wildlife
Everglades (Florida)	1,400,533	June 20, 1947	Subtropical wilderness grassland prairies, with mangroves, cypress and other plants; breeding colonies of egrets, herons ibises, etc.; manateed; includes most of Florida bay
Glacier (Montana)	1,013,129	May 11, 1910	Glaciated Rocky mountain peaks, glaciers, lakes, forests, wildlife. Forms part of Waterton-Glacier International Peace park, established 1932
Grand Canyon (Arizona)	673,575	National monument, 1908; national park, Feb. 26, 1919	Upper half of 217-mi. gorge of Colorado river, 4 to 8 mi. wide, about 1 mi. deep; tremendous pediments, mesas and buttes carved in multicolored rocks dating from Archean to Mesozoic eras; sonoran and montane ecology
Grand Teton (Wyoming)	310,350	Feb. 26, 1929; most of Jackson Hole National monument added 1950	Isolated glaciated Teton range with peaks to 13,766 ft.; broad open basin in foreground; conifer forests; winter feeding ground of largest American elk herd; moose, trumpeter swan, other wildlife
Great Smoky Mountains (North Carolina-Tenn.)	511,714	June 15, 1934	Appalachian ranges; primeval hardwood forests; wildlife
Haleakala (Hawaii)	26,403	July 1, 1961	Haleakala volcano on Maui; endemic plants. products of volcanif activity
Hawaii Volcanoes (Hawaii)	220,345	National park including Haleakala, 1916; separate unit, July 1, 1961	Mauna Loa and Kilauea active volcanoes on island of Hawaii; tree fern forests with rare endemic plants and wildlife
Hot Springs (Arkansas)	989	Federal reservation, 1832; national park, March 4, 1921	Hot mineral springs and baths; characteristic Ozark woodland
Isle Royale (Michigan)	539,339	April 3, 1940	Forested island in Lake Superior; moose and other wildliie
Kings Canyon (California)	454,650	General Grant National park, 1890; enlarged as Kings Canyon National park, March 4, 1940	Canyons of Kings river and crest of Sierra Nevada range; General Grant grove of *Sequoia gigantea*
Lassen Volcanic (California)	106,933	Part as national monument 1907; national bark, Aug. 9, 1916	Lassen peak is the only recently active volcano in continental U.S. outside of Alaska; geologic, botanic' and wildliie features
National Parks (*Cont.*)			
Mammoth Cave (Kentucky)	51,354	July 1, 1941	Limestone cave, 150 mi. of passages explored, with limestone, gypsum and cave onyx formations; underground rivers and lakes
Mesa Verde (Colorado)	51,334	June 29, 1906	Protects prehistoric Basket Maker and Pueblo Indian pit houses and finest cliff dwellings in the U.S.; Rocky mountain ecology
Mount McKinley (Alaska)	1,939,493	Feb. 26, 1917	Highest peak in North America, glaciers in Alaska ranee; arctic tundra: caribou. Dall sheep, wolves, 'bears, other wildlife
Mount Rainier (Washington)	241,782	March 2, 1899	Spectacular ancient volcano, with glaciers; dense forests, meadows, wildlife
Olympic (Washington)	896,599	Mount Olympus National monument, 1909; enlarged as national park, June 29, 1938	Wilderness of peaks, glaciers and rain forests; Roosevelt elk (subspecies of the wapiti); headlands and beaches along Pacific ocean
Platt (Oklahoma)	912	Sulphur Springs reservation, 1902; national park, June 29, 1906	Cold mineral springs; prairie ecology
Rocky Mountain (Colorado)	260,018	Jan. 26, 1915	Front ranges of Rocky mountains, with 65 named peaks in excess of 10,000 ft.; conifer forests alpine tundra, abundknt wildlife
Sequoia (California)	386,551	Sept. 25, 1890	Groves of *Sequoia gigantea;* adjacent to Kings Canyon National park and administered jointly with it
Shenandoah (Virginia)	212,304	Dec. 26, 1935	Blue Ridge of Appalachian mountains with hardwood forests and wildflowers. Skyline drive traverses crest, continuing south as Blue Ridge parkway to connect with Great Smoky Mountains National park
Virgin Islands (Virgin Islands)	9,500	Dec. 1, 1956	Caribbean island with green hills, bkaches, tropical plants and animals; historic relics of Carib Indians and colonial sugar plantations
Wind Cave (South Dakota)	28,059	Jan. 9, 1903	Limestone caverns in Black hills; conifer forests, open prairies; bison, antelope, prairie dogs, other wildlife
Yellowstone (Wyoming-Montana-Idaho)	2,221,773	March 1, 1872	World's largest geyser area; canyons falls, lakes, moun'tains; abundant ,wildlife of many species
Yosemite (California)	760,951	Oct. 1, 1890	Spectacular peaks, canyons, waterfalls in Sierra Nevada range; three groves of giant sequoias; dense forests; alpine tundra, wildlife
Zion (Utah)	147,035	Mukuntuweap National monument, 1909; named Zion National monument, 1918; national park, Nov. 19, 1919	Colourful tertiary canyons and mesas in high desert region
National *Monuments*			
A. Natural Areas			
Arches (Utah)	34,010	April 12, 1929	Eroded arches, pinnacles, in desert
Badlands (South Dakota)	111,530	Jan. 25, 1939	Eroded sedimentary badlands many fossils; short-grass prairie ecology

TABLE I.—A Partial List of Areas Administered by the United States National Park Service (Continued)

Name and location	Total gross acreage	Date established	Principal features
A. Natural Areas (*Cont.*)			
Black Canyon of the Gunnison (Colorado)	13,548	March 2, 1933	Sheer-walled canyon in San Juan mountains region
Buck Island Reef (Virgin Islands)	850	Dec. 28, 1961	Coral reefs and undersea formations; marine gardens
Capitol Reef (Utah)	39,173	Aug. 2, 1937	Colorful sedimentary sandstone cliffs dissected by a narrow gorge along Fremont river
Capulin Mountain (New Mexico)	680	Aug. 9, 1916	Asymmetrical recently extinct volcanic cinder cone
Cedar Breaks (Utah)	6,155	Aug. 22, 1933	Vast natural amphitheatre eroded into variegated Pink cliffs 2,000 ft. thick; wildflowers
Channel Islands (California)	18,167	April 26, 1938	Santa Barbara and Anacapa Islands (1,120 ac. land area) offshore from southern California to protect sea lion and sea bird rookeries
Chiricahua (Arizona)	10,646	April 18, 1924	Tertiary rhyolitic monolitbs and other geological features; arid mountains, desert and montane ecology with Mexican affinities
Colorado (Colorado)	17,693	May 24, 1911	Canyons, monoliths, in arid mesa region; bison
Craters of the Moon (Idaho)	48,184	May 2, 1924	Volcanic geology
Death Valley (California-Nevada)	1,907,760	Feb. 11, 1933	Desert wilderness: geological, botanical, faunal features; pioneer history
Devils Postpile (California)	798	July 6, 1911	Basaltic lava columns rising as high as 60 ft.
Devils Tower (Wyoming)	1,347	Sept. 24, 1906	865-ft. exposed volcanic intrusion
Dinosaur (Utah-Colorado)	205,136	Oct. 4, 1915	Spectacular canyons of Green and Yampa rivers; quarry of dinosaur fossils
Glacier Bay (Alaska)	2,274,595	Feb. 26, 1925	Large tidewater glaciers, fiords; postglacial forests; abundant wildlife, especially several species of bears
Grand Canyon (Arizona)	198,280	Dec. 22, 1932	Lower part of Grand canyon, including inner gorge
Great Sand Dunes (Colorado)	36,740	March 17, 1932	Shifting aeolian dunes at foot of Sangre de Cristo mountains; among the largest and highest dunes in U.S.
Jewel Cave (South Dakota)	1,275	Feb. 7, 1908	Limestone caverns with fine calcite encrustations
Joshua Tree (California)	557,992	Aug. 10, 1936	Stands of Joshua tree; sonoran desert ecology
Katmai (Alaska)	2,697,590	Sept. 24, 1918	Active volcanoes; Valley of Ten Thousand Smokes; subarctic conifer forests; Alaskan brown bear and other wildlife
Lava Beds (California)	46.239	Nov. 21, 1925	Volcanic geology; semiarid mountain ecology; site of Modoc Indian war of 1873
Lehman Caves (Nevada)	640	Jan. 24, 1922	Ornamented limestone cavern in isolated Snake range
Muir Woods (California)	504	Jan. 9, 1908	Virgin stand of coastal redwood (Sequoia *sempivirens*)
Natural Bridges (Utah)	2,650	April 16, 1908	Three natural bridges, the highest 222 ft. above stream bed, with span of 261 ft.
Oregon Caves (Oregon)	480	July 12, 1909	Limestone caverns, with Jeffrey pine forest on surface
Organ Pipe Cactus (Arizona)	330,874	April 13, 1937	Outstanding exhibit of sonoran desert plants and wildlife
Petrified Forest (Arizona)	94,161	Dec. 8, 1906	Extensive exhibit of petrified wood, Indian ruins and part of colourful Painted desert
Pinnacles (California)	14,498	Jan. 16, 1908	Volcanic and other geological features, with spire formations 500 to 1,200 ft. high

Name and location	Total gross acreage	Date established	Principal features
A. Natural Areas (*Cont.*)			
Rainbow Bridge (Utah)	160	May 30, 1910	Largest, most beautiful natural arch known, rising 309 ft. over stream bed
Saguaro (Arizona)	78,644	March 1, 1933	Saguaro forest and other succulent cacti
Sunset Crater (Arizona)	3,040	May 26, 1930	Volcanic cinder cone with summit crater formed just prior to A.D. 1100
Timpanogos Cave (Utah)	250	Oct. 14, 1922	Colorful limestone cave on Mt. Timpanogos
White Sands (New Mexico)	146,535	Jan. 18, 1933	Gypsum dunes 10 to 45 ft. high; wildlife showing adaptation to environment
B. Archaeological Areas			
Aztec Ruins (New Mexico)	27	Jan. 24, 1933	Excavated 12th-century Indian town
Bandelier (New Mexico)	30,703	Feb. 11, 1916	Prehistoric Indian homes of later Pueblo period in canyon-slashed slopes of Pajarito plateau
Canyon de Chelly (Arizona)	83,840	April 1, 1931	More than 400 cliff dwellings dating as early as A.D. 1066, in magnificent canyon scenery on Navajo Indian reservation
Casa Grande (Arizona)	473	Reserved 1892; national monument, Aug. 3, 1918	Unique adobe tower probably built by Salado Indians in the 1300s in earlier Hohokam settlement
Chaco Canyon (New Mexico)	21,509	March 11, 1907	13 major Indian ruins; hundreds of smaller ruins
Effigy Mounds (Iowa)	1,476	Oct. 25, 1949	Large Indian mounds in shapes of birds and other animals.
El Morro (New Mexico)	1,279	Dec. 8, 1906	Prehistoric petroglyphs, inscription in rock by explorers
Gila Cliff Dwellings (New Mexico)	160	Nov. 16, 1907	Cliff dwellings in centre of Gila Wilderness area
Grand Portage (Minnesota)	770	Historic site 1951; national monument, Jan. 27, 1960	Principal canoe portage route of Indians, explorers and missionaries
Hovenweep (Utah-Colorado)	505	March 2, 1923	Unique towers built in 12th century
Montezuma Castle (Arizona)	842	Dec. 8, 1906	Outstanding cliff dwelling dating from about A.D. 1100
Mound City Group (Ohio)	68	March 2, 1923	24 ceremonial burial mounds of Hopewell people, dating from about A.D. 1000
Navajo (Arizona)	360	March 20, 1909	Three of largest known cliff dwellings; Betatakin, Keet Seel and Inscription house, dating from 13th century
Ocmulgee (Georgia)	683	Dec. 23, 1936	Mounds built by farming Indians, dating from 10th century
Pipestone (Minnesota)	283	Aug. 25, 1937	Quarry from which Indians obtained materials for peace pipes
Tonto (Arizona)	1,120	Dec. 19, 1907	Salado Indian cliff dwellings, in Salt river valley, dating from about A.D. 1350
Tuzigoot (Arizona)	43	July 25, 1939	Outstanding pueblo containing 110 rooms, which flourished between A.D. 1000 and A.D. 1400
Walnut Canyon (Arizona)	1,879	Nov. 30, 1915	200 small cliff dwellings, dating from A.D. 1000 to A.D. 1200
Wupatki (Arizona)	35,545	Dec. 9, 1924	Pueblos built by several tribes, dating from about A.D. 1100; desert ecology
Some other units of national park system Protecting natural features			
Theodore Roosevelt National Memorial park (North Dakota)	70,374	April 25, 1947	Badlands along Little Missouri river, with abundant wildlife
National Capital parks (District of Columbia-Virginia-Maryland-West Virginia)	36,186		Park system of the nation's capital, comprising 780 units
Cape Hatteras National Seashore Recreational area	28,500	June 12, 1953	Atlantic coastal beach; migratory waterfowl
Cape Cod National Seashore	...	Authorized, Aug. 7, 1961	50 mi. of natural Atlantic coastal beach; migratory waterfowl

plemented by hundreds of millions of dollars in emergency relief funds and Civilian Conservation corps enrollees aided in keeping the parks in condition. World War II reduced the annual appropriations to as little as $5,000,000 and terminated emergency funds, but during that period relatively few tourists could travel to distant places for recreation.

The end of the war released an affluent, restless population with abundant leisure. Tens of millions of people sought their national parks, spending millions of dollars which served as a catalyst to all the myriad businesses and industries dependent on travel and recreation. Appropriations did not keep pace with this invasion of the parks, and as a park director commented, "The American people are loving their parks to death."

Supported by citizens' organizations, the park service urgently requested adequate funds from congress, with some success. But by 1953 only $33,000,000 was being provided to administer 180 areas. Antiquated accommodations were deteriorating, roads were being pounded to ruin, campgrounds were unable to withstand the constant overuse; in short, the parks were being worn out. "Mission 66," a ten-year, $459,000,000 park conservation, improvement and development program planned to meet the conditions anticipated in 1966, was announced in 1956 by Conrad L. Wirth, park service director.

In 1956 the Park Service had 3,500 personnel; by 1966, it was projected, 6,250 would be needed, mostly rangers, naturalists and seasonal employees. Interpretive services would be strengthened and facilities to translate park concepts and features to the public — visitor centres, museums, roadside and trailside exhibits, etc.— would be increased, as would opportunities for scientific research. In 1956 there were 12,833 automobile campsites in the system; about 30.000 would be required. Administration buildings, ranger quarters and other structures would be rehabilitated and new ones built. Where feasible. such buildings would be moved or constructed outside the park boundaries. About 2,000 mi. of roads were to be realigned and improved, 300 mi. of new roads were to be built and six parkways would be completed; 1,500 mi. of trails would be added to the 8,100 mi. then available. Historical and archaeological structures would be restored and stabilized.

New projects and the backlog of deferred construction were started immediately. The Sierra club, the Wilderness society, the National Parks association and other nongovernmental conservation organizations supported the program and offered their advice. They supported the park service in its insistence on the importance of ensuring that physical development did not impair the wilderness character of the parks and monuments, and they also approved of the decision to concentrate visitor and personnel facilities (if required to be built inside the parks) in a limited number of restricted localities connected by motor roads, leaving 95% of the land in its undisturbed natural state. These groups cautioned against the possibility that Mission 66 might yield to the pressures of special interests and become essentially a construction program. They also recognized that expansion of the interpretive program under Mission 66 was an equally vital aspect.

The park service's work in interpreting its areas provides factual information about scenic features, wildlife. geology, botany, history or archaeology, and also helps the visitor to widen his interests and knowledge. A staff of scientists, naturalists, historians, museum and educational experts, augmented during the travel seasons by additional ranger-naturalists and other interpretive personnel. conduct field trips, staff museums and devise original methods of enlarging the visitor's appreciation of what he sees.

Such visitor facilities as roads. trails, campgrounds and utilities are provided by the park service. Services for which a charge is made — hotels and lodges, cabins, restaurants. automobile services, buses, pack horses and other similar services — are under private management. If a facility or the land it occupies is owned by the federal government, the concessioner operates under a contract with the park service which regulates the character and financial aspects of the concession. There remain several hundred thousand acres within the parks held in nonfederal ownership (which are gradually being acquired by purchase or exchange) and visitor facilities on these lands are not under government control.

Mission 66 envisions expansion of the national park system to include additional examples of wilderness and pristine nature and significant historical sites and also types of environment not now represented. The remaining stretches of natural shore line along the Atlantic and Pacific oceans, the Gulf of Mexico and the Great Lakes have been surveyed with this in mind. The national park service serves as consultant to the states on park and recreational planning; in 1962 this function was transferred to the new Bureau of Outdoor Recreation. In all of its activities, the park service is guided by the statutory advisory board on national parks, historic sites, buildings and monuments. (*See* also articles on the various national parks. For state parks *see* articles on the various states.)

National Forests: Wilderness. Primitive and Wild Areas. —As the United States was settled, more and more land was of course cleared of forests, and not until 1877 was official recognition given to the danger inherent in the practice. In that year the secretary of the interior, Carl Schurz, aroused congressional interest in retaining permanent forests in public ownership and in improving administration of the federal real estate. This led to the beginning of a system of forest reserves authorized in 1891; 30 were created by Presidents William Henry Harrison and Grover Cleveland. Gifford Pinchot (*q.v.*), appointed chief of the forestry division in 1898, vigorously promoted the old-world concept of forest management through sound forest practices, enforced on public lands by laws and regulations imposed by the government as custodian of their resources. Pres. Theodore Roosevelt, who strongly supported this judgment, strengthened the federal interest in forest resources by assigning responsibility in 1905 to a new forest service in the department of agriculture, with Pinchot as chief forester, and created additional national forests. The practice of reserving portions of the federal real estate for regulated use and perpetuation of their resources was gradually extended to many aspects of a national conservation program.

Initially, the national forests were intended to safeguard watersheds (and were therefore located where preservation of water resources was a vital social and economic consideration) and to ensure a permanent supply of timber, harvested by private operators under forest service regulation. Since the national forests include large areas of grassland, grazing of livestock was soon added as a proper use. Mining laws apply to these lands, hunting of wildlife in accordance with state law is permitted, reclamation and power projects are located within them and other utilization of resources is authorized by law and regulation. This concept of multiple use is the conscious goal of administration of the national forests as a whole, although opinion varies as to whether this term should be construed to mean various uses on the same area, or whether emphasis on, or limitation to, the highest or most significant use should be applied on respective parts of a given area.

Even under careful regulation most of these activities change the character of the terrain and convert primeval wilderness into artificially controlled environment. Aldo Leopold of the University of Wisconsin was the first eloquent advocate of the wilderness concept: undisturbed wilderness itself is a resource of value; present and future generations require opportunity to experience the inspiration and surcease from an increasingly mechanized culture through healthful outdoor pursuits undertaken by individual effort;and those who inherit these resources should be bequeathed some virgin forests and unmodified open spaces which they could determine how to enjoy and use in light of the cultural patterns of their day. In 1921 Leopold aroused official interest in this proposition, and in 1924 the Gila Wilderness area was established in the Gila National forest in New Mexico as the first of what was to become a series of such reservations. In 1929 Regulation L-20 mas promulgated under which several chiefs of the forest service established 72 primitive areas totaling nearly 14,000,000 ac between 1930 and 1939. The wilderness area system was given another strong impetus in 1939 when regulations were set forth providing for the establishment of wilderness areas of more than 100.000 ac each by the secretary of agriculture and the establishment of suitable tracts of between 5,000 and 100,000 ac. by the chief forester. The existing primitive areas which had been established since 1929 continued in effect but were scheduled for restudy and reclassification within the new definitions. The wilderness concept received vigorous popular support, especially through the educational program undertaken by the Wilderness society and private citizens throughout the country.

Within the wilderness, wild and primitive areas and the Boundary Waters canoe area, no developments are permitted which are detrimental to the preservation of primitive conditions of transportation and environment. Roads may not be built in them nor timber harvested (except in one-half of the canoe area under certain specific regulations), and other commercial uses are kept to a minimum. Hunting is permitted, since the states have not ceded jurisdiction over the wildlife there.

Unlike the national park system, the wilderness area system is subject to alteration of boundaries and change of policy by executive order within the department of agriculture; congressional action is not required. Certain citizens' organizations feel that it should be, to ensure the permanence of the protection afforded by the system, and legislation to that end was introduced in congress.

Most of the wilderness and primitive areas are west of the Great Plains. Robert Marshall described them as "regions which contain no permanent inhabitants, possess no means of mechanical conveyance, and are sufficiently spacious that a person may spend at least a week or two of travel in them without crossing his own tracks. The dominant attributes of such areas are: first, that visitors to them have to depend exclusively on their own efforts for survival; and, second, that they preserve as nearly as possible the essential features of the primitive environment." Most of them are high, rugged terrain of peaks and forests, tundra and mountain glades, clear rivers and lakes. Some are vast stretches of arid and semiarid country, interspersed with varied ecological

TABLE *11.—Principal Refuges Administered by the United States Bureau of Sport Fisheries and Wildlife*

Name and location	Total gross acreage	Date established	Principal features
Big Game Refuges and Game Ranges			
Arctic National Wildlife range (Alaska)	8,900,000	1960	Undisturbed arctic coastal environment and eastern Brooks range; grizzly and polar bears Dall sheep, caribou, moose: wolves, wolverine, etc.
Cabeza Prieta Game range (Arizona)	860,000	1939	Mexican antelope, Gaillard bighorn, peccary; sonoran desert
Charles Sheldon Antelope Range and refuge (Sevada-Oregon)	543,898	1936	Pronghorn antelope, mule deer, sage hen, waterfowl; sonoran desert
Clarence Rhode National Wildlife range (Alaska)	1,890,000	1960	Low-lying tundra on northwestern coast near Bering sea; waterfowl, fur-hearing mammals, etc.
Desert Game range (Nevada)	188,415	1936	Pronghorn, Nelson bighorn, mule deer; sonoran desert
Fort Niobrara National Wildlife refuge (Nebraska)	14,401	1912	Bison, Texas longhorn cattle, elk, beaver, upland birds
Fort Peck Game range (Montana)	375,238	1936	Pronghorn, Rocky mountain bighorn, deer, elk, upland game birds; sagebrush basin
Hart Mountain National Antelope refuge (Oregon)	239,933	1936	Pronghorn, mule deer, upland birds; sagebrush plateau
Izembek National Wildlife range (Alaska)	415,360	1960	Waterfowl nesting and feeding grounds on the Alaskan peninsula; brown bears, caribou
Kenai National Moose range (Alaska)	2,057,197	1941	Kenai moose, brown bear, Dall sheep, mountain goat, fur bearers, birds; rugged wilderness of mountains, swamps, lakes and rivers.
Kodiak National Wildlife refuge (Alaska)	1,815,000	1941	Kodiak bear, deer, waterfowl colonial sea birds; forested Kodiak Island
Kofa Game refuge (Arizona)	660,000	1939	Gaillard bighorn, sonoran desert wildlife and vegetation, including rare *Washingtonia filifera* palm
Little Pond Oreille National Wildlife refuge (Washington)	41,708	1939	Upland birds, deer, black bear
National Bison range (Montana)	18,541	1908	300 to 400 bison, elk, deer, Rocky mountain bighorn; high prairie
National Elk refuge (Wyoming)	23,790	1912	Winter range of southern Yellowstone elk herd, trumpeter swan, sand-hill crane, beaver; in Jackson Hole basin adjacent to Grand Tcton Rational park
National Key Deer refuge (Florida)	6,744	1954	Rare dwarf Key deer, spoonbills, great white heron; on Florida Keys
Nunivak National Wildlife refuge (Alaska)	109,384	1929	Musk ox, reindeer, shore birds; tundra
Pribilof Islands reservation (Alaska)	50,163	1910	Established to protect endangered fur seals, which had increased to 1,500,000 animals in 1959; controlled harvesting under bureau of commercial fisheries; colonial sea birds
San Andreas National Wildlife refuge (New Mexico)	57,215	1941	Nelson bighorn, deer, bird life; sonoran desert
Simeonof National Wildlife refuge (Alaska)	10,442	1958	In southeastern part of Shumagin Island chain; sea otters
Sullys Hill National Game preserve (North Dakota)	994	1914	Bison, elk, deer, geese
Wichita Mountains Wildlife refuge (Oklahoma)	59,019	1905	Bison, elk, deer, pronghorn, longhorn cattle, turkey, rare Mississippi kite, water fowl; upland prairies and mountain range
Migratory Bird Refuges General			
Aleutian Islands Wildlife refuge (Alaska)	2,720,235	1913	50 major islands extending 1,200 miles from Unimak to Attu; active volcanoes, Pacific coastland arctic tundra; rare sea otters, colonial sea birds, shore birds, waterfowl, bears, whales, seals
Bering Sea Wildlife refuge (Alaska)	41,113	1909	Eiders and other sea ducks, alcidae, arctic foxes; tundra
Great White Heron Wildlife refuge (Florida)	2,127	1938	Great white heron, spoonbill, Key deer; mangrove keys
Okefenokee Wildlife refuge (Georgia)	330,973	1937	Cranes, ibises, egrets, limpkins, alligators, fur bearers; primeval bald cypress swamp
Santa Ana Wildlife refuge (Texas)	1,981	1943	Remnant of tropical forest on Rio Grande river; tree ducks chachalacas and other bird life with Mexican affinities
Migratory Bird Refuges Waterfowl			
Aransas Wildlife refuge (Texas)	47,261	1937	Sole wintering ground of rare whooping crane; abundant wintering waterfowl, migratory land birds and shore birds; spoonbill, egret and heron rookeries; deer, peccary; peninsula on Gulf of Mexico
Bear River Wildlife refuge (Utah)	64,899	1928	Vast marshes of Bear river delta on Great Salt lake; millions of nesting and migratory ducks and geese; 200 species of birds recorded; fur bearers
Cape Romain Wildlife refuge (South Carolina)	34,716	1932	Atlantic coastal marshes and islands; waterfowl, shore birds, rails, loggerhead turtles, fur bearers
Delta Wildlife refuge (Louisiana)	48,832	1935	Vast marshes on coast of Gulf of Mexico; major wintering grounds of blue, snow and other geese; abundant ducks, herons, rails and other birds; muskrats
Lacassine Wildlife refuge (Louisiana)	31,125	1937	
Sabine Wildlife refuge (Louisiana)	142,717	1937	
Kentucky Woodlands (Kentucky)	65,759	1938	Upland hardwood forests; eastern turkey, grouse, waterfowl
Lower Klamath (California)	21,460		Vast restored marshes on Pacific waterfowl flyway; millions of geese and ducks, white pelicans, shore birds, herons, upland birds, waterfowl
Sacramento (California)	10,776		
Tule (California)	37,337	1928	
Des Lacs (North Dakota)	18,881	1935	River marshes in northern prairies, restored to provide waterfowl nesting, feeding and wintering grounds; prairie chicken, sharp-tailed grouse
Lower Souris (North Dakota)	58,694	1935	
Upper Souris (North Dakota)	32,084	1935	
Loxahatchee (Florida)	145,477	1951	Subtropical swamp created by diked reserve, waterfowl wintering ground; limpkin, rare Everglade kite
Malbeur (Oregon)	184,747	1908	Restored river marshes on Pacific waterfowl flyway; abundant bird life, antelope, muskrat, beaver
Upper Klamath (Oregon)	12,533	1928	
Mattamuskeet (North Carolina)	50,178	1934	Atlantic flyway wintering grounds for waterfowl, especially whistling swan; fur bearers
Swanquarter (North Carolina)	15,501	1932	
Red Rock Lakes (Montana)	39,944	1935	Lakes and marshes on continental divide; principal U.S. breeding ground of rare trumpeter swan; Shiras moose, fur bearers
White River (Arkansas)	116,302	1935	Bottomland hardwood forest; abundant waterfowl, herons, turkeys, songbirds, fur bearers

conditions. Others have special attributes, such as the Boundary Waters canoe area (formerly known as the Superior Roadless area) in Minnesota, which protects the finest lakeland canoeing country in the United States by prohibiting logging on shore lines or the use of airplanes for transport, and which is contiguous with similar regions in Canada's Quetico Provincial park, in Ontario. Hikers and campers may follow thousands of miles of trails, on foot or with pack horses, to experience the kind of life their forefathers knew. The wild areas provide similar pursuits but are of smaller size. They are equally valuable as undisturbed examples of primeval ecology important to scientific research and for the determination of proper conservation practices on other land.

In 1961 there were within U.S. national forests 12 wilderness areas (total acreage 4,897,039); 41 primitive areas (7,964,309); 30 wild areas (1,052,743); and 1 boundary waters canoe area (1,034,852). (These totals included small acreages outside the national forests.)

Wildlife Refuges. — Before the advent of white man, the American continent teemed with wildlife. Bison in the millions roamed the eastern forests and Great Plains. Pronghorn antelope may have been even more numerous. Passenger pigeons. more than a billion in a flock, nested in the hardwood forests. Waterfowl bred by the tens of millions in lakes and sloughs and marshes. Great rookeries of egrets, ibises and other herons inhabited the southern swamps. Beavers and other fur bearers filled the waters of the forests, prairies and coastal swales. North America supported as many species and greater numbers of birds and mammals than any other temperate region on the earth.

Loss of the bulk of this wildlife heritage is part of the price the United States has paid for its civilization. The forest habitat of deer, bear, moose and many other species gave way to clearings as first the eastern and midwestern hardwoods were cut. and then vast stands of western conifers were logged. The prairies and plains became farms, many of their natural lakes, potholes and marshes were drained and plowed. Cities and highways occupied extensive acreages where once myriad animals lived. The pioneer settlers lived off the game of the land until cattle usurped the ranges. Meat from wild animals supported the rising cities; hundreds of thousands of barrels of passenger pigeons and Eskimo curlews, among other species, were shipped from St. Louis and other midwestern cities to cities in the east. Bison and antelope were slaughtered nearly to extinction, and the vogue for plumes on women's hats led to decimation of the egret and heron rookeries.

During the second half of the 19th century the states began to enact game laws but enforcement was weak until national sentiment stimulated more effective protection under state game and conservation commissions. Fortunately, action came in time to enable most species to survive but the passenger pigeon became extinct in 1914 and some species and subspecies of other animals no longer exist. The ranges of many animals, such as the grizzly bear and timber wolf, were restricted to a small number of protected localities, especially in national and state parks, refuges and preserves. A more thoughtful type of sportsman began to exert influence and to promote funds for restoration of endangered animals. The American Bison society purchased the last intact herd of bison left in the United States and shipped it to Yellowstone National park, where it thrived; in 1958, more than 6,000 bison existed in the United States and additional herds inhabited reserves in Canada. Pronghorn antelope were re-established in many places and spread into adjacent regions. Elk recovered so successfully under reasonable laws and on protected ranges that new herds were established in many parts of the country. White-tailed deer actually benefited from the conversion of dense forests into smaller woodlands bordered by open terrain and may be more numerous now than in aboriginal times.

The vigorous interest taken by the federal government in wildlife restoration has been primary in the success of this program. On July 1, 1885, the branch of economic ornithology was established in the division of entomology, U.S. department of agriculture; it became the bureau of biological survey in 1905 under the direction of C. Hart Merriam. Originally designed to undertake research into the economic importance of birds and mammals, the bureau achieved international eminence as a scientific institution. It administered the Lacey act of 1900 which prohibited shipment across state boundaries of game taken illegally, and gradually market hunting was eliminated. Under the Migratory Bird Treaty act of 1918, the bureau was given power to extend federal protection to avian species that migrated between Canada and the United States; in 1937 a similar treaty with Mexico broadened this power. Prior to ratification of these treaties, conservation of wildlife had been a responsibility only of the states, except in the national park system where jurisdiction over wildlife has been ceded to the federal government; these conventions enabled the federal government to share this responsibility.

Reservation of federal land as national wildlife refuges was accomplished initially by executive orders of the president, the first refuge being the three-acre Pelican Island off the east coast of Florida, established by Theodore Roosevelt in 1903. Many early bird sanctuaries, however, were created by the National Audubon society, a citizens' organization, to preserve egret rookeries in the south. The severe decline of waterfowl and shore birds because of overshooting and drought, and diminishing populations of larger mammals, evident during the first decades of the 20th century, stimulated reservation of large federal units such as Malheur and Upper Klamath National wildlife refuges in Oregon, the Pribilof Islands reservation in Alaska, the National Bison range in Montana and the Wichita Mountains Wildlife refuge in Oklahoma. By 1929, there were 87 federal refuges in 24 states and the territories.

The Migratory Bird Conservation act of 1929 provided broad legislative authority for refuge acquisition and development and some funds were appropriated for the programs. A second decline in the waterfowl population became evident and under the dynamic leadership of Director J. N. Darling new sources of funds for the refuge program were provided. The Migratory Bird Hunting Stamp act of 1934 required all waterfowl hunters 16 years of age and over to have in their possession a federal stamp, and the Pittman-Robertson act of 1937 called for a 10% (later 11%) federal excise tax on sporting arms and ammunition to be allocated to the states to pay three-quarters of the expense of wildlife restoration programs, By 1953 the federal grant amounted to $10,000,000 annually. Originally, refuges purchased with duck stamp money were inviolate but in 1949 the secretary of the interior was empowered to open one-quarter of the area of such refuges to public shooting if the status of the species' population warranted and in 1958 this was increased to 40% of most refuges. The 1940 Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere extended the application of certain protective measures to those American republics ratifying the treaty. In 1939, the biological survey was transferred to the U.S. department of the interior and in 1940, together with the bureau of fisheries, became the fish and wildlife service; in 1958, it was reorganized as the bureau of sport fisheries and wildlife, a part of the U.S. fish and wildlife service.

As of June 30, 1960, the bureau administered 280 national wildlife refuges containing 28,506,105 ac.; in addition, the secretary of the interior withdrew 9,000,000 ac. in the Brooks range of northeastern Alaska as an arctic wildlife range, pending proclamation or congressional action. Fifteen big-game refuges and five game ranges comprised 10,171,888 ac., and 255 migratory bird refuges comprised 7,147,857 ac. In 1958 the game refuges and ranges supported the following numbers of animals, compared with the estimated total United States populations (1951–55): pronghorn antelope, 3,352 (total 262,262); bear, 276 (143,086); bighorn sheep, 2,199 (19,438); bison, 1,306 (3,858); white-tailed deer, 23,601; mule deer, black-tailed deer, 22,818; (8,603,000 all species); elk, 5,511 (303,315); among other animals. The revival of these once drastically decimated species to these national population levels has been due in significant measure to these refuges, as well as to the protection afforded by the national park system and state game reserves and improved laws.

Similarly, largely as a result of preservation and restoration of essential breeding, feeding and wintering habitat in federal and state refuges, combined with favourable continental weather cycles, waterfowl population trends of the continent reached a peak during the years 1952 to 1956. Unfavourable weather conditions over a large segment of the breeding habitat, starting in 1956, resulted in a marked population decline in some species of waterfowl, especially the diving duck species. The objective of preserving waterfowl nesting areas, migration resting places and winter feeding grounds was co-ordinated in planning and legislative programs with other conservation activities. Vast sums were spent not only to acquire existing habitat on coastal marshes, bottomlands on the principal river systems and interior sloughs, but also to restore great areas that had been drained. Many storage reservoirs and other impoundments built to secure water benefits proved invaluable as waterfowl sanctuaries. Continued research by the fish and wildlife service revealed that waterfowl follow certain routes or flyways to and from their nesting grounds, each flyway being used by the population nesting in a particular geographic region. Series of refuges have been established to serve the welfare of the respective populations during the entire course of their movements.

In spite of the success achieved in arresting waterfowl declines and in perpetuating the species of ducks, geese and swans, their future security requires increased efforts to offset continued conversion of essential habitat to other purposes. Expert opinion indicates that as the matter stood in 1960 another 4,000,000 ac. should be added to the federal refuge system, and that if the states undertook to supplement the federal activity through restoration and protective programs, 12,500,000 ac. could be made available to meet the needs of the present waterfowl population and enable it to increase significantly.

The growth of such a large and varied system of federal refuges, and the corollary development of refuges and sanctuaries by the states and private organizations, is evidence of changed attitudes toward wildlife on the part of the American people. Since they seldom are dependent on game meat for food, hunting is regulated to preserve species for future generations, and most sportsmen's organizations support governmental controls. During the 20th century there developed a large body of public opinion interested in wildlife for its own sake and as a source of personal enjoyment and scientific study. Both of these interests have strongly endorsed refuge programs and the expenditure of tax revenues for this purpose.

II. CANADA

National parks in Canada are established by parliament and are administered by the national parks branch of the department of northern affairs and national resources. Banff, Jasper, Kootenay and Yoho National parks adjoin each other in the spectacular Rocky mountains, and Mt. Robson, Hamber and Mt. Assiniboine Provincial parks and Glacier National park, in British Columbia, extend the continuous protected complex to cover 13,000 sq.mi. These are accessible by highway and rail and have excellent visitor accommodations. Vast portions of these parks are true wilderness, enjoyed by explorers and mountaineers. Other national parks in the Canadian Rockies, in the forests and lakelands of the plains and eastward to the Atlantic coast, provide a variety of environment, recreation and wildlife. Except for recognition of native Indian rights, hunting is prohibited, and legislative action is required to alter boundaries.

Six provinces have set aside provincial parks, many as magnificently scenic and as important to wildlife as the national parks.

TABLE 111.—*Principal Parks in Canada*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
National Parks			
Banff (Alberta)	2,564 (1,641,000)	1885	Central Rocky mountain scenery, with peaks to 11,900 it.; bighorn sheep, mountain goat, elk, moose, bears, etc.
Cape Breton Highlands (Nova Scotia)	367 (234,900)	1936	Rugged Atlantic and Gulf of St. Lawrence shore line, with coves and forests
Elk Island (Alberta)	75 (48,000)	1913	Rolling prairie; fenced herds of mammals
Fundy (New Brunswick)	79.5 (50,900)	1948	Mixed conifer and hardwood forests rising above Bay of Fundy; moose, white-tailed deer, black bear and other wildlife
Georgian Bay Islands (Ontario)	5.4 (3,500)	1929	Tiny islands in Georgian bay, Lake Huron
Glacier (British Columbia)	521 (333,400)	1886	Rocky mountain wilderness; peaks, glaciers, lakes, coniier forests, abundant wildlife
Jasper (Alberta)	4,200 (2,688,000)	1907	Peaks to 12,394 it., famous Columbia ice field covers 150 sq.mi.; conifer forests; abundant wildliie
Kootenay (British Columbia)	543 (347,500)	1920	Rocky mountain scenery and wildlife; hot springs
Mount Revelstoke (British Columbia)	100 (64,000)	1914	Rolling alpine plateau 6,000 ft. in elevation; snow fields, glaciers
Point Pelee (Ontario)	6 (3,800)	1918	Peninsula in Lake Erie, noted as sanctuaty for birds
Prince Albert (Saskatchewan)	1,496 (957,400)	1927	Conifer and deciduous forest lakeland with excellent canoeing; migratory waterfowl and otber wildlife
Prince Edward Island	7 (4,500)	1937	25 mi. of forested coast line on Gulf of St. Lawrence, with beaches and bays; many kinds of small mammals
Riding Mountain (Manitoba)	1,148 (734,700)	1929	Forested plateau rising 1,000 ft. above the plains; many glacial lakes; abundant wildlife
St. Lawrence Islands (Ontario)	0.3 (172)	1914	Protects a mainland area and 12 of the Thousand Islands in the St. Lawrence river
Terra Nova (Newfoundland)	156 (99,800)	1957	Forests barrens and rocky hills rising! from sheltered sounds indenting Atlantic coast
National Parks (*Cont.*)			
Waterton Lakes (Alberta)	203 (129,900)	1895	Canadian portion of Waterton-Glacier International Peace park. Rocky mountain ecology, noted for lakes, wildflowers and animals
Wood Buffalo (Alberta–Northwest Territories)	17,300 (11,072,000)	1922	Protects only remaining herd of wood buffalo in its natural state, and related plains buffalo, the total herd numbering 12,000 to 14,000 animals
Yoho (British Columbia)	507 (324,500)	1886	Glaciers, ice fields, lakes and waterfalls among canyons and peaks, in Rocky mountains
Provincial Parks (partial list)			
Cypress Hills (Alberta)	77 (49,453)	1952	Rare specimens of preglacial plant and insect life
Garibaldi (British Columbia)	957 (612,615)	1927	Pacific coast mainland, with mountain lakes, peaks and glaciers
Hamber (Britisb Columbia)	3,800 (2,431,960)	1941	Northern wilderness conifer forest, adjoining Jasper and Banff National parks, on Big Bend highway
Mt. Assiniboine (British Columbia)	20 (12,800)	1922	Outstanding Rocky mountain scenery, south of Banff
Mt. Robson (British Columbia)	803 (513,920)	1913	Rocky mountain peaks, lakes and glaciers
Strathcona (British Columbia)	828 (529,920)	1911	Peaks, glaciers, alpine meadows and Della Falls, in centre of Vancouver Island
Tweedsmuir (British Columbia)	5,400 (3,456,000)	1938	Vast mountain wilderness area, with abundant wildlife
Algonquin (Ontario)	2,741 (1,754,240)	1893	Wilderness area and wildlife preserve in northern forests
Quetico (Ontario)	1,860 (1,190,400)	1913	Forested wilderness lakeland, adjoining Boundary Waters canoe area in U.S.
Gaspesian (Quebec)	514 (328,960)	1937	Rugged terrain on Gaspé peninsula reserved to protect caribou'and otber wildlife
Laurentide (Quebec)	3,612 (2,312,100)	1895	Park containing many lakes and tumultuous rivers; abundant wildlife
La Verendrye (Quebec)	4,746 (3,038,000)	1939	Wild terrain of forests, lakes and rivers
Lac La Ronge (Saskatchewan)	1,140 (729,600)	1939	Representative northern spruce and poplarforests, with many species of wildlife

They are administered under regulations promulgated by the respective provincial governments, and hunting is permitted in some of them. Tweedsmuir Provincial park, in British Columbia, is one of the largest wilderness areas (3,456,100 ac.) in North America. The Quetico Provincial park, in Ontario, protects 1,190,400 ac. of forested lakeland adjoining the Boundary Waters canoe area in Minnesota. Canada has reserved dozens of game preserves and wildlife sanctuaries. some of great size. Musk oxen, caribou and other abundant wildlife are safeguarded on about 1,000,000 ac. in the Northwest Territories, Yukon and Alberta. More than 1,200 sq.mi. of crown lands comprise bird sanctuaries under the Canadian wildlife service, and the provinces and local governments have reserved many other refuges. Until well into the 20th century much of Canada was remote wilderness, but the accelerated expansion of industrial exploration and development throughout the country, especially after World War II, increased the importance of these reservations in ensuring the survival of Canada's extraordinary wildlife populations.

III. AFRICA

Popular imagination envisions Africa as a continent still teeming with millions of wild animals roaming freely over velds, forests and jungles. Actually the habitat has been so restricted by human settlement and economic development and so many species of larger mammals have been hunted so ruthlessly that in many countries wildlife persists in significant numbers only where national parks and reserves have been established.

Even in the areas where the natural environment is preserved and the animals are protected, poaching by natives for meat and ivory endangers the wildlife populations. Parks and reserves are further threatened by pressures from native tribes to permit use of grasslands in national parks for cattle, frequently a symbol of wealth and prestige rather than a source of food, which have destroyed verdant pastures over wide ranges.

During the latter part of the 19th century the preservation of Africa's wildlife began to be a matter of concern, and various steps were taken in that direction (see WILDLIFE CONSERVATION: International Co-operation). The rise of independent native governments after World War II threatened to reverse these gains because of indifference and inexperience on the part of the new governments and the attitude of many native peoples that all land must be devoted to producing economic commodities to raise the standard of living for their increasing populations. Many tribes consider wildlife only a competitive nuisance and poaching is both widespread and increasing.

Most of the new nations have retained the parks and reserves their predecessors established and are endeavouring to provide administrative machinery to handle them. The future of these areas and their natural resources depends on how effectively sound policies are applied. Various conferences, such as the one at Arusha, Tanganyika, in Sept. 1961, under the sponsorship of the Commission for Technical Cooperation in Africa south of the Sahara (CCTA) and the International Union for Conservation of Nature were held to analyze these problems.

By the early 1960s there were about 25 African countries with national parks or equivalent reserves, protecting a total of about 265,678 sq mi. Kruger National park, in Transvaal, Republic of South Africa, covers 8.000 sq.mi. and presents one of the most extraordinary exhibits on earth of wild animals. From their cars, visitors can watch lions, elephants, giraffes, hippopotamuses. many kinds of antelopes and other creatures living their natural lives. Established in 1898 in response to Pres. Paul Kruger's warning that African wildlife would be exterminated unless protected, the park was enlarged in 1926 and is administered by a National Park Board of Trustees with official and civilian members. This board also supervises four other national parks, of which the Kalahari Gemsbok National park, in Cape Province and Bechuanaland, created in 1931, is a unique sanctuary for oryx, springbok, red hartebeest, kudus, elands, ostriches and many other animals of the arid desert, as well as the nearly extinct race of primitive human Bushmen. Other parks in South Africa are administered by similar but provincial boards.

Three national parks in Cape Province are notable for rare species protected in them. Addo National park preserves the last Addo elephants; Bredasdorp Bontebok National park safeguards a remnant herd of bontebok antelopes; the Mountain Zebra National park has ensured the survival of that race of zebras. The Umfolozi reserve in Natal has a population of about 300 rare southern white (or square-lipped) rhinoceroses (1959), as well as black rhinoceroses. The Orange Free State has 16 game reserves, of which the Somerville Game reserve (26,000 ac.) is the most important. There are many other reserves in South Africa where hunting is prohibited or strictly controlled, or where particular botanical, zoological, geological or historical features are protected.

Outstanding among the reserves of the world are the national parks of the Republic of the Congo. These were most efficiently protected under the careful policies of the Institut des Parcs Nationaux du Congo Belge, and in spite of the confusion attending establishment of an independent government the new administration continued the protection of these areas to the best of its ability. Albert National park was reserved in 1925, initially to protect the shy mountain gorilla, but by subsequent acts and royal decrees it was enlarged as a reserve dedicated to the protection of all animal life and vegetation and to scientific and ecological exploration and study. This park (part in Rwanda), and three others established later, Kagera National park (Rwanda), Garamba National park and Upemba National park, safeguard a wide variety of natural environment from the snow-clad peaks of the Ruwenzoris to the jungle rain forests of the Congo basin. They are the habitat of such rare animals as the okapi and bongo, as well as many other species and the pygmy people. Scientists from all over the world come to these parks, and their reports on every ecological aspect of the region published by the Institut are invaluable contributions to knowledge of Africa and to its development. Because of the scientific importance of preserving natural conditions unchanged, only certain portions of the Albert National park and of the Kagera National park are open to tourists.

In Southern Rhodesia an official program endeavouring to eliminate the tsetse fly, carrier of the nagana parasite in cattle, by widespread slaughter of the larger wild animals has led to scarcity of most wildlife except in national parks and forest reserves, where animals are protected. The Wankie National park with the adjacent Robin Game sanctuary covers a large area where tourists are encouraged to come between June and November to see great herds of antelope, buffalo. elephant, many species of birds and other animals. Victoria Falls National park to the north preserves one of the most famous scenic features in Africa.

Northern Rhodesia established its first national park, Kafue, in 1950 in the basin of the Kafue river; it is a reserve larger than Kruger National park. Native tribes, occupying 5% of the park, retain certain aboriginal rights, but passage through the reserve is restricted to determined routes. The park is open to tourists and supports a wealth of wildlife. Northern Rhodesia also possesses game reserves and "controlled areas" where the number of animals allowed to be killed by nonresidents is regulated according to the population of those animals; there are also reserves for fish protection, forest reserves and others where careful policies of protection are enforced. Some of these contain famous waterfalls, caves and other scenic and archaeological features.

In northern Tanganyika eastward from Lake Victoria as far as the conservation area stretches the Serengeti National park, which preserves the finest assembly of plains animals in Africa. During the dry season the animals roam the comparatively well-watered western section of the park which the tsetse fly makes uninhabitable to man and livestock. The park contains the best extensive grassland range of central Africa. undamaged by the light grazing of the native animals. In the wet season, the wildlife migrates into the eastern area of the park and even farther eastward into the conservation area, where it comes into contact with thousands of cattle herded by nomad Masai tribesmen. These cattle, sometimes diseased, usually undernourished and of little economic value, threaten to overgraze and destroy the range. In the mid-1950s, demands from the Masai, some of whom consider wild

TABLE IV.—*Principal Parks and Reserves in Africa*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
ALGERIA			
Djurdjura	64 (40,900)	1935	High terrain of Djurdjura; conifer and cedar forests; monkeys, boars, jackals wildcats, raptores and othkr birds; reptiles and other wildlife
ANGOLA			
Cameia National a	3,906 (2,500,000)		In the Haute-Cuenene; gnus and antelopes
Egito reserve			Central coast; elephants, elands, etc.
Luando reserve	7,740 (4,953,600)		Central Angola; protects abundant wildlife, especially giant sable antelope
Milando reserve	4,344 (2,780,000)		Near Congo border, especially rich in species of antelope
Moçamédès National park	7,277 (4,657,500)		Southwest coast; black rhinoceros, Hartmann's zebra, Burchell's gaeelle, oryx and other wildlife
Mupa reserve	2.578 (1,650,000)		South central Angola; black rhinoceros, many elephants and zebras, variety of antelope
Quiçâma reserve	3,889 (2,489,000)		Northern coast; abundant mammals and birds; eland has increased to more than 1,000 individuals
CAMEROON			
Waza Game reserve	580 (371,200)	1934	Sudanese plains, wooded on the west; giraffe, antelope, aquatic and marsh birds
Boubandjida Nature reserve	775 (496,000)	1947	Wooded plains; rhinoceros, giant eland and others
Faro Nature reserve	1,270 (812,800)	1947	Uninhabited plains; rhinoceros giant eland and other animal;
Campo Game reserve	1,200 (768,000)	1932	Dense equatorial forest and swamp completely uninhabited
Dja Game reserve	2,025 (1,296,000)	1950	Equatorial forest inhabited by 200 to 300 pygmies
REPUBLIC OF CONGO			
Odzala National park	424 (271,400)	1940	Almost inaccessible area in western Congo; abundant forest wildlife, including elephant, bongo antelope, anthropoid apes; pygmies
REPUBLIC OF THE CONGO			
Albert National park	3,160 (2,022,400)	1929; 1934	A world-famous national park on the Uganda and Rep, of Rwanda border; equatorial jungles, Ruwenzori mountains (Mountains of the Moon) and Virunea volcanoes with cloud forests giant lobelias and heath&; most of Lake Edward; great variety of wildlife, including mountain gorilla, elephant, thousands of hippopotamuses; pygmies
Garamba National park	1,000 (640,000)	1938	Grass and wooded savannas on ancient peneplain, on northern border; abundant wildlife, including white rhinoceros, giraffe, elephant, hippopotamus and other plains species
Upemba National park	2 3	1939	Vast plains, with deep river valleys rising to forested Kibara plateaus, in central Katanga; varied animal life, including eland, klipspringer and other antelope many elephants and buffalo. lion and other mammals, aquatic birds
Kibali–Ituri Nature reserve	1,300 (832,000)		Ituri forest, home of pygmies; rare animals, including okapi and bongo antelope
ETHIOPIA			
Managasha National park	12 (7,500)	1958	On mountain range west of Addis Ababa; experimental forestry practiced; most beautiful sections maintained in primeval state; wildlife strictly protected
FRENCH SOMALILAND			
Mt. Goudah reserve	38 (24,320)	1939	Mt. Dai and surrounding primitive forests of junipers (*Juniperus procera*), firs, *Medenia* palm, etc.
GHANA			
Mole River Game reserve	900 (576,000)	1958	Owned by the Gonja people, managed ior complete protection of wildiife; savanna forest
IVORY COAST			
Banco National park	12 (7,500)	1954	Dense ancient forest and forestry school
Bouna Game reserve	3,516 (2,250,000)	1953	Peneplain grasslands and dry woodlands; most large west African antelopes, carnivores, monkeys, etc.
IVORY COAST (*Cont.*)			
Tai Game reserve	1.660 (1,062,500)	1956	Little explored plains, with abundant wildlife
Elephant Plain reserve	76.5 (49,000)		Protection of elephants
KENYA			
National Parks			
Aberdare	228 (145,900)	1950	Higher elevations of Aberdare range, with glaciers lakes dense forests, bamdoo and moorland alpine meadows, abundant populations of elephant buffalo rhinoceros and other 'wildlife: including rare bongo antelope
Mount Kenya	227 (145,300)	1949	Elevations above 11,000 ft. surrounding Mt Kenya (17 058 ft.), with glaciers, tarns 'and moraines; heavily forested, alpine meadows many birds and smaller mammals but no larger animals
Nairobi	44 (28,200)	1946	Open plains and acacia savanna, deep river valleys, near, Nairobi; Ngong reserve contiguous; famous place to see lion, cheetah, leopard, rhinoceros, giraffe
Tsavo	8,034 (5,141,760)	1948	Semiarid plains, with dense brush and two principal rivers, lava cones, the Mzimi springs; baobab, acacia, euhorbia; elephant, rhinoceros, Eippopotamus, lion, many species of antelope
African District Council *Reserves*			
Masai Amboseli Game reserve	1,259 (805,800)	1948; 1961	Open level terrain at about 4,000 ft., north of Mt. Kilimanjaro; arid, interspersed with swamps and springs, belts of acacia forest; dry salt bed of Lake Amboseli; native trust land of Masai tribe; outstanding exhibit of most east African mammals and birds; competition with cattle being reduced by providing artificial water supplies; transferred to A.D.C., 1961
Masai Mara Game reserve	700 (448,000)	1948; 1961	Open rolling plains with thickets and riverine vegetation; abundant wildlife, including most east African mammals; part of Masai land unit, transferred to A.D.C., 1961
Meru Game reserve	600 (384,000)	1961	Foothills of Nyambeni hills to Tana river; grassland, rain forest and riverine forest; abundant variety of wildlife, *Oryx* beisa, reticulated giraffe, Grevy's zebra; transferred to A.D.C., 1961
National Reserves			
Marsabit	10,280 (6,579,200)	1948	Semidesert covered nith thornbush, two mountain ranges, eastern shore of Lake Rudolph; Crown land, but natives have vested rights; varied animal life, including reticulated giraffe, Grevy's zebra, northern ostrich
Ngong	455 (291,200)	1950	Migratory zone for wildlife inhabiting Nairobi National park; open plains with acacia rising to Ngong hills 8,000 ft. in elevation; Masai grazing land
West Chyulu	145 (92,800)	1948	Scenic western Chyulu ranges of recent volcanic origin, covered by bush grass and belts of forest; no surface water, heavy rainfall in season; migratory population of larger mammals; adjacent to Tsavo National park
MALAGASY REPUBLIC			
Ambre Mountain National park	71 (45,500)	1958	Volcano with smaller craters and lakes; dense deciduous moss forest; lemurs
11 nature reserves	1,639 (1,048,873)	1927–1952	Protects birds and small mammals, especially lemurs; forests with orchids and lepidoptera
MALI			
Boucle du Baoulé National park	1,367 (875,000)	1954	Baoulé river basin, with sudanese savanna and forests; elephant, giant eland, sable antelope and other wildlife
MAURITIUS			
Bel Ombre Kational reserve	3.5 (2,271)		High montane climax forest, with ebony .

TABLE IV.—*Principal Parks and Reserves in Africa* (*Continued*)

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
MAURITIUS (*Cont.*)			
Round Island National reserve	0.6 (374)		Volcanic formations, with endemic vegetation and animal life some species peculiar to the) island; red-tailed and white-tailed tropic birds, wedge-tailed shearwater, Trinidad petrel; endemic snakes, lizards and insects
MOROCCO			
Tazekka National park	2.3 (1,450)	1950	Jebel Tazekka (1,979 m. [6,493 ft.]) in Middle Atlas range; high rainfall produces forest cover, including Atlantic cedar; wildlife
Toubkal National park	141 (90,000)	1942	High Atlas mountains, peaks rising to 4,185 m. (13,730 ft.); desert, with juniper and oak forests at higher altitudes; endemic plants; mouflon, mountain gazelle, endemic lake trout
MOZAMBIQUE			
Gorongoza Nature reserve	906 (580,000)	1935	Protects all animals; surrounded by a protected zone of 7,000 sq.km.
Limpopo Game reserve	4,245 (2,716,498)		South African animal life; regulated hunting; adjacent to Kruger National park
Maputo Game reserve	930 (595,200)		Southern tip of Mozambique, between Indian ocean and Swaziland; South African fauna
NIGER			
National Park du "W"	1,289 (825,000)	1937; 1954	Wooded sudanese savanna, bounded by Mékrou, Niger and Tapoa rivers; all characteristic western African plains animals, except giant eland; contiguous with reserves in Dahomey and Upper Volta with combined total of 3,120,500 ac.
NIGERIA			
8 game reserves	5,348 (3,422,500)		Regulated hunting; giraffe, elephant, waterbuck, kob and other wildlife; several smaller animal life sanctuaries
NORTHERN RHODESIA			
Kafue National park	8,650 (5,536,000)	1950	Kalahari sand (south), forests flood plains, grasslands and marshes (north); Kafue river and tributaries flow 100 mi. within the park; eland, sable, roan, kudu, lechwe and other antelope, zebra, elephant, hippopotamus, rhinoceros, carnivores and other plateau species; marsh birds; tsetse flies
Isangano Game reserve	325 (208,000)	1957	Woodland and grassy plains with perennial streams and Bangweulu swamps; only sanctuary for the rare black lechwe elephant, buffalo lion, various antelope, bird life, etc
Kasanga Game reserve	150 (96,000)	1941	Papyrus swamp bordered by grassland and' woods; many wildlife species, including rare sitatunga and shoebill stork
Lavushi Manda Game reserve	580 (371,200)	1941	Wooded plateau and rocky hills; varied wildlife
Luangwa Valley Game reserve	4,990 (3,193,600)	1942	Flat valley of Luangwa river, with lower foothills; acacia woodlands, lagoons in river plain flood in rainy season, abundant and varied animal life, including elephants, rhinoceros, Thornicroft's giraffes
Lukusuki Game reserve	1,050 (672,000)	1942	Wooded escarpments and plateaus; primarily a breeding ground for elephants; other animals
Lunga Game reserve	650 (416,000)	1951	Low forests and small grass plains; varied wildlife
Lusenga Plain Game reserve	340 (217,600)	1942	Woodlands and plains along Kalungwishi river; varied wildlife
Mweru Marsh Game reserve	1,210 (774,400)	1942	Papyrus and Phragmites marsh merging into dry plains and woodlands; animal life abundant, including elephant, sitatunga, some black rhinoceros; myriad wading birds on mud flats in dry season
Sumbu Game reserve	780 (499,200)	1942	On southern shore of Lake Tanganyika, with river deltas rocky ridges. woodland and small grass plains; many animals, especially elephant and blue duiker
Lochinvar ranch (private game reserve)			A large area, especially important to perpetuation of the red lechwe

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
NYASALAND			
Kasungu Game Reserve	772 (494,100)		Buffalo, greater kudu, eland, bushbuck and other wildlife
Kota Kota Game reserve	347 (267,900)		Elephant, hippopotamus, rhinoceros, many antelope
Lengwe Game reserve	50 (32,000)		Protects nyala and other animals
REPUBLIC OF RWANDA			
Kagera National park	970 (627,500)	1934	Verdant basin of Kagera river on Rep. of the Congo border; varied animal life, with zebra, antelope and marsh birds predominating
SENEGAL			
Niokolo-Koba National park	977 (625,000)	1951	The limit of the northern sudan savanna, principal refuge for Senegalese wildlife, including elephants, giant eland, antelopes, carnivores, hippopotamus
SEYCHELLES			
Aldabra Islands Nature reserve	60 (38,400)		Complete protection of giant tortoise and, on South Island, of all animals
Praslin Island Vallée du Main	2 (1,280)	1946	Protects *Coco de mer* palm and native birds
REPUBLIC OF SOUTH AFRICA			
National Parks			
Addo Elephant (Cape province)	26.5 (16,932)	1931	Southern tip of province impenetrable bush, habitat for 28 rare Addo elephants (a South African race of *Loxodonta africana*) and scarce Cape buffalo; 11 species of extirpated antelope reintroduced, abundance of other mammals, birds and reptiles
Bredasdorp Bontebok (Cape province)	5 (3,200)	1959	Forested and open basin plateau; habitat for last 110 bontebok antelope; gray rhebok, gray duiker, steinbok
Kalahari Gemsbok	3,730 sq. mi. (2,387,200) in Cape province; 4,300 sq. mi. (2,752,000) in Bechuanaland	1931	Bright red Kalahari sandveld, 5 in. of rainfall annually; acacia trees and desert shrubs and grasses; Kalahari lion and other endemic species, pther animal life characteristic of Kruger National park
Kruger (Transvaal province)	8,000 (5,120,000)	1898; 1926	World famous wildlife sanctuary, extending from Crocodile and Levubu rivers to the Lebombo mountains and the Mozambique border; mostly open veld, other parts dense brush and open forests; almost every species of South African animal life may be seen at close range
Mountain Zebra (Cape province)	5.5 (3,545)	1937	arroo mountain region; established especially to protect the very rare mountain zebra; other indigenous animals reintroduced; not open to public
Royal Natal (Natal province)	32 (20,500)	1916	High scenery of Drakensberg mountains; gray rhebok, mountain reedbuck, other wildlife; Bushmen's paintings
Nature Reserves			
Cape province			
Cape of Good Hope	27 (17,300)	1939	On tip of Cape of Good Hope; rare vegetation, including blue *Disa* orchid, mielie heath, Vaal rhebok, grysbok, other wildlife
Game Reserves			
Natal province			
Giant's Castle	92 (59,000)	1903; 1952	Open rugged grassland and peaks of Quathlamba Drakensberg range, and headwaters of Mooi and Busman's rivers; highland species of antelope, many leopard
Hluhluwe	89 (57,000)	1951	Almost every species of wildlife in Zululand including white rhinoceros, black rhinoceros, impala, kudu, etc.
Ndumu	37 (23,700)	1924; 1947	Thorn savanna, Ficus riverine forests and a large lake; hippopotamus, crocodile, nyala
Nkuzi	97 62,000)	1912	Thorn veld and Ficus forest; nyala, impala and some black rhinoceros
St. Lucia	190 (121,600)	1897; 1939	St. Lucia lake and estuary on False bay, and coastal scrub and jungle; hippopotamus and many kinds of birds, especially waterfowl
Umfolozi	112 (72,000)	1897	Rolling thorn veld; sanctuary for white rhinoceros

TABLE IV.—*Principal Parks and Reserves in Africa (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
REPUBLIC OF SOUTH AFRICA			
Nature Reserves (*Cont.*)			
Orange Free State			
Willem Pretorius		1956	Open plains, bush and *kloofs* and Doornberg range; plains species of wildlife
Transvaal province			
Barberspan	14 (8,940)	1954	Ornithological research station on Lake Barberspan; thousands of waterfowl flamingo, pelican and other dirds
Loskop dam	41 (26,200)	1940	Protects wildlife on four farms bordering Loskop reservoir; cycads, including *Encephalartos*
SOUTHERN RHODESIA			
Robert McIlwaine National park	20 (12,800)	1952	Bushmen's paintings; lake
Matopos National park	300 (192,000)	1953	Granite *kopjes* and Bushmen's cave paintings; sable and other antelope
Rhodes Inyanga National park	133 (85,100)	1950	Mountainouscountry; exoticand indigenous forests; wildlife
Victoria Falls National park	205 (131,200)	1952	Victoria falls, 355 ft. high, 5,580 ft. long, in Zambesi valley; rain forest; elephant, sable, roan and other antelopes; lion; many other species
Wankie National park	5,128 (3,281,900)	1950	Gemsbok, 2,000 elephants, buffalo, wildebeest, sable antelope, impala, roan antelope, kudu, lion and other wildlife
Gona-re-Zhon Gape reserve	1,000 (640,000)		Contains all species of animallife of Southern Rhodesia
Kazuwa		1961	
SOUTH-WEST AFRICA			
Estosha Pan Nature reserve	26,000 (16,640,000)	1928	Desert region extending from ocean to plains; contiguous with Moçamédès reserve in Angola; huge herds of elephants, springhok, zebras and blue wildebeest
SUDAN			
Dinder National park	2,470 (1,580,800)	1939	Roan antelope, kudu, and other antelope, many other species of wildlife
Southern National park	7,800 (4,992,000)		Dense and open forests and plains; many species of wildlife in abundance
TANGANYIKA			
Serengeti National park	4,450 (2,848,000)	1940	Open grasslands, acacia bush and riverine thickets, rocky outcrops and ridges, extending east irom Lake Victoria to Kenya; habitat of largest populations of ungulates in Africa (about 400.000 head). and manv lions.' leopards. cheetahs
Ngorongoro Conservation area	2,500 (1,600,000)	1959	Grass plains thornbush rain forest and' mountain 'moorland, dominated by vast extinct Ngorongoro crater, rising over 11,000 ft., main gorge and Lake Eyasi branch of Rift valley; rhinoceros, elephant buffalo leopard mountain 'reedbudk and' giant forest hog in higher terrain; plains species at lower elevations
Game Reserves			
Biharamulo	450 (288,000)	1959	Wooded rolling plains on shore of Lake Victoria; northern limit of range of sable antelope; Lichtenstein's hartebeest, common reedbuck and Sharp's steinbok
Gombe Stream	61 (39,000)	1943	Shore of Lake Tanganyika, on Rwanda-Burundi boundary; precipitous mountain country, with woodland and thick gallery forest, and mountain meadows; chimpanzee red colobus monkey and 'other wildlife
Katavi Plain	650 (416,000)	1951	Woodland, thornbush, plains and lakes many buffalo, hippopotamus, elephant, lion and other animals
Kilimanjaro	720 (460,800)	Before 1914; 1951	Summit of Mt. Kilimanjaro between 6 000 ft., at forest line to 19,340 ft with rain forest, moorland, 'tundra and ice fields; animal life includes Harvey's and Abbott's duikers elephant, buffalo, leopard, 'eland., colobus and blue monkeys, and other wildlife

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
TANGANYIKA			
Game Reserves (*Cont.*)			
Lake Manyara	375 (460,800)	1957	An area between escarpment of rift wall and Lake Manyara, with swamp and gallery forests, acacia woods, meadows and flats; elephant, many buffalo, hippopotamus, oryx, white-bearded wildebeest, lion and other mammals; waterfowl, wading birds
Mkomazi	1,350 (864,000)	1951	Very arid hilly area, adjoining Tsavo National park in Kenya; semidesert vegetation and animal life, including lesser kudu, oryx, gerenuk, rhinoceros,, elephant and larger carnivora
Mt. Meru	99 (63,400)	Before 1914; 1951	Upper slopes of volcanic Mt. Meru from 5,500 to 14,979 ft., with rain forest, bamboo, cedar and heath; colobus monkey, giant forest hog, rhinoceros, elephant, etc.
Rungwa River	7,822 (5,006,100)	1951	Rolling wooded plains, with rocky ridges; sable and roan antelopes, greater kudu, elephant, buffalo, etc.
Selous	11,512 (7,367,700)	Before 1914; 1951	In Rufiji river basin, with open grasslands patches of dense hardwood ' forest; primarily an elephant reserve, with many other animals
Tarangire	525 (336,000)	1957	Acacia thornbush and flood plains; elephant, rhinoceros, wildebeest impala, Coke's hartebeest', eland, lesser kudu, etc.; ecological research station
Ngorodoto Crater	5	1961	
TUNISIA			
Djebel Bou Hedma State park	508 (32,500)	1936	Plateau area in southern Tunisia, with remnant of acacia park land; gazelle, mouflon
UGANDA			
Murchison Falls National park	1,504 (962,600)	1952	Includes famed Murchison falls and the Victoria Nile; mostly open grassy plains, large number of crocodile, hippopotamus, and characteristic plains animals, such as elephants rhinoceroses, lions, etc., and aquatic birds
Queen Elizabeth National park	764 (489,000)	1952	Includes Kazinga channel joining Lake Edward to Lake George, and adjacent to Albert National park in Congo; tropical forests, swamps, open grassland and volcanic crater area; mountain gorillas, chimpanzees, elephants., antelopes, lions, hippopotamuses
Aswa Lolim Game reserve	40 (25,600)	1959	Dry savanna, seasonal habitat of Uganda kob ranging from Murchison Falls National park adjacent; elephant, buffalo, various antelope
Kigezi Game reserve	200 (128,000)	1952	Grassland and tropical forest, a buffer zone for Queen Elizabeth National park; plains and forest animals
Toro Game reserve	202 (129,300)	1946	Savanna and swamps on shore of Lake Albert; variety of wildlife, including elephants, buffalos, lions, hippopotamuses
Bugungu Hippopotamus and Elephant sanctuary	183 (117,100)		On southwest boundary of Murchison Falls National park; special protectton for hippopotamus and elephant
Debastien Game sanctuary	760 (486,400)	1958	Open plains, with characteristic wildlife
Elephant sanctuary	1,350 (864,000)		On southern boundary of Murchison Falls National park; s ecial protection for eleplants
Gorilla sanctuary	17 (10,900)		On Congo border, special protection for gorilla
Mt. Kei and Otze Crown Forest White Rhinoceros sanctuaries	250 (160,000)		Basin of the White Nile river, special protection for the rare white rhinoceros

animals a competitive nuisance, threatened to cause drastic reduction of the national park with consequent destruction of the wildlife and its habitat. In 1956 the world-famous botanist and ecologist W. H. Pearsall studied the problem and recommended drastic changes in the government's plans. For the most part these changes were put into effect. In addition to the Serengeti, Tanganyika possesses game reserves where hunting is prohibited and other reserves where certain species are protected and where hunting is regulated.

Similar problems exist in Kenya and elsewhere in east Africa. The game department, the Royal National parks of Kenya and the Kenya Wild Life society have experimented with the concept of encouraging native participation in the benefits derived from national parks and reserves with a success that indicates this approach is feasible. Poaching, for biltong (meat), ivory and rhinoceros horn. is a serious threat to protected animals. Between 1946 and 1960 six national parks and six national reserves were established in Kenya. In 1961, three of the national reserves were transferred to African district councils under careful agreements in recognition of the growing interest of the native people in wildlife preservation. Nairobi National park is close to the principal city and is famous as a place where visitors can see lions at close range, giraffes, Thomson's and other gazelles, and a host of other mammals and birds beside the roads. It is too small to provide sufficient range for its wildlife, and herds of zebras and antelopes sometimes roam out of the park onto nearby farms, followed by lions which may commit depredations on livestock. Were it not for the supplementary habitat provided by the Ngong reserve nearby, the wild populations would find it difficult to perpetuate themselves. Tsavo National park to the south contains 8,034 sq.mi. of thorn scrub considered useless for human development but abounding with much wildlife. In its Mzimi pools hippopotamuses have lived for generations and may be observed swimming with escorts of fish in the crystal-clear water. A proposal to utilize these pools for a reclamation project was defeated by Mervyn Cowie, director of the Royal National park system in Kenya, and other conservationists. The Mount Kenya and Aberdare National parks were temporarily closed to the public because of the Mau Mau uprisings. The Marsabit reserve is one of the most beautiful regions of Africa and protects many species, some not found in the southern part of the country. There are also other reserves that support large wildlife populations. Two small national parks are historical and archaeological sites.

Murchison Falls National park, established in 1952 in Uganda, protects one of the famous waterfalls in Africa and is the habitat of many crocodiles, hippopotamuses, elephants, lions, leopards, antelopes and other species. Queen Elizabeth National park was also established in 1952 between lakes Edward and George. The view of the Ruwenzoris and other mountains across the lakes attracts many visitors and the park itself is noted for its volcanic craters. Among other forms of wildlife here, this park supports a considerable population of chimpanzees. Its thousands of hippopotamuses have so greatly increased under protection that they are creating an overgrazing problem near the two lakes and the Kazinga channel which connects them. The solution to this problem seems to lie in the hippopotamus-cropping program now in operation. Uganda also has special reserves for the rare northern white rhinoceros, for gorillas, and the large elephant sanctuary.

Equatorial Africa has suffered loss of animal life and vegetal cover, but the French authorities there were interested in preserving the most outstanding scenic areas and wildlife populations. The governments that replaced French administration endeavoured to continue this protection, although the change in political status caused some uncertainty about the future of the reserves. A number of nature reserves were established, of which the Vassako-Bulo reserve (375,000 ac.) protects wooded plains and arid forests in the Central African Republic. Adjacent to this reserve, and bounded also by three others, is the Parc National du Baminui-Bandoran (2,500,000 ac.); it has been suggested these areas be combined into a single national park. The Parc National Saint-Floris (40,000 ac.) is the sole habitat of the heronlike shoe-bill (Balaeniceps rex) in the Central African Republic. The Odzala National park in the Republic of Congo and the Parc Nationale de l'Okanda (475,000 ac. in Gabun) have been reserved in relatively unexplored regions. Most of these reservations are patrolled only by local inhabitants.

In Cameroon the Waza Game reserve protects rich animal life of plains species and thousands of aquatic birds. A 1,000 ac. isolated mountain forest was set aside in 1948 as the Monts Bamboutos reserve, and extensive areas are devoted to zoological reserves, game reserves and protected forest reserves where wildlife is safeguarded.

The Guinea Monts Nimba reserve (48,750 ac.), on the border between the Ivory Coast and Guinea, supports varied forest animal life, notably chimpanzees, and an abundance of epiphytic plants. In the mid-1950s proposals for mining activities in adjacent parts of Liberia threatened to extend into this reserve.

A large population of mammals and birds is protected in the Niokolo-Koba Kational park (625,000 ac.) in Senegal. The Parc National du "W" in Niger and a complex of contiguous reserves in Upper Volta and Dahomey, totaling 3,120,500 ac., protect many west African animals. The Banco National park (7,500 ac.) in the Ivory Coast contains a dense relict forest. In Mali, the Boucle du Baoulé National park is a mountainous scenic forested area with abundant wildlife, bordered by large game reserves.

The extraordinary and unique animal life and vegetation of the island of Madagascar have been decimated over seven-tenths of the country by exploitation, but between 1927 and 1960 six nature reserves were established under the guardianship of the Museum National d'Histoire Naturelle in Paris. Under a decree of 1952, four similar reserves were created to protect especially dugongs, all species of lemurs, egrets and the endemic vegetation. In 1956 Jean-Jacques and Arlette Petter undertook an ecological study of the lemurs on the island, under the sponsorship of the Museum, the Institut de Recherche Scientifique de Madagascar, the Conseil National pour la Recherche Scientifique en France and the International Union for Conservation of Kature; this study added greatly to scientific knowledge and led to recommendations for additional reserves.

In Angola elands have increased markedly in the Quiçâma National park (2,489,000 ac), as have other species. The beautiful rare giant sable antelope is especially protected with other wildlife in the Luando reserve. Black rhinoceros (150–200 in 1960) and Hartmann's zebra are abundant in the Moçamédès National park and inhabit others. The largest elephants in the world are found in Angola, and sizable herds are safeguarded in several of the reserves.

The Somali Republic has four national parks and one nature reserve for the protection of animal life and vegetation, and laws have been enacted to ensure the survival of certain endangered species and to regulate hunting of others. Zoological and game reserves have also been established.

The two national parks in Morocco, the Toubkal National park and the Tazekka National park, are bordered by game reserves where hunting is regulated on a rotation basis. The land is arid but supports some protected forests.

National parks in Algeria are administered under strict policies to ensure perpetuation of natural ecological conditions. Visitors may see the varied wildlife of North Africa, including apes, foxes, several species of cats, reptiles and birds. The animals of this region were depleted by the ancient Romans to provide for their circuses. Tunisia has reserved two areas of interest to tourists, the Parc forestier d'Ain–Draham and the Forêt domaniale du Bou Kornine.

IV. ASIA

Although interest in national parks came later in Asia than in Africa, several countries have very well-developed park systems. In Japan, for example, in spite of the large human population and need for agricultural and other economic exploitation of land, 4% of the total land area has been set aside as parks. Inspired by visits to the national parks of the United States in 1923 and 1924, Tsuyoshi Tamura influenced the Japanese government to enact a national parks law in 1931. By 1936, although funds were limited, 12 national parks had been established. After the close of World War II came recognition that the natural beauty of Japan represented one of its richest natural resources. Seven new parks were created and their development for tourists and the enjoyment of the Japanese people was stimulated. In addition. 20 quasi-national parks, administered by the prefectures, were established.

The Japanese people are highly sensitive to natural beauty and visit their parks in great numbers. The parks also protect many religious shrines and temples, the most notable being the Grand Shrine of Ise in Ise–Shima National park. Mt. Fuji, in Fuji–Hakone–Izu National park, is among the most nearly perfect volcanic cones in the world; it is revered by the Japanese people, and is also a major attraction for foreign tourists.

Japan possesses more crater lakes, or caldera, than any other country, and some of the largest in the world are in the national parks, those in Aso. Akan and Towada–Hachimantai being especially magnificent. The Japanese Alps are noted for gorges and waterfalls. for virgin forests and unusual wildlife. Equal in beauty are the rocky headlands and serene islands of the ocean coasts and borders of the Inland sea, with their forests and beaches and rocky islets inhabited by myriad nesting sea birds.

Any of the national parks may be visited from centres of population in a single day; accommodations in or near the parks are excellent.

India's national parks protect some of the outstanding forest, jungle and mountain scenery of the subcontinent and an abundance of wildlife of many species. They are administered by the chief conservator of forests, the North-East Frontier agency, or by other departments of the government; the Indian Board for Wild Life, founded in 1952, serves in a quasi-official advisory capacity.

Four of the many wildlife sanctuaries established in the respective states are of especial importance in the survival of rare endangered species. The Gir forest, northwest of Bombay, is the only remaining habitat of the Asiatic lion *(Panthera leo persica)*. (This or a closely related race survived in Greece until A.D. 100. The lion is referred to 130 times in the Bible; it became extinct in Palestine about the time of the Crusades, but survived into the 20th century in Arabia, Iraq and Iran.) In India, lions inhabited much of the north and central portions until the 19th century,

TABLE V.—*Principal Parks and Reserves in Asia*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
BURMA			
Nature Reserves (by Forest division)			
Kahilu (Thaton)	62 (39,700)	1928	Sumatran rhinoceros, serow, sambar, muntjac, barking deer, hog deer, musk deer; jungle birds
Kyatthin (Shwebo)	104 (66,600)	1941	Forests of Mt. Thaw: gaur, sambar, thamin, muntjac
Maymyo (Maymyo)	49 (31,400)		Barking deer, jungle fowl, partridge, peafowl
Mulayit (Thaungyin)	54 (34,200)	1936	Barking deer, muntjac, pig, tiger, leopard, birds
Pidaung (Myitkyina)	279 (178,400)	1918	East of upper Irrawaddy river; elephant, tiger gaur and hanteng (rare 'wild cattle), bear, leopard, barking deer, pig, jungle birds
Shwe-u-daung (east Katha and Mongmit)	126 (80,600)	1918	Sumatran rhinoceros, elephant, hanteng, serow, sambar, tiger, leopard, jungle birds
Shwezet-taw (Minbu)	213 (136,600)	1940	Gaur, tharnin, sambar, muntjac
CEYLON			
Gal Oya National park	98 (63,000)	1954	Skirts Gal Oya water storage reservoir; dry evergreen and savanna forests, range of mountains on outer border; elephant leopard, deer, sloth bear and' other animals; remnants of an ancient jungle tribe
Ruhuna National park	91 (58,300)	1938; 1954	Open plains jungle, rock outcrops and water holes; sambar, chital barking deer, mouse deer; sloth hear, elephant, leopard; former sites of Buddhist monasteries of 2nd century B.C., caves contain pre-Christian inscriptions
Wilpattu National park	252 (161,300)	1938	Mainly sandy area, a few rocky outcroppings; abundant wildlife, including elephant, sambar, leopard and many species of hirds
Yala Strict Nature reserve	111 (71,000)		High forests and rocky hills; elephant, deer, leopard and other mammals and birds
Amparai sanctuary	148 (94,700)		Noted for its aquatic bird population, including painted storks; migrating herds of elephants
INDIA			
National Parks			
Corbett (Uttar Pradesh)	125 (80,000)	1935	Jungle animal life, including elephant, tiger, leopard, sloth bear, several species of deer, sambar, goral, pig, wild dog, crocodile, python, many species of birds
Hacarihagh (Bihar)	150 (96,000)	1955	Tiger, ieopard bear sambar, barking deer)and dther wildlife
Hailey (Uttar Pradesh)	125 (80,000)	1935	Orchids; sambar, chital, elephant, leopard, caracal, etc.
Kanha (Madhya Pradesh)	98 (62,500)	1956	Vast amphitheatre covered with forestsin upper Banjar valley; abundant wildlife, including gaur, sambar, axis deer, muntjac, etc.
INDIA			
National Parks (Cont.)			
Shivpuri (Madhya Pradesh)	61 (39,000)		Tiger leopard, bear, sambar, spdtted bull, four-horned antelope, Indian gazelle and varied bird life
Taroba (Bombay)	45 (28,800)	1935; 1956	Tiger, leopard, sambar, spotted deer
Tirap (Assam)	800 (512,000)		Mountainous region in northeast Assam on China border, tiger, takin and other wildlife
Wildlife Sanctuaries			
Dachigam (Kashmir)	55 (35,200)		Denselv forested Himalayan mountain area north and east of the valley of Kashmir, between 9,000 and 13,000 ft.; primary refuge of the rare Kashmir stag; also musk deer, leopard, black bear, brown bear, boar and other wildlife
Gir (Bombay)	527 (337,300)	1900	On Kathiawar peninsula, arid desert with dry mixed deciduous teak forest surrounded by a belt of thorn scrub, intersected by narrow rivers; only remaining habitat of Asiatic lion; also chital, sambar, boar, chinkara, four-horned antelope, nilgai, monkey and leopard
Kaziranga (Assam)	166 (106,200)	1908	Tall elephant grassland bounded on north by Brahmaputra river; principal refuge of great Indian rhinoceros: buffalo. gaur, elephant, tiger, sambar hog deer swamp deer, boar: crocodile'and bird life
Keibul Lamjao (Manipur)	20 (12,800)	1954	Established to protect only known wild population in India (100 in 1960) of the brow-antlered deer
INDONESIA			
G. Indrapura Nature reserve (West Sumatra)	49 (31,325)	1929	Wildlife; habitat of rare *Anaphalis javanica* plant
Gunung Loser Nature park (North Sumatra)	1,625 (1,040;250)	1934	Habitat of elephant, Sumatran rhinoceros, deer, tiger
Lautan Pasir Tengger Nature reserve (East Java)	20 (13,025)	1919	A sea of sand in the Tengger mountains
S. M. Bali Nature park (Nusa Tenggara)	78 (50,000)	1941	Especially for protection of the "white starling" (*Leucopsar rothschildi*), tiger, deer and an ox indigenous to Bali
Sumatra-Selatan Nature park (South Sumatra)	1,394 (892,000)	1935	Sumatra; rhinoceros. elephant. deer, serow, mouse deer; tapir; macaques, gibbons; giant *Rafflesia arnoldi*
Udjung Kulon–Panailan Nature reserve	161 (102,800)	1921	On two Javan islands; especially protects the very rare Javan rhinoceros; also tiger, chevrotain, barking deer; extraordinary vegetation
JAPAN			
National Parks			
Akan (Hokkaido)	342 (218,745)	1934	Active volcanoes caldera lakes and hot spring;; virgin conifer forests with rhododendron, azalea and birches; brown bear, snow rabbit and other wildlife; home of primitive Ainu people

TABLE V.—*Principal Parks and Reserves in Asia (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
JAPAN			
National Parks (*Cont.*)			
Aso (Kyushu)	285 (182,717)	1934; 1953	Mt. Aso and vast atrio or sunken crater ringed with mountains in south, the Kuju plateau with many peaks in north, separated by grassland wilderness; forests and alpine meadows; wildlife; large human population
Bandai–Asahi (Honshu)	741 (474,153)	1950	Three disconnected sections: Mt. Gassan volcano and Asahi range (north); Mt. Iide, a granite peak with virgin forests and Mt. Azuma and Mt. Adatara volcanoes (central); Mt. Bandai (south) erupted in 1888 to produce some of world's largest dammed volcanic lakes; bear, monkey, serow in central section
Chichibu–Tama (Honshu)	475 (304,000)	1950	Spectacular scenic vistas of sedimentary ranges, rivers and dense dwarf bamboo moss forests with virgin pine and spruce' fir forests at higher elevations; several villages
Chubu Sangaku (Honshu)	663 (424,420)	1934	Forested Japanese Alps, with peaks, gorges and perpetual snows
Daisen (Honshu)	48 (31,008)	1936	Mt. Daisen and other peaks, with virgin pine and beech forests and snow-clad summits; religious shrines
Daisetsuzan (Hokkaido)	906 (579,823)	1934	Three volcano groups and Ishikari range, with cliffs, gorges, waterfalls; vast alpine meadows and virgin conifer forests; brown bear only Japanese habitat of ' crying "hare" (pika)
Fuji–Hakone–Izu (Honshu)	370 (237,035)	1936; 1955	Famous Fujiyama volcanic cone (3,776 m. [12,388 ft.]) with virgin forests, lakes and plains; Mt. Hakone area includes several volcanic peaks and hot springs; volcanic Izu peninsula noted for hot springs
Ise–Shima (Honshu)	203 (130,090)	1946	Forested peninsula and coast line and island archipelago; Grand Shrine of Ise is national centre of religious worship; pearl farms in bays; bird life abundant
Jo–Shin–Etsu Kogen (Honshu)	738 (472,288)	1949; 1956	Rugged Tanigawa range in north, with plateaus and volcanoes stretching south, including Mt. Asama, highest active volcano in Japan (2,542 m. [8,340 ft.]); Mt. Myōkō–Mt. Togakushi volcano complex to northwest; hot springs, forests; monkeys, antelopes
Kirisbima (Kyushu)	84 (54,000)	1934	23 volcanoes, some active, others with calderalakes; hot springs; evergreen and azalea forests; several religious shrines, with giant cryptomeria trees
Nikkō (Honshu)	550 (351,745)	1934; 1950	Scenic Nikkō volcanic area, peaks, lakes waterfalls, marshes, virgin'forests; abundant mammals and birds; several temples, including Toshogu shrine
Rikuchu Kaigan (Honshu)	34 (21,535)	1955	90 km. (56 mi.) of coast line, cliffs, islands and beaches; pine and deciduous forests and subtropical vegetation; abundant bird life
Saikai (Kyushu)	95 (60,810)	1955	Dendritic coast line, Kujuku islands and Goto archipelago; subtropical forests; many harbours
Seto Naikai (Honshu)	257 (164,775)	1934; 1950	About 600 islands and coast land of Inland sea; fishing villages and farmlands; religious shrines; monkeys
Shikotsu–Toya (Hokkaido)	385 (246,650)	1949	Scenic volcanoes and. caldera lakes, with virgin conifer forests and alpine vegetation. brown bear, Yeso squirrel' Japanese sable, birdsandothe; wildlife
Towada–Hachirnantai (Honshu)	326 (208,378)	1936; 1956	Lake Towada, a double caldera lake, headwaters of scenic Oirase river, and Hakkōda volcanoes, with primeval deciduous forests at lower elevations and dense conifers and alpine vegetation on slopes, the Hachimantai section includes a range of volcanoes and wide plateau, with hot springs
JAPAN			
National Parks (Cont.)			
Unzen–Amakusa (Kyushu)	100 (64,000)	1934; 1956	Northern unit consists of plateau of Mt. Fugen and other peaks, overlooking Sea of Ariake; noted for azaleas, hoxtrees and deciduous forests; Amakusa section is an archipelago, with villages and historical relics of Christianity in Japan
Yoshino–Kumano (Honshu)	216 (138,435)	1936	Mt. Yoshino and Yoshino shrine, noted for cherry blossoms; rugged Ōmine mountain chain and Mt. Odaigahara plateau stretch southward, with dense forests, gorges and cascades; the Kumano seacoast is bordered by innumerable rocky islets
Quasi-national *Parks*			
Abashiri (Hokkaido)	146 (93,530)	1958	Coast line with shallow lakes and dunes, arctic vegetation, sea birds, seals; relics of Ainu culture
Biwa-ko (Honshu)	430 (274,955)	1950	Lake Biwa and surrounding Mt. Ibuki region
Hakusan (Honshu)	185 (118,398)	1955	Small volcanic peaks gorges waterfalls, fossil forests; bear', antelope and other wildlife inhabit virgin forests; shrines
Izu Shichitd (Honshu)	109 (69,538)	1955	Chain of active volcanic islands
Sado–Yahiko (Sea of Japan)	180 (115,075)	1950	Volcanic Sado Island in the Sea of Japan
Yaba–Hida–Hikosan (Kyushu)	425 (272,023)	1950	Volcanic area, adjacent to Aso National park; religious relics
MALAYA			
King George V·National park	1,760 (1,126,400)	1938	Includes mountains, a wide plateau with unusual plant associations and many rivers and limestone outcrops; tropical rain forest; elephant, Sumatran rhinoceros, gaur, sambar, muntjac, Malayan tapir, bear, tiger, leopard
Endau–Kota Tinggi Wild Life reserve ,	878 (561,900)		Protection of native animal life
Templar	5 (3,000)	1955	Limestone deposits; forests
PHILIPPINES			
National Parks			
Aurora (Luzon)	22 (14,190)	1937; 1941	Rolling terrain, with dipterocarp forests and varied wildlife
Basilan (Basilan)	25 (16,128)	1939	Peaks and rough terrain, headwaters of six large rivers; virgin forest with large trees; varied wildlife
Bataan (Luzon)	123 (78,500)	1954	Verdant virgin forests on Bataan peninsula overlooking Manila bay; commemorates battle of Bataan; abundant and varied wildlife
Bicol (Luzon)	16.5 (10,563)	1934	Scenic virgin dipterocarp forests on plateaus and river valleys; deer, wild boar hornbill, jungle fowl and other wildlife
Canlaon (Negros)	96 (61,444)	1934	Mt. Canlaon (8,035 ft.) and surrounding rugged forested terrain, with craters, hot springs; monkey, deer, boar, upland birds
Central Cebu (Cebu)	60 (38,483)	1937	Only extensive remaining virgin forest on Cebu; wildlife abundant
Hundred Islands (Luzon)	7 (4,710)	1941	Coral islets, underwater coral formations, caves and fine beaches, Indian pygmy goose Philippine bulbul, fish and other wildlife
Mayon Volcano (Luzon)	21 (13,675)	1938	Mt. Mayon (7 943 ft.) and rugged terrain,' with grasslands and forests of dwarf trees; deer, boar, monitor lizard, many birds
Mt. Apo (Mindoro)	302 (193,250)	1936	Mt. Apo (9,691 ft.) volcano, highest in the Philippines, with moss anddipterocarp forests; varied wildlife, including monkey-eating eagle
Mt. Arayat (Luzon)	14.5 (9,285)	1934	Forested volcanic peak (3,379 ft.), with springs, rivers and small waterfalls
Mts. Banahaw–San Cristobal (Luzon)	43 (27,833)	1941	Rough forested country surrounding Mt. Banahaw (6,000 ft.) and Mt. San Cristobal (7 000 ft.); abundant wildlife
Mt. Data (Luzon)	21.5 (13,780)	1936	pine)-covered peak with ravines and waterfalls; varied wildlife
Mt. Isarog (Luzon)	52 (33,082)	1938	Rough forested region, with canyons, rivers and waterfalls; boar, deer hornbill and other wildlife; inhabited by Negritos

TABLE V.—Principal Parks and Reserves in Asia (Continued)

Name and location	Total gross area in sq mi (approx acreage in parens)	Date established	Principal features
PHILIPPINES *National Parks (Cont)*			
Mt Makiling (Luzon)	15 (9,723)	1933	Three peaks, with ridges and deep valleys covered with dipterocarp forests and dwarf trees, hot springs, deer, pig, waterfowl and upland birds
Naujan Lake (Mindoro)	11 5 (7,414)	1956	Naujan lake and surrounding marshes and forests, principal breeding area of marsh birds in the Philippines; crocodile, sail-finned lizards
Sohoton Natural Bridge (Vizayan)	9 4 (5,995)	1935	Large natural bridge in forested rolling terrain, with limestone cave, deer, boar, monkey, upland birds
Game Refuge and Bird Sanctuary			
Liguasan Marsh (Mindanao)	172 (109,825)	1940	Lush mangrove marsh; waterfowl nesting area, with other birds, monkey, deer, pig
SIYGAPORE			
Bukit Timah reserve	0 3 (184)	1883	Forest lowland covering granite hill with 581 ft elevation; type locality for many species of plants
Pandan reserve	2 (1,373)	1883	Pioneering and tidal mangrove plant associations
THAILAND			
Tung Slang Luang Natural park	425 (271,810)	1959	Virgin area of river, waterfalls and mountain scenery in northwest Thailand, wildlife includes tiger, leopard, deer, elephant and other mammals; varied bird life
TURKEY *National Parks*			
Karatepe–Arslantas	16 (10,297)	1958	High elevation red oak and red pine forests, inhabited by roe deer, wolf, jackal, wild swine, marten and other animals; partridges and eagles, Hittite epitaphs, Phoenician and Roman mosaics and reliefs, and historical museum
Manyas Bird Paradise	0 2 (130)	1950, 1959	Grove of willows and shore line reeds on Lake Manyas, in Balikesir, provides nesting habitat for 2,000 pairs of cormorants, egrets spoonbills, glossy ibises and'other birds
Soğuksu	4 (2,525)	1959	Protects forested watershed adjacent to thermal spring resort of Kizilcahamam; soil and forest conservation, wolf, fox bear, many species of land birds
Yozgat Pine Forest	1 (660)	1958	Representative example of indigenous pine and oak forests of Anatolia; reforestation projects

but the last recorded outside the Kathia ar peninsula was in 1884. Some 300 lions survive in the Gir forest, where they feed on other wild species and on livestock owned by the Maldhari, who have religious scruples against killing animals. After 1900 the lion was protected by decree of the many princes and the maharajah of the peninsula, and the animals have increased since.

The Kaziranga Wild Life sanctuary, in Assam, is the principal remaining habitat of the great Indian rhinoceros (Rhinoceros *unicornis*), which 500 years ago ranged over a large part of northern India and Nepal. Hunting, dessication of fertile land by unrestricted livestock grazing, agriculture and fires, and the fantastic value placed on rhinoceros horn and other parts of the carcass for magical medicine, to detect poison in drinking potions and as an aphrodisiac, reduced the population drastically. Nearly all of these animals remaining in India (about 400 in 1960) are in sanctuaries and reserves, 260 of them in Kaziranga, where they are safe from poaching and have become tolerant of human activity. In spite of royal, restrictions on hunting in the Rapti valley of Nepal, poaching is a serious problem.

The Keibul Lamjao sanctuary is the only habitat of the browantlered deer (*Cervus* eldi eldi), feared to be near extinction before World War II but now holding its own locally under protection.

The Kashmir stag (Cervus *elaphus hunglu*), the Himalayan relative of the European red deer and the American wapiti, was carefully protected by the maharajah of Kashmir prior to independence, and is safeguarded in the Dachigam and Chumnaiye sanctuaries.

Indonesia has set aside over 100 nature reserves, ranging from small sanctuaries for bird life to large territories designed to protect all natural features and wildlife. The most important is the Udjung–Kulon–Panailan Nature reserve at the western end of Java. This is the only known habitat of the Javan rhinoceros (R. sondaicus), a single-horned inhabitant of dense low tropical forest, of which possibly 24 to 48 individuals were surviving in the 1960s. Although these are given careful protection, scientists fear their numbers are too low to permit adequate reproduction, and that the species may become extinct in the near future.

In Ceylon, under the Fauna and Flora Protection act of 1938, three national parks and four strict nature reserves are dedicated to complete protection of native vegetation and animal life; entry to them requires payment of a fee in the case of national parks or a written permit in that of the strict nature reserves. Intermediate zones mostly adjacent to the reserves serve as buffers between them and areas of human culture; controlled hunting and other activities may be permitted in these zones by the warden.

In addition, several sanctuaries give strict protection to vegetation and wildlife. Preservation of a number of Ceylonese animals is dependent on these reserved areas. including the hog deer, leopard. sloth, bear and especially the Indian elephant, which may cease to exist as a wild species outside the reserves. (F. M. PD.)

V. GREAT BRITAIN

National Parks.—The tenth national park in England and Wales was established in 1957 in the Brecon Beacons. A total area of over 5,000 sq.mi. was then covered by national parks. They are: the Lake District National Park, the Peak District, Snowdonia, Dartmoor, the Pembrokeshire Coast, the North York Moors. the Yorkshire Dales, Exmoor, Northumberland (a part of the county) and the Brecon Beacons. National parks in England and Wales are set up under the National Parks and Access to the Countryside act which received the royal assent in Dec. 1949 and established a National Park commission among whose duties is that of selecting areas which it considers suitable to become national parks.

These are extensive areas of country possessing a marked degree of natural beauty and good opportunities for open-air recreation, which have been designated by the commission and confirmed by the minister of housing and local government, in order to preserve and enhance their characteristic beauty and to improve their facilities for enjoyment by the public. The provisions of the 1949 act relating to national parks did not extend to Scotland, but those relating to nature conservation extended to all parts of Great Britain and are the responsibility of the Nature Conservancy, as explained below.

The passing of the 1949 act was the culmination of a campaign dating from the second half of the 19th century, fought by various voluntary organizations which strived to preserve the countryside and its wildlife and to secure public rights of access to mountain and moorland. These included the Commons, Open Spaces and Footpaths Preservation society, the National Trust, the Society for the Promotion of Nature Reserves, the Ramblers Association, the Royal Society for the Protection of Birds and the Councils for the Preservation of Rural England (C.P.R.E.) and Wales.

In the early 1930s there was a growing public interest in the idea of creating national parks, and the efforts of the voluntary organizations were co-ordinated by the formation in 1935 of the C.P.R.E.'s standing committee on national parks, which made representations to the government to take effective action. Committees were appointed by the government of the day to consider the question of national parks and other relevant problems concerning the countryside, notable reports of this period being those of the Addison committee (Cmd. 3851) in 1931 and the Scott committee (Cmd. 6378) in 1942. It was by now generally realized that a further and more comprehensive investigation was needed.

In May 1945 a report on national parks (Cmd. 6628) by John Dower—an architect and a great authority on the landscape—was presented to parliament by the minister of town and country planning and published for information and as a basis for discussion. Later the same year the government appointed a committee under the chairmanship of Sir Arthur Hobhouse to consider the Dower report and to make recommendations.

The report of the Hobhouse committee (Cmd. 7121), published in 1947, recommended the setting up of a National Parks commission and the creation of 12 national parks. This report formed the basis of the legislation of 1949, but the passing of the Town and Country Planning act in 1947, which transferred planning control from district councils to county councils, had a profound effect on the degree to which the Hobhouse committee's recommendations were accepted.

The National Parks commission does not itself administer the national parks, as was recommended in the Hobhouse report; apart from its executive powers to select areas for such designation, the commission's duties are mainly advisory. The national parks are administered by special park planning authorities set up under the 1949 act, on which sit a proportion of members appointed upon the nomination of the minister of housing and local government by reason of their special concern with the national aspect of the parks.

Within national parks the normal life of the area goes on; the land is not sterilized, neither does designation affect in any way the existing ownership of the land. The park planning authorities control development just as county councils do elsewhere throughout England and Wales, but in doing this they pay special regard to the fact that the park is one of Britain's finest landscapes which stands in need of preservation.

Other duties of the park planning authorities include the drawing up of annual programs to accomplish the purposes of the parks. And they have special powers. They may, for example, make arrangements to provide accommodations, meals and places of refreshment where the existing facilities are inadequate. They may lay out caravan sites and parking places, and arrange for facilities for sailing, bathing, boating and fishing. For approved facilities of this kind, the government pays grants up to 75% of the total expenditure. Grants are also payable for approved measures taken to preserve and enhance the natural beauty of the parks, such as the removal of disfigurements, the restoration of derelict land and the planting of trees. (L. J. W.)

Nature Reserves.—Nature reserves in Great Britain may be traced back as far as the medieval royal forests which had nothing to do with silviculture but were managed under strict legislation designed to secure the maximum protection, cover and food for beasts and birds of the chase. In modern times a few small bird sanctuaries were created informally during the 19th or early 20th century and from 1894 there was statutory power to establish bird sanctuaries, although most of the orders made for this purpose were not actively enforced.

During World War I a comprehensive list of proposed nature reserves was drawn up for the board of agriculture but no official action was taken until the appointment by the planning ministers in 1945–46 of the two Wildlife Conservation Special committees for England and Wales and for Scotland, in connection with the National Parks committees. The reports of these committees resulted in the creation by royal charter in 1949 of the Nature conservancy as a crown body under the supervision of a committee of the privy council with the objects of advising scientifically on conservation, of operating nature reserves and of undertaking scientific research.

The program of national nature reserves includes areas in England, Scotland and Wales ranging in size up to approximately 40,000 ac. and forming the best available examples of natural or seminatural habitats including arctic-alpine vegetation, bogs, woodlands (both deciduous and coniferous), fens, grasslands, inland waters, dunes, salt marshes, expanses of shingle, sea cliffs and islands.

Up to February 1962, 95 national and 7 local nature reserves (the latter maintained by local authorities) had been declared under part 3 of the National Park and Access to the Countryside act. 1949. which includes powers of acquisition and control. The largest of these are the Cairngorms Nature Reserve in the eastern Scottish Highlands (39,689 ac.), the Inverpolly Nature Reserve in the western Highlands (26,791 ac.), the Moor House Nature Reserve in the Westmorland Pennines (10,000 ac.) and the Beinn Eighe Nature Reserve in the western Scottish Highlands (10,450

TABLE VI.—*National Parks in Great Britain*

Name and location	Total gross area in sq.mi. (with approx. acreage in parens.)	Date established	Principal features
Peak District (mainly Derbyshire but including parts of Cheshire, Staffordshire, West Riding of Yorkshire and Sheffield)	542 (346,900)	1951	Gritstone moorland of the south Pennines in central England; limestone uplands, wooded dales
Lake District (Cumberland, Lancashire and Westmorland)	866 (554,200)	1951	Spectacular mountain scenery with lakes and fells in northwestern England; interesting wildlife, rock climbing, wooded valleys
Snowdonia (Caernarvonshire, Denbighshire and Merioneth)	845 (540,800)	1951	Snowdon and the Cambrian mountains in north Wales and Cader Idris. Cwm Idwal and other National Nature reserves
Dartmoor (Devonshire)	365 (233,600)	1951	Plateau of wild moorland in southern England; tors, river valleys and hanging oak woods; prehistoric relics
Pembrokeshire Coast (Pembrokeshire)	225 (144,000)	1952	Rocky coast line and the Prescelly mountains in south Wales. Sorman castles, prehistoric sites and island bird sanctuaries
North York Moors (North Riding of Yorkshire)	553 (353,900)	1952	Open moorland plateau extending from the plain of York to the northeast coast of England; medieval castles and abbeys
Yorkshire Dales (North and West Ridings of Yorkshire)	680 (435,200)	1954	Wide, sweeping upland moors cut by deep pastoral valleys: in the central Pennines of England caves, castles and prehistohc and Roman sites
Exmoor (Devon and Somerset)	265 (169,600)	1954	Heather moorland, once a Norman Royal hunting forest with a fine sea coast on Bristol channel; prehistoric camps
Northumberland (Northumberland)	398 (254,700)	1956	Cheviot hills on Scottish border of England and Hadrian's wall; moorlands, fells, rivers and forests, ancient British and Roman camps
Brecon Beacons (mainly Brecknockshire, but including parts of Carmarthenshire and Monmouthshire)	515 (329,600)	1957	Northward-facinp escarpment in south Wales, rising nearly to 3,000 ft., with moorland on southern slopes, and many rivers; caverns, prehistoric and Roman remains; Carreg Cennen castle

ac.). At that date national nature reserves totaled 179,704 ac. and local nature reserves 5,168 ac.

British nature reserves inevitably differ from those in less developed countries in being mostly smaller, more frequented and farther from their primitive state. The majority are open to public access but several are closed except to permit holders. Some are primarily selected as "living museums" to conserve picked examples of natural communities of plants and animals or to serve as refuges for rarities. Others are partly or mainly used as open-air laboratories on which experiments are conducted into the effects of climate and drainage, or of different types of management treatment such as grazing, planting, fencing and control of burning. Comprehensive records are kept of the elements and changes in the animal life and vegetation and of the enrichment or impoverishment of soils.

The broad purpose of the conservancy's nature reserves is to provide suitable and secure arrangements for long-term studies of the natural resources of Great Britain and to preserve for future generations the best possible range of examples of the natural vegetation and animal life. These official nature reserves are supplemented by a somewhat larger number of unofficial reserves managed by the Society for the Promotion of Nature Reserves, the Royal Society for the Protection of Birds, the National trust, the National Trust for Scotland and various regional or county trusts, of which the Norfolk, Yorkshire and Lincolnshire Naturalists' trusts are leading examples. In addition the conservancy has notified to local planning authorities more than 1,700 sites of special scientific interest over which the Nature conservancy must be consulted before permission for development is given.

(E. M. N.)

VI. EUROPE

Plato and other philosophers of antiquity recognized the desirability of a harmonious relationship between man and his natural environment, but the ancient civilizations did not develop the concept that nature itself is worth preserving. Royal prerogatives, from early times through the middle ages and into modern times, often restricted hunting of certain species of animals to nobles, protected eagles and hawks for falconry and closed extensive areas to trespass by commoners. These were feudal measures to benefit the oligarchy, although they resulted in some measure of nature protection.

Some of these preserves were maintained for centuries and saved primeval regions and wildlife species. The aurochs, ancestor of domestic cattle, protected by royal decrees, survived in Poland until 1627. In the same country, all hunting was prohibited in the Bialowieza forest in the 17th century and only by this protection was the wisent, the European bison, perpetuated to modern times.

The Renaissance brought an interest in natural philosophy and with it the stirring of an appreciation of nature and its processes. Local communities began to restrict exploitation of the resources of economic importance, to control woodcutting and grazing, and even to preserve natural areas intact, as in the case of the Bois de la Haye, in Holland, in 1576. During the mid-19th century the German naturalist Alexander von Humboldt conceived the idea of establishing natural monuments for preservation of natural ecology.

It was not until the 20th century, however, and mainly after World War I, that European nations undertook extensive establishment of national parks and nature reserves in the modern sense. By 1960, almost every European country had set aside some areas to protect scenery, natural environment and wildlife.

In Austria, for example, the *Länder* have promulgated laws and ordinances which provide varying degrees of protection to a large number of nature reserves ranging in size from a few acres to many square kilometers. These include outstanding scenic mountain areas, forests, lakes, geological formations and relic habitats of

TABLE VII.—*Principal Parks* and ***Reserves in Europe***

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
AUSTRIA			
Karwendel Schutzgebiet	280 (179,200)	1943; 1947	Alpine and subalpine vegetation and animal life in limestone region of the Karwendel mountains of Tyrol
Hohe-Tauern Scenic reserve		1942	The valleys from the Gerlostal to the Raurisertal Gasteinertal, Kleinarltal anh the upper reaches of the Grossarltal
Neusiedler See and Seewinkel Scenic reserve		1940	On the Danube plain at the Hungarian border; source of major rivers; notable bird life; hydrobiological research station
BELGIUM			
Lesse et Lhomme National park	4 (2,500)	1954	Protects scenic region with unusual geological formations
Haute Fagues Nature reserve	8 (5,250)	1957; 1958	Swamps, peat bogs and Ardennes plateau with glacial and subalpine plant associations; ecological research station
Westhoek Nature reserve	1.3 (823)	1957	Sand dunes; beach research
BULGARIA			
Vitocha National park	25 (16,000)	1933	In the massif of Rila, near the Yugoslavian border, with forested mountains and a peat bog noted for its wild flowers
CZECHOSLOVAKIA			
Krkonose and Jizerské Hory	460 (294,400)	1955	Glaciers alpine meadows, peat bogs, hot springs, plants and wildlife; 150 sq.mi. classified as a strict nature reserve
Tatra	190 (121,600)	1946	High mountain scenery, on Polish border with glaciers, forests endemic plants, chamois, bear and other wildlife
DENMARK			
Skallingen	12 (7,700)	1939	Largest nature reserve in Denmark, on the west coast of Jutland, with dunes, marshes and a research laboratory
Tipperne og Klaegbanken	3.5 (2,200)	1895; 1936	Several islands on west coast of Jutland protect thousands of nesting shore birds, terns and other birds, also migrant species; ecological laboratory
FINLAND			
Linnansaari	3 (2,000)	1956	Group of about 20 islands in Lake Haukivesi; osprey colony; rare plants; access by boat
Pyhähäkki	4 (2,500)	1956	Virgin pine forest, swamps and peat lakes
Oulanka	40 (25,645)	1956	Wild terrain along the Oulounjoki river and its tributaries
Pyhätunturi	12 (7,500)	1938	Pyhätunturi is the most southerly arctic mountain in Finland, a traditional sacred place for Lapps
Palles–Ounastunturi	195 (125,000)	1938	Lapp fiord country, with arctic mountains, peat lands and forests
Lemminjoki	148 (95,000)	1956	Lemminjoki river drainage with mountain gorge and lakes
FRANCE			
Camargue Nature reserve	53 (33,750)	1927	Zoological refuge on delta of Rhône river; noted for nesting flamingoes; ecological research
Forest of Fontainebleau	6.5 (4,200)	1853	Protects natural beauty and biological features in environs of Paris
Pelvoux National park	107 (68,750)	1914	Alpine region, with chamois and other wildlife
FEDERAL REPURLIC OF GERMANY			
Naturschutzpark Hoher Vogelsberg (Hessen)	84 (53,750)	1958	Volcanic uplands; one-third covered by copper beech and spruce forest; balance agricultural
Naturschutzpark Luneburger Heide	78 (50,000)	1909	Established to protect and restore the landscape and native heath; spur ridges extend over a wide plain of alluvial sands, with valleys and streams; oak, birch and pine forests. Wilsede retains ancient village character; access is by foot and horse-drawn vehicles
Naturpark Munden (Lower Saxony)	76 (48,868)	1951	Hilly area with volcanic peaks, copper beech and spruce forests, and open pastures

TABLE VII.—*Principal Parks and Reserves in Europe (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
FEDERAL REPUBLIC OF GERMANY (*Cont.*)			
Naturpark Pfälzer Wald	654 (418,250)	1958	A sandstone plateau with deep valleys, the largest continuous forest in the Federated Republic. 120 villages are scattered in the area
Naturschutzpark Siebengebirge (Cologne)	33 (21,250)	1922; 1930	Many volcanic mountains and limestone formations; forests and wildflowers, including orchids. Mining, destruction of plants (except removal of timber under permit) and disturbance of wildlife prohibited
Naturpark Südeifel	42 (26,750)	1958	Plateau area in mountainous Eifel region on the Luxembourg frontier; one-half mixed deciduous and conifer forest, the remainder mostly farmland; wildlife abundant
GREECE			
National Park of Olympus	16 (10,000)	1938	Includes Olympus mountain peak, mythological home of the gods; light forests of pine, beech and broad-leaved evergreens
Park of Samarias Nature reserve	3 (2,000)	1953	An area of the Levka Ori (White mountains) between 800 and 2,200 m. (2,600 and 7,200 ft.) in elevation on the island of Crete: established mainly to protect the rare Cretan chamois
HUNGARY			
Tihany National park	2.7 (1,700)	1952	Volcanic area, with 100 rock cone geysers and lakes; Bronze Age ramparts and 12th-century monk cave dwellings
Kisbalaton reserve	5.5 (3,508)	1951	Reed marsh rookery of egrets, ibises, spoonbills and other herons; entry by permit only
Aggtelek–Jósvafő	3 (1,970)	1945; 1958	Limestone cavern, 15 km. (9 mi.) long, with large chambers and formations, extending into Czechoslovakia, where it is also protected
Szalajkavölgy reserve	2.2 (1,395)	1955	Centre of paleolithic culture in the Bukk mountains
ICELAND			
Thingvellir National park	15.5 (9,900)	1928	Postglacial lava plain with deep fissures; Öxará river; meeting place of ancient *althing* (parliament) of chieftains from A.D. 930
Eldey Nature reserve		1940; 1960	Rookery of 15,000 pairs of gannets; last two living examples of the now extinct great auk were found here
IRELAND			
Bourn Vincent Memorial park	17 (10,550)	1932	Mountains and lakes of Killarney, with farm and forest lands; last herds in Ireland of European red deer; Japanese deer introduced
North Bull Island Nature reserve	5 (3,200)	1931	Sandy island; sanctuary for migratory and wintering birds
ITALY			
Abruzzi	113 (72,000)	1923	High mountains in Marsica region in central Italy, with cirques, moraines and peaks rising to 2,247 m. (7,372 ft.); thick pine and deciduous forests; chamois, bear, roe deer and other wildlife
Circeo	29 (18,400)	1934	Promontory, southeast of Rome, containing maritime forest of Terracina, coastal dunes and associated animal life and vegetation
Gran Paradiso	219 (140,000)	1922	Scenic mountain ranges, rising to 4,061 m. (13,323 ft.), in northwest Italy, with extensive glaciers, alpine vegetation and animal life
Stelvio	368 (235,600)	1935	Magnificent alpine region on Swiss border, with [illegible]ral life zones and their characteristic plant associations and forests, with crags rising nearly 3,000 m. (9,842 ft.); glaciers; stag, chamois, roe deer, bear and other wildlife
NETHERLANDS			
Hoge Veluwe National park	23 (14,700)	1936	Forests, heaths with red deer and mouflon (introduced)
Kennemerduinen National park	4 (2,600)	1950	Dunes and bird life
Naardermeer Nature reserve	3 (1,900)	1906	Bearded tit and other marsh birds
Texel Island Nature reserve	5.5 (3,500)	1909	Terns and other sea birds
NORWAY			
Kong Karls Land National park (Spitsbergen)	200 (128,000)		Established to protect polar bears
Gutuha area	3 (2,000)		Primeval forests of Norway pine; marshes and moors
Ormtjernkampen area	1.8 (1,125)		Contains spruce fir, primeval forest and modrs
Vaggetem area	2 (1,250)		Pine barrens
POLAND			
Babia Gora	6 (4,105)	1924; 1954	Remnants of ancient Carpathian forests in the western Beskid range, in southern Poland, on the Czechoslovakian border
Bialowieza	20 (12,683)	1919; 1947	Protects examples of the primeval taiga, mixed deciduous and conifer lowland forest; herds of rare European bison, elk and other wildlife
Holy Cross mountains	24 (15,135)	1932; 1950	Lysogory mountain range, in southeast Poland, with virgin forests
Kampinos	159 (101,710)	1959	Forested dune area, near Warsaw; prehistoric dwellings; wildlife
Karkonosze	22 (13,773)	1959	Northern slope of Karkonosze mountain range in southeast Poland on Czechoslovakia border, with glaciated peaks, lakes, waterfalls and forests
Ojcow	6 (3,600)	1925; 1955	Picturesque Pradnik river valley, in northern Poland, covered with deciduous forests and endemic plant associations; notable rock formations and caves
Slowinski	150 (96,000	1960	Coastal dunes and lakes
Pieniny mountains	9 (5,580)	1921; 1954	Scenery of Dunajec river gorge; forests with endemic plants and varied wildlife
Tatra mountains	84 (53,890)	1954	Highest peaks of the Carpathians, with highland forests and ibex, bear and other wildlife
Wielkopolski	40 (25,773)	1957	Moraine area on Warta river; mixed forests and wildlife
Wolin	18 (11,500)	1960	Maritime scenery
RUMANIA			
Retezat National park	39 (25,000)	1935	40 glaciated summits above 2,200 m.; conifer forests; chamois, lynx, bear, raptorial birds
124 nature reserves	269 (172,250)		
SPAIN			
Cavadonga National park	60 (38,400)	1918	Forests of oak, beech, sycamore, ash, hazel; roe deer, chamois, brown bear, boar, wolf, wildcat
Gredos Nature reserve	290 (185,600)	1932	Protects Spanish ibex
Caza de la Serrania de Ronda Nature reserve	83 (53,100)	1948	Protects Spanish ibex and roe deer
Saja y Agregados Nature reserve	230 (147,200)	1948; 1949	Roe deer boar, brown bear, chamois', capercaillie
SWEDEN			
Absiko	19.5 (12,500)	1909	The forested Jokk river valley in northern Sweden, with abundant wildlife; Lapps pasture reindeer in park
Muddus	192 (123,000)	1941	Virgin conifer forests and extensive marshes in northeast Sweden; wildlife abundant; Lapps pasture reindeer in park
Sarek	742 (475,000)	1909	Alpine peaks with 70 glaciers, in northwdst Sweden; bear, lynx, wolf, wolverine and other wildlife; summer encampment of Lapps
Stora Sjöfallet	539 (345,000)	1909	Mountain ranges in central Sweden, with glaciers, waterfalls, sparse forests, and moors; wildlife abundant
SWITZERLAND			
Swiss National park	66 (42,175)	1914; 1959	Part of park area has been protected since 13th century; high Alps from 1,500 to 3,173 m.. with magnificent scenery; endemic plants; chamois, red deer, roe deer ibex (introduced 1920) an6 other wildlife
UNION OF SOVIET SOCIALIST REPUBLICS			
Russian S.F.S.R.			
Altai (Gorno-Altai autonomous *oblast*)	3,575 (2,287,800)		Scenic taiga of fir, cedar and larch, rising to alpine tundra; many wildlife species, including snow leopard, wild dog, ibex, musk and roe deer, bear and others

TABLE VII.—*Principal* Parks and Reserves in *Europe* (*Continued*)

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
U.S.S.R. (Cont.) Russian S.F.S.R. (Cont.)			
Astrakhan (Astrakhan oblast)	295 (189,075)		Protects nesting area of coot, sheldrake, pelicans, herons and spoonbills, and molting grounds for myriad waterfowl, on Volga delta; fish are abundant; hydrological research
Barguzin (Buryat A.S.S.R.)	970 (620,500)		Protects mountainous terrain of northern Transbaikalia and especially the dark sable inhabiting its forests; seal rookeries on the Ushkany Islands
Bashkir (Bashkir A.S.S.R.)	313 (200,250)		Mountain and steppe forests of southern Urals; varied wildlife; Kapov cave contains primitivedrawings
Caucasus (Krasnodar krai)	984 (629,500)		Beech and conifer forest with rhododendrons, rising to alnine meadows in western Caucasus; mountain goat, chamois, deer; re-established bison roaming at liberty
Darwin (Vologda & Yaroslavl *oblasti*)	651 (416,500)		Broken pine forest, sphagnum marshes and heather; elk, bear, lynx, upland birds, shore birds, waterfowl: established to study ecological changes in connection with building of Rybinsk reservoir
Denezhkin Kamen (Sverdlovsk oblast)	573 (366,750)		Taiga of spruce, fir and cedar, with pine forests alternating with belts of scrub, tundra and bare stony areas, in northern Urals; bear, wolverine, sable, upland birds
Ilmen (Chelyabinsk *oblast*)	125 (80,000)		In honour of Lenin; pine and birch forest; stretches of steppe covered with feather grass; preservation and study of geology; minerals and semiprecious stones
Kandalaksha (Murmansk oblasf)	79 (50,750)		Arctic tundra and mountainous terrain along Murmansk coast; vast numbers of alcids and other sea birds; elk, brown bear, lynx and wolverine on Veliki Island; islands in Kandalakshski gulf in the White sea are covered with spruce, pine and birch forests; seals along shore
Kedrovaia Pad (Primorski krai)	59 (37,750)		Mixed forest of Mongolian oak, Manchurian fir, cedar, Amur cork and other far eastern trees; sika (*Cervus nippon*), roe deer, musk deer, boar, leopard, bear, marten and other wildlife
Khoper (Voronezh oblast)	62.5 (40,000)		Oak and aspen groves and alder woods along Khoper river, protecting especially muskrat and beaver; semifree bison herd
Khosta Grove (Krasnodar krai)	0.9 (595)		Residual grove of yew and box, near Khosta
Kivach (Karelian A.S.S.R.)	40 (25,788)		Central taiga pine and spruce forests, with sphagnum marshes; Kivach waterfall on Suna river; elk hear, lynx, marten, forest birds
Kroroki (Kamchatka oblast)	3,766 (2,410,000)		Thin taiga of fir, birch, creeping cedar; volcanoes, only geysers in U.S.S.R.; Lake Kronotskoiye; snow ram reindeer, bear, sable, seal ahd sea lion rookeries; sea bird colonies and wintering waterfowl
Lapland (Murmansk oblast)	306 (195,750)		Mountain tundra thin spruce and pine forests: Imandra and other islands; established to protect a subzone of northern taiga and especially wild reindeer and beavers
Mari (Mari A.S.S.R.)	115 (73,750)		Coniferous and broad-leaved forests; otter,, bear, capercaillie, other wildlife
Mordovian (Mordovian A.S.S.R.)	118 (75,250)		Pine forests with some deciduous trees; varied wildlife
Oka (Ryazan oblasf)	88 (56,500)		Mixed forests and flood-plain marshes and lakes of Pra river
Pechera–Ilych (Komi A.S.S.R.)	2,790 (1,785,750)		Central taiga of spruce and pine; mountain taiga of conifers, including stone pine; sable, reindeer, capercaillie; domestication of elk
Prioksko–Terrasny (Moscow oblast)	19 (12,000)		Pine and broad-leaved forests, steppe vegetation; breeding of bison
U.S.S.R. (Cont.) Russian S.F.S.R. (Cont.)			
Sikhotye–Alin (Primorski krai)	2,342 (1,499,000)		Broad-leaved and conifer forests, including Amur lime, Korean pine, Yeddo spruce, Khingan fir and other species; tiger, leopard, baribal bear,' Amur bear, Manchurian deer and other wildlife
Stolby (Krasnoyarsk krai)	184 (117,500)		Mountain taiga belt mixed pine and larch forest;; pillarlike rock formations
Sudzukhe (Primorski krai)	547 (350,000)		Mountain zones are same as in Sikhote–Alin; southern vegetation of Manchurian type; sika, mountain antelope
Suputinka (Primorski krai)	62 (39,750)		Border zone between Manchurian cedar forests and mixed deciduous spruce and fir forests; varied wildlife
Teberda (Stavropol krai)	361 (231,000)		Conifer and beech forests. with rhododendrons, rising to alpine meadows on north slope of greater Caucasus mountains; a major tourist attraction
Tsentralno–Chernozemny (Kursk and Belgorod oblasti)	16 (10,500)		Three areas of virgin steppe, with oak groves
Tsentralno–Lesnoi (Kalinin *oblast*)	82 (52,750)		Mixed forests and meadow steppe; bear, marten, capercaillie
Volga–Kama (Tatar A.S.S.R.)	30 (19,000)		Varied pine forests, with lichen and moss; lime and oak forests; discontinuous section of taiga on forest steppe
Voronezh (Voronezh and Lipetsk oblasti)	120 (77,000)		Oak and pine forests with groves of European alder along Usman river: established to increase number of beaver: many roe deer
Zhigulevsk (Kuibyshev oblast)	53 (33,750)		Oak groves; residual pines on limestone; picturesque cliffs and crags
Armenian S.S.R.			
Dilizhan	113 (72,348)		Northern slopes of lesser Caucasian range and basin of Kura river; groves and sparse woods
Garni	103 (65,900)		Basin of Azat and Veda rivers, from 900 to 2,000 m.; scenery with waterfalls; Armenian mouflon, bezoar goat, boar, bear
Shikakhokh	39 (25,000)		Oak forests above Tsov river with plane trees in flood-plain: porcupine, leopard, roe deer, boar, bear
Azerbaijan S.S.R.			
Gek–Gel	27 (17,500)		Upper forest belt and sub-alpine meadows; Lake Gek–Gel, formed by landslide in A.D. 1139; bear, marten, roe deer
Kyzylagach	363 (232,500)		Gulf of Kirov in the Caspian sea and adjacent islands: coastal reed and salt marshes. wintering habitat of waterfowl, waders, flamingoes, bustards and other birds
Lenkoran	61 (38,750)		Protects remnant of Talysh forest with Hircanian species
Turianchai	109 (70,000)		Protects the only habitat of elder pine in the world, a stand of thick-trunked pistache and desert vegetation
Zakataly	109 (70,000)		Southern slope of greater Caucasian range, rising to 3,668 m.; zones of forest and alpine meadows; Dagestan mountain goat, chamois, deer, boar and other wildlife
Belorussian S.S.R.			
Belovezhskaia Pushcha	293 (187,500)		Mixed and deciduous forests of alder, oak and hornbeam; to protect and foster pure-blooded Belorussian bison and other wildlife
Berezina	262 (167,500)		Pine groves and spruce woods on Berezina river; to protect habitat of beaver and other wildlife for eventual distribution to other areas
Estonian S.S.R.			
Matsalu	137 (87,500)		Matsalu gulf and basin of Kassari river, nesting grounds and migratory routes of waterfowl and other birds; largest colony of graylag geese in Baltic area
Nigula	11 (6,825)		Pine and sphagnum marsh
Vaika	0.1 (88)		Eider duck and other sea birds
Viydumyaye	2 (1,493)		Rare and endemic plants on Saaremaa Island

TABLE VII.—*Principal Parks and Reserves in Europe (Continued)*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
U.S.S.R. (*Cont.*)			
Georgian S.S.R.			
Adzhameti	18.5 (11,883)		Residual stands of Imeritian oak, *Quercus hartwissiana*, and *Kolkhidian zelkova*
Babaneuli	11 (6,838)		To preserve stands of *Kolkhidian zelkova*
Batsarsky	12 (7,630)		To preserve residual yew groves and stands of beech
Borzhom	56 (35,875)		Forested western part of Trialeti range; mineral springs
Gumista	11 (6,860)		Black sea coastal forests and wildlife
Kintrish	23 (15,000)		Preserves native species of trees
Kolkhida	2 (1,250)		Lake Palnostomi, wintering grounds of waterfowl
Lagodekhi	52 (33,250)		Forested mountains and alpine meadows; mountain goat, deer and other wildlife
Mariamdzhavarsky	4 (2,750)		Scotch pine groves
Myussera	10 (6,363)		To preserve natural features of Abkhazia
Pitsunda	4 (2,778)		Groves of Pitsunda pine near seacoast
Pontic Oak	5.5 (3,500)		To preserve stands of Pontic oak
Ritsa	62 (39,820)		Lake Ritsa and deciduous forests; mountain goat, chamois, roe deer
Saguram	19.5 (12,500)		Residual tertiary vegetation
Satapliysky	1.2 (750)		Limestone caves with fossils
Tsiskarsky	15 (9,820)		Virgin oak forest, with rhododendron
Vashlovani	26 (16,900)		Steppe, semidesert and stands of pistache and juniper; central Asian gazelle
Kazakh S.S.R.			
Alma-Ata	500 (320,000)		Forested mountains of northern Tien Shan rising to 3,000 m., with meahows and glaciers; bear, Siberian deer, central Asian gazelle, mountain sheep and other wildlife
Aksu-Dzhabaglinsky	273 (175,000)		Talass Alatau range, rising to 4,000 m.; Aksu river canyon; snow leopard, bear, mountain sheep, bustard and other wildlife
Barsa-Kelmes	77 (49,500)		Coast of Lake Aral and Barsa-Kelmes Island; onager and central Asian gazelle introduced; gulls, waterfowl and flamingoes on shore
Kurgaldzhino	90 (57,500)		Highland desert and virgin steppe on Lake Kurgaldzhino
Naurzum	703 (450,000)		Most southerly Naurzum pine forest in plain region; areas of virgin steppe; waterfowl and wading bird nesting grounds
Kirghiz S.S.R.			
Kemin	78 (50,000)		Forest of Schrenk spruce; mountain sheep, mountain goat, roe deer
Sarychelek	156 (100,000)		Semenov fir, Schrenk spruce forest, with nut and fruit trees, in southern Tien Shan; water conservation
Latvian S.S.R.			
Engures	5 (3,350)		Lake Engures, habitat of nesting and migratory birds
Grini	2.7 (1,750)		Only habitat of cross-leaved heath (*Erica tetralix*) in U.S.S.R.
Kemeri	113 (72,250)		Mixed forests with rare plants; sapropelic mud medicinal resort
Moricsala	3 (2,088)		Gulf and islands in Lake Usmas with deciduous forests and rare herbaceous plants
Slitere	31 (19,620)		Protects virgin forest
Lithuanian S.S.R.			
Zuvinto	12 (7,918)		Lake Zuvinto and adjacent forest and marsh areas, nesting grounds of waterfowl, including 50 pairs of whooper swans
U.S.S.R. (*Cont.*)			
Tadzhik S.S.R.			
Childukhtaron	59 (37,500)		Residual nut and maple forests
Gazimailik	59 (37,500)		Natural environment of Kok-Tau range
Iskanderkul	117 (75,000)		Deciduous and juniper forest and high mountain steppe; picturesque mountain lake at 2,176 m.; snow leopard, ibex
Ramit	59 (37,500)		Forested upper reaches of Kafirnigan river, and alpine meadows
Tigrovaia Balka	162 (103,375)		Southern deserts of central Asia: flood plain forest of Vakhsh river, Tugai deer, central Asian gazelle, bird life
Turkmen S.S.R.			
Badkhyz	294 (187,863)		Hilly plains spurs of Paropamiz range anh deep Yeroilanduz salt depression; 500 onager, also gazelle and cheetah
Gasan-Kuli	272 (174,150)		Reed and salt marshes on Caspian sea; waterfowl wintering grounds; only habitat in central Asia of the partridge *Francolinus orientalis*
Repetek	135 (86,500)		Eastern sand desert of Kara-Kum, with desert plants; gazelle, the wild cat *Felis margarita*, the hare *Lepus tolai*, sand jerboa, reptiles, bird life
Ukrainian S.S.R.			
Azov-Sivash	47 (30,000)		*Solonets* steppe on islands and salt marshes around Sivash; protects migratory and wintering waterfowl; deer and game birds acclimatized on Biryuchy Island, and pheasant; and the goat antelope *Saiga tatarica* have been introduced
Aksania-Nova	2 (1,250)		Residual virgin steppe
Black Sea	47 (30,000)		Protects migratory and wintering waterfowl and nesting gulls and terns, as well as other bird life
Crimea	118 (75,500)		Highest peak in Crimean mountains Roman-Kosh (*1,545* m.); 'zones of oak, beech, mountain steppe, pasture, with Crimean and Scotch pine on southern slope; deer, mouflon (acclimatized), stone marten Crimean barbel and other wilhlife
Kamennye Mogily	1.4 (890)		Granitic hills rising to 100 m. above stony steppe, with rare types of plants
Khomutovskaia Steppe	4 (2,564)		Virgin feather grass and meadow steppe, with semidesert and desert animal life
Mikhaylovskaia Steppe	0.8 (505)		Virgin meadow steppe
Streletskaia Steppe	2 (1,313)		Virgin grass steppe; habitat of *Marrnota bobac*
Uzbek S.S.R.			
Amu-Darya	234 (150,000)		Delta and marshes of Amu-Darya river, with nesting and migratory waterfowl, flamingo, bustard and, other bird life: central Asian gazelle, saiga, boar
Chatkal Mountain forest	137 (87,500)		Stands of juniper and deciduous trees in western Tien Shan; central Asian goat, white-toed brown bear, snow leopard, Pallas's cat, other mammals and varied bird life
Zaamin Mountain forest	31 (19,750)		Forested mountains and alpine meadows of northern slope of Turkestan range; bear, lynx, mountain goat, mountain sheep and other wildlife
YUGOSLAVIA			
Tara	117 (75,000)		Mountainous region; forests of Siberian spruce (*Picea omorica*) and othrr conifers: brown bear and other wildlife
Fruska Gora (Serbia)	89 (57,125)	1961	Hills; native vegetation; birds; archaeological sites

rare plant associations as well as important wildlife habitat. A 200-m. zone is protected from exploitation along a number of scenic highways, and green belts have been established around certain cities.

In France, part of the Forest of Fontainebleau, near Paris, was established as a nature reserve in 1853; later the protected area was enlarged. The Pelvoux National park, established in 1914, is a scenic alpine area where, in spite of wars, many wild animals have survived, notably the chamois. The Camargue reserve. established in 1927, is a world-famous ornithological sanctuary and research area, where flamingoes, herons, avocets and other marsh birds breed in numbers and unusual plant associations occur.

A considerable number of nature reserves and bird refuges have been established in Belgium by the citizens' associations Ardenne et Gaume, Reserves ornithologique de Belgique, and De Wielewaal, to protect scenic features, habitat of nesting and migrating birds, plant associations and other natural features. They are relatively small but serve important conservation purposes. Two official nature reserves were established in 1957.

Nature protection has been practiced in Denmark since 1805 and in Czechoslovakia since 1838, but modern nature reserves in both countries are of much more recent establishment. In Poland. nature protection began in the 15th century. when the aurochs and other endangered species were given royal protection, but it was not until 1919 that a provisional state commission for the protection of nature was founded; this commission initiated establishment of national parks and enactment of conservation legislation. A nature protection act, which placed the national parks under the ministry of forestry, was passed in 1949. Scientific research is conducted in the parks by many institutions, under the direction of the Polish Academy of Sciences.

In the Federal Republic of Germany, legislative control over nature protection was the responsibility of the *Länder* after 1945; the federal government acts to develop uniformity of state legislation. Many agencies are concerned with problems relating to nature protection and a large volume of law has been promulgated, the most fundamental being the Reich Nature Protection law of 1935. In addition, there are numerous private organizations that co-ordinate their efforts and co-operate with the official agencies as closely as possible. Their problems are complicated by the fact that all nature reserves in Germany are leased from private landholders, except a part of the Liineburg Heath reserve that is owned by the Nature Reserves society. A variance of opinion exists between those people interested in the establishment of nature reserves primarily for the strict protection of species and associations of vegetation and animal life and related scientific research, and those who regard outdoor recreation as an essential purpose of reserves. In practice, reserves serving both purposes have been created, and in addition to the major nature parks there are hundreds of smaller reserves of scientific significance and scenic importance.

In Finland, legislation enacted in 1923, 1938 and 1956 provides for the establishment of reserve areas on government land. National parks are set aside on virgin land for the preservation of animal life and vegetation and for visitor enjoyment. Nature reserves are established mainly for scientific purposes and entry is by permit. Of ten national parks and reserves created in 1938, six were located on the area ceded to the Soviet Union; to compensate for their loss the 1956 law was passed to establish additional parks and reserves in southern Finland. The national parks and nature reserves protect forested mountains, lakes, coastal shore lines and islands. Roads, trails, lodges and campgrounds and other accommodations are provided in the national parks.

National parks and nature reserves in the U.S.S.R. are state property and come under the national budget. Special organizations or committees set up by the council of ministers direct the work in the parks, the responsibility in some cases resting with the U.S.S.R. Academy of Sciences or the Academies of Sciences of the union republics.

The natural features as a whole are under protection and may be put to use only by permission of the government of the U S.S.R. or of the union republics. If any special features in a certain area are protected, the area is declared a prohibited area; otherwise the parks are open to visitors insofar as the maintenance of the parks allows. Hunting and fishing or other destruction of wildlife and plants, as well as mining and livestock grazing are prohibited.

Extensive scientific research is carried out by personnel attached to the park administrations, by other scientific bodies and by universities. The results are published by the national parks themselves, some of which publish their own journals, and in scientific periodicals. Every park has a natural history museum, and the most popular parks. such as the Crimea, Caucasus, Ritza and Teberda, have prepared special itineraries for tourists. Several films have been made on the national parks. The U.S S R. also has set aside nature reserves for the protection of particular features and resources.

VII. AUSTRALASIA

The preservation of natural areas and wildlife in Australia is, generally speaking, on a state, not a commonwealth, basis. In New South Wales, for example, each national park is administered by a separate trust of local residents or, in some cases, by representatives of government departments. Western Australia has a similar system. The forestry department administers the national parks of Queensland, supported in an advisory capacity by citizens' organizations. notably the National Parks association of Queensland. An official National Parks authority has been established in Victoria, also assisted by a National Parks association. A board of commissioners in South Australia and a Scenery Preservation board in Tasmania have jurisdiction over national parks and reserves in those states.

Within the parks and reserves are representative examples of most of the scenic characteristics of the continent—mountain ranges, gorges, waterfalls, marshes and lagoons—and its extraordinary vegetation and animal life. They are vital to the perpetuation of endemic species of wildlife, including unique marsupials, platypuses and other rare animals, and most unusual bird

Table VIII.—*Principal Perks and Reserves in Australasia*

Name and location	Total gross area in sq.mi. (approx. acreage in parens.)	Date established	Principal features
AUSTRALIA			
New* South *Wales			
Blue Mountains Kational park	242 (155,000)	1959	Rugged scenic sandstone country in Blue mountains. with peaks, towering cliffs, deep gorges and bushland valleys; stunted trees on higher slopes, dense rain forest in valleys; with eucalypts and blue gums; varied wildlife
Brisbane Water National park	23 (15,000)	1959	Broad ridges dropping to tidal waters; rain forest in gullies; Hawkesbury sandstones have unique vegetation and abundant wildflowers; Bouddi National park (1,280 ac.) and sanctuaries adjacent
***New* South Wales (Cont.)**			
New England National park	88 (56,150)	1935	East slopes of Great Dividing range, to 5,200 ft., largely rain forest, with hardwoods on ridge tops; varied wildlife
Royal National park	57.5 (36,800)	1955	Forest reserve, with coastal surf beaches
Warrumbungle National park	13 (8,300)	1953	Rugged volcanic Warrumbungle range; kangaroos, wallaroos, giant wedge-tail eagles, etc.
Kosciusko State park	2,344 (1,500,000)	1944	Mt. Kosriusko, 7,316 ft.. and other peaks and rolling grassy plateaus; Yarrangubilly caves; Snowy mountains hydroelectric scheme is mainly withln park; winter sports area

TABLE VIII.—*Principal Parks and Reserves in Australasia (Continued)*

Name and location	Total gross area in sq.mi. (approx acreage in parens)	Date established	Principal features
AUSTRALIA (*Cont.*)			
New South Wales (*Cont.*)			
Kuring-gai Chase	59 (38,000)	1894	Exposed sandstone ridges, hushland scrub, rain forest in gullies, tidal inlets; profuse native flowers; koalas, kangaroos, dormouse "opossums" (phalangers), Albert lyrebird, etc.
Shoalhaven (Morton Primitive Area reserve)	70 (45,000)	1938	Rugged mountain terrain with sandstone summits and deep gorges; open bloodwood-scribbly gum forest and heathland on higher slopes; hardwood forests and rain forest in gorges
Nadgee Faunal reserve	44 (28,000)	1957	Combination of seashore, lagoon, moorland, swamp, river valley, open forest and mountain habitat, with great variety of plant and animal life
Northern Territory			
Ayers Rock Mount Olga National park	487 (311,700)	1958	Two huge quartzite monoliths rising out of open plain from 1 720 to 2,820 ft ; native paintings on rocks; desert oak, mulga, mallee and spinifex; wildlife
Cobourg Peninsula Flora and Fauna reserve	100 (64,000)	1924	Large, indented peninsula 20 to 50 ft. above high-water mark, with two small hills to 230 ft.; open savanna forest, with eucalypt, cypress pine; kangaroo, buffalo, many species of birds
Queensland			
Rartle Frère and Bellenden-Ker Group National park	125 (80,000)	1921; 1940	Mt. Bartle Frère and other jungle-clad peaks in McPherson and Great Dividing ranges; kangaroos
Eungella National park	188 (120,360)	1936; 1950	Dense jungle and tropical forest; waterfalls on peaks up to 4,000 ft.
Lamington National park	76 (48,640)	1915	Magnificent mountain scenery, waterfalls and forests which include the antarctic beech; Albert 1s-rebird, ruious scrub-bird, marsupials
Hinchinhrook Island National park	152 (97,000)		One of the world's largest insular national parks
South *Australia*			
Ferries and McDonald Nature rcserves	3 (2,000)	1956	On east slope of Mt Lofty ranges; low, scrubby eucalypts and brush; last habitat of mallee fowl (*Leipoa*) in South Australia; kangaroos
Flinders Chase	212 (135,700)	1905; 1919	Ancient peneplain and coastal cliffs and beaches on Kangaroo Island; great gray and sooty kangaroos, endemic black-faced kangaroo, wallaby, echidna, phalangers; koala and platypus introduced; penguins, pelicans and other birds; orchids
Tasmania			
Cradle Mountain–Lake St. Clair National park	525 (333,107)	1922	Mountain region, 2,000 ft. to 5,305 ft. (Mt. Ossa), with rivers and lakes; extensive forests of Sing William pine, pencil pine, eucalypt, Tasmanian rain forest, savanna and plains; various marsupials and other wildlife
Mt Field National park	60 (42,020)	1916	Glaciated valleys with forests of giant eucalypt and rain forest, rising to Mt Field West (4,721 ft.) and highland moors; Russell Falls, extensive areas of vegetation unique to Tasmania; mountain shrimp (*Anaspides tasmanica*) in mountain tarns; wildlife plentiful
Victoria			
Kinglake National park	22 (14,079)	1928	Heavily forested south slopes of Plenty ranees, with deep fern gullies and waterfalls; 326 plant species recorded, including rare orchids; several species of kangaroo, wallaby, bandicoot, dasyure, wombat, koala, echidna, plat>-pus, reptiles and a variety of birds
Victoria (*Cont.*)			
Mallacoota Inlet National park	17.5 111.225)	1932	Evergreen bush on Genoa river; wildlife
hft. Buffalo National park	(	[illegible]	Granite plateau rising nearly 6,000 ft.; wet sclerophyll forest, subalpine woodland, sod tussock grassland in valleys; wombat, wallaby, echidna, kangaroo, lyrebird and other bird life
Wilson's Promontory National park	160 (102,379)	1905	Magnificent mountain and coastal scenery, fern gullies; wombat, koala, emu and other wildlife
Wyperfeld National park (Mallee)	219 (140,000)	1921	Semidesert Mallee region in west, sand hills lightly covered with heath and dwarf shrubs in east; black box and red gum trees on creek flats; black-faced kangaroo; abundant bird life including Regent parrot, cockatoo, emu, mallee fowl
BRITISH SOLOMON ISLANDS PROTECTORATE			
Queen Elizabeth park	24 (15,200)	1954	Contains Mt. Austen and the Mantanikai river valley, a very broken country interlaced with ridges and valleys; tropical hardwood forests; bird life
FIJI			
Ravilevu Nature reserve	15.5 (9,930)	1959	Forested mountain area with spectacular waterfalls and gorges: distinctive animal life
Tomaniivi Nature reserve	6 (3,720)	1958	Tomaniivi (4,341 ft.) and surrounding forests; rkre birds
NEW ZEALAND			
National Parks			
Abel Tasman (South Island)	67 (43,061)	1942	Coastal and elevated region along Tasman bay, with virgin forests and beaches
Arthur's Pass (South Island)	374 (239,152)	1929	Southern Alps, with glaciers, river valleys and virgin forests, birds; 29,990 ac. wilderness area where buildings, horses and vehicles are excluded
Egmont (North Island)	127 (81,236)	1900	Mt. Egmont, with alpine vegetation, subtropical forests, sphagnum swamp and waterfalls; kiwi, rifleman bird, fantail and other birds
Fiordland (South Island)	4,567 (2,923,153)	1952	Mountain forests and fiords on coast line, with lakes. rivers and waterfalls; only habitat of the rare flightless rail or takahe (Sotornis *hochstetteri*) and of the large owl parrot or kakapo (*Strigops habroptilus*); other birds; seals
Nount Cook (South Island)	270 (172,979)	1953	17 peaks above 10,000 ft. in Southern Alps, Tasman glacier and other glaciers, montane scrub and alpine growth
Nelson Lakes (South Island)	218 (139,834)	1956	Two lakes in mountainous terrain, with dense virgin forest
Tongariro (North Island)	252 (161,552)	1894	Three active volcanoes, forests, treeless plains, and Mt. Ruapehu with small glaciers; crater lake; hot springs and geysers
Urewera (North Island)	709 (453,971)	1954	Mountain ranges, crags, waterfalls and virgin forests; Maori-owned Lake Waikareiti; kiwi and other bird life
Westland (North Island)	328 (210,070)	1960	Western slope of Alpine chain iover 11,000 ft.) extending to sea level; glaciers, lakes, dense forests
Scenic, *Natural* and *Historic Reserves*			
Waipoua Forest reserve	36 (22,800)	1952	Kauri pine (*Agathis australis*)
Kapiti Island Bird sanctuary	6 (4,300)		Bush birds, waterfowl, sea birds, tuatara
Little Barrier Island Bird sanctuary	11 (6,960)	1894	Bush birds
SARAWAK			
Bako National park	10 (6,400)	1956	Coastal hays and coves near Cape Po; forest and open country; wild pig, mouse deer, monkeys, gibbon, bird life

life. Some of these are dependent upon preservation of particular habitat or plant associations, an example being the koala, which requires oils of certain varieties of eucalyptus trees in its diet. Some Australian reserves are in remote sections, while many others are popular localities for camping, hiking, swimming and other outdoor pursuits. The more accessible parks have excellent accommodations within or near their boundaries.

In New Zealand, public reserves in general. including those set apart for the preservation of vegetation acd animal life, are administered by the department of lands and survey. The minister of internal affairs is charged with the protection and control of wildlife, and the regulation of shooting of such wildlife as is considered game. Research and field work are conducted by the wildlife division of the department of internal affairs, the department of scientific and industrial research and various museums. In New Zealand native wildlife consists mainly of birds, there being no indigenous land mammals other than rare bats and the native rat. Marine animals are protected by the marine department. The deficiency of wild game animals led to the introduction of various species for sporting purposes in the latter half of the 19th and the beginning of the 20th century. These included red deer, wapiti, chamois. Himalayan tahr and opossum. Pigs and goats were allowed to run wild, and introduced rabbits soon became so great a pest that stoats, weasels and ferrets were let loose to prey upon them. A spectacular result of their importation was the rapid diminution in the numbers of ground-dwelling and flightless birds

TABLE IX.—*Principal Parks and Reserves in Central and South America*

Name and location	Total gross area in sq mi (approx acreage in parens)	Date established	Principal features
ARGENTINA			
El Rey	140 (89,600)	1948	Subtropical forests on border of Bolivia, with tapir, jaguar giant anteater, birds, reptile6 and other wildlife
Iguazú	210 (134,400)	1934	Subtropical forest on Brazilian border, with cataracts, including Iguazú falls, 240 ft. high; abundant wildlife
Laguna Blanca	44 (28,200)	1949	Black-necked swans
Lanfn	1,520 (972,800)	1937	Lanín volcano on Chilean border, with Araucaria forests and many lakes; varied wildlife
Los Alerces	1,000 (640,000)	1937	Mountainous region with immense forests; ancient glaciers, lakes; principal habitat of guemal deer: other wildlife
Los Glaciares	2,300 (1,472,000)	1937	Southern Andes on border of Chile aith growing intercontinental glaciers, lakes and unusual plant associations; guanaco, chinchilla, guemal and pudu deer, condor and other wildlife
Nahuel Huapi	3,057 (1,956,500)	1922; 1934	Andean peaks on Chilean border, with glaciers forests and lakes; guemal and pudu deer, condor and other wildlife
Perito Francisco P. Moreno	450 (288,000)	1936	Forested Andean peaks on southern border of Chile; habitat of guanaco, guemal deer, Patagonian fox, condor, swan and other wildlife
Angel Gallardo Nature reserve	231 (147,800)	1945	Subtropical forests and swamps of the Chaco, near Paraguayan border, with pure forests of quebracho (*Schinopsis balansae*) and characteristic animal life
Tierra del Fuego	251 (160,620)	1961	Spectacular lakes and mountains
BRAZIL			
Ignaçu National park	801 (512,500)	1939	Mountains and canyons, on Argentine border, with virgin evergreen forests and tropical vegetation; abundant wildlife
BRITISH GUIANA			
Kaieteur	45 (28,800)	1930	Savanna and brushwood fauna on Potaro river; Kaieteur falls; wildlife, especially tropical birds
CHILE			
Cabo de Hornos		1949	Protects islands, some in primeval state, in Strait of Magellan; aquatic animals
Easter Island and Juan Fernández	138 (88,250)		Protect vegetation, animal life and archaeological relics on islands in Pacific ocean
Fray Jorge	20 (12,997)	1931	Extensive forests and wildlife
Los Paraguas	70 (45,000)	1940	Spectacular scenery, including the Llaima volcano; Araucaria forests
Nahuelbuta	21 (13,558)	1939	Coastal cordilleros primeval *Araucaria* and dther forest species
GUATEMALA			
Atitlán		1955	Lake Atitlán is bordered by active volcanoes and the park supports pine, cypress and oak forests on their slopes; deer, squirrel and bird life, including a grebe (*Podilymbus gigas*) endemic to the lake
GUATEMALA (*Cont.*)			
Rio Dulce		1955	Lake Izabal and Río Dulce from Atlantic ocean to ruins of San Felipe castle, magnificent jungle scenery, with tapir jaguar, howler monkey and tropic bird life; open savannas with mahogany, blood trees and other native trees
Santa Rosalia	16 (10,153)		Pine and deciduous forests, with abundant wildlife, including deer, the raccoon *mapache* (*Procyon lotor*)
Tikal		1955	Tropical forest in El Petén, with mahogany, Spanish cedar and the sapodilla tree, or *chicozapote* (*Achras sapota*); deer, Puma, jaguar, ocelot, tapir, mapache and other wildlife; Mayan ruins
MEXICO			
Cañon del Rio Blanco (Veracruz)	218 (139,225)	1938	Forested headwaters of Rio Blanco
Cumbres de Monterrey (Nuevo Leon)	963 (616,255)	1939	In Sierra Madre Oriental range, thick pine forests and wildlife
El Tepozteco (Mexico)	78 (50,000)	1937	Protects archaeological and natural features
Grutas de Cacahumilpa (Guerrero)	5 (3,080)	1936	Spectacular cave formations; source of Amacuzac river
Iztaccíhuatl-Popocatepetl (Puebla, Moreles, Mexico)	100 (64,198)	1935	Two volcanoes rising to over 5,000 m. (16,100 ft.); with forested slopes and perpetual snows
La Malinche (Tlaxcala, Puebla)	154 (98,665)	1938	La Malinche peak and forested slopes
Lagunas de Chacahua (Oaxaca)	55 (35,468)	1937	Lagoons bordering centre of Mixtec kingdom at time of Spanish conquest; waterfalls
Nevado de Colima (Jalisco)	86 (55,000)	1936	Active volcano with subtropical forest on lower slopes, and pine and evergreen oaks above
Nevado de Toluca (Mexico)	262 (167,500)	1936	Nevado de Toluca (4,570 m. [15,433 ft.]) with lagoons in extinct crater; pine and oyamel forests; wildlife
Pico de Orizaba (Veracruz)	77 (49,375)	1936	Citlaltepetl (5,700 m. [18,701 ft.]), highest peak in Mexico; forests include giant trees
Pico de Tancítaro (Michoacán)	115 (73,290)	1940	Extinct volcano
Sierra de San Pedro Mártir (Baja California)	215 (137,500)	1947	San Pedro mountain range, with streams, canyons, forests and wildlife
URUGUAY			
San Miguel National park	6 (3,740)		Scenic coastal area with endemic vegetation
Santa Teresa	13 (8,220)		Scenic coastal area. with endemic vegetation
VENEZUELA			
Avila	312.5 (200,000)	1958	Forested mountain area between Caracas and the Caribbean sea
Guatopo	352 (225,000)	1958	Established to safeguard watershed endangered by agricultural burning, natural cloud forest on Cerro Azul in eastern section
Rancho Grande (Henry Pittier)	352 (225,000)	1937	Primeval tropical cloud forest in Cordillera de la Costa, with abundant wildlife, especially tropical birds; biological research station
Sierra Nevada de Mérida	625 (400,000)	1952	Pico Bolivar (16,411 ft.) and other snow-clad peaks in Venezuelan Andes near Colombia forested on lower slopes 'with glacial lakes and wildlife
Alexander von Humboldt Natural monument		1949	Guácharo caves, with limestone formations and oilbirds (*Staetornis caripensis*)
Yacambú		1962	Scenic forested volcano

and significant effects on other birds. Active extermination measures had to be taken against many of the foreign animals in order to try to restore the balance.

The Wildlife act. 1953, provided for the establishment of wildlife sanctuaries and refuges; it also protected most indigenous species wherever they might be found. Most reserves protect native plants as well as animals and some are set aside for the preservation of a certain species of plant; *e* g., the stands of kauri pine at Waipoua, the very rare evergreen shrub *Pittosporum obcordatum* in Hurumua reserve and the buttercup *Ranunculus pancifolium* at Mount White sheep station. There is also a large number of scenic reserves. The main purpose of the national parks is to provide untouched country for the enjoyment of the people, but their work in the preservation of the indigenous birds is also vitally important. In the parks of the North Island may be seen tuis, bellbirds, rifleman birds, owlet-frogmouths (moreporks), wekas and many others. But the largest of the parks, Fiordland, in the South Island. contains the greatest number of birds peculiar to New Zealand, especially the famous flightless rail or takahe (*Notornis hochstetteri*), long thought extinct but rediscovered in 1948. The area in which the takahe occurs is specially protected and no one may enter without a permit.

VIII. CENTRAL AND SOUTH AMERICA

Mexico first reserved land to protect historical sites late in the 19th century. but the establishment of national parks for the preservation of natural features and vegetation and animal life was undertaken on a major scale in the 1930s. Included in the system are spectacular scenic areas. The parks also protect vital watersheds, forests and wildlife in a country which has suffered devastating destruction of its natural resources irom shortsighted exploitation. The most famous landmark in Mexico is the towering snow-clad summits of Iztaccihuatl-Popocatepetl, visible from the capital city and visited by thousands of people annually. Other peaks in the Sierra Madre ranges, caverns, forests and lagoons inhabited by myriad waterfowl are protected in other parks.

In Guatemala, national parks have been established to protect outstanding natural and archaeological features. Lake Atitlán, dominated by active volcanoes, resembles scenery found in Java; the precise boundaries of the national park have not been defined. The boat trip up the Rio Dulce from Livingston through Lake Izabel, winding amid virgin jungles resounding with the calls of tropical birds and howler monkeys, is a famous attraction. The great plain of El Petén is a region of grasslands and tropical forests, the habitat of abundant wildlife, with buried Mayan cities.

The long-continued destruction of Venezuelan natural resources by overgrazing, fire and abusive agricultural practices stimulated an active conservation program in that country. which has included the establishment of national parks and natural monuments. Avila National park, near Caracas, is a popular recreational area as well as one of scientific importance. The tropical cloud forests in Rancho Grande and Guatopo National parks preserve humid jungle growth on the upper slopes of mountain ranges, with many unusual birds: mammals, reptiles and insects. The Sierra Nevada de Mérida National park is an Andean terrain of exceptional beauty.

The southern Andes possess some of the most spectacular mountain scenery in the world and several outstanding examples along the Argentine–Chilean border have been set aside as national parks. There live two Andean deer, the guemal and the pudu, and also guanaco, chinchilla, condor and other unusual animals. Of Argentina's other national parks, El Rey and Iguazú protect subtropical forests on the Bolivian and Brazilian border, while the Angel Gallardo Nature reserve in the Chaco on the boundary of Paraguay includes dense subtropical forests and swamps. These forests, rich in a variety of unusual plant life, are the habitat of most species of jungle fauna, including tapirs, carnivores and other mammals, many reptiles and myriad species of tropical birds. Often considered to be of almost limitless extent, these forests could easily be destroyed by exploitation. Their preservation is essential to the perpetuation of plants and animals of still little-understood economic and sociological importance.

Several of Chile's national parks are corollaries of the Andean parks in Argentina, protecting similar mountainous terrain and its forests and wildlife. Among Chile's other parks. the Cabo de Hornos National park is difficult of access, a region of gales and cold fogs, established to safeguard islands inhabited by seals and other aquatic mammals and birds. Easter Island is famous for its mysterious archaeological sculptures. Juan Fernández National park supports an endemic vegetation and animal liie of scientific importance. which is seriously endangered by livestock grazing.

See also references under "National Parks" in the Index volume and, for current developments, the annual summary in *Britannica Book of the Year*. (F. M. Pd.)

NATIONAL PROVINCIAL BANK LIMITED. This British banking institution, founded in 1833, has branches in London and the provinces. The amalgamation movement wrought great changes in the English banking system, and the National Provincial bank was closely identified with it, particularly during the period from 1918 to 1924. An important amalgamation effected by the bank took place in 1918 when it took over the Union of London and Smiths Bank, Limited. In the same year, the business of the Bradford District Bank, Limited was acquired. The Sheffield Banking Company, Limited was absorbed in 1919, the Northamptonshire Union Bank, Limited in 1920 and the Guernsey Banking Company, Limited in 1924.

NATIONAL SAVINGS: *see* Savings, National.

NATIONAL SECURITY COUNCIL, U.S. The need for a national policy co-ordinating group more formal in character than the presidential cabinet was not recognized in the United States until the eve of World War II. Until the Budget act of 1921 even that basic policy control which a unified budget creates did not exist. During the McKinley. Theodore Roosevelt and Taft administrations no secretary of state asked for a military accounting before some diplomatic venture. Thereafter in the 1920s and 1930s co-ordination was either nonexistent or rudimentary.

It was not until 1938 that a standing liaison committee of the undersecretary of state, the chief of naval operations and the army chief of staff was created. With the onset of World War II, however, policy co-ordination virtually ceased except in the person of the president, Franklin D. Roosevelt. Not until the last year of the war did a group, the state-war-navy co-ordinating committee, come into being with the express purpose of co-ordinating policy. The SWNCC was ineffective for it could consider only policy referred to it by one of the departments, and furthermore its membership, made up of the assistant secretaries, lacked the requisite political prestige.

Following World War II, congressional investigation focused attention on the lack of co-ordination which had been a factor in the Pearl Harbor disaster, and there was a general pressure for reorganization of deiense agencies. The suggestion for a national security council (NSC) originated in studies by a staff of experts appointed by James Forrestal, then secretary of the navy. The NSC was established by law in 1947, and consisted of the president, the secretary of state, the secretary of defense, the secretaries of the three military services and the chairman of the national security resources board. (Reorganization Plan 6 abolished the national security resources board. An executive order of March 13, 1953, named the director of the Office of Defense Mobilization to replace the chairman of the NSRB on the council.) Most important, the NSC was provided with a staff of its own. In time it was felt by those called upon to observe NSC operations that the staff base should be further strengthened and its military top-heaviness reduced. These criticisms were taken into account in the National Security act amendments of 1949.

The functioning of the NSC continued to be the butt of criticism. however, even after that second reorganization. After President Eisenhower took office in 1953 the NSC was given a new importance. Meetings were made smaller. with fewer departmental advisors Members were categorized in different fashion. Some were named statutory members. the president, the vice-president, the secretaries of state and defense and the director of the Office of Defense Mobilization (later called the Office of Civil and Defense Mobilization). Others, although actually enjoying a status equal to that of statutory members, were categorized as "regular participant members." Such members included the secretary of the treasury and the director of the bureau of the budget. Still others, such as the attorney general, the chairman of the Atomic Energy commission, and the administrator of the National Aeronautics and Space agency. attended on an *ad hoc,* participant basis for subjects material to their responsibilities.

More active than before. the NSC was given a stronger staff by the formation of a Planning board. The members of this board, each with the rank of assistant secretary, functioned as representatives of members of the NSC. An Operations Coordinating board was also established by executive order.

The NSC seems in the second half of the 20th century to be an institution destined for continuous change as the philosophy of government alters with changes in party control and executive personnel. Major segments of national policy may well continue to be formed outside it, and the extent to which its advice will be followed will depend on the policies of the president.

(E. L. KH)

NATIONAL SOCIALISM, the name of a movement started as the Nationalsozialistische Deutsche Arbeiterpartei (N S.D.A.P.), National Socialist German Workers'—called Nazi—party, by Adolf Hitler (*q.v.*) in Germany in 1919 Its name revealed its emphasis upon nationalism, socialism. Germanism and the working class. Like Benito Mussolini's Fascism, it combined an appeal to extreme and exclusive nationalism and chauvinist expansionism with a revolutionary call to the masses. It had from the beginning many traits in common with Fascism. and National Socialism may be regarded as the German form of Fascism. Both proclaimed themselves the implacable enemies of liberalism and democracy, of individual rights and all movements of international co-operation and peace; both stressed the subordination of the individual to the state, the inequality of men and races, the right of the strong to rule the weak and the necessity of the principle of blind and unswerving obedience to leaders appointed from above. Both praised the military virtues, despised and rejected pacifism, humanitarianism and charity, glorified hatred and conquest and aimed at the transformation of the whole nation into an armed camp and an instrument of perpetual readiness for warfare.

Origins. — National Socialism, however, had its peculiarly German roots. Some can be traced to the Prussian tradition as it developed under the inspiration of great soldier kings, such as Frederick William I and Frederick II, and men of blood and iron, such as Bismarck. This tradition had always regarded the militant spirit and the discipline of the Prussian army as the model for all individual and civic life. To it was added the tradition of political romanticism. with its sharp hostility to rationalism, to the principles underlying the French Revolution and to the "superficiality" of the west. and with its emphasis on instinct, on the past. even on the remote past, and its proclamation of the rights of the exceptional over all universal law and rules. Thus, the exceptional becomes a law unto himself. These two traditions were later enforced by the 19th-century adoration of science and of the laws of nature, which, with their "iron logic," worked out beyond all concepts of good and evil. Further reinforcements came from a biological theory of life that led to the acceptance of that racialism first proclaimed by Joseph Arthur, count de Gobineau, in his *Essai sur l'inégalité des races humaines* (1853–55). It was then propounded by Richard Wagner (1813–83), who combined it uith a heroic ideal of the Nordic superman, and by his son-in-law Houston Stewart Chamberlain. whose *Grundlagen des neunzehnten Jahrhunderts* (1899; Eng. trans., *Foundations of fhe Nineteenth Century,* 1911) profoundly influenced early Hitlerism. To romanticism, National Socialism owed the vague and fluid conceptions of folk as the basis of cultural and political organization, and of *Weltanschauung* or "total world outlook" as opposed in the name of *Kultur* to the more rational civilization of the west.

In addition to these currents in the German tradition, it ought to be pointed out that Hitler's formation was influenced during his youth by specific Austrian movements. National Socialism owed much to Karl Lueger (1844–1910), who organized the Catholic lower middle classes of Vienna in an anticapitalistic and anti-Semitic movement called the Christian Socialist party, but who remained loyal to Habsburg conservatism; and to Georg von Schonerer (1842–1921), who combined racial anti-Semitism with a violent anti-Catholicism and pan-Germanic expansionism and a bitter hostility to the Habsburgs. Schonerer's disciple Karl Hermann Wolf founded among the Sudeten Germans in Bohemia a German Workers' party that later was to assume the name of Deutsche National-Sozialistische Arbeiterpartei. This occurred a few years before Hitler founded his almost identically named N.S.D A.P. in Munich.

Much in Hitler's ferocious nationalism and his contempt of the Slavs can be explained by the experience of his youth amid the bitter nationality struggles of the multiracial Habsburg empire.

When Hitler started his agitation in Munich immediately after World War I he found the intellectual soil well prepared by the writings of the German romanticists and of the German publicists of the War of Liberation, such as Ernst Moritz Arndt (1769–1860) and Friedrich Ludwig Jahn (1778–1852).

The last years before World War I were characterized by a renewed interest in romanticism and in the War of Liberation of 1813. In those years a German youth movement with its longing for a true community, a *Gemeinschaft,* the rebirth of the nation, and with its vague mystical enthusiasm for leadership and comradeship. expressed the opposition to rationalism and "bourgeois" liberalism. It had come largely under the influence of Friedrich Nietzsche (1844–1900) and the German poet Stefan George (1868–1933). Oswald Spengler (1880–1936; *q.v.*) and Arthur Moeller van den Bruck (1876–1925) can be regarded as the immediate forerunners of National Socialism in the intellectual field.

But the intellectual preparation would in no way have been sufficient for the growth of National Socialism in Germany if the defeat in World War I. with its ensuing disillusionment and pauperization. especially in the lower middle classes. had not paved the way for Hitler's propaganda. The peace treaty of Versailles gave Hitler a starting point, but the violent opposition which he evoked was not directed in reality against the peace treaty but against the fact that Germany had been defeated and that its plans had been frustrated. From the beginning Hitler's propaganda appealed to the military circles, which regarded the peace only as a temporary setback in Germany's expansionist program. Hitler added to the pan-Germanic aspirations for world hegemony the almost mystical fanaticism of a faith in the mission of the German race and the fervour of a social revolutionary gospel. In the years of political and economic depression which followed Germany's defeat, Hitler's appeal to the German masses as the bearers of the most exalted racial ideals in the world was eagerly accepted to counteract their inferiority complex.

Psychological Methods and Theoretical Aims. — Though Hitler accepted many elements of the technique of the Bolshevik revolution, he found a powerful ally in the widespread fear of Bolshevism. which he exploited, first in Germany and then on a world-wide scale, posing as the bulwark against Bolshevism. Thus, he secured the financial and moral support of many conservative elements that misunderstood the revolutionary and nihilistic character of his movement and its many points of similarity (as in its antiliberalism) with Bolshevism. On the other hand, he gained the adherence of the masses by vague promises of an anticapitalistic order. The banner of the N.S.D.A.P. was the red flag of the revolution, but altered to the German imperial colours by the addition of a white circle and a black swastika in the centre. Thus Hitler combined the appeal of social revolution and that of a militant and mystical nationalism; the extraordinary flexibility of his dynamic doctrine enabled him to stress different elements at different times and to adapt his attitude momentarily to changing circumstances, even with complete disregard for previous statements.

Hitler's most important individual contribution to the theory and practice of National Socialism was his deep understanding of mass psychology and mass propaganda in the contemporary world and his perfection of the methods learned from Bolshevik technique. His chapter on propaganda in *Mein·Kampf* (1925–27) can be regarded as of the most fundamental importance. He stressed the fact that all propaganda must hold its intellectual level at the capacity of the least intelligent of those at whom it is directed. and that its content of truth does not count compared with the only valid criterion. that of success. "The slighter its scientific ballast, and the more exclusively it considers the emotions of the masses, the more complete the success." Propaganda should concentrate on a few simple statements (however terrible they may be in their denial of the humanity of man)

Hitler understood that, especially with as wide and far-reaching a goal as world domination, it was of the utmost importance to be able to present under one common denominator all potential adversaries who might themselves change according to the circumstances.

The art of truly great popular leaders in all ages has consisted chiefly in not distracting the attention of the people, but concentrating always on a single adversary. The more unified the object of the people's will to fight, the greater will he the magnetic attraction of the movement and the more tremendous its impact. It is part of a great leader's genius to make even widely separated adversaries appear as if they belonged to hut one category, because among weakly and undecided characters the recognition of various enemies all too easily marks the beginning of doubt of one's own rightness. (From Hitler's *Mein Kampf.)*

It was a stroke of genius on the part of Hitler to find this common denominator in the Jews and Judaism. This enabled him to discover the "Jew" behind all his changing adversaries, sometimes behind Communism or Moscow, at other times behind Great Britain and the United States—in short, behind everybody and everything that at a given moment opposed his wishes or aroused his wrath.

Anti-Semitism served him also for two other purposes. National Socialism was fundamentally opposed to all concepts of international co-operation and universal catholicity; it destroyed the framework of a common humanity with common and absolute standards of law, truth and good, applicable to all men. National Socialism, therein following Nietzsche, regarded Christianity and prophetic Judaism. with their emphasis on the equality of all men under one common God and upon absolute standards of justice, as alien and inimical to the new hero ideal of the superrace, which was interpreted—not by Nietzsche. but by the National Socialists—as the true Germanic ideal. Judaism and the ethics of the Bible therefore stood in opposition to National Socialism.

National Socialism proclaimed the Germanic race as the new corpus *mysticum* on which the salvation of the world depended. as the embodiment of all nobility and creative genius and as the Reich ("empire") which must become the world-controlling *Reich.* This Reich necessarily had to have a Gegenreich ("Counter-*Reich*"), a counterrace that on a similarly world-wide basis would represent the antithesis of salvation and creative genius. So the Jewish people became the counterrace. National Socialism saw its duty not only in the destruction of this counterrace, but in the preparation of the German race for its real task of establishing the new world order. The third Reich—the hoped-for successor to the defunct second or Hohenzollern Reich—ruled by what Hitler called "the highest human species given by the grace of the Almighty to this earth," will have, by suitable education of the youth, in the future a generation mature for the ultimate and greatest decision on this globe. "The nation which will first take this road will be victorious," and become "one day the master of the globe."

The Jews were to be discriminated against not according to their religion but according to their "race." The fundamental contention of Hitler was that man is inescapably determined by his descent or "blood." Whoever was born from German parents remained a German forever in his nationality and character; whoever was born from Jewish parents remained forever a Jew by nationality and character. Thus Jews were declared, whatever their educational and environmental development, to be forever fundamentally different from Germans.

Hitler's racial theory was applied not only to Jews but also to people of German "blood" living in non-German lands. Germans who had emigrated from Germany and had become nationals of other countries, and even their descendants, were regarded as Germans, as *Stammesbruder* ("racial bretheren") and *Volksgenossen* ("national comrades"). Active propaganda was to be started among these Germans living in the "diaspora" (*Auslandsdeutsche*). If possible they were to be brought "home" into Germany, the true homeland of all Germans wherever they lived. If they could not be brought home, at least their loyalty to and activity for the German homeland was to be encouraged by all means. Study of German language and culture was to be promoted by all means among those Germans.

Rise to Power.—Working from these principles, Adolf Hitler was able to carry his party from its small beginnings in a beer cellar in Munich to a dominant position in world politics within 20 years. Among his more important collaborators were Alfred Rosenberg, the author of Der *Mythus* des *20ten* Jahrhunderts ("The Myth of the 20th Century"; 1930), the most widely read book of the National Socialist movement besides Hitler's own *Mein* Kampf; Rudolf Hess, who helped Hitler write *Mein* Kampf during their internment in the fortress in Landsberg am Lech in 1924; Gregor Strasser, probably the most important of Hitler's collaborators, who separated from him in protest against the leader's opportunist policies and was killed in the blood purge of June 1934; his brother Otto Strasser, who in 1930 founded the Black front as a more radical wing opposed to Hitler; Gottfried Feder, who drew up the first program of National Socialism and was for several years its economic "expert" but thereafter receded into oblivion; Capt. Ernst Roehm, the founder and organizer of the SX. or *Sturmabteilung,* the National Socialist militia, who was purged in June 1934; Julius Streicher, who became famous through his anti-Semitic weekly Der *Stürmer;* Heinrich Himmler, the organizer and commander of the SS. or *Schutzstaffel,* Hitler's personal elite guard, and of the Gestapo, the secret state police; Josef Goebbels, the master of National Socialist propaganda; Hermann Goring, the organizer of the German air force and controller of the German industrial mobilization; R. Walther Darre, the organizer of the National Socialist peasant policy; and finally Robert Ley, the leader of the German Workers' front.

It took 14 years for the N.S.D.A.P. to achieve power in Germany. It had been born at a time when it was only one of many semirevolutionary, reactionary and terrorist organizations springing up throughout Germany, composed of former officers and soldiers, students and other elements dissatisfied with the republican, democratic and peaceful order which seemed to dawn for Germany in 1919. That it survived and absorbed all others was due to Hitler's leadership and to the fact that Captain Roehm interested the *Reichswehr* in supporting Hitler. On Feb. 24, 1920, the N.S.D.A.P. drafted in Munich, the centre of its activities, a program of 25 points, which in 1926 was declared unalterable, but which in reality was very soon surpassed by developments. On Nov. 9, 1923. Hitler, supported by Field Marshal Erich Ludendorff, attempted his first Putsch in Munich, but it miscarried. Reaction was so firmly entrenched then in Bavaria, however, that Hitler was let off with only a formal punishment. The ensuing years of political and economic consolidation in Germany did not allow Hitler to make any considerable progress. The economic crisis at the beginning of the '30s, however, and the lack of energetic measures on the part of the government against the indefatigable propaganda to undermine democracy brought the first great success of the N.S.D.A.P. in the Reichstag elections of Sept. 14, 1930.

The Reichstag elections of Nov. 6, 1932, marked a temporary setback for Hitler; but an intrigue, started by Franz von Papen, prevailed upon the aged president of the German republic, Marshal Paul von Hindenburg, to name Hitler chancellor on Jan. 30, 1933. He was then only the head of a coalition cabinet of National Socialists and members of the conservative and nationalistic right. A fire in the Reichstag building on Feb. 27, 1933, gave Hitler the chance to rouse the spectre of a Bolshevik revolutionary danger and to hold the elections of March 5, 1933; though they gave the National Socialists only 44% of the votes, the antidemocratic totalitarian parties (National Socialists and Communists) had a majority following in Germany against the democratic republic, while the democratic forces were weak and without a clear program. Thus: the new Reichstag, meeting on March 21, 1933, in the garrison church in Potsdam, the historic receptacle of Prussian military spirit, "enabled" the government to assume dictatorial powers. From that moment on, the relentless process of Gleichschaltung ("co-ordination") began, and within a few months the German *Reich* had become a totalitarian state which was entirely identical with the N.S.D.A.P. in every concern of public or private life, and that meant with the will of its leader. *(See* GERMANY: History.)

Once firmly in power Hitler wished to secure his position against the left within his own party and against opposition from conservative circles without. Many of the adherents of National Socialism, especially in the SA., demanded radical social reforms. Hitler, on the other hand. wished to stabilize his revolution and to avoid alienating big business circles. The leader of the SA., Roehm, also wished to incorporate his semimilitary formations into the army. thus endangering Hitler's relationship not only with big business but also with the army leadership. The approaching crisis was heightened by the intraparty rivalries between Roehm on the one hand and Goring and Himmler on the other. The crisis was solved by the "blood purge" of June 30, 1934, when Roehm and many other Nazi leaders were executed without trial. Hitler used the opportunity to have murdered a number of other prominent men whom he feared or disliked. Among these were Gen. Kurt von Schleicher, Hitler's predecessor as chancellor of the German *Reich,* and Gregor Strasser, who had been friendly to the trade-union movement.

National Socialism regarded Christianity from the beginning as an un-German faith, National Socialism was, in itself, a total creed centred upon Germanism and its unique and special mission bestowed upon it by nature and history. Though Hitler, for opportunist reasons, stressed his tolerance of the Christian church, or what he called "positive Christianity." true Christianity was incompatible 'with National Socialism as it is incompatible with Russian Communism, and the Nazis and the Communists knew it better and earlier than many Christians. The Vatican even signed a concordat with Hitler's government on July 8. 1933. But the concordat protected the Roman Catholic Church in Germany as little as it did the Protestant church from constant interference and even persecution by the German authorities. Many Protestant ministers, though acknowledging the Nazi government's authority in all secular and political matters, denied it the right to interfere with the preaching of the Gospel and with the internal administration of the church. They founded the *Bekenntniskirche* ("confessional church"), of which the best-known leader was Martin Niemoller.

The last conservative obstacle to Hitler's totalitarian police state was removed by the death of Hindenburg in his 87th year on Aug. 2, 1934. Hitler abolished the presidency and assumed the position of supreme commander. He now contented himself with the titles of *Reichsführer* and *Reichskanzler,* leader and chancellor of the *Reich.* All troops and officials were immediately forced to take the oath of fidelity to Hitler personally. A plebiscite held on Aug. 19 confirmed these measures. Out of 43,529,710 votes 88.2% were cast in Hitler's favour.

In Power. — Outwardly, the Nazi party, following the pattern of the Communist party. was strictly centralized. Hitler's word was the supreme and undisputed command. The outward aspect of efficiency and unity was impressive. Nazi documents found after 1945 revealed, however, how much the party, like other totalitarian parties, was torn by internal dissensions and jealousies. There was constant overlapping and aorking at cross-purposes on all levels of the complex organizational system. The situation deteriorated when. after 1938 and especially with the progress of the war, the older. trained civil servants and army leaders were replaced by party members.

Opposition to the regime was broken either by outright terror or. more frequently, by the all-pervading fear of possible repression, even if no actual repression took place. As in the Soviet Union, all opponents of the regime were declared enemies of the state and of the people. An elaborate web of informers—often members of the family or intimate friends—working and reporting in secrecy imposed utmost caution on all expressions and activities. Justice was no longer recognized as objective but was completely subordinated to the alleged needs and interests of the "people." In addition. however, to the now debased methods of the normal judicial process, special detention camps were erected. In these camps—of which some, such as Dachau and Auschwitz, achieved notoriety—the SS. exercised supreme authority and introduced a system of sadistic brutality unknown in modern times and by far surpassing anything known in that respect in Fascist Italy or Communist Russia.

Resistance. — Church leaders participated actively in the resistance movement against Nazism. This movement never reached any popular dimensions and did not become active before the later years of the war into which Germany plunged Europe and the world. When the more rational leaders of the German army, together with members of the German official and educated class, recognized that Hitler was leading the Germans into defeat, they joined in a conspiracy that led to the attempt on July 20, 1944, to assassinate Hitler in his headquarters in East Prussia. The attempt miscarried, and the party took a frantic revenge on the conspirators. Many members of the German aristocracy and many high-ranking officers were executed, and the movement stressed again its antiaristocratic mass character as it had done at its beginning.

Turning Point; the War.—The history of National Socialism after 1934 can be divided into two parts of about equal length. The years between 1934 and 1939 were used to establish the full control of all phases of life in Germany by the party. The principal instrument of control was the unification of all the police, security and SS. organizations under the direction of Himmler and his chief lieutenant. Reinhard Heydrich. The years between 1938 and 1945 witnessed the attempt to expand and apply the Nazi system to territories outside the German *Reich.* This attempt was confined. in 1938, to lands inhabited by a German-speaking population. In 1939 began the subjugation of non-German-speaking nationalities to the totalitarian Nazi police state. In 1945 this attempt collapsed.

'The turning point in the brief but disastrous career of the Nazi regime in Germany was the year 1938. In that year the conservative influence in the two remaining bulwarks of an older, authoritarian but civilized Germany was ended—in the army and in the foreign office. In the same year. Hitler began German territorial expansion, carried through under diplomatic pressure, by "peaceful" means. In such a way he incorporated into the German *Reich* first the republic of Austria and then the Sudetenland (the German-speaking parts of the republic of Czechoslovakia).

By 1939 the military preparations, including the militarization of German life and education and the establishment of a war economy, had made such progress in Hitler's opinion that he could challenge the European order even at the risk of a second great war. On Aug. 23, Hitler, without consultation with his Italian and Japanese "allies," concluded a pact of friendship and nonaggression with the U.S.S.R. The pact contained a secret treaty between Germany and Russia partitioning Poland and dividing the whole of eastern Europe into spheres of influence. It was the first step opening the road into the heart of central Europe to Stalin and Russian Communism and the immediate prelude to World War II *(q.v.),* which began in Poland on Sept. 1.

To a certain extent World War II repeated the pattern of World War I: great initial German military successes; the forging of a large-scale coalition against Germany as the result of German pretensions and behaviour; the loss of the war because of German overreaching and conduct. *(See* also Germany: *History.)*

Ultimate Party Goals and **Failure.**—When Germany started World War II, it came as the logical outcome of Hitler's plans, known to the Germans since his publication of *Mein Kampf* (1926), and of his systematic preparations since 1933. From the beginning, National Socialism did not intend to establish a new order of authoritarianism and of inequality for Germany alone. Therein it again imitated Communism. Its dynamism was bound to expand and to spread By its own nature it could not recognize any limits to its own volition, only limits set by opposed superior forces. Thus Hitler's first years were spent in preparing the Germans for the approaching struggle for world control and in forging that instrument which would enable Germany to establish its military and industrial superiority, and thus to fulfill its ambitions. With mounting success, the aims grew in quick progression. The first aim was to unite all people of German descent within their historic homeland on the basis of "self-determination." The next step foresaw the creation of a *Grosswirtschaftsraum* ("large economic unified space") or a *Lebensraum* ("living space"). *(See* GEOPOLITICS.) Thereby the Germans would acquire sufficient soil to become economically self-sufficient and militarily impregnable. There, the German master race *or Herrenvolk* would rule over a hierarchy of subordinate peoples and organize them with German ruthlessness and efficiency. The initial success of that plan in 1941 widened it into the vision of a hemispheric order that would embrace all of Europe, western Asia and Africa, and finally of a world order that would establish the principle of National Socialism all over the globe and give to mankind as a whole the "benefits" of a peace maintained by German bayonets and administered by a unified party bureaucracy.

The extreme neomercantilist economic self-sufficiency, protectionism and rejection of free trade, which received the new name of *Wehrwirtschaft* ("defense" or "war economy"), was accompanied by an extreme cultural nationalist self-sufficiency and a resolute hostility against all western thought. The world rule to which National Socialism aspired would not only represent a military, economic and political domination, but equally an intellectual and moral leadership. The new world age or *Weltzeitalter* would be German and National Socialist at the same time.

These extravagant German hopes came to an end with Germany's defeat in 1945, after almost six years of war. Out of the ruins of National Socialist Germany there arose a divided and occupied Germany. The eastern provinces were put under Russian and Polish administration. The lands east of the Elbe, Saxony and Thuringia, formed, under Russian occupation, a Communist-dominated state, called the German Democratic Republic. In western Germany, in close co-operation with'the western democracies, the German Federal Republic, under the chancellorship of Konrad Adenauer, came into being in 1949. Though a number of Germans remained faithful to National Socialism, its principles and dreams, even after Hitler's downfall, and though there were several attempts made to reorganize National Socialist groups in the German Federal Republic, the political and mental climate there was not favourable to it, and it was hardly possible to speak of, or to expect, a revival of National Socialism in Germany.

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NATIONAL WORKSHOPS (in French, *Ateliers Nationaux),* the term applied to the workshops established to provide work for the unemployed by the French provisional government after the revolution of *1848.* (The term is also incorrectly applied to the proposed *ateliers sociaux* of Louis Blanc [*q.v.*], state-supported co-operative productive societies.) The revolution was both preceded and followed by a severe financial and industrial crisis which rendered the problem of unemployment in Paris very acute. The provisional government under the influence of one of its members, Louis Blanc, and on the demand of a deputation of Parisian workers, passed a decree (Feb. 25, 1848) which contained bold promises assuring relief from the extreme conditions then prevailing. Moreover, this relief was to be immediate, effectual and universal. As stated in the decree:

> "The provisional government of the French Republic undertakes to guarantee the existence of the workmen by work. It undertakes to guarantee work for every citizen.':

For the carrying out of this decree Louis Blanc wanted the formation of a ministry of labour, but this was shelved by his colleagues who, as a compromise, appointed the "Luxembourg" labour commission under the presidency of Louis Blanc and with power of inquiry and consultation only. The carrying out of the decree of Feb. 25 was entrusted to the minister of public works, Marie de Saint-Georges, and various public works were immediately started. These included clearing the trench of Clamart and conveying the earth to Paris for the construction of a railway station on the *chemin de ter* de l'Ouest; construction of the Paris terminus of the Paris-Chartres railway; improvement of the navigation of the Oise and extension of the Sceaux railway to Orsay.

Those applying for work far exceeded the number of jobs available. There was no effective administrative service and no real desire on the part of the government to make the experiment a success. The disorder and waste were amazing.

Owing to the increase in the number of those claiming work or relief, disorganization set in, and both the bureaus and the *mairies* became the centres of disturbances, those in charge of the offices being unable to control the crowds. As a consequence Marie de Saint-Georges commissioned Émile Thomas, a chemist, connected with the École Centrale, to reorganize the works. When Thomas took the work in hand on March 5, the number of unemployed had increased to 14,000 in addition to about *4,000* or 5,000 employed on public works, and it was steadily on the increase. On March 16 the daily pay of the workmen who were not working was reduced to one franc; work was guaranteed for at least every other day, in which case the pay was to be two francs for the day.

The national assembly had in the meanwhile been elected, and met on May 4. The executive commission was elected a few days later; Louis Blanc was excluded, but all the other members of the provisional government were on it. Blanc renewed his motion for a ministry of labour; this was rejected. The dispersal of the *emeute* of May 15 freed the assembly from fear of the revolutionary clubs, and on May 15 Thomas received instructions to dismiss all unmarried men under 25 years of age who would not enlist in the army, all men who could not prove six months' residence in Paris and all who refused offers of private employment. Piecework was to be established instead of timework, and men were to be prepared to be drafted into the provinces. The protests of Thomas held this plan up, but he was removed from office on May 26 and on June 20 the proposals were approved, and the sequel was the insurrection of June 23 and following days *(see* FRANCE: *History*).

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NATIONS, LAW OF: *see* CONFLICT OF LAWS; INTERNATIONAL LAW, PUBLIC.

NATIVISTIC MOVEMENTS. Nativistic movements are efforts by members of a society to build for themselves a more satisfying way of life by eliminating foreign persons, customs, material objects or ideas. Such movements belong to the larger class of revitalization movements, all of which aim to better the life of a society, but not all of which are nativistic. Sometimes the term nativistic movement is used loosely to denote any type of revitalization movement. The term is largely restricted in usage to anthropologists and is therefore commonly applied to primitive peoples in contact with western civilization. Similar events occur, however, in western societies and are frequently studied by historians and sociologists, who employ a different vocabulary (sect formation, messianic movement, revolution, religious revival).

Revitalization movements occur in societies which have been subjected to stress and whose culture has suffered disorganization. The typical process of a revitalization movement (and therefore of a nativistic movement) may be divided into six states: (1) the inspiration of the prophet; (2) the preaching of the inspired new code; (3) the development of an organization of disciples and followers; (4) the modification of the new code to fit local and temporal requirements; (5) the transformation of the society's culture along the lines of the new code; (6) the redefinition of the new code as traditional and the translation of the revolutionary organization into a conservative status.

Generally speaking, nativistic movements are religious; the new (or revived) religion itself details the changes to be made in such secular affairs as political organization, family structure. economic pursuits, war and international relations. Revitalization movements may bring about drastic changes in culture in very short periods of time.

Typologies of nativistic movements have been developed. One such analysis divides them into four groups: (1) revivalistic-magical; (2) revivalistic-rational; (3) perpetuative-magical; and (4) perpetuative-rational. Another typology is based on the extensiveness of the new code's coverage of cultural categories. There exist also various culture-area classifications based on typical forms taken by nativistic movements in various regions.

Thus Melanesia. and especially New Guinea, has been since the latter part of the 19th century the home of various native cargo cults, which emphasize the belief that a ship. with the ancestors as crew and passengers, is approaching with a cargo of European goods. On its arrival European personnel and native custom alike are to be cast aside and the cult members will enjoy the full benefits of European civilization without the interference of white masters. Some believers destroy much of their property in anticipation of the new wealth.

South American Indians have for centuries produced *terre sans mal* (literally, "land without evil") movements, based on the belief in a promised land, either on earth or on some other plane, to which the people can by religious ritual or physical migration actually translate themselves. Africa south of the Sahara is the home of hundreds of separatist churches.

North American Indians have tended to produce revivalistic doctrines, emphasizing the spiritual purity to be achieved by following ancestral (or at least distinctively Indian) ways of ritual and daily life. In 1805 in Ohio the "Shawnee Prophet" Tenskwatawa preached rejection of European mode of dress, the use of alcohol, and intermarriage with whites, and certain Indian practices such as witchcraft. The movement became an antiwhite religious crusade lasting until the War of 1812. The so-called Ghost Dance of the 1870s and 1890s is the best known example of a North American Indian nativistic movement. Although the prophet Wovoka was a Paiute, the Dance itself spread widely among tribes west of the Mississippi river. In essence the doctrine was millenarian: the world was soon coming to an end and the new dawn would see all Indians, dead and alive, reunited to live according to more or less aboriginal standards; in the meantime, the Indians were to avoid any sort of conflict, to dance and in trances induced by continued dancing to meet ancestors (ghosts) and supernatural beings. The second Ghost Dance received special notoriety from its association with the Sioux outbreak of 1890.

Theories about the causes of nativistic and other revitalization movements generally emphasize that individual psychological and physiological stress are elicited by cultural disorganization and in turn elicit both the inspiration of the prophet and the motivation of his followers. Study of such movements has contributed to a scientific understanding of the dynamics of culture change and of processes of mental disorder and resynthesis.

See also GHOST DANCE; INDIAN, NORTH AMERICAN: *Indians in Contemporary Life;* PEYOTISM. Modern revivalism is discussed under REVIVALISM.

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NATROLITE, a mineral species belonging to the zeolite group, is a hydrated sodium and aluminum silicate. Needlestone or needle zeolite are other names, alluding to the common shape (acicular habit) of the crystals, which are often very slender and are aggregated in divergent tufts. Larger crystals have the form of a square prism terminated by a low pyramid: the .prism angle being nearly a right angle, the crystals are tetragonal in appearance. though actually orthorhombic. There are perfect cleavages parallel to the face of the prism. The mineral also often occurs in compact fibrous aggregates, the fibres having a divergent or radial arrangement. Natrolite is usually white or colourless, but sometimes reddish or yellowish. The lustre is vitreous, or in finely fibrous specimens sometimes silky. The formula is $Na_2Al_2Si_3O_{10}2H_2O$. The specific gravity is 2.2 and the hardness 5.5.

The mineral is readily fusible. It is decomposed by hydrochloric acid with separation of gelatinous silica.

See also ZEOLITE.

NATSUME SŌSEKI (pseudonym of NATSUME KINNOSUKE) (1867–1916), is by general consent the outstanding figure of modem Japanese literature. He was graduated from the English literature department of Tokyo university in 1893 and from 1900 to 1903 studied in England.

The influence of English literature is most conspicuous in his earliest published works, the satirical *Wagahai wa Neko de Aru* ("I Am a Cat," 1905) and *The Tower of London* (190j). but it can be traced through most of his later writings as well. To this knowledge of European literature Natsume brought an unusual understanding of Japanese *haiku (see* JAPANESE LITERATURE) and Chinese poetry, in both of which he excelled. His writings, indeed, represent one of the rare successful blendings of western novelistic techniques with Japanese traditions.

Natsume's reputation as a novelist was firmly established with *Botchan* (1906; Eng. trans., in part, by Watson, in D. Keene, *Modern Japanese Literature,* 1956) and *Kusamakura* (1907). In 1908 he left his post at Tokyo university, where he had been teaching English since 1903, in order to devote himself entirely to his novels, which were published serially in the *Asahi* newspaper. *Mon* ("The Gate." 1910) contains a first enunciation of Natsume's concern with egoism in human relations, a theme that was treated with increasing profundity and incisiveness in each of his successive novels and finally resolved in his principle of *sokuten kyoshi,* "to follow Heaven and depart from the self." *Kokoro* (1914; Eng. trans. by E. McClellan, 1957) and *Meian* ("Darkness and Light," unfinished at his death in 1916), perhaps Natsume's finest novels, deal largely with this same theme.

Natsume also wrote literary criticism, diaries and works, such as *My Individualism* (1915), in which he stated his philosophy. He died on Dec. 9, 1916, leaving behind many devoted disciples.

See Toyotaka Komiya, *Natsume Sōseki* (1953); Okazaki, *Japanese Literature in the Meiji Era,* trans. *by* Viglielmo (1955). (DD. K.)

NATTIER, JEAN MARC (1685–1766), French painter, known for his portraits of the ladies of Louis XV's court in mythological attire, was born on March 17, 1685, in Paris. the son of Marc Nattier, a portrait painter. and of Marie Courtois, a miniaturist. He received his first instruction from his father and took the first prize at the Paris academy at the age of 1j. He refused to study at the French Academy in Rome and in 1715 went to Amsterdam, where Peter the Great was then staying. There he painted portraits of the tsar and his wife, the empress Catherine, but declined an offer to go to Russia. Between 171j and 1720 he painted the "Battle of Poltava" for Peter the Great, and the "Petrification of Phineus and of His Companions" (Tours museum), which led to his election to the Academy. The financial collapse of 1720 all but ruined Nattier, who was obliged to turn to portraiture. Notable examples of his straightforward approach are the "Marie Leszczinska" at the Dijon museum and "The Artist Surrounded by His Family," dated 1730.

Among his pictures are the "Magdalen," at the Louvre; "La Camargo" and "A Lady of the Court of Louis XV," at Nantes; the "Head of a Young Girl," at Orléans; and "Mme. de Pompadour," at Marseilles. The Versailles museum owns a group of two ladies, and the Dresden gallery, a portrait of the Maréchal de Saxe. In the Wallace collection are "The Comtesse de Dillières," "The Bath (Mlle. de Clermont)," "Portrait of a Lady in Blue," "Marie Leszczinska" and "A Prince of the House of France." Four portraits of the daughters of Louis XV, with the attributes of the four elements, are in the Museo de São Paulo, Braz.

He died in poverty in Paris on Nov. 7, 1766.

See Louis Dimier *(ed.), Les Peintres français du XVIII^e siècle,* vol. ii (1930); P. de Nolhac, *Nattier, Peintre de Louis XIV* (1905).

(M. N. B.)

NATURAL **GAS** is the name given to flammable gas found in porous, subsurface, imperviously capped earth formations in North and South America, Europe, Asia and Africa. Estimates by the American Gas association, World Power conference and International Conference on Peaceful Uses of Atomic Energy indicated (in trillions of cubic feet) these known reserves in 1955: United States 225; Canada 22.5; Mexico 1.2; Argentina 0.5; Chile 0.14; U.S.S.R. 35; France 0.22; Hungary 0.13; Rumania 8.9; Italy 2.5; Japan 2.9.

Recoverable reserves in the United States might run as high as 500 to 1,000 trillion cubic feet, and 300 to 500 trillion cubic feet in Canada.

Natural gas is frequently found with petroleum; in the U.S. one-third of natural gas production comes from oil wells. Thus, it is assumed that huge stores of gas exist in the middle east countries of Kuwait, Saudi Arabia, Iraq and Iran which have three-quarters of the entire world's known oil reserves.

In geologic terms, natural gas is found in the Carboniferous, Devonian. Silurian, Ordovician, Cambrian, Tertiary, Cretaceous and Jurassic systems. Some wells are more than 3 mi. deep.

Chemical Composition.—Natural gas is largely methane (CH,) and other gaseous hydrocarbons of the paraffin series, including ethane, propane, the butanes, pentane, hexane, heptane, and octane. (For the chemistry of these organic compounds, see PARAFFIN HYDROCARBONS.) Varying percentages of carbon dioxide, nitrogen, hydrogen sulfide and helium are removed as valuable by-products before the "sweet" gas is transported to consuming markets. Unconditioned "sour" gas is burned to produce carbon black.

Natural gas in the U.S. is generally 80% to 95% methane which has a high heat of combustion:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 210{,}800 \text{ cal.}$$

Heating value of commercial "dry" natural gas, at 60° F. and atmospheric pressure, varies from 1,000 to 1,200 British thermal units (B.T.U.) per cubic foot. Common terms of measurement are MCF (thousand cubic feet) and therm (100,000 B.T.U.). Specific gravity of natural gas (air= 1) varies from 0.56 to 0.67. Explosive limits in air are 4.5% to 14.5%. Natural gas has no odour, so that chemical odorants are added to aid in detecting leaks; with such odorants, a concentration of 1% gas in free air may be detected.

Natural gasoline and liquefied petroleum gas (LP-Gas) plants, located at or near producing wells, strip these products from natural gas before it goes to consumers. Natural (or casinghead) gasoline made up about 10% of U.S. motor fuel supply in the 1950s. LP-Gas is shipped under pressure in liquid form in railroad tank cars, tank trucks, pipelines and tank ships all over the world.

Production of Natural Gas.—Gas and oil men were under constant pressure in the 1950s to find new supplies and extend known fields, because of growing populations and spiraling use of fuel per capita all over the world.

The American Petroleum institute (A.P.I.) estimated well completions in the U.S. in 1956 at a new all-time high: gas 4,275; oil 31,500; dry 22,025; and service 1,050. A.P.I. also estimated new record production of 12.7 trillion cubic feet of natural gas in 1956.

U.S. bureau of mines natural gas statistics for 1955 gave these details (in trillions of cubic feet): gross withdrawals 11.72; marketed production 9.4; repressuring 1.54; vented and wasted 0.77. Value at point of production in the U.S. was 10.8 cents per MCF; with a low of 5.6 in Arkansas, 8 in Texas, and a high of 29.9 in Pennsylvania. Natural gas was produced in 29 states, Texas leading with almost half of the U.S. total, followed by Louisiana, Oklahoma, California, New Mexico and Kansas. Natural gas accounted for 26% of 1955 U.S. production of energy from fuels and energy from water power, the remainder of production being crude petroleum 37%, coal and lignite 33.3%, water power 3.7%.

Transporting Natural Gas.—Few large diameter natural gas pipelines had been built for long distances outside of the U.S. by the mid-1950s. Notable among these were a 348-mi. line from Sui to Karachi in West Pakistan; a 530-mi, line from Yelshanka, on the Volga river, to Moscow; a 1,100-mi. line from Commodoro Rivadavia field to Buenos Aires; an 800-mi. line from Stavropol oil fields to Moscow; and scheduled to be the longest line in the world, about 2,250 mi. in length, from Alberta to eastern Canada. A 1951 study of a proposed 2,500-mi. line from the middle east to Paris indicated a delivery price of 32 cents per MCF.

Because natural gas is found under only 1% of total U.S. land area, large (10- to 36-in. diameter) pipelines carry this fuel to distant consuming markets, as far as 2,000 mi. away. The American Gas association (A.G.A.) reported in 1955 some 46,000 mi. of field and gathering lines, and 142,000 mi. of transmission lines. Pressures in these lines range from 200 to 1,000 lb. per square inch (p.s.i.), and average speed of gas travel is about 25 m.p.h. Average deviation of natural gas from Boyle's law (*q.v.*) at 60° F. is 8% at 300 lb. pressure and 20% at 1,300 lb.

Before World War II, natural gas pipelines were built for about $100,000 per mile, and cost of transporting 1,000 cu.ft. for 100 mi. was about 1 cent. Postwar costs rose to about $150,000 and 1½ cents.

Liquefaction of Natural Gas.—Because it is mostly methane, natural gas can be liquefied at atmospheric pressure by refrigerating it to −258° F.; and 1 cu.ft. of liquefied product is equivalent to 600 cu.ft. of gas. Thus, storage of huge supplies can be accomplished economically during summer months, to be released for peak winter demands, especially home heating.

A liquefaction plant was operated successfully by the East Ohio Gas Co. at Cleveland, O., from Feb. 1941 to Oct. 1944, when one of four insulated storage containers ruptured, causing a disastrous fire. An official bureau of mines investigation concluded that "the application of the system . . . is not invalidated."

Transportation of liquefied natural gas in insulated ships or barges is considered practical and economical; such shipments could be made from the middle east to London at about half the thermal cost of manufacturing gas in England. Similar transportation from Central and South America to distant markets is also considered feasible.

Storage of Natural Gas.—U.S. producers, pipelines and distributing companies have accelerated programs for safe, economical storage of natural gas closer to major markets. In 1955, A.G.A. reported, there were 178 underground storage pools in 18 states, with ultimate capacity of 2.1 trillion cubic feet. Most of these pools were in depleted oil and gas fields, but there were also salt domes and aquifers (rock-capped domes with water seal underneath) for the same purpose. Maximum day's output from these 178 pools was estimated at 6.5 billion cubic feet. Pennsylvania, Ohio, Michigan, West Virginia and Oklahoma have the largest total reservoir capacities.

Natural Gas Use in U.S.—The bureau of mines report for 1955 showed interstate shipments and exports to Canada and Mexico constituted 54% of marketed production. Natural gas was served in 43 states and the District of Columbia. Oregon and Washington received natural gas in 1956; and Idaho in 1957.

Major 1955 uses in the U.S. (in trillions of cubic feet with average value in cents per MCF at points of consumption) were: residential, including heating, 2.1 and 88.7 cents; commercial 0.63 and 62.7 cents; field use, drilling, pumping 1.5 and 10.1 cents; carbon black 0.245 and 7.9 cents; refinery fuel 0.625 and all other industrial 3.9 and 25.7 cents. The Federal Power commission in

1955 estimated 1.15 trillion cubic feet used for generating electricity, and this was included in industrial use. Average value at all points of consumption was 40 cents per MCF.

Greatest growth in use in the **1950s** was for residential heating (by **1956** more dwelling units were heated by gas than any other fuel) and as raw materials for petrochemicals, the latter included in "all other industrial" above. Petrochemical production in the U.S. was estimated at 35,000,000,000 lb. in **1956,** with natural gas supplying raw material for about **75%** of tonnage.

(H. W. Sn.)

Minor uses of natural gas include the following:

1. Pentane in the production of 50 synthetic chemicals of greater or less commercial importance.

2. Mixtures of ethane, propane and the butanes in the mass production of 100 synthetic chemicals—alcohols, alcohol ethers, ketones, esters, acids, acid anhydrides, aldehydes, oxides, amines, ethers and chlorinated derivatives.

3. Mixtures of ethane, propane and the butanes in the mass production of "poly" gasoline—a motor fuel of high octane rating.

4. Butane in the production of butadiene, synthetic rubber and as a solvent for the extraction of oils, fats, resins, nicotine and perfumes.

5. Propane as fuel in isolated districts and as selective solvent in mass production of motor oils of low cold test, high viscosity index, better colour and bloom and high resistance to oxidation and the formation of carbon and sludge.

6. Ethane in the production of ethylene—useful in citrus fruit ripening, as an anesthetic, as a refrigerant and in the manufacture of mustard gas and ethylene bromide. Large quantities of the latter chemical are used in connection with tetraethyl lead to yield high octane (antiknock) motor fuels. (J. B. G).

See Gas Industry: *Gas Supply* in *the United States; see* also Index references under '.Natural Gas" in the Index volume.

NATURALIZATION: *see* Nationality; Naturalization Laws.

NATURALIZATIONLAWS. Naturalization is the act of investing an alien with the status of a national in a given state. It takes place wherever a new nationality is acquired by a person after his birth. It may be accomplished as the result of voluntary application, special legislative direction, marriage, parental action or annexation of territory. The conditions under which the privilege of naturalization will be granted are fixed by the laws of each nation. International law, however, imposes some limits on the power of a state to naturalize persons, especially nonresidents.

UNITED STATES

The constitution of the United States, article 1, section 8, clause **4,** authorized congress to "establish an uniform Rule of Naturalization." Congress fulfilled that mandate by enacting naturalization statutes, commencing in 1790, to establish the conditions under which aliens may be admitted to citizenship. The requirements have never been exacting, and the consistent national policy has been to encourage the naturalization of all qualified aliens. That policy aided in developing the strength and homogeneity of a nation whose growth resulted largely from the contributions of millions of immigrants and their descendants.

Naturalization by Court Process.—The principal method of acquiring a new nationality is through voluntary application in the manner provided by law. Most countries authorize the grant of citizenship by an administrative official. In the United States, however, naturalization from the first became a function of the courts. Congress conferred power to grant naturalization upon all federal district courts and upon state courts of unlimited jurisdiction which have a seal and a clerk. An applicant may appeal to the higher courts from a decision rejecting his petition. The government also is a party in every naturalization case, and it too may appeal when it deems that naturalization was improperly awarded.

The principal disqualification for naturalization was directed against some racial groups. Originally the statutes permitted the naturalization only of "free white persons." In 1870, folloning the Civil War, Negroes were granted the privilege of naturalization. The next modification was made by the Nationality Act of 1940, which permitted the naturalization of races indigenous to the western hemisphere, chiefly North American Indians and Eskimos. Further modifications were made in 1943, when Chinese were declared eligible; in **1946,** when Filipinos and East Indians were permitted to apply; and in 1950, when naturalization benefits were extended to noncitizens of Guamanian ancestry. Except for these specifically designated racial groups, Asiatics were not eligible at mid-century for naturalization as United States citizens. Also disqualified from naturalization were: (1) aliens identified with certain proscribed organizations, activities or beliefs at any time during the period of ten years immediately preceding the petition for naturalization; (2) certain aliens who claimed exemption from military service because of their alienage; and (3) deserters from the armed forces during time of war.

Several basic qualifications always have been prescribed, virtually without change, in the statutes relating to naturalization. It is important to bear in mind that these are general requirements which often have been modified with respect to special groups whom congress desired to favour.

First, the applicant for naturalization must have resided in the United States for at least five years following a lawful admission for permanent residence. Lesser periods of residence, and in some cases no fixed residence requirements, were prescribed for naturalization applications by wives and children of U.S. citizens, persons who serve in the armed forces or the merchant marine and other special categories.

Second, the applicant must establish that he is, and was during the requisite period of residence, a person of good moral character. Persons who have committed serious crimes during that period generally are barred.

Third. the applicant must establish that he is, and was during the requisite period of residence, attached to the principles of the constitution of the United States and well disposed to the good order and happiness of the United States. The latter requirement was designed to exclude from citizenship aliens hostile to the United States and its institutions. For many years the courts also interpreted this requirement as forbidding the naturalization of conscientious objectors to military service. In **1946,** however, the supreme court, reversing its earlier holdings, determined that conscientious objectors might be naturalized (Girouard v. *United States,* **328** U.S. **61** [1946]).

Finally, the applicant generally must meet several educational requirements. He must demonstrate an understanding of the English language, including an ability to read, write and speak words in ordinary usage. He must sign the petition for naturalization in his own handwriting if he is physically able to write, and must demonstrate some understanding of the constitution and form of government of the United States.

While the ultimate power to grant or deny naturalization was conferred upon the courts, the law vested in the immigration and naturalization service of the department of justice administrative supervision over the naturalization process. The service, headed by a commissioner of immigration and naturalization, was placed under direction of the attorney general and was organized into **16** district offices as well as numerous suboffices throughout the United States. Under the act of June **29,** 1906, the immigration and naturalization service was given broad legal authority to receive applications, issue certificates of legal entry, interrogate the applicants and their witnesses and make recommendations to the naturalization courts. This administrative function was designed to aid the courts in discharging their responsibilities in granting or denying naturalization.

The naturalization process commences with the filing of a declaration of intention to become a U.S. citizen. Prerequisites to the filing of such a declaration are lawful entry into the United States for permanent residence and the procurement of an official certificate establishing such entry. The requirement that a declaration of intention be filed is waived in the cases of spouses of U.S. citizens, persons with specified service in the armed forces or the merchant marine and other special groups.

The next step is the filing of a petition for naturalization. **If** a declaration of intention is required, the petition may not be filed sooner than two years nor later than seven years after the date of the declaration of intention. An applicant who desires to file his petition for naturalization is notified to appear with two citizen witnesses in court, where they are interrogated under oath in the office of the clerk of court by an examiner of the immigration and naturalization service. Then the applicant files the petition for naturalization, which is signed and sworn to by the petitioner and his two witnesses. Further investigation is conducted and the petitioner is then notified to appear before a judge for final hearing. At the final hearing a representative of the immigration and naturalization service appears and recommends that the petition be granted or that it be denied.

If the court grants the petition, the petitioner takes an oath in open court forswearing all foreign allegiance and pledging allegiance to the United States; the judge then signs an order admitting him to citizenship. Thereafter the newly invested citizen receives an official certificate of naturalization. The fees established by law were as follows in 1951: $3 to the clerk of court at the time of filing the declaration of intention and $8 to the clerk of court at the time of filing the petition for naturalization. The latter fee included all charges through completion of the hearing before the naturalization court; no further fee was prescribed for the final hearing or for issuance of the certificate of naturalization.

A naturalized citizen acquires status equal to the native-born, except that he is not eligible to become president of the United States. However, even after naturalization is finally granted, it may be revoked through a judicial proceeding. The statute authorizes such revocation only if the naturalization was induced by fraudulent misstatements or was illegally granted (*e.g.*, misstatements relating to entry into the United States or to criminal record). The supreme court insisted upon strong evidence of irregularity before any naturalization might be cancelled and declared that such revocations would be sanctioned only if there was clear, unequivocal and convincing proof that the naturalization was improperly awarded (Schneiderman v. United States, 320 U.S. 118 [1943]).

Other Forms of Naturalization. — Another method of acquiring citizenship is by derivation through a husband or parent. Prior to Sept. 22, 1922, marriage to a U.S. citizen or the husband's naturalization conferred U.S. citizenship upon an alien wife. The Cable act of Sept. 22, 1922, abolished the joint citizenship of husband and wife and enabled a wife to choose her own nationality. Citizenship status previously acquired, however, was not affected.

Prior to the Nationality Act of 1940 a child under 21 years of age acquired U.S. citizenship through the naturalization of either parent while he resided in the United States or if he subsequently commenced to reside in the United States prior to his 21st birthday. After Jan. 13, 1941, the effective date of the Nationality Act of 1940, such transmission of citizenship could not occur after the child had attained the age of 18 years. In addition, derivation was to take place only if both parents became citizens, unless one parent was dead or there had been a divorce or legal separation, in which event the naturalization of the parent having legal custody would suffice.

A person who has acquired U.S. citizenship by derivation may apply to the commissioner of immigration and naturalization for a certificate recognizing that status. The fee for this application in 1951 was $5. Upon presentation of proof establishing a valid claim to U.S. citizenship, the commissioner issues a certificate of citizenship to the applicant.

Congress also may grant citizenship by special legislation. In some instances, so-called private bills have been enacted conferring citizenship rights upon named individuals. Much more common has been the award of collective naturalization to large groups of noncitizens, particularly the inhabitants of U.S. territories and possessions.

The nationality status of the inhabitants of certain acquired territories was fixed by the treaty-making power of congress. Statutes have from time to time effected collective naturalization either prior to or upon the admission of territories to statehood. Such action was taken in territory acquired under treaties concluded with Great Britain (territory of Michigan, 1794, 8 Stat. 116), France (Louisiana, 1803, 8 Stat. 200), Spain (Florida, 1819, 8 Stat. 252), Mexico (Guadalupe-Hidalgo, 1848, 9 Stat. 922; Gadsden, 1853, 10 Stat. 1031), Russia (Alaska, 1867, 15 Stat. 542) and Denmark (Virgin Islands, 1916, 39 Stat. 1706).

In the absence of definite treaty stipulations, citizenship has been conferred upon inhabitants of acquired territory by legislative enactmects. In this category were the Hawaiians (act of April 30, 1900, 31 Stat. 141), Puerto Ricans (sections 5 and 5[a], act of March 2, 1917, as amended; section 202, Nationality Act of 1940), Virgin Islanders (act of Feb. 25, 1927) and Guamanians (act of Aug. 1, 1950, 64 Stat. 385). Finally, United States citizenship was conferred collectively through the political incorporation of the original states into the United States; in the case of the state of Texas, upon its annexation and direct admission into the union; and upon American Indians born in the United States through special legislation on June 2, 1924.

Full status as U.S. citizens, however, was not conferred on all the inhabitants of U.S. territorial possessions. Complete citizenship rights were extended to inhabitants of Alaska and Hawaii (when still territories), Puerto Rico, the Virgin Islands and Guam; but the natives of other possessions such as American Samoa were regarded as noncitizen nationals of the United States, entitled to U.S. protection but not to full citizenship status.

COMMONWEALTH OF NATIONS

United Kingdom. — In 1844 Great Britain adopted legislation which authorized for the first time the naturalization of aliens as British subjects. Previously aliens could acquire British allegiance only through a private act of parliament or through the grant of letters of denization by the crown. After 1844 the latter processes were invoked only in rare cases. One such instance occurred when Lord Reay succeeded to a Scottish peerage in 1877 and was naturalized by an act of parliament. The process of denization fell into disuse because denizens were not granted full rights as British subjects.

The British Nationality act, 1948, which became effective Jan. 1, 1949, drastically revised earlier concepts of British nationality. It abolished the previously recognized status of common British nationality throughout the empire and recognized separate citizenship status for the United Kingdom and colonies and for each of the commonwealth nations; namely, Canada, Australia, New Zealand, the Union of South Africa, Newfoundland, India, Pakistan, Southern Rhodesia and Ceylon. Every citizen of the United Kingdom and colonies and of each of the other constituent nations of the commonwealth consequently acquired the status of a British subject, and was also referred to as a commonwealth citizen. Following enactment of the British Nationality act, 1948, Newfoundland became a province of Canada and was governed by the Canadian Citizenship Act of 1946. Citizens of the Republic of Ireland were no longer regarded as British subjects.

Under the British Nationality act, 1948, a noncitizen of the United Kingdom and colonies generally could acquire such status either through registration or naturalization. Both processes are entirely administrative and are entrusted to the discretion and control of the secretary of state, whose discretion in passing upon applications generally is absolute and unqualified. He may, with or without assigning any reason, grant or withhold any such registration or naturalization for any reason he deems conducive to the public good. His decision on any such application is not subject to appeal or review in any court.

Persons in the following groups may be registered as citizens of the United Kingdom and colonies upon application made in the prescribed manner to the secretary of state: (1) citizens of the Commonwealth of Nations or Ireland ordinarily resident or in crown service in the United Kingdom; (2) noncitizen women who marry citizens of the United Kingdom and colonies and who take an oath of allegiance to the British crown; (3) minor children of any citizen of the United Kingdom and colonies, upon application filed by the parent or guardian; (4) in such special circumstances as the secretary of state thinks fit, any other minor may be registered as a citizen of the United Kingdom and colonies.

The second major process for acquiring status as a citizen of the United Kingdom and colonies is through naturalization, which also is accomplished ordinarily upon application to the secretary of state in the prescribed manner. The naturalization application may be made by an alien or by a British protected person (a citizen or resident of a protectorate, protected state, mandated territory or trust territory). Upon satisfying the secretary of state that he meets the established requirements such applicant is granted a certificate of naturalization and, on taking an oath of allegiance to the British crown, he becomes a citizen of the United Kingdom and colonies by naturalization from the date on which the certificate was granted.

The following qualifications must be met by an applicant for naturalization: (1) he must have resided or been in crown service in the United Kingdom for at least 12 months immediately preceding the date of the application; (2) he must, in addition, have resided for specified periods aggregating at least four years in the United Kingdom or its colonies; (3) he must be of good character; (4) he must have sufficient knowledge of the English language; (5) he must intend to reside in the United Kingdom or its colonies or to perform crown or other specified service in the United Kingdom or its colonies. In special cases the secretary of state may waive or modify the residence requirements. Any person whose status as a citizen of the United Kingdom and colonies is in doubt may be granted a special certificate of naturalization by the secretary of state, and such certificate may declare that it is issued for the purpose of quieting such doubts. A certificate of naturalization granted for this purpose is conclusive evidence that the recipient was a citizen on the date of its issuance, but does not preclude his establishing that he was a citizen at an earlier date. A certificate of naturalization does not become effective until the applicant takes an oath of allegiance.

A person who becomes a citizen of the United Kingdom and colonies by registration or naturalization is entitled to all the rights, powers and privileges and is subject to all obligations, duties and liabilities of a natural-born citizen of the United Kingdom and colonies and to all intents and purposes enjoys the status of a natural-born citizen. However, such a person may be deprived of his citizenship, through order of the secretary of state, for fraud, false representation or material concealment in procuring registration or naturalization. In addition, a naturalized citizen may be deprived of his citizenship through order of the secretary of state on any one of the following grounds: (1) disloyalty, before or after the naturalization; (2) unlawful communication with or assistance to an enemy in time of war; (3) conviction and sentence in any court of certain serious crimes within five years of the naturalization; (4) continuous residence in foreign countries, except under certain specified conditions, for seven years after the granting of the certificate. The secretary of state may also revoke the naturalization of a citizen of the United Kingdom and colonies who is deprived of his citizenship in any of the commonwealth nations or in Ireland on grounds that are substantially similar to those mentioned above.

In no case does the secretary of state deprive any person of citizenship, even under the enumerated conditions, unless he is satisfied that it is not conducive to the public good that the person should continue to be a citizen of the United Kingdom and colonies. Before making an order revoking citizenship the secretary of state is required to give to the person affected written notice specifying the cause for the proposed action; in addition, such persons generally may demand a hearing before a committee of inquiry before any final action is taken.

The citizenship status of alien women married to British subjects has been treated differently at different times. The original common-law doctrine regarded a woman's citizenship as independent from that of her husband, and an alien woman did not gain British nationality or lose her native citizenship upon her marriage. The act of 1884 provided for the first time that an alien woman acquired British nationality upon marriage to a British subject. Thereafter, and until 1933, the statutes directed that the wife of a British subject should be deemed a British subject This mas modified by the act of 1933, which provided that when a certificate of naturalization was granted to an alien, his wife did not become a British subject unless she elected to, accept British nationality. The original common-law concept was fully reinstated by the British Nationality act. 1948. so that after Jan. 1, 1949, an alien woman married to a citizen of the United Kingdom and colonies did not automatically acquire her husband's citizenship. She could become a citizen of the United Kingdom and colonies, if she desired such citizenship, only by applying for registration, in the manner previously described. The minor children of naturalized citizens likewise might become citizens of the United Kingdom and colonies through registration, upon application made by a parent or guardian.

British Colonies.—As previously indicated. the British colonial possessions were joined with the United Kingdom for the purpose of determining a common citizenship status in the United Kingdom and colonies. The authority of the secretary of state in granting registration or naturalization as a citizen of the United Kingdom and colonies and in revoking such citizenship status is reposed in the governor of any colony, protectorate or United Kingdom trust territory, whose actions generally are subject to the approval of the secretary of state.

Commonwealth Nations.—Completing a process inaugurated on a limited basis in 1914, the British Nationality act. 1948, recognized separate citizenship privileges for each of the countries in the Commonwealth of Nations and confirmed in addition the authority. without any limitation, of each of such countries to enact laws defining its own citizenry. As previously stated. the citizens of each such nation—Canada, Australia, New Zealand, the Union of South Africa, Newfoundland, India, Pakistan, Southern Rhodesia and Ceylon—were designated as British subjects or as commonwealth citizens. It has already been noted that Newfoundland became a province of Canada after enactment of the British Nationality act, 1948, and thereby became subject to Canadian laws.

The nationality laws adopted in each of the commonwealth countries must be consulted in order to determine citizenship status in those countries. Typical of such laws was the Canadian Citizenship act, 1946, which became effective Jan. 1, 1947. Indeed, the enactment of the Canadian law doubtless was an important factor in the subsequent revision of the British statute which ultimately mas enacted as the British Kationality act. 1948

Under the Canadian statute, naturalization became essentially a judicial function. An executive officer, the secretary of state. was entrusted with broad administrative responsibilities in relation to that process. This division of responsibility thus resembled the system prevailing in the United States.

An applicant for naturalization must meet the following qualifications: (1) he must have filed a declaration of intention in the office of the clerk of court not less than one year nor more than five years prior to the date of final application; British subjects and spouses of Canadian citizens are exempt from this requirement; (2) he must have been lawfully admitted to Canada for permanent residence; (3) he must have resided continuously in Canada for one year immediately prior to the application and generally must also establish residence in Canada for a further specified period of not less than four years; applicants with specified military service and wives of Canadian citizens are exempt from this latter residence requirement; (4) he must be of good moral character; (5) he generally must have an adequate knowledge of either the English or the French language; (6) he must have an adequate knowledge of the responsibilities and privileges of Canadian citizenship; (7) he must intend to reside permanently or to enter public service in Canada.

Naturalization applications are filed and posted in the office of the clerk of court. After a three-month waiting period, during which any person may file objections, the applicant must personally appear before the court for an examination and must produce such evidence as the court may require. The court determines whether the applicant has satisfied the prescribed requirements. If the court orders that naturalization shall be granted. its decision is transmitted to the secretary of state together with the application and other relevant documents.

The certificate of citizenship is issued by the secretary of state to any person whose application has been granted by the court. However, if the secretary of state questions whether such application was properly approved he may refer it to the court for a rehearing, but the court's decision on such rehearing is final and conclusive.

The marriage of an alien woman to a Canadian citizen does not change her nationality status. The law recognizes her right to control her own nationality status. She may acquire Canadian citizenship through naturalization upon her own application, but provision is made for some relaxation of the normal requirements on her behalf. A certificate of citizenship may be issued to a minor child of a naturalized citizen upon application made by his parent.

The secretary of state may grant a certihcate ot citizensnip to any person whose status as a Canadian citizen is in doubt, and the certificate may specify that it is granted for the purpose of quieting such doubts. No certificate of citizenship can become effective, except in the case of a minor under the age of 14 years, until the applicant has taken the prescribed oath of allegiance.

Naturalization may be revoked upon order of the secretary of state for any of the following reasons: (1) unlawful communication with or assistance to an enemy in time of war; (2) fraud, false representation or material concealment in procuring naturalization; (3) residing outside Canada for a period of six years following the naturalization; (4) disloyal acts or speech outside Canada, or, if in Canada, conviction of treason or sedition.

The secretary of state must give advance notice to the naturalized person concerning the proposed revocation and must afford him an opportunity to request that the case be referred for a hearing: If such hearing is requested it is held before a commission of inquiry or, in specially designated cases, before a court. Revocation of a naturalized person's citizenship generally does not terminate the Canadian citizenship derived through him by his wife and minor children unless specially directed or unless the wife of such person files a declaration renouncing her Canadian citizenship or her status as a British subject.

The Canadian Citizenship act also provided specifically that a Canadian citizen is a British subject; that a naturalized citizen shall have full equality with a natural-born Canadian citizen; and that a citizen of any country of the British Commonwealth other than Canada shall be recognized in Canada as a British subject.

OTHER COUNTRIES

Virtually every nation has some provision for the naturalization of aliens. Most countries entrust the authority to grant naturalization to executive officers. In this group in 1951 were: Afghanistan, Albania, Algeria, Australia, Austria, Belgian Congo. Belgium, Bolivia, Brazil, Bulgaria, Chile, Costa Rica, Dominican Republic, Ecuador, Egypt, Finland, France, Germany, Greece, Guatemala, Haiti, Honduras, Hong Kong, Hungary, Iceland, Iraq, Italy, Japan, Madagascar, Monaco, Morocco, the Netherlands, New Zealand, Nicaragua, Norway, Palestine, Panamá, Paraguay, Poland, Portuguese East Africa, Rumania, Salvador, Siam, Spain, Sweden, Switzerland, Syria, Tunisia, Turkey, the Union of South Africa, the U.S.S.R., Uruguay, Venezuela and Yugoslavia.

In still other countries naturalization is granted by the legislature, although in some of these executive officers perform coordinate or auxiliary functions. In 1951 these included Belgium, Bolivia, Paraguay, Rumania, Salvador and Uruguay.

In Belgium and Uruguay the legislature, the executive branch and the judiciary each might award naturalization. Other nations in which naturalization remained a judicial function in 1951 included Algeria, Argentina, Bulgaria, Liberia, Mexico and Spain.

Naturalization laws of the various countries vary as to the requirements for age, residence, eligible classes and other basic qualifications and procedures. A collection of the naturalization laws of each country is found in R. W. Flournoy, Jr., and M. O. Hudson (eds.), *Collection of Nationality Laws of Various Countries, as Contained in Constitutions, Statutes and Treaties* (1929). Some of the important requirements of such laws were summarized in *Research in International Law* (1929), published as special supplement to *American Journal of International Law*, 23:83–100.

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NATURALIZATION OF PLANTS AND ANIMALS, in the broad sense, is a term applied to the fact that plants or animals may be introduced, artificially or naturally, into a country with a climate the same as or different from that of their original habitat, and may successfully propagate there. What would come to the same thing is the successful persistence and propagation of plants and animals in a country whose climate has undergone some notable change, such as would be involved in the setting in of an ice age or a period of aridity. In this broad usage the term naturalization is practically synonymous with acclimatization (*q.v.*).

But in its narrow usage naturalization means a process by which organisms are changed in the course of generations in adaptation to new climatic conditions in the same or in another country. This usage implies the theoretical postulate of racial adaptation to withstand climatic influences which were at first more or less unfavourable. The establishment of the adaptation might be interpreted by some along Lamarckian and by others along Darwinian lines, and this raises additional theoretical questions.

Thus some investigators, *e.g.*, G. M. Thomson, who find little evidence of acclimatization in the strict sense, prefer to keep the term naturalization, which expresses an indisputable fact that organisms may thrive well when taken to another and in some respects different country.

Effects of Naturalization.— When plants and animals get a footing in a new and different country, what changes may be looked for? (1) There is often a marked increase in the number of individuals in a given area, as is illustrated by the multiplication of the rabbits in Australia, or of greenfinches and skylarks in New Zealand. The reason is twofold: favourable conditions, such as abundant food, may increase the rate of multiplication, and there may be an absence of the enemies and other checks which kept the numbers down in the old country. There have been some costly verifications of the numerical increase that is apt to follow naturalization, as in the familiar case of rabbits in Australia and New Zealand.

(2) Another consequence that has been repeatedly noted is increase in individual size and perhaps vigour. The new conditions prove unusually stimulating. Speaking of plants introduced into New Zealand, G. M. Thomson writes: "Water-cress—a plant of two to four feet in length in European waters—grew in some streams to a length of from 12 to 14 ft., and with stems as thick as one's wrist." This riotous exuberance is due positively to the stimulating conditions of the new territory, and negatively to the absence of the previous checks.

The popular interpretation of the rapid spread of introduced plants, *e.g.*, "weeds," in new countries, is that they come from places where the struggle for existence is keener and where they have therefore become particularly efficient. According to John Christopher Willis, "the real explanation, in all but a very few doubtful cases, is that their spread is due to change of conditions. This has usually been effected by man, who has often altered, or even destroyed, the conditions under which many societies of plants formerly flourished, thus giving a fair field to those newcomers that were suited to the new circumstances."

(3) Many naturalists have concluded that the lessening of the stringency of natural selection after transport to a new country allows an increase in the number of varieties, and the survival of peculiar forms, which would be speedily eliminated in the original environment. Thus, if there are few enemies, one might expect more numerous conspicuous variants, such as albinos. Here the careful work of G. M. Thomson is of great value. In 1891, he concluded that conspicuous colour variations were on the increase

among the rabbits introduced into New Zealand, and also among introduced birds like sparrows, thrushes, blackbirds, skylarks and starlings. Thirty years later he definitely withdrew this conclusion, the fallacy being that he was at first so busy looking for anomalous characters that he met with many, and unconsciously exaggerated the ratio of their occurrence. But inquiry must be made in other fields to see whether there is nothing to be said for the old view.

(4) So many naturalizations have been effected in different parts of the world that one would expect to find it easy to collect instances of change of habit; but there seems to be a strong conservative tendency among animals introduced into new haunts. When domesticated animals are transported to a wilder country there is sometimes an interesting individual rehabilitation of a long lost ancestral trait. Thus cows taken from Scotland to wilder conditions in California have been known to hide their calves in the thicket when they went to graze in the open. Sometimes, however, something novel occurs. Thus, sheep in New Zealand have shown in some places the novel habit of stripping off long pieces of bark from the gaya trees. On the whole it seems that change of habit in consequence of naturalization is infrequent and very gradual.

(5) Some types are quickly at home in a new country, but do not show external change. Horses, rabbits, rats, sparrows and fowls are usually somewhat indifferent to change of climate, while a tough animal like the yak of the Tibetan mountains refuses to thrive below a certain altitude.

Many facts confirm the suggestion that the success or failure of attempted naturalization may depend on inconspicuous constitutional peculiarities. Thus G. M. Thomson notes for New Zealand that the greenfinch and the chaffinch have thriven remarkably, while the allied linnet has failed. "The reasons for these failures are often so obscure that no plausible explanation has yet been given."

A hint of the frequent subtlety of conditions may be found in cases where the attempted naturalization of a plant fails, as of heather in Ceylon, because the associated root-fungus or mycorrhiza will not grow.

(6) When an organismal change directly induced by some change in environment, nutrition or habit, takes such a grip that it persists after the inducing conditions have ceased to operate, it is called a modification, or less conveniently, an individually acquired character. There seem to be some climatic modifications, and the following may be mentioned: *(a)* An Englishman who works half his lifetime under a tropical sun may become so tanned that the deposit of melanin pigment in the skin does not disappear during all the years in which he enjoys his pension at home. Of course it must not be inferred that the blackness of the Negro's skin was directly produced in this way by the tropical sun. *(b)* Karl Naegeli brought some Alpine plants to the Botanical garden at Munich, and there many of them became in the first year so much modified that they were hardly recognizable as the same species. Their descendants in the garden were also quite different from the Alpine originals. Thus the small ha kweeds (*Hieracium*) became large and thickly branched with abundant blossoms. The modifications were very striking, and in some cases many generations were observed—even for *13* years. The reappearance was probably due to the fact that the original modifications were directly reimpressed on each successive crop, for when the plants were removed from the rich garden to poor, gravelly soil, the acquired characters gradually disappeared, and the plants exhibited once more the original Alpine characters. There was no convincing evidence of hereditary entailment.

It is important not to think of these matters too simply. Thus, as Richard B. Goldschmidt points out, the normal development of particular characters, such as general growth and pigment formation, has been "harmonized" for a definite environment. But they have different temperature coefficients, and novel conditions may throw them out of harmony. Moreover, modifications resulting from climatic change must not be thought of as necessarily beneficial. Thus some Lepidoptera tend to melanism in the cold, and others at high temperatures, without there being any demonstrable advantage in either case.

(7) If evidence could be obtained of the hereditary entailment of climatic modifications, this would serve as a basis for a Lamarckian theory of acclimatization. It is necessary to inquire afresh whether there are any facts supporting the Lamarckian interpretation. Bordage records some observations on peach trees (*Prunus persica*) grown from seed of European origin sown in Reunion. For ten years or so the trees shed their leaves as in Europe. Later on, after 20 years, a considerable degree of evergreenness was exhibited. There was no bare period. When seeds of these partial evergreens were sown in the lowlands they grew into trees verdant throughout the year, but the same was true of seeds sown in certain mountainous districts with a considerable degree of frost. They also grew up into young peach trees which were also evergreen. But European seeds sown in similar situations developed into ordinary deciduous trees. This is a peculiar case and may be interpreted as follows: The original imports underwent a gradual constitutional change—some modification of their metabolism; this might affect the constitution of the seed during the period when it was still part and parcel of the parent's body. The change in the metabolism might result in the affected seeds developing into evergreens, though the direct environmental influence would work in the opposite direction. It is unfortunate that the observations mere not carried further.

A famous case, often referred to, is that of the feral horses of the Falkland Islands, which Charles Darwin studied on his "Beagle" voyage *(1833)*. He says that the horses and also the cattle were introduced by the French in *1764*. Whereas the cattle are large, the horses are small, and Darwin speaks of them as "having degenerated." "They have lost so much strength that they are unfit to be used in taking wild cattle with the lazo: in consequence, it is necessary to go to the great expense of importing fresh horses from the Plata. At some future period the southern hemisphere probably will have its breed of Falkland ponies, as the northern has its Shetland breed." Darwin regarded the degeneration of the Falkland Islands horse as due to the humid climate and the lack of suitable food, but it is difficult to believe that marked changes were effected between *1764* and 1833. It would be necessary to know more about the horses originally imported.

Various statements have been made in regard to changes brought about in the hair of sheep, goats, cattle, sheep dogs and even cats, when these animals are taken to a more rigorous climate. It is said that the fur becomes longer and thicker, which would be a useful adaptation. But there is a lack of precision in these statements, and a regrettable absence of measurements. It would be useful to know what additions were made to the coat after the climatic change; whether the offspring, exposed to the cold from birth, showed further additions; and the character of the fur in the grand-offspring. As regards modifications, no inference can be drawn from the occurrence of adaptive peculiarities, unless the history is known.

On the whole we are forced to the conclusion that the evidence of the heritability of climatic modifications is unsatisfactory.

Naturalization in the Past.—All the world over there are instances of related species flourishing under different climatic conditions, and few evolutionists have any hesitation in regarding these as the outcome of divergent evolution. It may be recalled that while Darwin did not think much of man's achievements in naturalization, he had no doubt as to nature's powers in this direction.

Three saving-clauses should be kept in mind: *(a)* when two nearly related species are thriving in climatically different surroundings, it should not be taken for granted, as it usually is, that all their differences are now part and parcel of the inheritance. Some of the differences may be modificational, hammered on each successive generation in the course of development. There is need for more experimental study of species. *(b)* There has been a tendency to strain the interpretation of specific characters as adaptive to particular conditions of life, such as those implied in climate. Many characteristics separating related species in different localities may be reasonably interpreted as climatic adaptations, but each case should be carefully judged on its merits. (c) When a species is extending its range in consequence perhaps of increasing numbers, the factor of isolation may come into operation, say in the form of a river or a watershed, and variations may be separated off which have no particular relation to the new territory or climate in which the leaders of the advance find themselves. Thus new species may arise by the physical segregation of diversely varying contingents of an advancing army, till the climatic difference itself may become an isolating factor.

Accepting, with these saving-clauses, the idea of naturalization, we must now ask how it may have been effected. The Lamarckian answer involves the postulate of the transmissibility of modifications, especially of functional modifications; and the evidence of this, summed up by Paul P. R. Kammerer (1924) and by Ernest William MacBride (1924), appears inconclusive. The interpretation which seems to involve fewest assumptions is that of Darwin. In discussing naturalization (1868), Darwin laid most emphasis on the natural selection of spontaneous variations. As to these variations he expressly says "there is no evidence that a change in the constitution of the offspring necessarily stands in any direct relation with the nature of the climate inhabited by the parents." In regard to selection he lays emphasis on two points: (a) the organism's power of resistance to difficult conditions in the new climate, and (b) some useful change in the period of reproduction, such as earlier flowering and fruiting.

To Darwin's interpretation an addition may be suggested. It is conceivable that the climatic peculiarities may affect the metabolism of the organism through and through, and may thus serve as stimuli to the variability of the germ cells. If the climatic peculiarity should induce (a) an adaptive modification in the body of the organism and (b), at the same time, a variation in the germ cells which finds expression as a similar new character in the offspring, the phenomenon is called "parallel induction." It must be distinguished theoretically from the transmission of a somatic modification; it is a change induced in the germ cells along with, but not through, the bodily modification (see EVOLUTION, ORGANIC).

But it is possible that climatic peculiarities may penetrate into the germ cells and affect them without producing any modification in the body. Thus W. L. Tower subjected full-grown potato beetles (Leptinotarsa) to peculiar conditions of temperature and humidity during the time when the eggs were maturing, and found that "mutations" occurred in a certain proportion of the offspring. The parents were not affected, having passed the plastic stage; and some of the eggs were not affected at all. Moreover, the same environmental peculiarity, analogous to a climatic change, did not always evoke the same mutation. Some of the mutations in colour and markings were very striking; others affected minute details of structure. In subsequent generations there was no reversion. This case is of particular interest in connection with naturalization, for the artificial environmental conditions, effected in large steel and glass cages, were comparable to different climatic conditions in which different species of potato beetle live.

By Hermann J. Muller in particular it has been shown that an exposure of the germ cells of the fruit-fly (Drosophila *melanogaster*) to appropriate doses of X-rays is followed by numerous mutations, which often breed true. This experimental irradiation illustrates the possible action of the environment as a variational stimulus. A mutation following a climatic change might have this origin. As August Weismann said many years ago (1904): "It does not seem impossible that the climate may have a variational influence upon certain determinants of the germ-plasm, for we have already seen that the influence of cultivation may incite plants and animals to hereditary variations, and that slowly increasing disturbances in the equilibrium of the determinant system may thereby be produced, which may suddenly find marked expression as 'mutations.' But there is little probability that adaptations, that is, transformations corresponding to the altered climate, can arise in this way!" The meaning of this last sentence is that Weismann believed these adaptations were the outcome of the prolonged natural selection of fluctuating variations in the germ-plasm.

The Darwinian theory, as applied to naturalization may be briefly resumed in more technical terms. In any species in any given environment there will be an observable percentage of variations from type in a given number of births, and these variations yield a curve of frequency or probable error. The steepness of the curve is a measure of the variability of the species. The aberrants on all sides are pruned off by selection. If the environment is changed, selection may no longer operate on the same axis as before, but may tend to prune off variations on one side of the mean more than on another. In the course of time, the apex of the curve, representing the type form, will shift to suit the new conditions, since more of the aberrants on the favoured side will live to reproduce.

Quite a separate question is this: that the new environment may increase the variability of the species, flattening the curve of probable error. The effect of this is that selection has more material to work with, and therefore attains its end more rapidly, although of the variations appearing as many will be unfavourable as favourable. A species in which there is little variation presents a greater inertia to the shifting effect of altered climatic conditions than a variable species. In the less variable species there will be relatively fewer favourable variations to mate with the type.

William Bateson's Silliman Lectures contain a valuable criticism of the somewhat facilely accepted views (a) that local and climatic varieties are adaptational, (b) that the influences of environment have directly led either to the production of these varieties or to their selective stabilization, and (c) that there is gradual transition — or mass transformation — from one species to another in response to climatic influences. Bateson lays much emphasis on the role of isolation and on the intrinsic character, *e.g.*, Mendelian dominance of the sporadic variations that are of frequent occurrence.

Of importance in connection with naturalization is Erwin Baur's study of cultivated snapdragons, especially *Antirrhinum majus*. He finds a frequent occurrence of small mutations, transmissible in Mendelian fashion, often showing themselves in "pure lines," and sometimes suggesting an enhancement of vigour, as when a mutant appears with deeper green in its leaves. According to Baur wild species of snapdragon, like garden races, have often arisen by the summation of small mutations (see EVOLUTION, ORGANIC: GENETICS OF POPULATIONS).

Change of Climate. — So far we have considered what may happen when organisms are naturalized, perhaps acclimatized, in a new and different environment. But similar biological problems are raised when we think of the changes that occur or have occurred in the fauna and flora of a country after some drastic alteration of the climate—toward aridity or humidity, toward markedly higher or lower temperature. To what extent have changes of climate functioned as factors in organic evolution?

(1) In extreme cases, as when a country is covered with glaciers, there may be an almost complete elimination of life, as happened over the greater part of Britain during the quaternary glacial periods.

(2) In less severe conditions the gradual setting in of unfavourable climatic conditions would exert a selective influence. Thus xerophytic plants would tend to survive when arid conditions encroached; quickly flowering and fruiting plants, entrenched below ground in winter, with reserves in rhizome and bulb, would tend to survive when the snow began to cover the ground for many months of the year. In a country becoming warmer there might be survival value in aestivation; in a country becoming colder the advantage might be with the hibernators. In scores of ways a gradual change of climate would sift the fauna and flora.

(3) Some animals able to move about for considerable distances and not too slowly would be prompted by climatic changes to shift their quarters. As the severity of the ice ages spread southward in Europe, many northern mammals came with it; thus remains of reindeer, lemming and arctic fox are found in deposits far to the south. As milder climates set in and the glaciers melted, the descendants of some of the arctic types, like reindeer and white fox, were able to trek for the north. Some, however, remained as refugees on the mountains, like the snow vole (*Microtus nivalis*) of the high Alps. Some of the true bird migrations may owe their origin in part to distant climatic changes such as those of the quaternary ice ages (see MIGRATION, BIRD; MIGRATION OF ANIMALS).

(4) It is reasonable to suppose, though difficult to prove, that change of climate in a country induced important changes of habit. Thus Barrell and Richard Swann Lull have suggested that continental elevation and consequent aridity, especially in the Himalayan region, led in the Miocene or early Pliocene ages to a dwindling of the forested area where man's ancestors were at home. The alternatives

were to find other forests in warmer countries, as the present-day anthropoid apes did, or to be eliminated, or to come to earth and begin afresh on a new line of life. The last solution may have been of critical moment in the evolution of Hominoids.

(5) Climatic changes in a country may also have played an important part in punctuating the life history. A kind of variation which has not received adequate attention may be called "temporal." It includes alterations in the tempo, or rate, or rhythm of metabolic processes, or in the duration of particular phases in the life history. In vertebrate animals, at least, this might be brought about by variations (also, of course, requiring to be accounted for somehow) in the secretory activity of the ductless or endocrinal glands, the hormones of which serve now as accelerators and again as brakes. The life histories of many types differ from one another in the shortening or lengthening of particular arcs on the life curve or trajectory. Here is a kind of evolution to which climatic variations may have applied a frequent spur. Thus, when the rate of development was such that the life cycle could not be completed in the first summer, there would be a tendency to favour variations in the direction of interpolating a larval phase, as in insects, suited for an accumulation of reserves, a reduced intensity of life in cold weather, a diminished exposure of vulnerable surface, and so on. Opinions may differ in regard to particular cases, but it is a legitimate and instructive inquiry to associate temporal variations in the life curve with seasonal and with climatic periodicities.

The Arctic tundra is marked by a long dark winter of bitter cold and a short nightless summer of intense illumination, therefore it is reasonable to postulate a prolonged process of elimination as the climate changed—an elimination of those types which did not vary in the direction of quick-flowering and quick-fruiting, dying down in winter, dispensing with all but a little water and accumulating stores in underground parts.

Among the features of the life curve that may be tentatively associated with climatic changes, the following may be suggested—the length of the mammalian gestation and the season for giving birth; the periodicities of migrating birds; the interpolation of periods of winter sleep, rest, coma, lethargy and even de-differentiation. Every trajectory of life should be looked at in the light of the evolution of climates.

Often in the history of the earth a change toward great cold has involved severe elimination. In humid periods there tends to be abundant succulent fodder for browsing animals and extensive forests affording shelter. Diminution of moisture, if it does not go too far, favours the increase of grasses and of grazing animals. Aridity makes the forests shrink and prompts the search for new haunts. The times of quickening, the "expression-points" or "pulsations" of evolution, may often be correlated with climatic changes, chiefly in temperature and humidity, due sometimes to topographic, at others to general atmospheric, conditions. Behind these, again, lie larger factors still, such as shrinkages of the earth's crust.

Interaction of Endemic and Introduced Faunas.—The newcomers may destroy the indigenous or previously naturalized forms. Thus the mongoose, introduced into Jamaica, destroyed the indigenous "cane-rats" and the alien ship-rats. The introduced animals may become so numerous that they make life difficult for their predecessors though they do not actually devour them. They may, for instance, seriously reduce the food supply, but they may be prejudicial with varying degrees of directness. When the brown rat (*Rattus norvegicus*) found its way to Britain in the early 18th century, it proved itself hardier, more plastic and more fecund than the black rat (*Rattus rattus*), with the result that in 50 years the latter was almost exterminated except in places where it was continually being reintroduced by ships.

Sometimes the influence is more subtle. Thus, an extension of squirrels into an area may be followed by the reduction of the number of wood-pigeons. There does not seem at first sight any intersection of the two lives; but squirrels, though largely vegetarian, cannot resist killing and eating the young squabs in the nest; and this is, from the farmer's point of view, a useful check.

The introduction of an animal into a new country may involve the introduction of its parasites; thus rats harbour rat-fleas which disseminate bubonic plague, and it is from rats that pigs, and thence men, become infected with the disease of trichinosis, which is due to *Trichinella spiralis,* a small nematode. Many of these interrelations are very subtle; thus the problem of getting rid of Bilharziasis in Durban is easier than it is in Japan, for in South Africa the only host of the adult parasite is man, whereas in Japan it also occurs in cattle. In both countries the juvenile stages are spent in various water snails, and their abundance or rarity in turn is correlated with the presence of water birds which feed upon them and of water plants on which they feed.

The Case of New Zealand.—The peculiar value of New Zealand in reference to the problems of naturalization is that the introduction of the majority of the nonindigenous larger animals is more or less definitely known; *see* G. M. Thomson's masterly study: *The Naturalization of Animals and Plants in New Zealand* (Cambridge, 1922).

Apart from two species of bats, it is doubtful if there are any indigenous mammals in New Zealand; but 48 species have been introduced, 44 purposely and 4 accidentally. The 4 comprise the mouse and 3 rats, one of which, the Maori rat (*Mus exulans*), disappeared after European settlement began. Twenty-five of the 48 species of mammals are at present well-established and feral in certain districts—wallaby, common opossum, sooty opossum, pig, horse, various deer, cattle, sheep, goats, chamois, cat, ferret, stoat, weasel, black rat, brown rat, mouse, rabbit, hare and hedgehog.

About 130 species of birds have been purposely introduced into New Zealand since the date of Captain James Cook's landing, and 24 have become truly wild, such as mallard, pheasant, pigeon, skylark, thrush, blackbird, hedge sparrow, rook, starling, Indian mynah, house sparrow, chaffinch, goldfinch, greenfinch and yellowhammer.

On the other hand, since 1868, nine species of birds have become either very rare or extinct, such as native crows, huia, native thrushes, the burrowing parrot *Stringops,* the native quail and the white heron. Others, once abundant, have been driven back into areas where there has not been much settlement. As to the causes, Thomson writes: "It must not be supposed that it is the introduced animals alone which have produced this effect, even though rats, cats, rabbits, pigs, cattle, stoats and weasels, as well perhaps as some kinds of introduced birds, have penetrated beyond the settled districts. It is largely the direct disturbance of their haunts and breeding-places, and the interference with their food supply, which has caused this destruction and diminution of the native fauna."

What is true for birds holds also for lower animals, from lizards to insects; but again the reasons are to be found in human intervention rather than in direct competition with newcomers. This is corroborated by the fact that there were some notable cases of increase after about the 1870s. Thus the bellbird has become abundant in the South Island, though scarce in the North Island; and the harrier has greatly increased, perhaps in relation to the abundance of young rabbits. The wax-eye or blight bird (*Zosterops coeruleus*) has apparently increased greatly since first recorded in 1832, perhaps in relation to the supply of animal food about houses and stockyards. The case of the long-tailed cuckoo (*Urodynamis taitensis*) is interesting as an illustration of the complexity of interrelations. It seems to have become increasingly numerous after the 1890s and this is attributed to the increase of small European birds, whose eggs and young it eats, and also to the food afforded in and about trout hatcheries.

Method of Naturalization.—What should man do when he wishes to naturalize a valuable plant or animal in a new and markedly different country? If trial has shown that naturalization is not easy, the transporter should work with those varieties which seem most likely to be suitable. Attention should also be paid to the quality of variability, for some stocks are much more fixed than others. It may be useful to transport individuals of the most promising stocks to some intermediate station, where selection may be made among the variations that continue to arise. Darwin noted that "Merino sheep bred at the Cape of Good Hope have been found far better adapted for India than those imported from England." (*Variation,* p. 305 [1868].) In cases where success in the new country seems to depend on the possession of a particular character, such as thick fur or woolly leaves, the variants selected would be those tending most markedly in that direction, but Mendelian methods might enable the breeder to "graft" on to the tentative imports the desirable character in question if it existed elsewhere in an allied race. By more systematic selection of heritable variations and by Mendelian hybridizing, it seems likely that the process of acclimatization might be greatly extended and hastened.

Willis notes that man has often failed in naturalization by attempting too much abruptly. Learning from failure, he is now trying gradual transitions, "as in the way he has treated Liberian coffee in Java, taking the seed of successive generations a few score yards higher up each time, till he has persuaded the tree to do well at a much higher elevation than that to which it is naturally suited." The attempts to acclimatize the beautiful *Cyperus papyrus* in the Ceylon Botanic garden failed when seed from Europe was used, but seed from Saharanpur in India succeeded at once. The moral is that man must moderate his impatience and take a hint at least from nature's operations by small steps throughout long periods.

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NATURAL LAW, in science, means the formulation of some uniform character, mode of behaviour or uniform correlation of things or events; but it is frequently used for the uniformity itself as it exists in natural phenomena. Any such uniformity may be called a natural law; *e.g.,* all the laws formulated in physics and chemistry. On the other hand the term law of nature is sometimes restricted to irreducible or ultimate laws (like the law of gravitation) as distinguished from derivative laws (like Johannes Kepler's three laws of planetary motion). See LAW; SCIENTIFIC METHOD.

NATURAL PRODUCTS, TOTAL SYNTHESIS OF. Natural products include all chemical substances produced by living plants and animals. Examples of classes of natural products include fats, proteins, carbohydrates, vitamins, alkaloids, antibiotics, steroids, terpenes, essential oils and many others. Total synthesis, rigidly defined, means the synthesis of a chemical substance from the elements of which it is composed; since many relatively simple substances have already been made from the elements, in practice a total synthesis means synthesis from these substances rather than from the elements themselves.

The original objective of the science of organic chemistry was to elucidate the structures of and to totally synthesize all knonn natural products. Before such an ambitious objective could be realized, however, it was necessary to develop a logical and systematic science of organic chemistry. (See CHEMISTRY. *Organic* Chemzstry). This development occupied the attention of numerous chemists over a period of about 200 years. Although many notable successes in total synthesis were achieved relatively early in the history of organic chemistry, only in the mid-20th century was sufficient knowledge accumulated to permit organic chemists to turn vigorously and successfully toward their original objective. Many truly amazing total syntheses of natural products were achieved during the 1940s and 1950s.

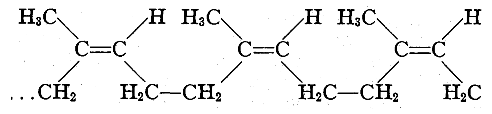
Perhaps the first total synthesis of an organic substance was the synthesis by F. Wöhler in 1828 of urea, a nitrogenous waste product formed in the kidneys of animals. Wöhler found that urea was formed simply by heating an aqueous solution of ammonium cyanate:

$$NH_4^+OC\overline{N} \longrightarrow H_2N{-}CO{-}NH_2$$

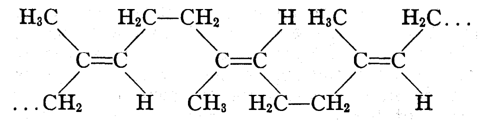
Since ammonium cyanate was a well-known inorganic substance and could be made from the elements carbon, nitrogen, oxygen and hydrogen, this reaction constituted a total synthesis. This first synthesis of a typical organic substance from purely inorganic starting material contributed toward abandonment of the idea of a "vital force" associated with the formation of organic matter, and organic chemistry was free to develop as a logical, orderly science utilizing concepts which had been formulated much earlier in the study of inorganic chemistry.

Total synthesis of organic substances is taken by the organic chemist as final and conclusive proof for the correctness of a structure arrived at by degradative or other methods. Sometimes this conclusive structure proof is the motivation for total synthesis. Frequently, however, total synthesis has important economic significance. As an example, the cultivation of the plant from which the blue dye indigo may be prepared was once an important agricultural industry. In 1883 A. von Baeyer elucidated the structure of indigo as the result of experiments extending over 18 years and devised two syntheses for the substance. In 1890 K. Heumann devised a commercially practical synthesis of indigo permitting the sale of the synthetic product at a price lower than that of the natural dye. The synthetic product soon controlled the market. A quite different case is that of the total synthesis of the natural drug quinine by R. Woodward and W. Doering in 1945. Although a brilliant chemical achievement, the synthesis has not been applied commercially. Other synthetic drugs such as Atabrine adequately control malaria, and are much easier to produce.

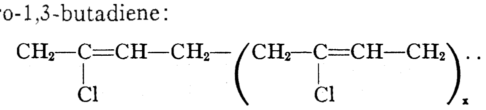
It is to be emphasized that a total synthesis leads to a material which is chemically identical in all respects to the natural product; the synthetic product is not a substitute or "artificial." The field of the rubbers affords a good example of this distinction. Natural rubber is a polymer (see POLYMERIZATION) of isoprene (2-methyl-1.3-butadiene) in which all of the isoprene units are arranged in the cis manner; *i.e.,* similar groups are arranged on the same side of the molecule. The arrangement is as follows:



The alternative all trans arrangement of the isoprene units represents the structure of gutta-percha:

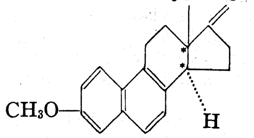


During the World War II period, when supplies of natural rubber were cut off from the western Allies, many synthetic rubbers were developed and used. All of these were substitute rubbers having some of the desirable properties of natural rubber but only grossly approximating its chemical structure. One of the first synthetic rubbers widely used in the United States was neoprene, a polymer of 2-chloro-1,3-butadiene:



Neoprene has a random cis-trans arrangement of the 2-chloro-1, 3-butadiene units. It was not until later that a synthesis of natural rubber was achieved. In 1954 Goodrich-Gulf Chemicals, Inc., announced the synthesis of a rubber identical with natural rubber (referred to as "synthetic natural rubber"). In 1955 the Firestone Tire and Rubber company announced a similar product, and in 19j6 the Phillips Petroleum company announced the synthesis of both cis and trans polyisoprene in pure form. These syntheses were achieved by polymerizing isoprene by means of certain stereospecific catalysts, perhaps a trialkylaluminum complexed nith titanium tetrachloride.

The attainment of stereospecificity was one of the principal problems to be conquered in the total synthesis of natural products. In the case of the rubbers, the problem nas production of a cis rather than a trans arrangement of the isoprene units. An even more subtle type of isomerism is involved in the structures of many natural products, so-called optical or dextro-levo (d, *l*) isomerism (see STEREOCHEMISTRY). This isomerism is dependent upon the fact that a molecule containing an asymmetric carbon atom (one which is attached to four entirely different groups) can exist in two arrangements in three-dimensional space. The two possible arrangements are mirror images of each other; *i.e.,* bearing the relationship of a right to a left hand. A given natural product represents only one of the various possible geometrical arrangements. Thus, the natural estrogenic hormone (*q.v.*) equilenin (I) contains two different asymmetric carbon atoms (denoted by the asterisks) and is capable of existence as 2^2 or 4 isomers; these are d- and 1-equilenin and .d- and 1-isoequilenin. The first total synthesis of a steroid was the W. Bachmann, W. Cole and A. Wilds synthesis of equilenin in 1939. All four of the possible stereoisomers were obtained.



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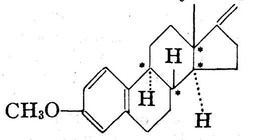
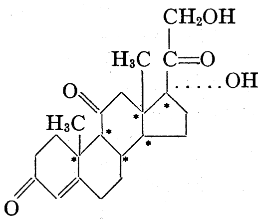


II

The estrogenic hormone estrone (II) represents a more difficult synthesis problem. Since there are four different asymmetric carbon atoms present, this structure can exist as 2^4 or 16 possible stereoisomers. Due largely to the efforts of G. Anner and K.

Miescher in 1948 and by W. Johnson later, all of the stereoisomers of estrone were synthesized. Only one of these, of course, is the natural product. Considerable interest centred around the steroid cortisone (111), which is able to relieve the



III

symptoms of rheumatoid arthritis and is beneficial in the treatment of various allergies. A partial synthesis of this steroid from other naturally occurring steroids is carried out commercially. Total syntheses were devised by Woodward in 1951, by L. Sarett and by L. Barkley.

The examples cited above point up some of the problems encountered in total synthesis and indicate the extremely rapid progress being made. The following listing of a few notable total syntheses further indicates something of the scope of the field: camphor (G. Komppa, 1903); cocaine (R. Willstatter, 1923); riboflavin or vitamin B_2 (R. Kuhn, W. Karrer, 1935); thiamine or vitamin B_1 (R. Williams, 1936); vitamin A (O. Isler, 1947); carotene (Karrer, H. Inhoffen, 1950–51); morphine (M. Gates, 1952); sucrose or cane sugar (R. Lemieux, 1953); oxytocin, a peptide hormone (V. du Vigneaud, 1953); strychnine (Woodward, 1954); reserpine, a Rauwolfia alkaloid (Woodnard, 1956); penicillin V (J. Sheehan, 1957).

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NATURAL RESOURCES. The materials of the environment useful to man are resources. Any of the many substances of the earth, the oceans and the air may become invested with an economic interest and thereby become resources. For anything to be sufficiently useful to be a resource it must satisfy three fundamental conditions: (1) it must satisfy a need of man without alteration, as water does, or it must be easily adaptable to his needs; (2) man must have developed his skills sufficiently so that he can utilize the resources available to him; and (3) the resource must be readily available with a reasonable expenditure of energy or other resources. A material may be essentially inert and economically useless one day and become a valuable resource the next.

Resources are either human or physical, and physical resources are either natural or manufactured. This article is concerned with natural resources which are commonly classified as vegetable, animal or mineral but these three categories may be extended to include energy from the sun, the soils of the earth and water. Resources may be further classified as nonrenewable (*e.g.,* minerals) or renewable (vegetation and water). The nonrenewable resources may be regarded as fund resources which are diminished by use. This is particularly the situation in the case of the fuel minerals. Many of the metals are not destroyed and varying fractions, depending upon the metal, can be recovered and reused. The renewable resources may be termed flow resources for the reason that with careful use they may last indefinitely. For example, a forest, managed on a sustained-yield basis, can produce timber and other forest products year after year without depleting the resource.

The adequacy of the earth's resources to sustain a growing population at different levels of culture is subject to debate, depending in part on the outlook of the inquirer. The more optimistic observer looks to technology to satisfy man's increasing demands. Great dams can be built to impound water; crop yields may be increased by plant breeding, fertilization, irrigation and mechanization. By geophysical methods mineral resources may be located and by improved methods of recovery, beneficiation and processing greater quantities of minerals may become available. The more pessimistic investigator observes the destructiveness of wars and the unproductive use of a rich heritage. He notes the impoverishment of the soil, the evidences of accelerated erosion, the destructiveness of great floods and the rapid use of fund resources.

It is obvious that wastefulness and the capacity to conserve resources, especially nonrenewable resources, exist simultaneously and a people would be without hope if they did not believe in the ability of man to satisfy his needs for an indefinite future.

Aside from economic motives, there may be humane or historic reasons for conservation of natural resources (see NATIONAL PARKS AND NATURE RESERVES; WILDLIFE CONSERVATION; FISH AND WILDLIFE SERVICE).

This article is divided into the following sections representing the main categories of natural resources:

I. Soils
II. vegetation
III. Animal Life
IV. Water
V. Minerals
VI. Strategic Resources
VII. Climate

The natural resources of the continents and nations are discussed more specifically in the articles on those areas.

I. SOILS

The soil is one of the most fundamental resources of the world. The countries that have large areas of arable land are most fortunate. The food-producing capacity of the land, if protected against destructive erosion and depletion of the plant nutrients, can be maintained indefinitely. To the extent that the fertility is maintained without impairment, soil may be regarded as a flow resource.

The soils of the world were formed under a variety of conditions. The parent material from which the soil is derived is acted upon by a number of physical and chemical processes. The properties of the soil reflect something of the climate, the slope of the land, drainage conditions and the stage of development the soil has attained, but the parent material imparts distinctive characteristics to the soil which other factors cannot destroy or alter substantially. A sandy soil derived from a sand-yielding formation remains a sandy soil although climatic conditions may impart to it distinctive structural characteristics. Abundant precipitation may result in excessive leaching but limited rainfall may permit the retention of plant nutrients in sufficient quantities to guarantee high productivity over a long period of time. Plants and animals, and especially the microorganisms in the soil, assist in the formation of the soil and contribute humus (*q.v.*), which serves a number of useful purposes such as the retention of moisture and the maintenance of cultivability.

Soils may be classified into zonal soils, intrazonal soils and azonal soils. These major groups of soils may be further classified into families, series and types. The well-developed or mature zonal soils are strongly identified with the climatic and vegetational conditions under which they have developed. The intrazonal soils show less distinctively the influence of climate and vegetation and show more certainly their relation to other factors such as slope or drainage. The azonal soils, such as recent alluvium and slightly altered parent material, have not advanced sufficiently in development to take on the physical and structural characteristics of the mature soils.

Within the tropics where rainfall is abundant and the temperatures are uniformly high, the tropical forest is the typical vegetational cover, Under these conditions the mature zonal soils are generally low in plant nutrients because of excessive leaching, high in the oxides of iron and aluminum, and under cultivation deteriorate rapidly. These soils are commonly brick red in colour and contain beneath the surface a claylike substance known as laterite (*q.v.*). The mature soils in tropical America, central Africa, Indonesia and southeastern Asia, developed under humid tropical conditions, are known as latasols and require careful management to maintain their fertility once the original forest has been removed and the land brought under cultivation.

On the savannas and the steppes of the tropics the soils are not so seriously leached as in the humid tropics but laterization is an important feature of the soil-forming processes. The leaching process is interrupted during the dry season and the maturing of the grasses helps to maintain the fertility of the soil. The mineral nutrients that the grasses have brought up from the lower horizons are made available in the surface layer when the grasses die and decay or are burned. The soils of these extensive grasslands, to the extent that they have been brought under cultivation or will be transformed from natural savannas into cultivated fields, constitute a resource of major dimensions. When the world needs the food and industrial raw materials these fertile soils can produce, cultivation can be greatly expanded.

Extensive areas in the humid subtropics such as southeastern United States, southern China, southern Brazil and southeastern Australia have soils that have developed under a forest cover. The soils in these areas are commonly red or yellow and display some of the characteristics of soils of the tropics. They show also the results of podsolization, a process identified with soil formation in the northern latitudes. These are not everywhere rich in plant nutrients because of excessive leaching, but with proper land management and fertilization these soil areas can produce great quantities of corn, cotton, tobacco, peanuts and vegetables. If they are neglected, their erodibility may result in rapid deterioration. To preserve and maintain the land in a high state of productivity will require vigilance and an understanding of the needs of the land.

Over a broad area across central Canada from the Rocky mountains to the Atlantic and across Eurasia from Scandinavia to the Pacific, the soils developed under the northern softwood forest or taiga are classed as podsols. These light gray or ashen-coloured soils are the result of the decomposition of organic matter which charges the downward-moving waters with acids which help to remove in solution the iron compounds which otherwise would give the soil a reddish colour. Beneath the thin layer of leaf litter the topsoil or A horizon of the podsols is distinctly light coloured and generally infertile. The do nward percolating waters transfer the humus, clay and other fine materials downward into the subsoil. The topsoil becomes a white bleached layer directly beneath the forest litter. The subsoil is compact and coffee bronn in colour. In the glaciated parts of northeastern North America and northwestern Europe are extensive areas of true podsols, which because of their sandy character, natural acidity and poor drainage have limited usefulness. Land just cleared is deceptively dark in colour because of the thin layer of leaf litter, but after being cultivated for a few years the organic matter decays and an infertile layer of ashen-gray inorganic matter is all that remains. These acidic podsols are not well suited for agriculture though potatoes, rye, oats, certain meadow grasses and vegetables do well. Large areas probably should remain in forest and be used for the production of timber and other wood products.

In northeastern United States, in much of west central Europe and in northern China the soils, developed under the deciduous forest, are mainly podsolic in character. These soils are grayish-brown in colour and have inherent structural characteristics that give them an enduring quality. The humus content is greater than in the podsol soils but they require care to maintain their high productivity.

The eternally rich lands of the world are those that have developed under a cover of grass in the intermediate latitudes. The soils in these great grasslands originated and evolved in areas of moderate to scant rainfall. In the tall-grass prairie there has been sufficient precipitation over a long period of time to remove the calcium salts and other easily dissolved minerals. The soils developed under these conditions are deep and fertile though they may require the application of lime. Nowhere in the world are the black prairie soils so well developed as in the corn belt of the United States.

In the grassland areas that receive a smaller amount of precipitation, the calcium salts and other minerals are retained and the soil may be described as slightly alkaline. These soils are known as chernozems (black earth). They are widely distributed in the dry plains of the United States and Canada, the Soviet Union, Manchuria, India, the Argentine pampas, Uruguay and eastern Australia. Where the surface of the land is relatively flat or gently undulating the danger of water erosion is slight. Under cultivation the chernozems and other soils rich in organic material suffer from wind erosion if not protected by wind stripping, mulch tillage (stubble mulching) or by the use of cover crops.

On the dry margins of the chernozems lie extensive areas that are best described as steppe. In these areas the soils have developed under subhumid conditions. These dark-coloured soils are not as rich in organic matter as the chernozems and the prairie soils. In favourable years these dry lands may be brought under cultivation and used for the production of the drought-tolerant grains such as wheat and barley. The steppes are well suited to grazing and most areas should be left in grass and used to support a pastoral industry. The soil resources of the steppes can be used most effectively if only limited areas are brought under cultivation.

In the deserts of the world small areas of fertile soils can be irrigated and brought under cultivation. The soils developed under low-rainfall conditions are potentially productive where sufficient water is available. These irrigable lands usually have soils that are rich in mineral nutrients but are generally low in organic matter and nitrogen.

The full use of the soil resources of the world to meet the needs of an increasing population for more food, fibres and other industrial raw materials will require the clearing of virgin lands, the drainage of marshlands, the irrigation of larger areas of desert and semiarid lands, the use of fertilizers and the development of more productive plants and animals. Extensive areas must be protected from destructive erosion and depletion if their productivity is to be maintained and enhanced for an indefinite future. See SOIL; SOIL EROSION AND CONSERVATION; SOIL FAUNA; SOIL TESTING AND ANALYSIS; AGRICULTURE; FERTILIZERS AND MANURES; IRRIGATION; LAND RECLAMATION.

II. VEGETATION

A very high proportion of the earth, in spite of great irregularities in terrain, high altitude, expansive ice-covered areas in Antarctica, Greenland and the high mountain areas, and the extensive wastelands of the deserts, is mantled by vegetation either natural or cultivated. The natural or original vegetation of the earth may be classed as grasslands, grass and shrubs of the steppes and deserts. and forest. The plant communities may differ greatly over the world, particularly in respect to floristic composition, but the assemblage of plants makes it possible to identify the major vegetation zones of the earth. The forest of equatorial Africa is very different from the spruce forest of Canada but both are forests. Similarly, the component grasses of the campos of Brazil may be quite unlike the plants that make up the assemblage of grasses in the Nebraska prairie but both are grasslands. Also the scant grasses and shrubs of the desert margin of the Sudan produce a steppe area not unlike the great steppes that border upon the desert of Soviet Central Asia. The science concerned with plant communities and the environmental, biological and physical factors that affect composition and succession is known as plant ecology (see PLANTS AND PLANT SCIENCE: Plant Ecology).

Grasslands. — Approximately 13,000,000 sq.mi. or 24% of the land area of the earth can be classed as grassland. The great grasslands consist of (1) tall-grass savanna, 31%; (2) high-grass savanna, 2270; (3) desert-grass savanna, 18%; (4) tall-grass prairie, 13%; (5) short-grass steppe, 10%; and (6) mountain grassland, 6% of the total.

The savanna grasslands cover extensive areas between the equatorial forests and the trade-wind deserts and lie largely within the tropics. The rainfall ranges from 30 to 80 in. annually with the maximum strongly concentrated in the summer or high-sun period. It is this marked seasonality of the precipitation that has favoured the development of the tall luxuriant grasses that make up the savanna. Where the savanna borders upon the equatorial forest the expanse of grass may be interrupted by clumps or islands of trees or by a gallery forest along the watercourses or in low areas where water is available in all seasons. Toward the desert margin of the savanna the grasses are shorter and less abundant and drought-resistant shrubs become a part of the assemblage of species in the plant communities.

The tropical savannas are well represented in South America in the llanos of the Orinoco basin, the campos of Brazil and the Gran Chaco of northern Argentina and Paraguay. In Africa the Sudan is largely an expansive grassland extending from the Atlantic to the highland of Ethiopia along the parallel of latitude 10° N. This grassland extends southeastward onto the highland of east Africa. Also south of the equatorial forest an area of savanna lies across northern Angola and the southern portion of the Belgian Congo. In northern and northeastern Australia, savanna covers an important fraction of the continent.

These extensive grasslands of the tropics, in spite of hot humid summers and the dry season in the winter or low-sun period, are widely used for cattle grazing. Locally the grassland has been brought under the plow and cultivated crops such as cotton, peanuts, sorghum grains and vegetables are grown. Potentially large areas in the tropical savannas can be cultivated and when the world requires larger quantities of the crops that can be produced there, greater use will be made of these fertile and productive lands.

The tall-grass prairies originally included the immense prairies of midland North America, the pampas of South America, the rich prairies of eastern Europe such as the Hungarian basin, the Rumanian plain and the extensive grasslands of the Soviet Union north of the Black sea and extending eastward between the northern forest and the desert interior of Asia. Limited areas of prairie once made up the vegetational cover of the veld in South Africa, the upland of Madagascar, the plains of southeastern Australia and the eastern half of South Island in New Zealand.

The tall-grass prairie of the mid-latitudes was the natural habitat of a great variety of grazing animals such as the buffalo in North America. Because of the high fertility of the soil developed under the prairie vegetation and an annual precipitation of 15 to 40 in., a high proportion of the mid-latitude prairie has been brought under cultivation. In many areas in the corn belt of North America the original grasses, including bluejoint (blue stem), needle grass and wheat grass. have all but disappeared. Only along fence rows and in a few relict areas have the original plant communities been preserved. These immense grasslands are now the great granaries of the world where much of the world's corn, wheat, rye, flax, oats, barley, soybeans and sorghum grains are grown. Also, the cultivated grasses and feed grains that have replaced the native grasses support a livestock industry of major proportions.

Grasses and Shrubs of the Steppes and Deserts.—Short scant grasses and intermingled shrubs border the desert areas both in the tropics and in the intermediate latitudes. With the mountain grasslands these areas cover approximately 32% of the land area of the world. The component grasses of these steppelands include grama, buffalo grass and needle grass. In drier parts of the steppe open spacing of the clumps of grass and herbaceous plants is a characteristic feature. These great realms of scant grass supported a pastoral civilization in the old world, and briefly a range industry in the new. In the more fertile parts of the steppe and where the annual precipitation exceeds 12 in., dry farming may be practised. The crops grown must be drought resistant such as wheat, barley, millet and the sorghum grains.

Other areas commonly included among the grasslands are the diminutive patches of grass and herbaceous plants that give greenness to desert areas after each rain or brief rainy season. In the high latitudes the tundra, and in high altitudes, the alpine meadows present some of the aspects of grassland. To a limited extent they are used for grazing and support an animal population of reindeer, musk oxen and a variety of fur-bearing animals. (See Grassland; Grasses.)

Forests.—The natural forest areas of the world cover approximately 22,000,000 sq.mi. or 42% of the earth's surface. The forests may be classified into a number of major types related chiefly to the nature of the assemblage of trees and the geographic location of the forest.

Tropical Rain Forest.—This is luxuriant, evergreen forest consisting of trees of unequal size and height and of varying ages forming a dense canopy of thick, leathery leaves, and composed of a variety of trees such as legumes, laurels, myrtles, figs, satinwood, mahogany and rubber trees, a true climax forest with an intermingling of many species. This type of forest thrives in areas within the tropics where temperatures are uniformly high and where the annual precipitation amounts to 60 to 200 in. In the equatorial areas of South America, Africa and Indonesia and the windward coasts within the tropics the temperature and moisture conditions support the true tropical rain forest.

Light rain forest consists of a variety of conifers and deciduous trees in the lower middle latitudes and extending into the tropics. It occupies extensive areas in southeastern United States, eastern Brazil, southeastern Asia, parts of east Africa and northern Australia. Temperatures are not as high in these areas as in the equatorial lowlands. The rainfall is also somewhat lower, averaging from 40 to 80 in. annually. As a consequence these humid subtropical areas originally were mantled by a light but valuable forest.

Deciduous forest consists of broadleaf trees which drop their leaves chiefly in the autumn and come into leaf again each spring. Typical trees include the oak, birch, beech, maple, ash and hickory. The dominant trees differ from place to place depending in part on drainage. The beech-maple association may be dominant in the wetter areas whereas the oak-hickory association may be characteristic of the higher, well-drained regions. The original deciduous forest was best developed in eastern United States, western and central Europe and eastern China. The total area of approximately 6,500,000 sq.mi. covered 12% of the land area of the earth.

Coniferous Forest.—Characteristic of middle and higher latitudes, this type of forest is made up of uniform stands of similar or related evergreen trees such as pine, fir and spruce. In the northern hemisphere it is commonly known as the northern softwood forest. In Eurasia from Scandinavia to the Sea of Okhotsk it is called the taiga. To the north, this evergreen forest decreases in height and merges into the tundra. This is a rich commercial forest and supplies large quantities of timber and pulpwood to the world's markets.

Dry Forest.—In the dry areas of the world, particularly where there is a long dry season, the open woodland may be described as the dry forest or the monsoon forest. Extensive areas in southern Asia, Australia, South America and Africa have a hot wet summer that alternates with a dry winter season. Most of the trees in this dry forest lose their leaves during the dry season but come into leaf at the beginning of the rainy season.

Thorn Forest.—Locally within the dry subtropical and tropical areas the limited rainfall of 10 to 20 in. annually may support a thorn forest. A tangle of thorn-bearing trees may make the area difficult to penetrate or cross. These areas have little or no value agriculturally but limited areas in Africa, South America, Mexico, Australia and Asia produce gums, fruits, rubber and tanbark.

Sclerophyll brushland is a meagre forest of diminutive trees and brush. Since it is characteristic of the Mediterranean borderlands it is sometimes called the Mediterranean forest. The rainfall of these areas varies from 20 to 30 in. annually and in spite of dry summers these lands are well suited to the cultivation of citrus fruits, olives, vegetables and cereals such as wheat and barley. This type of brushland covers important areas of Mediterranean climate in north and south Africa, southern Europe, western Asia, southern California, central Chile and southwestern Australia.

Land Use and Forest Products.—As in the case of the prairies and other rich grasslands, extensive areas that were once forested have been converted into cropland. In China and in many parts of Europe and the United States the forest has been sacrificed in order that the cultivated lands might be greatly expanded to meet the demand for increasing quantities of food and industrial raw materials. The soils of the forestlands generally were not as fertile as the chernozems and other black and brown soils developed under a cover of grass. However, the soils are easily cultivated and amenable to fertilization so that their productivity can be maintained indefinitely with proper management.

Over the many centuries when the farms of Europe and North America were literally being hewn out of the forest, the need for lumber was met by using the trees from the nearby woods. But as clearing continued and the woodlands were greatly reduced, the need for timber for homes, factories and other structures had to be met by tapping the forest resources of more distant areas. In Europe the great forests of Scandinavia, the Baltic countries and the mountain areas supplied lumber and other timber products for centuries. In eastern Asia the more heavily wooded lands of Hokkaido and the Amur valley and forests in the Soviet Union supply lumber, wood pulp, mine timbers, posts and other wood products to southern Japan and China where local supplies of timber have been largely exhausted. In, the United States, after the forests of the northeastern part of the country and the middle west had been greatly reduced, commercial lumbering in the Great Lakes basin provided a rich harvest of white pine and other woods. Lumbering on a large scale spread to the south. to the Rocky mountains, the Pacific northwest and. later, to the northern forest of Canada. See FORESTS AND FORESTRY; LUMBERING: ARBORICULTURE; TIMBER; RAIN FOREST.

III. ANIMAL LIFE

Before man took possession of the earth and modified the natural environment to meet his needs. the numerous animals were widely distributed in accordance with the suitability of the various habitats and the competitive situation among the animals themselves. The animals of the world, both wild and domesticated, constitute a major biological resource subject to both the laws of nature and the facts of economics and culture. Man in his ignorance or thoughtlessness has brought destruction and virtual extermination to herds of wild animals such as the buffalo and the caribou and to great flocks of waterfowl and other birds. At the same time he has brought his scientific knowledge and management skills to bear upon the animals he nished to retain. At mid-20th century the number of cattle in the world reached an estimated 972,000,000 head; sheep numbered 917,000,000; and swine, representing one of the major food animals of the world, totaled 386,000,000. These and other animals available to the more than 2,600,000,000 people in the world constitute a viable resource of immense worth. Yet among the animals of the earth there are predators, insects and microscopic forms of life nhich may challenge man's mastery over the animal kingdom The predators may serve to hold in check the rate of gronth of certain animals nhich might become destructive. Among the insects there are some such as the bees that are of great value, but others may be the carriers of disease germs causing unnumbered deaths each year. Man's control over the animals of the world is partial rather than complete and in effect he may be in competition with other animals, particularly the insects, to see which shall win supremacy.

In nature, without any interference from man, wild animals established a living relationship with the environment, both physical and biological. Over a long period of time the animal populations evolved from more primitive ancestors and became dispersed over the earth in relation to the favourable and limiting conditions of the environment. A habitat that is particularly favourable in respect to the essential requirements of a single or a number of species may become fully populated in a relatively short period of time. Conversely, an environment that is repeatedly subject to extremes of temperature or moisture may be sparsely occupied and the native and migrant animals may be subject to restrictions on continued increase in numbers. Under natural conditions something in the nature of a biological balance is achieved but this nice relationship can easily be disturbed by a change in the physical habitat or by a devastating disease that may weaken or decimate an animal group. The science of animal ecology is concerned with the relation of animals to the conditions of the environment, both physical and biological. (See ECOLOGY, ANIMAL.)

Habitat Factors.—All animals are dependent upon an adequate supply of oxygen and water to meet their essential physiological needs. The temperature conditions of the habitat must have limits that can be tolerated by the animal community. Through the process of natural selection only the fittest survive. By this means a species retains its competitive advantage. The food supply must be adequate and available at the usual and necessary feeding times to maintain the animal populations. Whereas many animals such as the carnivores feed upon other animals, fundamentally they are all dependent upon adequate supplies of plant substances for continued existence. From the smallest and lowliest forms of life to the largest predators there are animals that derive their food from other animals, many of which are plant eaters. In the sea, the larger fish and other forms of life are dependent upon the availability of smaller animals, particularly fish, to maintain life but the smallest animals of the sea are dependent upon plankton (q v.) and other very tiny forms of life.

Domesticated Animals.—When man began to domesticate animals and use them as a means of livelihood for himself, his family, his tribe or his group, economics became a factor in the life of the people. Before this time, only natural factors had significance in the evolution. dispersal and relative abundance of the many animals that populated the earth.

Man in his early evolutionary history became a meat eater and satisfied his need for this type of food by hunting and fishing, two occupations that have continued to the present time. The domestication, breeding and the biologic and economic development of a number of animals have contributed immense quantities of animal products to the food resources of the world and introduced a stabilizing factor in the animal food industries.

The principal animals that have been domesticated include poultry. swine, cattle, water buffaloes, horses, sheep, goats, camels, the Tibetan yak, reindeer and llamas. It was largely because of man's need for a work animal and a burden bearer that several animals were domesticated, although some of these'same animals also contributed products such as wool, milk, meat and hides.

Animal Power.—Domestication of animals was for companionship, for hunting, for food and for transportation. The principal work animals for centuries have been horses, cattle, water buffaloes, camels. llamas and elephants. In the densely populated areas of the orient where manpower is relatively abundant and food resources are limited, the larger work animals such as horses and oxen have been eliminated or are maintained in limited numbers only. Water buffaloes, because they are particularly well suited for work on the wet rice lands, have been retained. In parts of the tropics, because of the climatic conditions and the economic status of the people, oxen have continued to be an important source of power.

Into the early 19th century, oxen mere also widely used as work animals in much of Europe and America, but they were shortly displaced by the horse. Prized for its speed, endurance, longevity and intelligence, the horse became the principal work animal throughout west and central Europe, much of Russia, in the United States and in the intermediate latitudes where European culture spread. When the European or American farmer prospered he gave up the slow plodding oxen for the horse, which was able to hold its own until the development of the tractor and the subsequent mechanization of agriculture.

Animals as a Source of Food.—The use of animal products for food is largely the result of cultural inheritance. Taboos of cultural origin may limit the consumption of certain foods which, from the nutritional point of view, are edible. For example, certain visceral organs may not be acceptable in the diet of some people but may be regarded as a delicacy by others. In India, where cattle are most numerous, the use of meat for food is restricted. On the other hand, Eskimos and other peoples far removed from foods of plant origin are heavy consumers of meat.

Although there are millions of people who do not eat meat because of religious prejudice or personal preference, meat in varying amounts is consumed widely throughout most parts of the norld, depending on its relative abundance and its cost in relation to other available foods. While it is most economical for man to derive his foods directly from plant sources, there are many plants that he cannot eat. Animals act as intermediate processors of such plant foods as the coarse feed grains.

The rich agricultural lands of the world that were once in forest or in grass are now the leading producers of meat animals. Cattle by the millions are raised on the farms and ranches of the United States, Canada, Mexico, Argentina. Uruguay and Chile and on the extensive grasslands of the tropics. In Europe from the Atlantic to the dry steppes of the Soviet Union cattle are raised for dairy products, for meat and as sources of pomer.

Snine and poultry are more economical in the utilization and conversion of feed into edible products than cattle. Both are scavengers and make use of food materials that would otherwise go to naste. Both reproduce rapidly and mature quickly. When there is a need to increase the quantity of foods of animal origin, it can be done more quickly with swine and poultry than with cattle. In China, Europe and the United States swine and poultry are raised in great numbers though the feeds used differ from country to country. In China these animals are scavengers but in the U.S. quantities of grain are used for feed. In Europe the by-products of the dairy industry. locally grown and imported grains and wastes from the table support the two industries.

The intensive development of animal industries is a means of maintaining soil fertility if the methods of cultivation are nondestructive. By giving the animals the feeds grown on the land and by returning all manures and other organic wastes to the land, the soil, by means of the livestock industry, may be regarded as a renewable resource, and with proper management is virtually inexhaustible.

Fisheries. — The animal resources of the sea have been used for human food for centuries. The most important fisheries are located in the northern hemisphere between 40° and 60° N. where the cool waters of the North Atlantic and the North Pacific cover extensive areas of the continental shelf and where plankton and other foods are relatively abundant. They include the North sea and the shallow waters off the coast of Europe. the Grand Banks south of Newfoundland and other nearby coastal waters. the shallow coastal waters along western North America and favourable waters around Japan and the seas adjacent to the mainland of northeastern Asia. Through the years certain species such as cod, salmon and halibut have been taken in such quantities that the fishery resources have been reduced and require regulation to maintain their continued productivity.

In somewhat warmer latitudes the shellfish industry contributed important quantities of lobsters, oysters, clams and crabs to the food resources of the world, but depletion has been a threat to the industry. In Japan, western France, northnestern Washington and Chesapeake bay the oyster industry has been brought under control and a continued supply is assured. In the warm waters of the tropics fish are not as abundant as in the cooler waters of the intermediate and higher latitudes, but fish caught in local waters are important in the diet of the people. The tuna fishery in the Pacific and the shrimp industry in the Gulf of Mexico provide valuable foods prized by millions. See DISTRIBUTION OF ANIMALS; ZOOGEOGRAPHY; FISHERIES; FISH CULTURE; ANIMALS, DOMESTICATION OF.

IV. WATER

Approximately 71% of the surface of the earth is covered by the oceans. These extensive salt-water areas function in various ways in the affairs of men. The broad seas serve or did serve to separate the continents and the nations that have divided the land areas of the world among themselves. The size and the distribution of the seas affect in various ways the climatic conditions of the earth and influence, as a consequence, the character of the soils, natural vegetation. agriculture and commerce. Also, the sea is a reservoir of mineral resources, but only a few, such as salt and magnesium, have been recovered.

The fresh waters that lie upon the land in the form of streams, lakes, ponds, swamps, springs and reservoirs and the ground water that occurs beneath the surface constitute the water resources of the land, though the saline waters of inland seas and subsurface structures have commercial value also.

If all the fresh water on the land and the quantity contained in the rock formations could be calculated accurately, it probably would not exceed much more than 1% of the total water on the earth. Fresh-water resources become available through the operation of the hydrologic cycle. The energy of the sun evaporates enormous quantities of water from the sea and the resulting vapour becomes a part of the atmosphere. The winds distribute this vaporous moisture widely over the earth. Upon condensation and precipitation. 30% of it is returned directly to the sea. Out of the water vapour that is transported over the land areas, precipitation provides varying amounts of fresh water for use by man. Of the water that falls on the land an important fraction penetrates the soil, percolates downward to levels below the root zone and becomes, temporarily at least. a part of the reservoir of ground water.

Under favourable topographic and geologic conditions, some of the ground water returns to the surface in springs, many of which, because of their perennial character, contribute to the regularity in the flow of streams. Waters that penetrate deeply may be returned to the surface by the numerous wells that have been put down in thickly settled areas to provide the people with potable water. By evaporation and by transpiration some water is returned to the atmosphere. but much of it becomes runoff and returns to the sea, thus completing the hydrologic cycle.

Water is a multiple-purpose resource that may be made to serve a number of functions on its way to the sea. Water on the land supports vegetation and if it is more abundant than is necessary for agriculture it may form a habitat for aquatic plants and animals. Only to a limited extent is water an industrial ingredient, but it does serve as a source of power and as a coolant. Water of the larger streams and lakes may be used to supply the culinary and personal needs of people in urban communities and the wastes from cities are discharged into these same streams and water bodies. Abundant supplies of water are required in a sanitary system to treat the sewage, dilute the effluent and flush away the wastes. In quantity, the fresh waters of the earth bear a significant relationship to the amount of precipitation that falls upon the land and its seasonal distribution. When the first land areas were uplifted above sea level, fresh water began to enter the pore spaces and other cavities in the various geologic formations. Originally most formations, especially those originating through deposition of sediments in the oceans and saline seas. contained salt water. But as fresh water penetrated these aquifers and moved along under hydrostatic pressure, most of the salt water was gradually replaced by fresh water. In the deeply buried formations salt water is still trapped and there is very little prospect that these saline waters or brines will ever be replaced by fresh water. Some rock formations contain soluble minerals that are taken into solution by the deeply penetrating fresh waters that originally fell as rain. These brines, whether they represent deeply entrapped sea uater or solutions containing saline materials from the country rock, constitute an important natural resource.

Where thick layers of sedimentary and other porous rocks are so disposed structurally that surface waters are readily absorbed and penetrate deeply. the total quantity of underground water may be enormous. This reservoir of ground water is in a sense a capital fund that can be drawn upon to meet local and regional needs for water. The earth materials into which the surface waters penetrate filter and purify the water and make it readily usable for most culinary and industrial purposes. However, the water may contain sufficient mineral matter such as lime carbonate and other salts to make it hard and unsatisfactory for particular purposes unless treated.

The fresh water on the land in the form of streams. lakes, ponds and marshes represents only a fraction of the total rainfall. Like springs, lakes, ponds and marshes help to steady the flow of streams. These natural regulators have been supplemented by the construction of dams both large and small to hold back the water in times of heavy precipitation so that adequate supplies may be available for power, irrigation, industrial and culinary purposes in times of low rainfall.

The total power derived from falling water is relatively small when compared with the power available from coal, petroleum, natural gas and atomic sources, yet certain countries such as Italy, France, Switzerland, Norway, Sweden, Canada and Japan are heavily dependent upon water power. In the mid-1950s the capacity of the water-power plants in the United States was in excess of 130,000,000 h.p., a little more than one-quarter of the world total.

Inland waters have long been highways of commerce. In the United States other means of transportation, except on the Great Lakes, have competed strongly with the waterways. In Europe, waterways, both natural and man made, are relatively more important. But throughout history, the great rivers of the world such as the Rhine, the Volga, the Yenisei, the Yangtze, the Nile, the Amazon and the Mississippi have been arteries of trade.

As the demand for water increases, the available supplies will need to be more carefully utilized. With proper treatment. water may be used over and over again as it moves downstream toward the sea. By cloud seeding in areas where conditions are favourable. the amount of precipitation may be increased slightly. By desalting saline waters the quantity of fresh water may be increased, but except in areas of scant supply where desalting may be practical, the immediate needs for more water mill probably be met by the treatment and reuse of known supplies. See WATER; GROUND WATER; HYDROLOGY; OCEAN AND OCEANOGRAPHY; WATER SUPPLY AND PURIFICATION; and individual articles on hydrographic features.

V. MINERALS

In order to simplify this discussion of minerals, the great variety of inorganic substances contained in the earth's crust and the seas is treated in a limited number of categories: mineral fuels, iron and the ferroalloys, the nonferrous metals, the precious metals and the nonmetallic minerals.

Mineral Fuels.—Coal.—The coal resources of the world are essential to continued industrial development. Petroleum and natural gas and to a limited extent water power and nuclear fuels supplement coal, but the strong industrial nations must have access to this essential industrial fuel.

All coal, whether classed as anthracite, bituminous or lignite, is derived from vegetable matter accumulated and preserved under favourable geologic conditions. To be regarded as workable resources for the foreseeable future, the coal must occur at depths not exceeding 6.000 ft. beneath the surface and under structural conditions that will permit economic mining at the greater depths. The thickness of the seams or layers is an important factor in the economic production of coal, particularly in deep mines.

The leading producers of coal are the United States. Germany, the Soviet Union, the United Kingdom and Poland, all of which produce from 100,000,000 to more than 400,000,000 tons annually. Smaller quantities, generally under 100,000,000 tons annually, are produced by China, India, Japan, Czechoslovakia, France, Belgium and Australia.

The reserves of coal yet to be developed are similarly distributed over the world. In North America, chiefly in the United States, more than 2,000,000,000,000 tons of coal remain to be mined. In the Soviet Union and China the reserves total more than 2,400,000,000,000 tons, enough to meet the needs of these two great powers for many decades or even centuries. In Europe significant reserves are located in Germany, the United Kingdom and Poland. In the southern hemisphere large reserves are available in Australia and South Africa.

Petroleum.—Like coal, petroleum is believed to be of organic origin. Because it is a liquid it can be transported in pipelines, tank cars, barges and tankers. The refining of petroleum consists of distilling or fractioning off the various liquid constituents and of cracking, a process in which the heavier oils are used to produce the lighter products such as gasoline, kerosene and fuel oil which are in great demand. From petroleum are derived a number of basic raw materials used in the manufacture of plastics, detergents, synthetic rubber, explosives and dyes.

Petroleum occurs in porous sandstones and other formations with large and abundant interstices. Early man used limited quantities of petroleum as an illuminant, as a lubricant and for pharmaceutical purposes. The first well drilled specifically for oil was put down at Titusville, Pa., in 1859. For 100 years the United States has held the leadership in production except for a brief period from 1898 to 1901 when leadership passed to Russia. The principal petroleum producers are the United States, Venezuela, Saudia Arabia and Kuwait, the Soviet Union and Iraq. Others of importance include Canada, Mexico, Rumania, Indonesia and Iran. From 1918 to 1926 Mexico mas second to the United States, only to be surpassed by the Soviet Cnion. The relative decline of Mexico was offset by the rise of Venezuela, which achieved second place in 1944, a position it continued to hold.

The ease with which crude petroleum can be transported makes it possible to concentrate refining capacity in or near the market areas. Approximately half of the world's refining capacity is located in the United States. Other major refinery centres are in the Soviet Union, the Netherlands West Indies (Curaçao and Aruba), Canada, the United Kingdom, France, Italy and Iran (Abadan).

The reserves of petroleum are unequally distributed over the earth. The United States, long a leading producer, has less than 20% of the world's known reserves. The middle east countries, having achieved recently a high place among producing areas, have approximately 66% of the reserves. The proven reserves in the Soviet Union amount to only 5%, though future exploration may increase them greatly. In South America, particularly along the eastern margin of the Andes, reserves of petroleum may maintain production for many decades.

Natural Gas.—In most petroleum areas natural gas is available for use as a fuel and as a raw material. Outside of the Soviet Union, for which production data are not available, natural gas is produced chiefly in the United States, Canada, Mexico, Venezuela and Italy. In the United States natural gas from Texas, Louisiana, New Mexico, Kansas and Oklahoma is distributed by pipeline to the industrial and domestic consumers in the northeast including New England, the south, the middle west and the Pacific coast. Production of natural gas in the United States in 1957 amounted to 10,200,000,000,000 cu.ft.

The recoverable reserves of natural gas in the United States were estimated to be 446,500,000,000,000 cu.ft. in the late 1950s. New discoveries in the southwest and California have increased U.S. proven reserves substantially.

Atomic Energy.—Uranium (*q.v*) is the chief source of atomic energy though thorium and other radioactive minerals may be used as fissionable fuel. The known quantity of uranium in the earth's crust is equivalent to 0.008%. It is twice as abundant as zinc and many times more abundant than the precious metals. However, it is widely distributed and only in a few places is it sufficiently concentrated to warrant development and production. It has been estimated that the total heat energy available from the reserves of atomic minerals may be as much as 25 times that available from the known reserves of coal.

Atomic energy thus far has been used chiefly for weapons, but a number of reactors are being used as sources of power in electrical generators and on submarines. It will continue to be used for these and other purposes, but in the United States and other countries where other sources of power are available at low cost the use of atomic energy may be restricted for some time to come.

Uranium is recovered from deposits of pitchblende which occur in the Belgian Congo, Canada and Czechoslovakia. In the United States, uranium ores are contained in the thick sedimentary formations of the Colorado plateau of western Colorado, New Mexico and Utah. Other sources of uranium are in the Union of South Africa, Australia, France and Portugal. (See FUELS; COAL AND COAL MINING; PETROLEUM; NATURAL GAS; GAS INDUSTRY; ATOMIC ENERGY.)

Iron and the **Ferroalloys.**—*Iron.*—In the earth's crust, iron is one of the most abundant metals, exceeded only by aluminum.

Whereas iron as an element is widely distributed, however, the major iron minerals such as hematite (Fe_2O_3), magnetite (Fe_3O_4), limonite ($Fe_2O_3H_2O$), siderite ($FeCO_3$) and others are concentrated in rich ore deposits in a limited number of places. The richest ores. consisting chiefly of magnetite, contain 60% to 70% iron. Hematite ores seldom contain metallic iron in excess of 60% and the poorer or leaner ores may contain as little as 20%–25%. When the iron content is under 25% the ores may be described as uneconomic or submarginal. In the United States ores under 35% iron are seldom used unless first treated to enrich them.

With the exhaustion of the rich ores in the iron ranges of the upper Lakes area in Minnesota and Michigan, the iron-bearing taconites and jasperites have become potential sources of iron. These iron-bearing formations are crushed and by magnetic and other means of enrichment the iron minerals are concentrated and pelletized by a sintering process so that the resulting ore can compete with the naturally rich ores. Domestic sources of iron ore have been unable to meet the demand and as a consequence foreign ores to the extent of 15,000,000 tons annually are imported from Canada, Sweden, Venezuela and Chile and from a number of countries that supply only limited quantities of ore.

With the completion of transportation facilities from the Gulf of St. Lawrence to the rich iron resources along the Labrador-Quebec boundary, the Knob lake ores have become available to Canadian and U.S. blast furnaces. Other Canadian ores are mined in the Steep Rock and Michipicoten areas in the Lake Superior upland. The Wabana ores of Newfoundland have long been available to furnaces in eastern Canada.

In the Latin-American countries important iron deposits in the Cerro Bolivar area of Venezuela have become available for domestic use and for shipment to the U.S. Iron ores are also produced in Chile and Brazil. The rich resources of Venezuela and the state of Minas Gerais in Brazil constitute a major reserve that may be drawn upon to support the iron industry of the future.

In Europe the chief centres of iron-ore production are in the United Kingdom, France, Germany, Sweden and the Soviet Union. In western Europe the Minette ores of Lorraine have long held first place as a source of iron. Other contributors include Spain, Italy and Austria. The Soviet Union is the leading producer of iron ore in Europe with the Krivoi Rog of the Ukraine and the Magnitnaya and other centres in the Urals accounting for most of the production. Large reserves of iron ore are known to exist in the Soviet Union so that its iron and steel industry will be adequately supplied with ore in the future.

Ferroalloys.—Limited amounts of a number of ferroalloy metals are required to produce the specialty steels needed by modern industry. These metals include manganese, chromium, nickel, tungsten, vanadium. molybdenum and cobalt.

Manganese is used as an oxidizer and as an alloy and is required in the manufacture of all steel. In the late 1950s manganese ores were mined in the Soviet Union, India, Brazil, the Union of South Africa, Ghana and Morocco. Chromium, used with nickel to make stainless steel and as a plating metal, is available in quantity in the Philippines, Turkey, the Union of South Africa. Southern Rhodesia and the Soviet Union. The Sudbury area of Canada produces nearly 60% of the world's nickel. Smaller quantities are produced in Cuba, the Soviet Union and New Caledonia. Tungsten, important in the manufacture of tungsten carbide and as an alloy, is widely distributed but for many years China has been a principal supplier of this metal. Other producers include the Soviet Union, the Cnited States, Bolivia, Portugal and the Republic of Korea. Molybdenum, like nickel, is highly concentrated in a single mining centre, Colorado. More than 95% of the world's molybdenum is produced in the United States. Vanadium, which imparts strength and resilience to steel, is produced chiefly in the Cnited States, Peru, southwest Africa and Finland.

These ferroalloys, considered together, are widely distributed among many nations, but the major steelmaking countries are largely dependent upon imports to meet their needs. For example, the United States produces only molybdenum and vanadium in sufficient quantities to meet its requirements. All the other ferroalloy metals must be imported. (See IRON; ALLOYS; ORE DEPOSITS; and articles on the various minerals and ferroalloy metals.)

Nonferrous Metals. — These. including copper, aluminum, lead and zinc, tin, mercury. magnesium and several others, have become essential to modern industry. In the early history of man the metals that occurred in the native state such as gold, silver and copper were used for decorative and practical purposes. Either by accident or intention, copper and tin were combined to produce bronze, a metal of immense cultural and economic importance. In time other nonferrous metals acquired industrial importance. These include lead and zinc alone or in combination with other metals, aluminum, magnesium. tin and several more.

Copper. — Because of its superior quality as an electrical conductor and its usefulness as sheet metal and as a component metal in a number of alloys, copper ranks high among the nonferrous metals. Copper as a metal was known and used before the Christian era but its use in quantity came with the development of the electrical industry. Only limited quantities of copper are produced in Europe, where the mining and smelting of copper were developed early. With the development of practical methods of processing low-grade ores, many formerly uneconomic deposits have become major factors in the mining industry. The leading producers of copper ores are the United States, Chile, Northern Rhodesia, the Soviet Union, Canada and the Belgian Congo.

Aluminum. — The difficulty of separating aluminum from bauxite and a number of other aluminum-containing minerals deferred its industrial use for many centuries. The lightness of aluminum, its conductivity and its resistance to corrosion led to its use as sheet metal, for electrical equipment, in transportation equipment and for a variety of products. Bauxite, the chief source of aluminum, is produced chiefly in Jamaica, Surinam, British Guiana, France, the United States and the Soviet Union. In the production of aluminum metal the United States, Canada, the Soviet Union, west Germany and Norway, all producers of cheap electrical power, are the leading contributors. The major producers and users of aluminum are dependent upon imported raw materials with the exception of France and the Soviet Union, which are generally self-sufficient.

Lead and Zinc. — Modern industry continually requires supplies of lead and zinc. In the mid-1950s approximately 2,400,000 tons of lead were produced annually. The leading countries included the United States, Australia, the Soviet Union, Mexico, Canada and South Africa. In spite of the threat of rapid depletion of reserves, production of lead increased through the extension of known reserves and the recovery of a higher proportion of the metal in the ores.

Despite competition from aluminum and other metals, corrosion-resistant zinc is extensively used for galvanizing. Along with copper, zinc is used in the manufacture of brass. Nearly 40% of the world's zinc is produced in North America with the United States in first place. Large quantities are contributed by Canada and Mexico. The continent of Europe produces 32% of the world's supply with important contributions from the Soviet Union, Poland, Italy, Spain and west Germany. In Asia, Japan is the leading producer but larger quantities are mined in Australia. In South America, Peru is the major source. In tonnage zinc exceeds lead but both serve particular purposes in industry.

Tin. — The mining of tin ore is highly concentrated in a few centres but the metal is marketed in all parts of the world. Major production areas are in Malaya, Indonesia, Bolivia and the Belgian Congo. During World War II Japan controlled the tin resources in the far east. The United States and many other countries had to reuse tin already on hand by detinning tin cans and recovering the metal from collapsible tubes and other sources. The U.S. built a tin smelter at Texas City, Tex., and processed imported ores. chiefly from Bolivia, to help meet its needs.

Other *Nonferrous* Metals. — The list of nonferrous metals could be extended to include magnesium, antimony, mercury and several others but the metals discussed above are of major importance and are representative of this group of metals. ***(See*** ORE DE-

POSITS and articles on the various nonferrous metals.)

The Precious Metals.—Because of the nonperishable character of gold and its use as a monetary standard, the total quantity of metal in the world accumulates over the years. Small quantities are consumed, dispersed or lost each year but generally the total supply of gold in the world tends to increase. New gold comes chiefly from the Union of South Africa, the Soviet Union, Canada and the United States.

While silver does not enjoy the preferred status of gold as a monetary metal, it is widely used in domestic and international transactions. In addition to its monetary use, it is also used extensively in the arts: for tableware, jewelry, photographic film and other purposes. Some silver occurs in nature as a pure metal but more often it is only one of several metals occurring together as sulfides. Mining, smelting and refining of these ores results in the recovery of copper, nickel, lead and zinc as well as silver. North America is the leading silver continent. Mexico, the United States and Canada usually rank as first, second and third. respectively, in the mining of silver ores. Other producers include the Soviet Union, Peru, Australia and Bolivia.

Platinum, osmium, iridium, rhodium, ruthenium and palladium collectively make up the platinum group of metals. These metals are of major importance in the electrical industry, in the chemical industry, chiefly as catalysts, in the arts, especially jewelry manufacture, and in dentistry and medicine. They are most nidely used in the industrial countries. Production is highly centralized in the Union of South Africa, Canada, the Soviet Union, Colombia and the United States. (See articles on the various precious metals)

Nonmetallic Minerals.—The common earth materials such as rocks of various kinds, unconsolidated sediments such as sand and gravel, and clay and silt are so abundant in most parts of the world that any needed material not available locally can be obtained from nearby areas. Generally these earth materials are low-value, short-haul resources. Only a few, such as china clay, decorative stone and others that may have some special quality, can be transported over great distances economically.

Among the nonmetallic substances present in the earth's crust, a few have special qualities which make them vitally necessary in industry. Among these are such minerals as asbestos, sulfur, quartz crystals, mica, salt, the fertilizer minerals and several others.

Sulfur.—Modern industry is heavily dependent on sulfur for its proper functioning. Sulfur is obtained chiefly from deposits of elemental or native sulfur and from sulfur-containing minerals such as the sulfides. Along the Gulf coast of Louisiana, Texas and Mexico are numerous salt domes that contain native sulfur. This coastal strip is the world's leading producer. Other major producers of native sulfur are Italy, chiefly in Sicily, and Japan, where the deposits are associated with volcanic rocks. More widely over the world the processing of sulfide ores yields important quantities of sulfur. This is done in Spain, a long-time producer, Canada, Japan, the United States, the Soviet Union, Norway and the island of Cyprus.

Quartz.—Silica, consisting of oxygen and silicon and commonly occurring as quartz or in silicate minerals, is one of the most abundant earth materials. As quartz sand it is used for a variety of purposes from glassmaking to sandblasting. In spite of its relative abundance in nature, quartz crystals of great purity and large size are relatively rare and production to meet the needs of the electronics industry is largely centred in Brazil. (See QUARTZ; SILICA.)

Mica —A thin platelike mineral, mica is widely known in nature where it occurs in small flakes in igneous and schistose rocks. Sheet mica in large crystals occurs in pegmatite dikes and can be quarried, split and cut to the required dimensions. Large quantities of flake mica are available wherever coarse-grained igneous rocks occur and the needs of the rubber, roofing, paint and abrasive industries can be met from these sources, The high-quality sheet mica used by the electrical industry is produced in more restricted areas including India, Madagascar, eastern Siberia, Brazil and the United States. (See MICA; PEGMATITE.)

Asbestos.—Before the development of spun glass and rock wool as noncombustible and heat-resistant materials, asbestos was in high demand for these purposes. Asbestos, because of its fibrous nature, can be spun and woven into heat-resistant fabrics for fire curtains, gaskets, brake linings, fire fighters' suits and many other items. Asbestos in combination with portland cement, magnesia and other substances is used in the manufacture of roofing materials and wallboard. High-quality asbestos is produced chiefly in the Thetford area of eastern Canada, but important tonnages are contributed by the Soviet Union, the southern part of Africa and Japan. (See ASBESTOS.)

Fertilizer Minerals.—The continued productivity of the land is dependent upon the availability of four major elements, calcium. nitrogen, phosphorus and potassium, and a number of minor or trace elements including magnesium, manganese, boron, iron, copper, sulfur, zinc and others. Calcium, chiefly in the form of lime carbonate, is relatively abundant and areas without limestone can easily secure this material.

Nitrogen in the form of nitrates is widely distributed in soil but because of its solubility it is continually being lost. The nitrogen content of the soil can be maintained by the application of manures and other organic wastes to the land. Mineral nitrates. available in the Atacama desert of northern Chile, were formerly used extensively in the manufacture of commercial fertilizers. After World War I nitrogen obtained by fixation from the atmosphere became increasingly important and makes up more than three-quarters of the nitrogen content of the commercial fertilizers.

Phosphorus usually is available from phosphate rock which contains the mineral calcium phosphate. In order to make the phosphorus readily available, the phosphatic material is treated with sulfuric or nitric acid. Small quantities of calcium phosphate occur aidely in limestones and, as a result of weathering, phosphatic minerals may be residual in the soils locally. Phosphate rock in sufficient abundance to support the fertilizer industry is available in the United States. Morocco and Tunisia in north Africa, the Soviet Union and Nauru in the west central Pacific. Phosphatic material is also available from phosphorus-containing minerals and ores. For example. basic slag from the steel industry may contain enough phosphorus to justify its preparation and use as a fertilizer.

Before World War I Germany had a virtual monopoly on potash but with the loss of Alsace a portion of the production and reserves passed to the jurisdiction of France. Stassfurt, Ger., remains a major source of potash but production from deposits in New Mexico has given the United States second place. Other producers include the Soviet Union, Spain and Israel. (See FERTILIZERS AND MANURES; MINERAL PHOSPHATES.)

VI. STRATEGIC RESOURCES

All materials, inorganic or organic in origin, necessary to national defense or the prosecution of war may be said to be strategic No nation should risk involvement in a major war unless its supplies of strategic materials are adequate for an extended conflict or unless it has the capacity to produce or secure these resources by trade. Certain resources may be available in quantity but they may be regarded as strategic if they are essential to de-' fense or military effort. For example, steel and cotton are strategic materials but in the case of the United States adequate production can be maintained. The resource situation may vary from completely adequate supplies of a number of materials to negligible supplies of others. Because of technological developments, the number of materials that may be classed as strategic has grown and the problem of securing and maintaining adequate supplies has become increasingly complicated.

Stock-piling.—In the case of scarce materials the resource situation may be so critical that stock piles of a long list of metals, ores and organic materials should be built up to meet the needs of a nation while it absorbs the first shocks of a major war. Such emergency supplies should be large enough to meet wartime needs over a period of two to five years or even more, depending on the ease or difficulty of securing replacements.

Stock piles of organic materials such as rubber, fibres, timber, hides and skins, condiments and mood pulp are subject to deterioration or destruction while in storage. For example, the stock-piling of raw rubber requires that a regular and continual renewal program be maintained to keep up the quality of a nation's hoard of this essential commodity.

The program of stock-piling of Strategic materials should be reexamined from time to time to make sure that the proper quantities are maintained. People can be lulled into a false sense of security by the knowledge that the strategic materials have been stock-piled. As the needs of defense change the character and dimensions of the stock pile will need to be restudied.

Substitution. — If metals and other materials are not available in sufficient quantities to meet defense needs, the national security may be endangered. Substitute materials should be included in the stock pile or be in production so that the national economy will not suffer if it becomes necessary to substitute one material for another. If all of the ferroalloys are not accessible in the proper quantities the steel industry may make more abundant use of the alloy metals that are available. This in effect is the substitution of an abundant metal for one in short supply. During World War II, when the supply of tin was greatly reduced. glass containers and lacquered cans replaced the widely used tin can. It is evident that plastics can be used extensively to replace metals and wood. Continued research and technological developments will provide a variety of substitute materials when the need arises.

Subsidies. — In some instances a mining operation or manufacturing facility engaged in the production of a strategic material may be in financial difficulties. A modest subsidy may be all that is required to give such an industry economic stability and the prosperity it requires to continue in operation.

Trade and **Tariffs.**—National security for all nations, even such powerful countries as the U.S. and the U.S.S.R., depends upon international trade. Materials in short supply are imported and inventories and stock piles built up. To encourage this, nondiscriminatory tariffs and other politico-economic devices may be used to facilitate the movement of essential materials. *See* ECONOMIC WARFARE; MOBILIZATION, ECONOMIC.

VII. CLIMATE

On the basis of temperature and rainfall, the earth can be divided into a variety of climatic regions. Five major thermal zones may be identified: the tropical zone. the north and south intermediate zones and the north and south polar zones. On the basis of precipitation. the earth can be divided into rainfall regions: humid, subhumid, semiarid and arid. By combining temperature and moisture conditions the earth can be divided into approximately 15 major types of climate though individual climates may be repeated over the surface of the earth as many as five or six times.

Humid Tropical Climates. — Between the equator and approximately latitude 18° to 20° north and south lies an area with a humid tropical climate. Near the equator the climate is rainy at all seasons because the area is always under the influence of the doldrums. The annual amount of precipitation varies between 60 and 100 in. except in mountains where the maximum may exceed 300 in. In these equatorial areas the precipitation in the driest month may be as little as three inches in the low-sun period. When the sun is directly overhead the amount of precipitation may exceed ten inches per month. These wet equatorial climates are well developed in the Amazon basin and nearby coastal areas, in the Belgian Congo and the borderlands of the Gulf of Guinea and in Indonesia, the Philippines and the coastal margin of southeast Asia.

Generally poleward from the equatorial climates there are extensive areas that have a savanna type of climate, a name that indicates the character of the natural vegetation. These areas have a hot climate the year around with a precipitation of 30 to 60 in. The rainfall is heavily concentrated in the summer season or the high-sun period. When the sun is low in the sky and the trade winds prevail, these savanna areas are very dry. The savanna type of climate is characteristic of large areas in South America such as the llanos and the campos and of many areas in Central America and the Caribbean. In Africa the Sudan and the plateaus of east and south central Africa contain extensive savanna areas. Large areas in India, southeast Asia and northern Australia also have this type of climate.

Dry Climates. — Large areas in the trade-wind belt and in latitudes 15° to 30° north and south are characterized by desert or semiarid conditions. These dry areas extend generally poleward into the interior areas of the continents of South America, North America and Asia. Those that lie between the true deserts and the humid areas near the coasts are semiarid and characterized by the scant vegetation of the steppe.

Humid Climates of Intermediate Latitudes. — On both the west and east sides of the continents in latitudes 30° to 65° north and south the precipitation varies from 20 to 80 in. annually. In these latitudes the annual range of temperature is much greater than in the tropics. Along the west coasts temperatures are more moderate than on the east coasts, where continental extremes are common. Summers are hot and winters cold. On the west coasts the maximum precipitation comes in the winter season but on the east sides of the continents precipitation is more evenly distributed throughout the year. Interior locations generally have a warm-season maximum.

Polar Climates. — In the arctic and antarctic areas, where the sun is continuously above the horizon for as much as six months and is below the horizon for a similar period of time, the climate is characterized by a low mean annual temperature and even in summer the temperatures are low. The winters are long and bitterly cold. Limited areas that are free of ice and snow during the short summer have a tundra type of climate. Extensive areas are always covered by ice and snow and have an icecap or glacial climate. *See* CLIMATE AND CLIMATOLOGY; SEASONS; METEOROLOGY.

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NATURAL RIGHTS. The doctrine that all men equally are naturally free "to order their actions and dispose of their persons and possessions as they think fit, within the bounds of the law of nature," found its clearest expression in John Locke's *Second Treatise* of *Government* (1690), from which this passage is quoted. It is characteristic of Locke, as of modern political thought generally, that he conceived of natural law not so much as a law ultimately derived from God and imposing obligations upon men but as a principle self-evident to human reason that all men are "equal and independent" and that "no one ought to harm another in his life, health, liberty or possessions." Since men are by nature "free. equal, and independent" it follows that "no one can be put out of this estate and subjected to the political power of another without his own consent." According to Locke "the great and chief end" for which men agree to form governments, to live in community, "is the preservation of their property."

The doctrine of natural rights stems from the individualism that emerged at the time of the Renaissance and Reformation and the transformation of the medieval Christian theory of natural law (which prescribed conduct appropriate to human beings as creatures of God) into a theory of natural rights (which emphasized the self-evident character of individual freedom and equality). This transformation was accomplished principally by Hugo Grotius (1583–164j). Thomas Hobbes (1588–1679), Samuel Pufendorf (1632–94) and John Locke (1632–1704) (*qq.v.*). The doctrine which in its Lockian form emphasized the natural right to acquire unequal amounts of property, especially in the form of money, appealed to the rising middle classes and helped to supply a justification for capitalism. Although the doctrine was frequently employed in the 19th century by conservative thinkers who sought to justify the economic *status* quo, originally it had radical implications nhich were fully exploited in the American and French Revolutions.

Locke was defending the Whig revolution of 1688 but his argument was employed in the American Revolution and found succinct summarization in the Declaration of Independence (1776), which states that, "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life. Liberty and the pursuit of Happiness — That to secure these rights. Governments are instituted among Men, deriving their just powers from the consent of the governed. — That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it. . . ." The French National Assembly adopted a similar Declaration of the Rights of Man and of the Citizen in 1789 in the belief "that the grievances of the citizen, being henceforaard based upon simple and indisputable principles, should always be conducive to the preservation of the Constitution and to the happiness of all."

The doctrine did not go unchallenged and the English utilitarian Jeremy Bentham characterized natural rights as "rhetorical nonsense. — nonsense upon stilts" (*Anarchical* Fallacies, 1795). One can speak meaningfully, he contended, of legal rights but not of "natural" rights. Despite such objections, which became more numerous in the 19th century, 20th-century thinkers have persisted in proclaiming "the equal and inalienable rights of all members of the human family." a phrase which occurs in the Universal Declaration of Human Rights adopted by the general assembly of the United Nations at its meeting on Dec. 10, 1948, in Paris.

The revolutionary significance of the doctrine of natural rights which emerged in the 17th century was the fact that it sought to ground government upon individual will and consent. Society itself was thought to be the product of a contract; justice was no longer conceived as embodying principles transcending individual will and consent but rather as a reflection of the terms of the contract. In the Christian tradition as reflected in the thought of St. Thomas Aquinas, as well as in the older Aristotelian tradition, the purpose of the state was dictated not by the subjective desires of individuals but by the nature of man and the end for which he is destined. The state was conceived as existing to promote justice among men, to help men to become better human beings, to help unleash their creative capacities for good and to restrain their propensity to do evil. Justice was not a subjective concept but was rooted in objective reality. Within this tradition individuals are conceived as having rights as human beings but the rights derive from duties rather than the duties from the rights.

The proclamation of "equal and inalienable rights of all members of the human family" would appear to stem from the conviction that there are principles of justice which transcend the positive laws of any society, principles which are the same for all men in all places at all times. They provide the inspiration for social justice and the norms for evaluating existing legislation. They are the raison *d'être* of constitutional government.

Difficulties arise when an effort is made, as it must be made in practice, to distinguish between the possession of such rights and their exercise. Not only may the rights claimed by one individual conflict with the rights claimed by another, but questions arise as to the priority to be established among rights. Is "the pursuit of happiness." which the proclamation of human rights is designed to foster and protect, to be conceived in hedonistic terms or in terms of a life of reason or a life of spiritual growth in awareness of God?

There is more widespread agreement concerning the enumeration of human rights than there is agreement concerning their ultimate justification and practical exercise. Ultimately these disagreements reflect basic disagreement concerning what constitutes the good life for man. Much depends upon whether this good is conceived in material or spiritual terms, whether man is conceived to be primarily a producing and consuming animal or a spiritual creature whose ultimate destiny lies beyond life in this world. In speaking of natural rights much hinges upon how "nature" is interpreted, whether we mean by "nature" how men do in fact act when unrestrained by reason or how men ought to act in order to perfect their natural (human) potentialities.

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NATURE RESERVES: see NATIONAL PARKS AND NATURE RESERVES; WILDLIFE CONSERVATION.

NAUKRATIS, an ancient Greek settlement in Egypt. The site uas discovered by W. M. Flinders Petrie in 1884, on the eastern bank of a canal, about 10 mi. W. of the present Rosetta branch of the Nile. In ancient times it was approached by the Canopic mouth, which was farther to the west.

The identification of the site is placed beyond doubt by the discovery of inscriptions with the name of the town and of great masses of early Greek pottery. A list of the temples of Naukratis is given by Herodotus; they were the Hellenion, common to all the colonizing cities, and those dedicated by the Aeginetans to Zeus, by the Samians to Hera and by the Milesians to Apollo. A temple of Aphrodite is mentioned by Athenaeus. A temple of the Dioscuri was also found.

In addition to these temples, there was a great fortified enclosure, about 860 by 750 ft., in the southeastern part of the town; within it was a square tower or fort. Another great walled enclosure was found to the northeast of the town.

Apart from the historic interest of the site, as the only Greek colony in Egypt in early times, the chief importance of the excavations lies in the rich finds of early pottery and in the inscriptions upon them, which throw light on the early history of the alphabet. There are clear traces of a settlement going back to the 7th century, including a scarab factory, and yielding fragments of early Greek pottery. It seems a fair inference that the makers of these were Greeks, and that they probably represent the early Milesian colony, settled there in the time of Psammetichus I.

NAUMACHIA, the Greek word denoting a naval battle, used by the Romans as a term for a mimic sea fight. These entertainments took place in the amphitheatre, which was flooded with water, or in specially constructed basins (also called naumachiae). The first on record. representing an engagement between a Tyrian and an Egyptian fleet, was given by Julius Caesar (46 B.C.) on a lake which he constructed in the Campus Martius.

See GAMES, CLASSICAL; PANATHENAEA; ROME: Ancient City.

NAUMBURG, a town in the district of Halle, Ger., in the former *Land* of Saxony, on the Saale, near its junction with the Unstrut, 29 mi. S.W. from Halle. Pop. (1959 est.) 37,607. In the 10th century it was a stronghold of the margraves of Meissen, who in 1029 transferred it to the bishopric of Zeitz.

The bishopric fell to the elector of Saxony. In 1631 the town was taken by Tilly, and in 1632 by Gustavus Adolphus. It became Prussian in 1814. The cathedral, a building in the Romanesque Transition style (1207–42), is remarkable for its large crypt and its towers.

NAUNDORFF (NAÜNDORFF), **KARL WILHELM** (d. 1845), French pretender. claimed to be the dauphin Louis Charles, son of Louis XVI and Marie Antoinette, who was announced as having died in the Temple in 1795.

Kaundorff, who had arrived from nowhere in Berlin in 1810, with papers giving the name Karl Wilhelm Naundorff, in order to escape the persecutions of which he declared himself the object, settled at Spandau in 1812 as a clockmaker, and married in 1818 Johanna Einert. In 1822 he removed to Brandenburg, and in 1828 to Crossen, near Frankfurt. He was imprisoned from 182j to 1828 for coining, though apparently on insufficient evidence, and in 1833 came to push his claims in Paris, where he was recognized as the dauphin by many persons formerly connected with the court of Louis XVI. Expelled from France in 1836, the day after bringing a suit against the duchess of Angoulême for the restitution of the dauphin's private property, he lived in exile until his death at Delft on Aug. 10, 1845.

NAUPLIA, a town in the Peloponnesus, Greece, at the head of the Argolic gulf, the seaport of the plain in which Argos and Mycenae are situated, with several tombs of the Mycenaean age. A hero Nauplius took part in the Argonautic expedition; another was king of Euboea. In classical times it was of no importance, and Pausanias, about A.D. 150, found it deserted. The mythic importance of the town revived in the middle ages, when it became chief city of the Morea. It was captured in 1211 by Godfrey Villehardouin with the help of Venetian ships; a French dynasty ruled in it for some time and established feudalism. In 1388 the Venetians bought Argos and Nauplia. In the wars between Venice and the Turks it often changed masters: given to the Turks in 1540, it was recaptured by Venice in 1686, and the Palamidhi hill was fortified. In 171j it was taken by the Turks; in 1770 the Russians occupied it for a short time. The Greeks captured it during the War of Independence on Dec. 12, 1822, and it was the seat of the Greek administration till 1834, when Athens became the capital of the country. It is the chief town of the department of Argolis. Pop. (1951) 8.459.

NAUSICAA, in Greek legend, daughter of Alcinous, king of the Phaeacians in the island of Scheria. When Odysseus (*q.v.*) swam ashore to Scheria, he was found by Nausicaa, who supplied him with clothes and took him to her father's palace, where he was hospitably entertained.

NAUTCH, a dance form of India, literally, any art presentation of song and dance combined. After about 192j the title was generally applied to the stage presentation of dances of Marwari women who wear and manipulate the wide *gargari* skirt. Spinning turns, the beating of belled feet, coquetry and fluid arm movements are characteristic. (R. M. Hs.)

NAUTILUS, the name given by the ancient Greeks to a cephalopod mollusk, *Argonauta argo* (the paper nautilus). Linnaeus, however, applied it as a scientific designation to another cephalopod, the pearly nautilus of eastern seas, and named the "nautilus" of the Greeks, *Argonauta.* The structure and zoological position of the pearly nautilus are discussed in the article CEPHALOPODA. It is represented at the present time by four species, which are restricted to the area between the Fiji and the Philippine islands. It usually lives near the sea bottom at considerable depths, though at night it comes into shallow water where it is caught for food by the natives.

The paper nautilus (*Argonauta*) is found in practically all subtropical and tropical seas. Although it has been taken from depths of more than 500 fathoms it is characteristically found at the surface. It is placed along with a few other genera in a separate family of the Octopoda or eight-armed cephalopods. The genus is characterized by several very peculiar features. In the first place the male *Argonauta* is very much smaller than the female, the latter in certain cases being as much as 15 times the size of the male. Like the rest of the Octopoda the male *Argonauta* lacks an external shell, but the two dorsal arms of the female secrete a calcareous shell which is unique in the mollusk phylum. Its origin from the arms is unlike that of the shell of other mollusks, which is developed from the mantle. Moreover this shell is used as a receptacle for the eggs and in it they are incubated until the young are hatched out. (G. C. R.)

NAUVOO, a small historic town in Hancock county in western Illinois, U.S., situated on the Mississippi river about 15 mi. S. of Fort Madison, Ia., and 50 mi. N. of Quincy, Ill. The population is about 1,000. Chief industries are nine and *bleu* cheese making. A grape festival held each fall includes the "wedding of wine and cheese," a ceremony brought from Roquefort, France. In Nauvoo is St. Mary's academy, a Roman Catholic boarding school for girls

Nauvoo's history and significance is especially related to the Mormon era in Illinois history (see LATTER-DAY SAINTS. CHURCH OF JESUS CHRIST OF: *Nauvoo*). When the Mormons arrived in 1839 there were already a few buildings in what was called Commerce City; it mas renamed Kauvoo (Hebrew for "beautiful place") by Joseph Smith.

Following the exodus of the Mormons to Utah in 1846 the town was settled temporarily by a new group. the Icarians, a body of socialists chiefly of French origin; their founder and leader was Étienne Cabet (*q.v.*) of Dijon, France. After purchasing land, Cabet proceeded to establish a communal settlement not unlike other so-called communistic, frontier experiments of the time. At their peak the Icarians at Nauvoo numbered between 1.200 and 1,800. The community was open to anyone who would pay the introductory sum of 300 francs and would donate all his possessions to the community. Men 21 and over and women 18 and over were extended suffrage. A community school was established with separate instruction for boys and girls and a large community dining hall was constructed in the remains of the Mormon temple where all members of the community took their meals. Their economic theories proved unworkable in a frontier situation, however, and the Icarian community was doomed to early failure. A crisis developed when Cabet demanded and mas refused dictatorial powers over the settlement. Voted from office, he left Nauvoo with 200 loyal follouers and went to St. Louis, where he died soon after on Nov. 8, 1856. The community never recovered from the split; it soon disbanded and the members were absorbed into the general population.

Evidences of the Mormon and Icarian settlements are still standing, particularly in the area set aside in 1948 as the Nauvoo state park. A number of buildings are maintained as shrines by the Reorganized Church of Latter-Day Saints. (G. R. GA.)

NAVAHO, the largest Indian tribe in the United States, numbering close to 90,000 in 1960 according to estimates of the bureau of Indian affairs. Contrary to the myth of the "vanishing Indian," their numbers have increased remarkably; in 1868 there were not more than 12,000. The Navaho reservation and government-allotted lands in the states of New Mexico, Arizona and Utah comprise an area roughly the size of New England without Maine. The region, however, is mainly arid and will not support enough agriculture and livestock to provide a livelihood for the tribe. Thousands earn their living as transient workers away from the Navaho country, and appreciable numbers have settled more or less permanently on irrigated lands along the lower Colorado river and in cities such as Los Angeles and Kansas City.

The Navaho speak a language closely related to the Apache tongues and more distantly related to other Athabascan languages spoken in California, Oregon and northwestern Canada (see ATHABASCAN). The ancestors of the Apache and Navaho undoubtedly came from the north and probably did not reach the southwest until A.D. 1000 or later. The Navaho borrowed extensively from the Pueblo Indians: agriculture, weaving, sand paintings and ceremonial traits. Later they acquired livestock from the Spanish through the Pueblos. In the 19th century they learned metalworking from the Mexicans and came to specialize in the silversmithing for which — along with Navaho rugs — they are famous. Painted pottery was never strongly developed and the arts of pottery and basketry have nearly disappeared. The traditional type of house — the hogan — is made of logs plastered with earth and sticks, and always faces to the east. In some localities, hogans are made of stones. Nearby is a sweat house, where male members of the family bathe in ceremonial fashion.

Social Organization. — The Navaho trace descent through the mother, and residence of a newly married couple is most often near that of the bride's mother. The brothers of the mother take certain responsibilities for the upbringing, marriage and property of their sister's children. Traditionally, inheritance was mainly in the mother's line, but this custom is breaking down in the face of the law of the United States and the practices of the English-speaking neighbours of the Navaho. Today children often inherit from both parents.

There are about 60 clans. A Navaho belongs to the clan of his mother but also considers himself related to the clansmen of his father. No Navaho may take a spouse uho belongs to the clan of either parent. Indeed the circle of forbidden matings is larger, for some clans are considered to be "linked," and marriage into such clans closely associated with the parental ones is also forbidden. In modern times clans function largely in the regulation of marriages, although one owes a clan relative hospitality and certain other courtesies. In the past, clan as well as biological relatives could claim part of the property left by a deceased person. Some clans have a particular association with certain ceremonials.

Traditional Navaho society was organized primarily along the lines of kinship. Toward one's relatives on the mother's side and on the father's side and toward one's connections by marriage one had specified obligations according to the kinship category in question. These relatives had. of course, reciprocal duties. Even the permitted and expected forms of joking between two classes of relatives were prescribed in some detail. The code of behaviour to ard those not related either by biology or by clan was an extension of these: "Behave toward everyone as you behave with your relatives."

Religion. — The religious system is intricate. Some of the many myths relate the emergence of the first people from various worlds beneath the surface of the earth; others tell stories which justify the numerous rites that are performed. Some of these are simple rituals carried out by individuals or families for luck in travel, trade and gambling and for protection of crops and herds. The more complex rites demand a specialist who is paid according to his skill and the length of the ceremonial. One type of specialist is the "diagnostician," who carries out one of various forms of divination to determine what is required. Most rites are primarily for the purpose of curing an illness, mental or physical. Ordinarily, ill-health is held to have a supernatural cause, such as the violation of a taboo or the malevolent activity of ghosts or witches. The patient is purified by emetics and sweating. fed herbal medicines, sung and prayed over, placed upon a sand painting. In other ceremonies there are simply prayers or songs, and dry paintings may be made of pollen and flower petals — rather than of minerals upon a background of sand. In some cases there are public dances and exhibitions at which hundreds or thousands of Navahos gather.

Whites often attend these, especially the "squaw dance" which is frequently held during the summer months. This "girl's dance and sway-singing" (as the Navaho call it) is a feature of an ancient war ceremonial held to cure men who had been made sick by the ghosts of slain enemies. In modern times it serves as a marriage mart where young people meet each other and parents and other relatives can discuss the economic arrangements for projected alliances. More solemn are the night chants and mountain chants, held in the autumn months "after the thunder sleeps." The former concludes with all-night singing and dancing by masked impersonators of the divinities, and the latter with the famous fire dance in which the almost naked participants jump through flames and chase each other with burning brands.

Arts. — There are hundreds of Navaho silversmiths, principally men. For most of them silversmithing is a part-time occupation, but some are full-time professionals, either self-employed or working for stores both on and off the reservation. They make bracelets, necklaces, rings and other kinds of jewelry. Turquoise and, to a lesser extent, coral and various stones are used as settings. Silver pieces are both hammered and cast. Increasingly in modern times tableware. cigarette boxes and other articles are made for white use. First American and later Mexican coins were the source of the silver; now it is supplied by traders. The Navaho — mostly the women — have practised the art of weaving wool since at least 1706. The earliest surviving specimens date from the first years of the 19th century. The "classical" period. which attracts most collectors, dates from the late 1840s to about 1875. The blankets, poncho blankets and women's dresses from this period exhibit both technical excellence and great beauty of design. While hand-spun yarns continued to be used as weft elements in coarser utility articles, ravelings of a red cloth, imported from England and called in Spanish bayeta, were prominent in loom goods intended as body coverings. Bayeta provided a shade of red brighter than could be obtained from the native dyes then available. Three-ply yarns (Saxony and zephyr) of European manufacture were also introduced by some traders.

After the mid-1870s the importation of bayeta and other foreign yarns declined. Four-ply yarns (Germantown type) made in the United States were often substituted. At about the same time the increase in the availability of manufactured clothing and other textiles brought about a gradual shift in the type of articles woven. Since 1890 the Navaho have woven only saddle blankets and women's sashes for their own use, concentrating the bulk of their production on floor coverings purchased by whites. These rugs are of varying quality and aesthetic appeal. Commercial dyes of garish colour have frequently been employed, and outlandish designs (railroad trains, flags, masonic emblems and the like) have sometimes been woven. On the other hand, many rugs of the 20th century have been produced in the natural colours of white. black, brown and gray or in the soft tones derived from vegetable dyes. A small number of rugs reproducing sand paintings have been woven, often by the few Navaho men who weave. In the past all adult Navaho women knew how to spin, card and weave, and most of them produced rugs, at least occasionally.

The Navaho Today. — In spite of the activities of missionaries and of U.S. government officials, Navaho religion and social behaviour remained — except in areas immediately adjacent to the railroad and the highway — little altered until about the time of World War II, when several thousand tribesmen entered the armed services and thousands more worked in defense industries. The period after 1946 was one of vast change. Many Navaho moved into white-style cabins and began to dress much like their non-Indian rural neighbours. The level of literacy and of competence in English greatly increased. After 1955 the vast majority of children of school age were receiving instruction, as opposed to a minority in earlier years; 26,787 Navahos between the ages of 6 and 18 were in school in 1957 — 91% of this age group. The tribal council, using funds accruing from gas, oil and mineral royalties. was providing loans and scholarships for hundreds of young people to attend college or pursue other forms of advanced training. In 1956–57, 294 Navaho were attending institutions of learning beyond the high school level. The council was also vigorous in building roads and motels to attract tourist income, and in inviting small industries to locate on or near the reservation.

The income of the tribe from oil and gas leases and royalties came to $1,500,000 for 1956. In the same year tribal income from other minerals came to about $500,000, and there were also substantial increments from timber and other tribal properties. In addition, the tribe has received very sizable lease bonuses — about $45,000,000 from 1950 through 1957. The tribal budget for 1958 went to more than $14,000,000, of which about half was allocated to capital investments. The remainder was assigned to such categories as community services, legal and judiciary, management of minerals and range lands and operations of the tribal council.

There remained many serious problems for the tribe. Per capita income was low. About 1,590 Navahos were the recipients of public financial assistance in 1957. Of those relocated off the reservation nearly 40% had returned; yet the reservation could not support steadily increasing numbers. Young people who received training beyond high school found it difficult to obtain positions with salaries appropriate to their skills.

Death rates were still very high; of major causes of death only those for heart disease and malignant growths were appreciably lower than for the United States as a whole. Tuberculosis and certain diseases of the intestinal tract were nine times as great and accidents and various diseases of early infancy twice as great as the U.S. average. *See* INDIAN, NORTH AMERICAN: *Southwest Periphery; see* also references under "Navaho" in the Index volume.

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NAVAL ACADEMY, UNITED STATES: *see* MILITARY, NAVAL AND AIR ACADEMIES.

NAVAL AFFAIRS (ARTICLES ON). The survey article SEA POWER analyzes the nature of the influence that navies and naval bases have exerted on the course of history. and the contributions to combat strength of ships of various categories. The principles of naval warfare are outlined, and illustrated in terms of decisive battles, in NAVAL STRATEGY AND TACTICS; ATLANTIC, COMMAND OF THE; and PACIFIC, COMMAND OF THE.

The roles of the various components of a navy in contesting control of the sea lanes and in serving as mobile bases for artillery and aircraft are summarized in FLEET. NAVAL. Individual types of warship are described, and their historical backgrounds and contemporary roles discussed. in a series of articles that includes AIRCRAFT CARRIER; BATTLESHIP; CORVETTE; CRUISER; DESTROYER; FIRESHIP; FRIGATE; MONITOR, NAVAL; and SUBMARINE. Navies of antiquity and the strategic plans around which they were built are discussed in NAVIES, EARLY HISTORY OF.

Articles on naval installations include DOCKYARDS AND NAVAL BASES; and BUKKERING, SHIP. NAVAL SCHOOLS, U.S., describes the general educational program and specific types of functional training for enlisted men of the U.S. navy and naval reserve. The training of professional officers is treated in MILITARY, NAVAL AND AIR ACADEMIES.

Various shipboard activities in war and peace are covered in such articles as GUNNERY, NAVAL; KNOTS; NAVIGATION; RULE OF THE ROAD AT SEA; SEAMANSHIP; and SIGKAL COMMUNICATION. Articles on equipment include ARMOUR, NAVAL; BUOY; ECHO SOUNDER; LOG, MARITIME; MINE, NAVAL; PARAVANE; RADAR; RADIO; SONAR; TORPEDOES; etc.

Specialized phases of naval warfare, in addition to those mentioned above, are described in BLOCKADE; COAST DEFENSE; and CONVOY. Articles devoted to special branches of naval service include COAST GUARD; MARINES; and SEABEES.

Many articles deal in whole or in part with the relationship between sea power and international relations. These articles include ANGARY, RIGHT OF; CONTRABAKD; EMBARGO; MARE CLAUSUM AND MARE LIBERUM; NORTH ATLANTIC TREATY ORGANIZATION; PARIS, DECLARATION OF; PRIZE COURTS AND PRIZE LAW; STRAITS QUESTION; VISIT AND SEARCH; WATERS, TERRITORIAL; WATERWAYS, INTERNATIONAL; etc. Additional listings are given under INTERNATIONAL RELATIONS (ARTICLES ON).

Articles on wars and major campaigns that contain sections on naval warfare include AMERICAN CIVIL WAR; AMERICAN REVOLUTION; DARDANELLES CAMPAIGN; DUTCH WARS; FRENCH REVOLUTIONARY WARS; NAPOLEONIC CAMPAIGNS; SEVEN YEARS' WAR; etc. Additional articles are devoted to great naval battles; *e.g.,* ARMADA; COPENHAGEN: *Battle of Copenhagen;* CORONEL, BATTLE OF; DOGGER BANK; FALKLAND ISLANDS, BATTLE OF; FIRST OF JUNE; JUTLAND, BATTLE OF; "MONITOR" AND "MERRIMACK," BATTLE OF; NAVARINO, BATTLE OF; NILE, BATTLE OF THE; QUIBERON, CAMPAIGN AND BATTLE OF; SAINTS, BATTLE OF THE; ST. VINCENT, BATTLE OF; TOULON: The *Battle* of *Toulon* (1744); TRAFALGAR, THE BATTLE OF; YORKTOWN.

Further information on the historic encounters of individual navies and on their contemporary status will be found in history and defense sections in articles on nations; *e.g.,* FRANCE; GERMANY; GREAT BRITAIN; UNITED STATES (OF AMERICA).

Questions of administration and personnel are dealt with under ADMIRAL; ADMIRALTY; INSIGNIA, MILITARY; MEDICAL SERVICES, MILITARY; MIDSHIPMAN; STAFF, NAVAL; UNIFORMS; etc.

Articles on related topics include those listed under MILITARY AFFAIRS (ARTICLES ON); also, such articles as BOAT; SEAPLANE; SHIP; and SHIPBUILDING (MERCHANT AND NAVAL).

Biographical articles summarize the careers of the great naval strategists and tacticians.

Wherever comprehensive information on a topic is desired, the Index should be consulted for an inventory of material connected with it.

NAVAL ARCHITECTURE is the art and science of designing boats and ships to perform the missions and to meet the requirements laid down by the prospective owners and operators. It involves knowledge of mechanics, hydrostatics, hydrodynamics, steady and unsteady body motion, strength of materials and design of structures. A good naval architect and ship designer must have experience in a number of fields of engineering. He must also understand the characteristics and properties of construction materials and be familiar with the latest and best methods of fabricating parts and joining them. Like other branches of engineering, naval architecture involves estimates and predictions of the final performance of the ship and all its parts. Such calculations must be made while the ship is still in the paper stage in the form of plans and specifications.

This article is divided into the following sections and subsections:

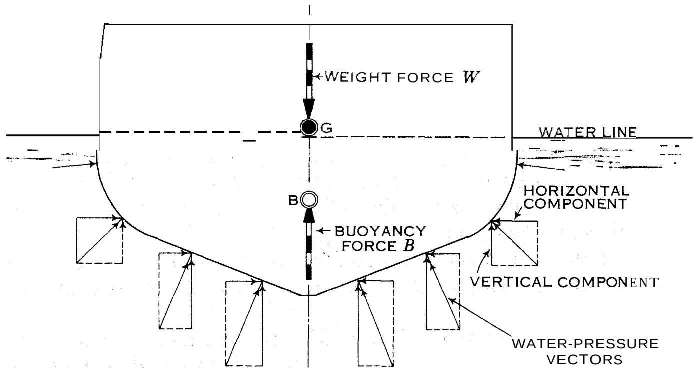


FIG. 1.—FORCES ACTING ON A SHIP HULL AT REST IN CALM WATER

I. THE MISSION OF A SHIP

The detail requirements for any given ship are made up on the basis of its mission. Just how much cargo and how many passengers is it to carry? What are the limitations on draft in the harbours it must enter? What is to be its maximum or sustained speed, and under just what conditions? What must be its cruising radius. in terms of days as well as of distance? For a tug, the towing pull or free-running speed must be stated. For an icebreaker, capacity to push its way through ice of a specified thickness must be shown. For a warship, the armament must be given, and the boundaries to be protected by armour must be specified.

The wide variety of missions for watercraft produces a great number of distinct and specialized types. Considering naval architecture and design. these are subdivided roughly into two main classes, warships and merchant ships. But the distinction is not alnays a sharp one. A naval transport may closely resemble a merchant passenger ship, and may be designed in the same way. A fast motor cruiser may be designed like a PT boat nithout torpedoes, guns and depth charges. In fact, the navy of any nation includes many merchant types, among them store and supply ships. oilers, ammunition- and missile-supply ships, repair ships, tenders for small craft, hospital ships and personnel transports.

II. WEIGHT AND BUOYANCY

1. Hydrostatic Forces.—A ship floating at rest in calm water is acted upon by two gravity forces: weight and buoyancy. Weight is the downward force on the ship. The total weight force (W) acts on the ship as if it were concentrated at the balancing point or the centre of gravity (G). Buoyancy is the upward force of all the hydrostatic pressures on the hull. The horizontal components of the water pressures on unit areas of the ship's sides and bottom, increasing with depth, act in opposite directions and cancel each other (fig. 1). The vertical components of the water pressures on unit areas combine to form an upward force (B) equal to the weight of the water displaced by the underwater hull volume. This weight varies slightly with the specific gravity of the water. The centre of buoyancy (B) lies at the geometric centre of the immersed volume. The ship sinks in the water until the force B exactly equals the force W.

2. Calculation of Ship Weight and Buoyancy **Volume.**—In an early stage of the design, the ship weight is estimated as the sum of the weights of the cargo, hull, fittings! equipment, propelling and auxiliary machinery, piping systems. electrical and electronic gear, fuel, water, consumable stores, passengers and crew, plus a margin of a few per cent for weights that are underestimated. At a later stage the weights are calculated more precisely, or are taken from actual weights of similar items. In many cases, the weight estimates are revised constantly as the design proceeds to avoid an ultimate overweight that might detract seriously from the ship's performance.

The underwater volume of the ship under design must be adequate not only to displace a weight of water that will support the entire ship, but it must be so disposed in length, breadth and height and so shaped in every part that all the other operating and naval architectural requirements are fulfilled. When the ship is built and fully laden it must float level and upright at the designed water line (fig. 2).

As the naval architect fashions the underwater and above-water portions of the hull and maintains a running check of the estimated weights and calculated buoyancy volumes, he also keeps track of the products of these weights and volumes times the horizontal fore-and-aft distances or "moment arms" of each from the transverse vertical reference plane at mid-length. These products are known as the longitudinal weight and buoyancy moments.

To carry out these operations systematically, the underwater hull is divided into segments by imaginary transverse planes called stations. There may be 10 such segments for a boat, 40 or more for a large ship. The volume of each segment is computed together with the position of the centre of volume for each. The forward and after moments of volume are then computed in the same way as for the fore-and-aft moments of weight. A summation of the individual segment volumes gives the total underwater hull volume. The fore-and-aft positions of the centres of gravity of the individual weight groups are then estimated. Separate sums are kept of the moments of these groups forward of and abaft the mid-length. Dividing the total underwater hull volume by the volume per unit weight of the fresh. brackish or salt water in which the ship is to run gives the neight of nater displaced This must equal the total neight if the ship is to float at the designed water line. The net weight moment. forward of or abaft mid-length, is divided by the total weight to give the distance at nhich the centre of gravity (G) lies forward of or abaft the mid-length. The same operation for the volume moments gives the fore-and-aft position of the centre of buoyancy (B).

3. Achieving Level Attitude or Trim.—For the ship to float at the level attitude or zero trim desired, G and B must lie in the same vertical transverse plane (fig 2). If their calculated positions are different, and the size, proportions and shape of the underwater hull are satisfactory, it is customary to shift the weights within the hull until the desired trim is attained.

In practice, the record of estimated weights and fore-and-aft moments is accompanied by a record of vertical moments above the keel (K) or the base plane. From this it is possible to estimate the position of G above K. At the same time, a record is made of vertical moments of buoyancy. When summed up and

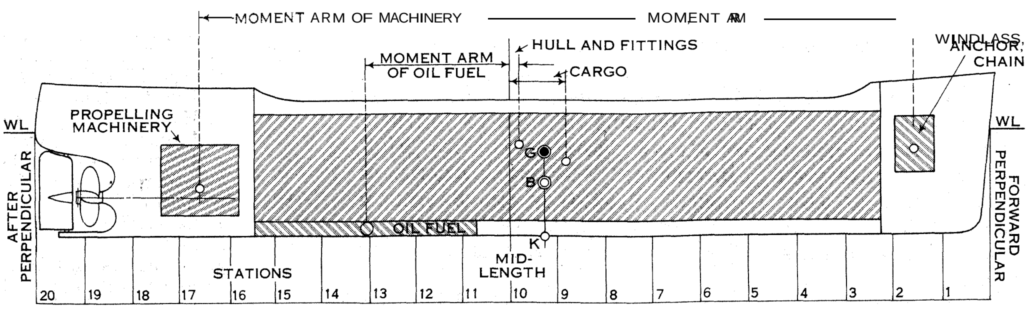


FIG. 2.— CENTRES OF BUOYANCY, GRAVITY AND PRINCIPAL WEIGHTS FOR A SHIP

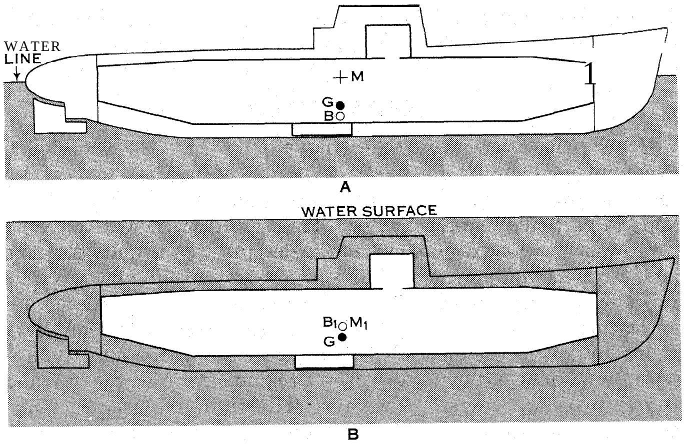


FIG. 3.— RELATIVEPOSITIONS OF CENTRES OF BUOYANCY AND GRAVITY FOR A SUBMARINE (A) DURING SURFACE CONDITION WHEN MAIN-BALLAST TANKS ARE EMPTY TO PROVIDE RESERVE BUOYANCY AND (B) DURING SUBMERGED CONDITION WHEN MAIN-BALLAST TANKS ARE FLOODED

B = centre of buoyancy of the outer hull; B_1 = centre of buoyancy of pressureproof hull

divided by the volume, these give the position of B above the keel. Both the distances $\overline{KG}$ and $\overline{KB}$ are required for estimating the metacentric stability, discussed below.

If, when the ship is built, the actual weights and volumes, or their centres, do not agree exactly with the estimated values (some equipment may have been added during the construction period), the ship floats at a water line slightly different from that contemplated by the operator and designer. For a surface ship this difference is usually of no great importance. However, for a submarine, *W* and B must equal each other exactly. It is' also important to ensure that, when submerged, the centres G and B are in the same transverse plane, so that the craft floats level when stopped under water (fig. 3).

The weights and weight moments for a submarine are estimated and calculated exactly as for a surface ship but two separate volumes must be calculated, one for the surface condition. nith main-ballast tanks empty, and one for the submerged condition, involving principally the volume of the pressureproof hull. To the volume of the latter there must be added the water-excluding volumes of all parts external to it. Among these are the outer hull structure, shafting, propellers, rudders and diving planes, anchors and chains, masts and periscopes, and the great multitude of external items. For every seven tons of solid steel in this category, about one ton of buoyancy force is gained.

III. METACENTRIC STABILITY

1. Concept of the **Metacentre.**—One would think, at first sight, that the average surface ship of fig. 1, nith its weight concentrated above its point of support (considered as the centre of buoyancy), would fall over like a top that has stopped spinning. But if properly designed it does not do so, because as the ship is inclined transversely. say by a strong wind, the centre of buoyancy of the immersed portion of the hull shifts sideways, in the same direction as the inclination. This is because the volume of the wedge of emersion (fig. 4) shifts to the low side, in the position indicated for the wedge of immersion. At the new inclined water line (W_1L_1) the centre of buoyancy moves from B to B_1. The total buoyancy force continues to act upward along the true vertical, now in the direction of B_1M. Provided no weights shift as the ship inclines, the centre of gravity remains at G, in the keel-to-deck centreline. The buoyancy force acting upward along B_1M and the weight force acting downward through G produce a righting moment $W(\overline{GZ})$ which acts to return the ship to its upright position.

For small angles of inclination 4. say less than 10°, the verticals through the shifted centres of buoyancy intersect the ship centreline at or close to a point M, called the metacentre. The stability provided by the action described is therefore called metacentric stability. For the situation diagramed in fig. 4, the one most often encountered in practice, it is transverse metacentric stability. For a similar situation in which the ship is inclined or trimmed in its fore-and-aft centre plane, it is longitudinal metacentric stability.

If the centre of gravity of the ship is too high, as at G_1 in hg. 4, the righting moment for any inclination is negative; that is, it acts to incline the ship still further. The ship then has transverse metacentric instability. Whether it will capsize or not depends upon whether the position G_1 is overtaken by the vertical through B_1 as the inclination increases. If so, the ship remains in that inclined position, with a righting moment that is practically zero.

2. Indexes of Metacentric Stability. — The distance $\overline{GM}$ for positive stability, known as the metacentric height, is taken as one index of the degree of metacentric stability. The other is the range of stability, or the angle of inclination at which the metacentric height diminishes to zero. For example, when a ship is heeled transversely until the depressed deck edge goes under water (fig. 4[B]), the centre of buoyancy B_2 cannot move to the inclined side far enough to keep the metacentre M_2 well above the centre of gravity G_2 on the ship centre plane. At a critical inclination the metacentre lies at the centre of gravity and the righting moment disappears. For inclinations beyond this the metacentric height becomes negative, the righting moment becomes a capsizing moment and the ship rolls over.

A greater range of metacentric stability is built into a ship by raising the uppermost watertight deck to a higher position above the calm-nater plane of flotation. The ship can then heel to a greater angle before water comes over the lower deck edge. For a craft like a sailing yacht, with a deep, heavy stabilizing keel, the deck edge can actually go under water and the range of positive stability can extend to large angles, provided water is kept out of the hull as the water level climbs higher and higher over the inclined deck.

The desirable value of transverse $\overline{GM}$ varies with the type, size and service of the ship. but within limits it is still subject to the experience and judgment of the naval architect. It averages from 0.04 to 0.06 of the beam but may be as high as 0.10 of the beam for combatant vessels subject to heavy damage. For fishing vessels it may have two values, one for the outgoing and one for the return or loaded part of the voyage. The range of positive transverse $\overline{GM}$ for a normal ship to run in the open sea is usually in excess of 40° and may run as high as 70° or more, provided the hull remains intact and the weights do not shift.

3. Vertical Position of **Metacentre.**—The height of the metacentre above the keel. or other selected point, depends upon the shape and size of the underwater body and of the at-rest water line. The total height $\overline{KM}$ (fig. 4) is the sum of the height $\overline{K}$B of the centre of buoyancy above the keel and the height B$\overline{M}$ of the metacentre above the centre of buoyancy, The latter is known as the metacentric radius. The distance KB can be estimated by an approximate formula; it can be calculated by procedures applying to irregular volumes; or it can be determined by a mechanical integrator. The distance $\overline{BM}$ is the quotient of **I** divided by V, where *I* is the square moment of area of the water line plane from W to L (the sum of each unit of area multiplied by the square of its distance from the centreline) and V is the immersed

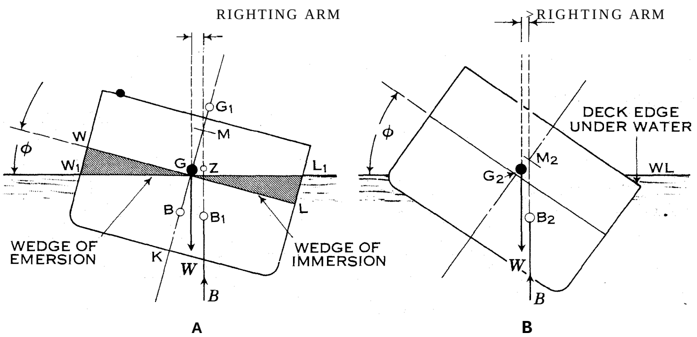


FIG. 4.— FORCESACTING ON A SHIP WHEN HEELED

volume. For a given ship length and underwater volume, both I and $\overline{BM}$ are proportional to the cube of the beam, so that the latter is an important factor in transverse metacentric stability.

4. Vertical Position of Centre of Gravity.— The vertical position of the centre of gravity is as important as that of the metacentre in determining metacentric stability and the behaviour of the ship at sea. For a cargo ship, or even for a warship. this position may change by many feet, depending upon the nature, amount and vertical position of the loads, fuel and stores. Ballast may be used to increase the total moving mass in a seaway or to place G in a more advantageous position. Ice accumulating on the upper works of fishing boats, trawlers and other small craft may be so thick, so heavy and so high above the normal centre of gravity, as well as so difficult to remove at sea, that G rises above M and the craft capsizes.

5. Inclining Experiment.— Fortunately, the naval architect is able to make a full-scale check of the predicted or calculated metacentric stability before the completed ship goes to sea. By shifting liquids or solid masses whose weights and offset positions are known accurately, the centre of gravity of the whole ship is shifted and the ship is heeled. This shift, corresponding to the distance $\overline{GZ}$ in fig. 4, is sideways for a determination of transverse $\overline{GM}$ and lengthwise for a measurement of longitudinal $\overline{GM}$. The angle of inclination ϕ of the ship for each such shift is measured accurately with special devices. Then from the relation $\overline{GZ} = \overline{GM} \sin \phi$, the actual metacentric height GM is determined for that loading condition. The height of the centre of gravity above the keel is then calculated from the relation $\overline{KG} = \overline{KB} + \overline{BM} - \overline{GM}$.

6. Stability **of Submarines.**—When a submarine is in surface condition its metacentric stability situation is the same as that of any surface ship. When diving or submerging its water-plane area diminishes progressively to a negligible amount. The square moment of area I_T of this plane likewise diminishes and with it the value of $\overline{BM}$. Moreover, as the main-ballast tanks are flooded and the pressure hull is taken under, buoyancy is transferred from a low to a high position, so B rises in relation to the hull. Since G remains in its original position, M drops to the vicinity of G. Indeed, for some moments during diving and surfacing it may be below G, with a negative $\overline{GM}$. The flooding, venting and blowing of the main-ballast tanks, with separate port and starboard controls, enable the submarine crew to counteract any list that may develop during this brief transition period.

When the submarine is under the surface the water-plane area is zero, as is $\overline{BM}$. This means that B_1 and M coincide (fig. 3). In this condition B_1 is higher than G, so that the action of the buoyancy force and the weight force produces a stable situation and the craft is said to have pendulum stability. $\overline{B_1G}$ (or $\overline{GM_1}$) then replaces $\overline{GM}$ as the criterion of both transverse and longitudinal stability.

IV. ARRANGEMENT

Despite the many ships of each type that have been designed over the years and the general similarity of various spaces and their locations within the types, ship operators still find advantages in particular arrangements. This situation reveals the variety of combinations possible when the designer endeavours to make large-scale compromises with both major and minor features. Propelling machinery at the stern with crew accommodations and navigating spaces in one group aft over the machinery represents efforts to devote the most useful spaces to the cargo and to concentrate services and living spaces in a region clear of cargo-stowing and cargo-handling areas. Naval architectural requirements impose limitations concerning weight distribution, metacentric stability, hull strength and stiffness and subdivision and damage control which can rarely be disregarded.

1. General Arrangement Features by Ship Type.—A brief tabulation of principal ship types serves to highlight the arrangement features characteristic of each.

Passenger liners for ocean crossings, carrying only passengers, baggage and incidental cargo, devote large volumes in the most comfortable part of the ship to passenger accommodations, with large additional volumes for public spaces in deckhouses and superstructures. The propelling machinery, uptakes and hatches are placed clear of the accommodations.

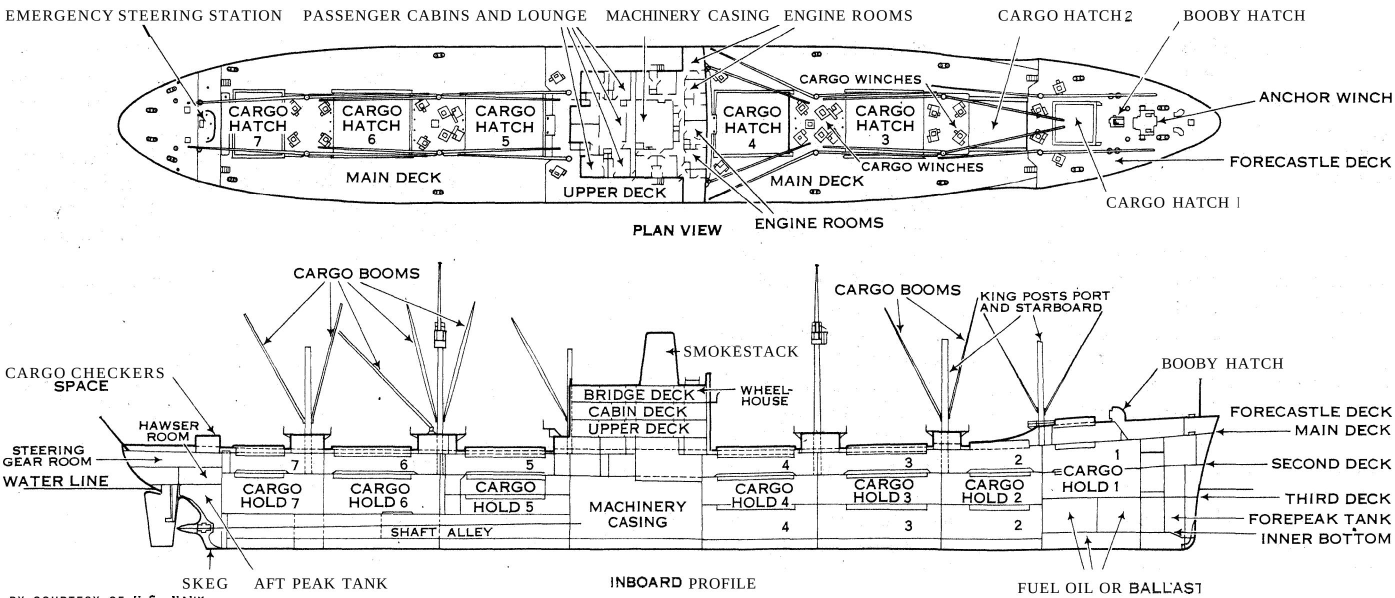
Passenger ships for service on rivers and in protected waters utilize deck and superstructure volume as passenger spaces for practically the entire length. Excursion ships for day service extend the accommodations to overhangs beyond the main hull.

Combined passenger and cargo ships devote the most comfortable positions to the passengers without encroaching unduly on storage and handling facilities for cargo.

General dry-cargo ships provide the best available spaces and facilities for the cargo hatches, side-loading ports and holds (fig. 5). The propelling machinery is preferably aft, to keep the best cargo spaces clear; means are provided to trim the ship with liquids in ballast tanks.

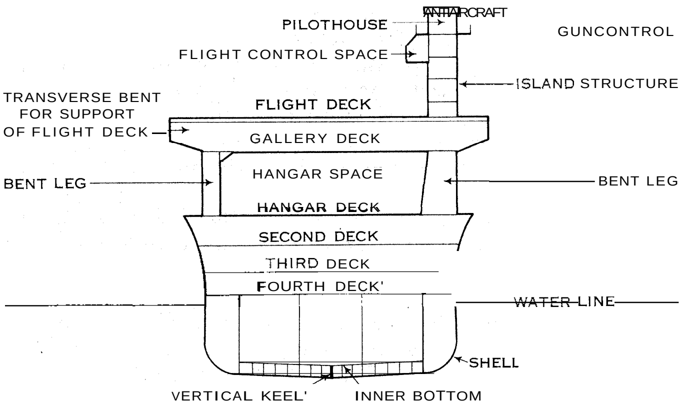
Container ships, roll-on-roll-off ships, seatrains and car ferries embody special arrangements of structure, machinery and crew spaces to keep them clear of the spaces for large containers and for wheeled vehicles.

Bulk-cargo carriers. for solids or liquids or both, are the ultimate in large, single-purpose ships, with everything possible sacri-



BY COURTESY OF U S NAVY

FIG. 5.— PLAN OF WEATHER DECKS AND INBOARD PROFILE OF A "MARINER" CLASS CARGO SHIP



BY COURTESY OF U.S. NAVY

FIG. 6.— CROSSSECTION OF AN AIRCRAFT CARRIER

ficed to cargo capacity.

Aircraft carriers (*q.v.*) have flight decks of the greatest practicable area, even to the extent of using overhangs beyond the main hull. High hangars under the flight deck (fig. 6) provide storage and repair space for aircraft. Internal and deck-edge elevators move these craft to and from the flight deck.

Submarines (*q.v.*) are of the double-hull type. with a ship-shaped outer hull of relatively light construction, if their mission calls for high speed and good sea-keeping qualities on the surface. If submerged performance is the primary function they have single hulls of suitable shape. The volume between the heavy inner and light outer hulls of a double-hull craft is devoted to carrying fuel and ballast liquids which need not be protected from hydrostatic pressure.

Underwater cargo vessels or submersible bulk carriers also require some of their bulk volume devoted to main-ballast tanks, by the blowing of which the craft may be lifted with its deck above water and aith its bottom high enough to clear the beds of estuaries and harbours. (See also SHIP.)

2. Cargo Handling.— The ship arrangement must lend itself to getting the cargo and other objects in and out as well as to carrying them from one port to another. Indeed, speed in loading and unloading cargo is just as important as speed through the aater. Access to the holds and to the internal deck spaces is provided by hatches through the decks and by doors in the ship's side leading to the deck storage areas.

Ships carrying dry general cargo usually are equipped with their own handling gear. This enables them to transfer cargo in any port and to load to and from lighters in places where they must anchor offshore. Some bulk-cargo ships carry a huge swinging boom nith a belt conveyer running on it, by which material may be dumped in high piles at a distance from the ship's side. Freight cars are loaded and unloaded from seatrains by special dock cranes that pick up an entire loaded car. Liquid cargo is pumped aboard through flexible pipes from storage tanks on shore; the unloading is invariably done by the ship's own high-capacity pumps.

3. Watertight Closures.—Whatever the mission of a craft, or the arrangement of major and minor features adopted, nater must definitely be excluded from the hull under severe operating conditions. This calls for strong. tight closures for openings. including doors, port covers and protectors for glass windows. It also requires the watertight and wave-resistant sealing of large openings such as cargo hatches. On many ships these openings are closed by heavy meta! covers handled by mechanical power and capable of secure sealing and locking. The structure surrounding these openings must be so rigid that its deformation under nave or sea loads or other service conditions does not jeopardize the watertightness of the cover.

4. Ballast **Tanks.**—When a ship is running rather light, carrying little or no cargo, and with its hull relatively high out of water, it is at a disadvantage in winds and waves It needs added inertia to help it drive through waves, added weight to put the hull farther donn in the water and more mass high in the ship to reduce the righting moment and to ease the rolling. These needs are met by building in tanks that can be filled with fresh water or reserve fuel. The tanks are easily emptied when the weight is no longer desired. Anknard and inaccessible places in the hull, where neither cargo, machinery nor useful load can be placed to advantage, can often be used for these tanks.

All submarines, whether they have two separate hulls or not, carry main-ballast tanks. These are empty when the craft is on the surface; they help to lift the bridge. the deck and the hatches above the water and to provide reserve-buoyancy volume mhen rolling and pitching in waves. By opening flood valves at the bottom and air-vent valves at the top, these tanks may be completely flooded with sea water to make the craft submerge. To raise the submarine, the vent valves are closed and the water is blown out by compressed air. Another set of tanks, called the variable-ballast tanks. have water taken into or pumped out of them from time to time to keep the weight of the submarine always equal to the weight of the water displaced by the buoyant volume. When a submarine runs from salt water into brackish water having less weight per unit volume, some water must be pumped out of the variable-ballast tanks because the supporting forces are less in the lighter water.

V. RESISTANCE AND PROPULSION

The resistance to forward motion of a ship is of three principal kinds: friction; wave making; and separation or eddy making. Friction or viscous resistance is caused by the necessity for accelerating liquid particles in a forward direction as the bow continually runs into a region of liquid at rest. The layer of accelerated particles, augmented by vortex motion and turbulence, becomes progressively thicker as it moves aft, forming what is known as the boundary layer. The vortexes and disturbances in this layer are visible in the belt of "confused" water around a moving ship at the water line. The energy in this layer represents the work done by the ship in overcoming viscous resistance. It is eventually dissipated as heat and is not recovered.

Wave-making resistance is caused by transferring kinetic energy in the ship to energy in the surface or gravity wave system which accompanies it. While the configuration of this system near the ship remains fixed for a given speed, waves are continually left astern and the energy in them is lost.

Separation is caused by the lack of sufficient pressure in the water (see *Separation* Resistance, below) in a given region to force this water laterally inward and to make it flow closely along all parts of the ship. especially in the tapering or blunt after portion. In the region knonn as the separation zone, water is dragged in from astern to fill the gap that mould be left because the flow does not close in from the sides. Resistance is generated by the forward acceleration of nater that would otherwise flow aft and be left behind. The confused and eddying mass of water being dragged along in the separation zone abaft the square transom stern of a motorboat is clearly visible at low and moderate speeds. The added drag due to separation abaft the square stern of a skiff, immersed deeply by passengers sitting in the stern, is very real to the rower in that skiff.

1. Computing Friction Resistance.— For want of a better or more precise method, the friction resistance of a ship is computed from a knowledge of its wetted area and a friction value per unit area derived from the towing of flat planks or friction planes of various lengths at various speeds. By using very thin sections, sharply pointed at the ends, nave making and eddy making are eliminated. From the known towing forces and wetted area of the plank or plane there are derived a set of friction values per unit surface area of the plane. in terms of the towing speed For calculating the friction resistance of a ship at any given speed, it is usually assumed that the friction value for each unit of wetted-surface area is equal to that for a friction plane having the same length as the ship and toned at ship speed. The wetted area of the ship is calculated by averaging the girth at a series of stations equally spaced along the length and multiplying by the wetted length. The flat-plate friction data cannot be applied indiscriminately to the curved surfaces of ships. Effects of given curvatures are not well known but it is assumed that the friction resistance increases as the curvature becomes sharper.

Rough areas on wetted ship surfaces are caused by uneven plating and planking; laps, butts, rivet points and weld beads; anticorrosive and antifouling coatings of plastic paint and other materials; and fouling due to marine organisms. All of them increase friction resistance and the thickness of the boundary layer. For resistance calculations their effects are lumped in a general roughness allowance, which is added to the value of the friction for a given area of smooth surface.

2. Wave-making Resistance.— Information available to the naval architect on the surface waves generated by a moving ship is derived originally from the observations of John Scott Russell in the 1840s, the experimental work of W. Froude and R. E. Froude in the 1870s and 1880s and the analytic studies of Lord Kelvin in the latter decade. These showed that: (1) A gravity wave system is formed by a moving pressure disturbance. For example, drawing one's finger across a water surface makes waves. (2) Pressure disturbances exist where there are changes in curvature around a ship, such as those at the extreme bow and stern and at the "shoulders." (3) The progressive or traveling wave system caused by each pressure disturbance consists of two parts: (a) a diverging group of waves, with crests and troughs lying at a small angle to the direction of motion of the disturbance, and (b) a transverse group of waves, with crest lines slightly convex forward, where they cross the path of the moving disturbance. The diverging waves at the bow are easily seen on any moving boat or ship, as are the transverse waves abaft the stern on any craft which is traveling rapidly. The transverse waves of the bow system, modified by the forward shoulder system, are also indicated by the crests and troughs in the wave profile alongside the ship.

In addition to the progressive waves, whose shape remains the same for a given speed but which spread outward and aft, there is a water-level disturbance that moves along with the ship and whose elevations at the bow and stern and depression amidships are not radiated as gravity waves. There may thus be six or eight or more sets of water-level changes generated by the movement of one ship. The changes of elevation due to each are superposed so that two crests coinciding produce a sort of double crest, while a crest and a trough coinciding act to cancel each other.

From a resistance standpoint the most important progressive wave systems are generated at the bow and stern. The length of a gravity wave depends upon its velocity, and the velocity of a wave whose crest travels along with the bow must correspond to the ship speed. It follows, therefore, that the second, third and succeeding crests of the transverse bow series move aft along the ship as the speed increases. This means that at certain ship speeds a transverse crest of the bow system is superposed on the stern system in such manner as to build up a traveling mound of water at the stern. The internal hydrostatic pressure in this mound acts to push the ship forward and hence to diminish its wave-making resistance.

At other ship speeds the superposition of the bow and stern wave systems drops the water level at the stern, with no compensation for the hydrostatic pressure which the bow of the ship must push against at this speed. As a result the total resistance of a ship fluctuates above and below what is known as its "natural" resistance as the speed is increased and as the various progressive wave systems combine to produce beneficial or harmful effects (fig. 7).

The velocity of gravity waves varies as the square root of the product of the acceleration of gravity and the wave length. The forward speeds of the transverse waves generated by a ship correspond to the ship speed V. The interference effects described depend upon a relation between the wave lengths L_W and the ship length L, hence the wave systems are geometrically similar if the ratio of V to the product $\sqrt{gL}$ remains constant, where g is the acceleration of gravity. This ratio is the Froude number $= \frac{V}{\sqrt{gL}}$.

D. IT. Taylor simplified this relation in the 1900s to the ratio of the ship speed V in knots to the square root of the ship length L in feet. Thus the speed-length quotient = Taylor quotient $T_q = \frac{V}{\sqrt{L}}$.

When the estimated wave-making resistance is plotted on a basis of Froude number or Taylor quotient, humps and hollows show up in the curves, as shown in fig. 7, corresponding to the wave-crest and wave-trough positions in the three ship-and-wave profiles of that figure. The naval architect selects a ship length whose wave-making resistance will be less than its "natural" resistance when the ship is traveling at its most efficient speed.

The extreme case in this category occurs with the destroyerlike craft which, at a speed-length quotient of about 2.0 or a Froude number of about 0.6, rides largely on the back of its own first bow-wave crest with its stern in the first trough following. It is, in fact, constantly running uphill; part of its resistance, called the slope drag, is due to this action. A planing boat such as a speedboat is in a corresponding position, with bow high in the air and stern squatting deeply, when about to pass through what is known as its hump speed. As this speed is reached and exceeded: if the engine has ample power and the boat is not too heavy, the boat approaches and reaches full planing speed. Here it is literally riding on top of the first crest of its own bow-wave system. With its flat stern sliding gracefully over the water there is, in effect, no stern-wave system.

A great deal of theoretical work, having as its aim the calculation of wave-making resistance from the known form of a ship hull, produces resistance curves which resemble those obtained by toning tests in model basins. The work is still limited by certain mathematical simplifications and it appears that more physical laws, not yet fully known, will have to be taken into account before the method becomes practical for engineering predictions.

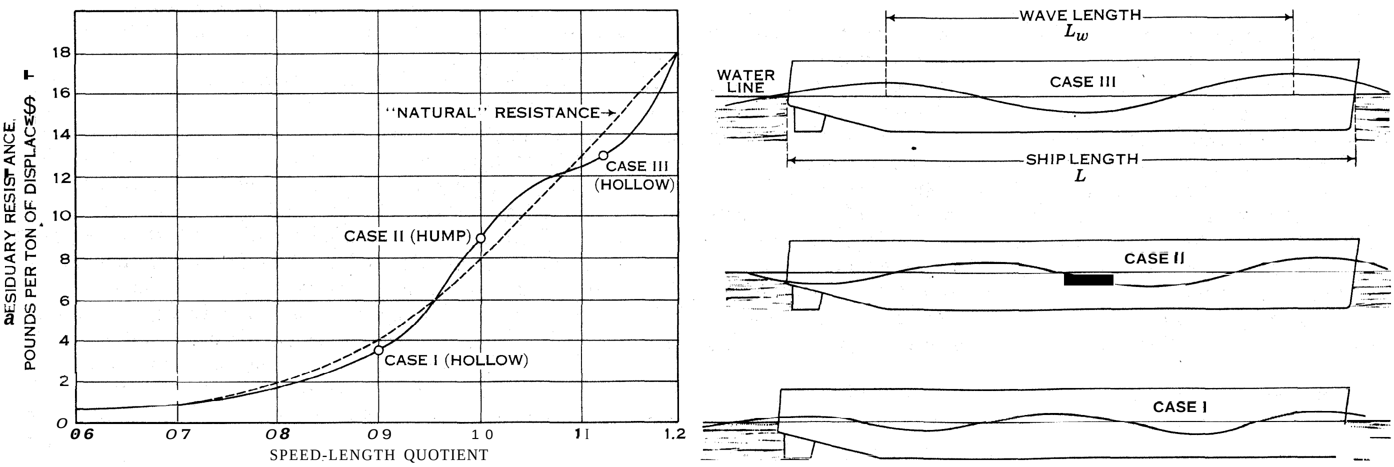


FIG. 7.— WAVE FORMATIONS CAUSING HUMPS AND HOLLOWS IN A GRAPH OF SHIP RESISTANCE. FOR CASE I, $\frac{L_w}{L} = 0.451$; FOR CASE II, $\frac{L_w}{L} = 0.557$; AND FOR CASE III, $\frac{L_w}{L} = 0.698$

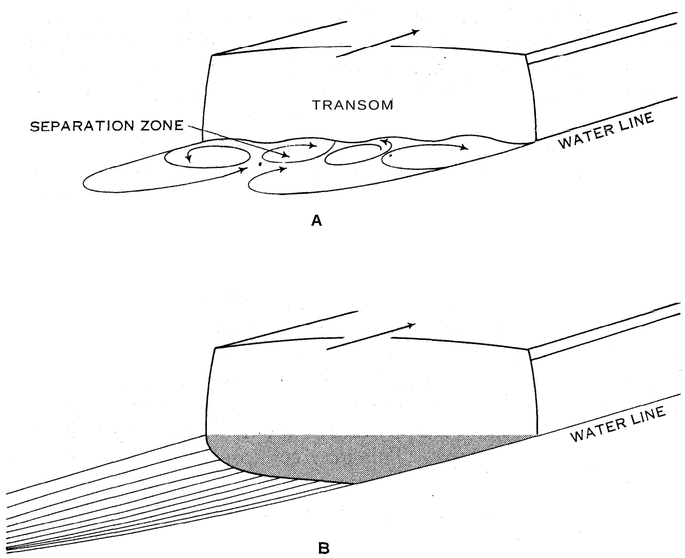


FIG. 8—SEPARATION ZONE AND AIR FILLED DEPRESSION ABAFT A MOTORBOAT (A) DURING SLOW SPEED AND (B) DURING HIGH SPEED, WHEN THE LOWER TRANSOM AREA IS EXPOSED TO ATMOSPHERIC PRESSURE

3. Separation Resistance.—The drag due to separation of the boundary layer from a ship surface, and to eddying and backwash in the separation zone, is a form of pressure resistance. This means that. like nave-making resistance and some types of roughness resistance, it is due to forces exerted at right angles to the hull surface. Like these resistances, it varies usually as the square of the ship speed.

Hydrodynamic knowledge of separation phenomena and the physical laws nhich govern them have not progressed to the point where the onset of separation can be predicted in advance aith certainty and uhere the magnitude of separation resistance can be calculated. It is known, however, that the pressure in such a zone is less than atmospheric, so that the water literally sucks backward on the ship. If air can be led to the zone to displace the eddying water, the suction is removed. When a motorboat with a square or transom stern extending below the water is speeded up until the stern "clears." the backwash and eddying disappear (fig. 8). With the square stern exposed to the atmosphere, the separation resistance also disappears.

4. Resistance of **Submarines.**—When a submarine submerges to a depth below the surface equal to four or more times its maximum diameter or its hull depth, the surface disturbance resulting from its forward motion becomes negligible and its wave-making resistance practically disappears. This is a great advantage, especially at high speed, despite the increase in wetted surface and friction resistance caused by taking the whole craft under the aater. However, much of the gear above the nater line in surface condition, such as flat decks, rails, anchors, capstans, chocks and similar fittings, are put there for operation on the surface. It is difficult to streamline them for low resistance under water. Moreover, minor irregularities which are accepted on the undernater hulls of surface ships become, when taken all together, major sources of added and unnecessary resistance on a submerged submarine moving at high speed.

5. Resistance in Shallow and Restricted Waters.—The forces on a ship traversing shallow waters are governed by the presence of solitary waves caused by ship motion and other disturbances. If the ship speed is slightly less than the solitary wave speed, the ship runs uphill on the back of this wave so that its hydrodynamic resistance is increased by the slope drag. If it can be speeded up so as to run slightly faster than the wave, it slides downhill on the face of the wave and its resistance is reduced below that of its deepwater resistance.

The speed of progressive waves of a given length is less in shallow than in deep water. If a tug, for example, is running at a speed in shallow water at which it has a crest at the bow and another at the stern, its speed must be decreased if the two crests are to be kept at the advantageous positions indicated. At the same time. the crests may be higher and the trough may be lower because waves become steeper as they enter shallow nater. A fast craft also squats more deeply at the stern when running in shallow water. In fact, this increase in squat may be sufficient to cause the craft to scrape bottom even though it has plenty of water under it when at rest.

When the clearance between the bottom of the ship and the bed of the water body is initially small, the water that flows under the ship is speeded up, with an increase in friction resistance on the ship. When the sides or walls of the channel are close to the ship, the lateral constriction speeds up this flow still further. Methods of approximating the increased resistance and the depth of water necessary to give the equivalent of deepwater resistance are available, based on the method of O. Schlicting (*Hydrodynamics in* Ship *Design,* vol. ii, ch. 61, 1957).

Self-propelled craft designed for efficient operation in shallow and restricted waters must have (1) provision for adequate flow of water to the propellers; (2) adequate shielding to prevent drawing air from the surface; and (3) rudders of extra-large area, usually one rudder abaft each propeller, to overcome the horizontal forces resulting from the closeness of adjacent banks or of other craft being met in a channel.

6. Ship **Form** for Minimum Resistance.—The art and the science of naval architecture have not yet progressed to the point where the form of a ship to meet given requirements, including minimum resistance at a given speed, can be fashioned by a direct method, starting with a clean sheet of paper. Nevertheless, certain general rules based upon hydrodynamics are available: (1) The use of easy and fair surfaces along the general paths followed by the water flow. Small changes of curvature in the flou lines are particularly important. (2) At and near the surface the flow lines must follow the surface or the wave profile. Since most of the wave-making resistance is generated by pressure disturbances near the surface, easy curvature is important there. Proof of good design in this respect is low wave crests and shallow troughs around the ship nhen running. (3) Most of the flow in almost any type of ship goes under the bottom rather than around the sides, hence the ship form must not interfere with it. (4) Submerged bulbs intended to produce surface-wave systems that will partly neutralize the crests and troughs produced by pressure disturbances elsewhere require careful design and positioning. (5) Probably the most important feature in shaping the hull of a self-propelled craft is to provide a good flow of water to the propulsion devices. So far as known, this calls for the highest practicable degree of uniformity of relative velocity over the whole thrust-producing area, the greatest possible degree of flow opposite to the direction of advance of the blades of the propulsion device and the greatest mass density of the water in uhich the device is to work. Concerning the last item, it is known that the water entering the propeller disks of destroyers and other high-speed craft contains many air and gas bubbles. In the aggregate, the reduction of mass density due to them can be appreciable.

7. Action of Propulsion Devices.—Thrust by a ship propulsion device acting on the water (or on the air) is produced by imparting sternward acceleration to a mass of that nater or air. The forward thrust is proportional to the product of the mass of fluid acted upon and the accelerating rate. For the most efficient propulsion, the mass should be large and the acceleration small. In a screw propeller, this calls for a large diameter and a small increase in relative backward velocity when water is passing through the propeller.

The thrust per blade of a propulsion device is measured by the reduction in pressure on the back or advancing side of the blade and the increase in pressure on the face or after side. As a rule, the former is much larger than the latter so that the blade draws or pulls rather than pushes itself through the fluid in which it works.

Modern propulsion methods for boats and ships include oars, sails, paddle tracks, paddle wheels, hydraulic and pump jets, airscrews, rotating-blade propellers and screw propellers. Screws are usually run in the open but for producing high thrusts at low ship speeds, as when towing, they may be surrounded by a fixed shrouding such as the Kort nozzle. Rotating-blade propellers offer the great advantage that the magnitude and direction of thrust can be varied at will, making them vastly more versatile than any known combination of screw propeller and rudder and giving the craft exceptional maneuverability. A tug fitted with one or more such propellers can exert a pull equally well in any direction with respect to its axis.

The number of propulsion devices depends upon the available power in each engine, the need for reliability or maneuverability, the limiting draft and many other factors. By the late 1950s shaft powers of 25,000 h.p. had been applied to single screws and in excess of 50,000 h.p. on each of four screws.

8. Interactions Between Propeller and Ship. — The operation of a screw propeller involves a number of interactions that are by no means fully understood. Part of the water through which the propeller moves is the boundary layer moving aft past the hull, with a relative velocity less than that at a distance. Another part of it lies within the wave crest (or trough) that runs along above the propeller. Because of these and other effects, the water moves at different velocities and in different directions in different parts of the propeller disk. In general, the ship drags the water along with it to a certain extent, so that its speed past the propeller is less than the ship speed. The difference is the wake velocity, and the ratio of this velocity to the ship speed is the wake fraction.

There are reduced pressures in the region forward of the propeller, resulting from corresponding pressures on the fonvard sides of the blades. These act to retard the ship, diminishing by a certain amount the usefulness of the full propeller thrust.

9. Efficiency of Propulsion. — The efficiency with which any mechanical propulsion device drives a ship is a product of three separate ratios. The first is the ratio of input to output when the device is running in open water by itself, as when a model is tested in a model basin. The second, known as the hull efficiency, is the ratio of the quantity representing the proportion of useful thrust to total thrust to the quantity expressing the ratio of the speed of advance to the ship speed. The third, known as the relative rotative efficiency, is the ratio of the turning moment on the propulsion-device shaft to produce a given thrust when the device is running in open water to the moment on the shaft when the device is operating in conjunction with the ship.

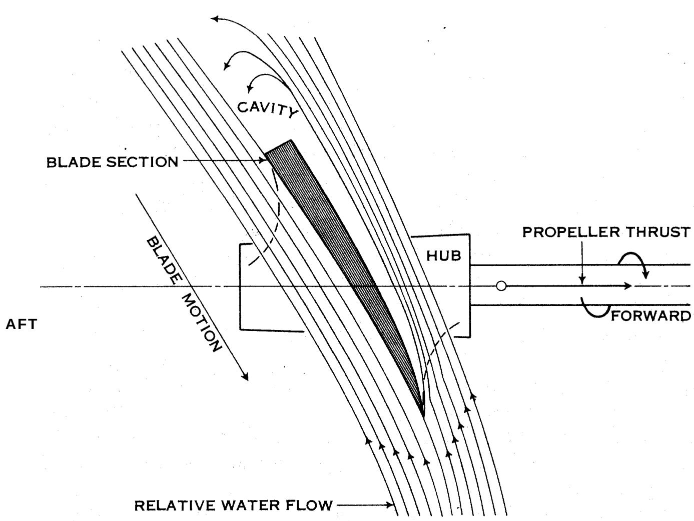


FIG. 9.—SECTION OF A SUPERCAVITATING PROPELLER BLADE

For ships having screw propellers, the efficiency of propulsion decreases as more propellers are added. It varies from 0.76 to 0.80 or more for a well-placed and well-designed single screw, from 0.65 to 0.72 for twin screws and from 0.60 to 0.64 for quadruple screws such as are carried by large liners and warships.

In practice. the open-water efficiency for a given size of propulsion device is found to vary in almost predictable fashion with the ratio of the thrust produced to the square of the speed of advance. This ratio is known as the thrust loading. Starting with this factor, it is possible to estimate in advance the shaft power required to drive a ship having a known resistance at any given speed.

10. Cavitation. — Any moving submerged body, like a screw-propeller blade, has to push the water aside as it moves. If it moves so fast that the surrounding pressure is not sufficient to cause the water which has been pushed aside to close in around the body and follow its contours, or if the pressure is so low that the same thing occurs when the blade moves slowly, the water either "opens up" or it leaves the blade. In the first case, bubbles are formed in it, each filled with water vapour. When they move along into a region of increasing pressure, they collapse suddenly. The resulting severe pressure fluctuations may cause pieces of the metallic blade surface to break off in an action known as erosion. In the second case, a relatively large vapour-filled cavity is formed next to the blade (fig. 9). This may collapse on the blade or at a distance behind it.

For screw propellers of normal form, any cavity next to the blade interferes with proper flow around it and usually has a harmful effect on thrust and propulsion. Cavitation can be minimized by proper attention to the design of the propeller. The shape selected for the section is one known to be relatively free from cavitation and one on which the reduced pressure is as uniform as possible along the chord (length) of the section, from leading to trailing edge.

At each radius the blade is made wide enough to carry the local thrust load at the velocity of and at the average water pressure for that radius. The use of large blade areas to delay cavitation must be balanced against the loss of efficiency caused by greater friction drag on the wider blades.

On supercavitating propellers of special design, the blades travel so fast that the water pressure is never sufficient to permit the flow to follow the blade. The vapour cavity is then allowed to expand until it covers the whole back of the blade. The pressure on the back approaches absolute zero while the friction on that side disappears, since the water no longer touches it. Propeller blades of this type. with sharp leading edges and blunt or square trailing edges (fig. 9), have been used successfully on racing motorboats since the 1920s. New techniques developed in the late 1950s permitted them to be designed by logical methods.

11. General Design and Positioning of Propellers. — The propulsion device should be treated as an essential part of the ship, not as a sort of appendage to the hull, and should be designed with it. The flow to and from the propulsion device, whatever its form, is a most important feature from the standpoint of efficient propulsion as well as avoidance of objectionable vibration. Fortunately, it is possible to "see" this flow on medium and large models in circulating-water channels, to study it at length and to correct unsatisfactory features of it while the ship is still in the design stage. Model techniques are also available to give the designer a reasonably good preliminary warning of excessively large periodic forces which may be generated on the ship if corrective measures are not taken.

Because of the great thrust sometimes exerted by the single blades of powerful propulsion devices and the rapid changes of pressure and velocity which take place near them, adequate clearance spaces must be allowed between these blades and the adjacent parts of the ship.

Propulsion devices mounted in transverse ducts or tunnels, extending through the thin ends of the ship from one side to the other, apply transverse forces or swinging moments when the ship is moving or stationary. These devices greatly improve the ship's handling qualities around docks and piers.

On shallow-draft vessels, screw propellers are fitted inside fore-and-aft arch-shaped recesses called tunnels. A large proportion of the propeller area is often above the at-rest water line, but if air is excluded from entering. the tunnel fills with water when the propeller starts rotating, permitting the latter to develop thrust over its entire area.

In many cases it is possible to select the principal features and proportions of a screw propeller by the use of one or more of the many sets of series charts based upon test results of systematic series of propeller models. The disadvantage of this method is that the designer is restricted to the number of blades, blade profiles and blade-section shapes of the models that have been tested. However, there are usually two or three sets of models which approximate what the designer has in mind so that with the data from these he may feel that his combination of tentative characteristics is rather well bracketed. If the designer feels that he may encounter cavitation or if he is able to spend more time on the project, a propeller may be designed rationally by methods described in the technical literature.

12. Model Experiments. — The towing of ship models to determine their resistance and similar characteristics was initiated in 1872 by W. Froude to take the place of limited knowledge of physical laws governing ship behaviour, complexity of the interactions encountered and lack of understanding of the effects of changes in shape and proportions. To make the procedure workable at all, Froude had to separate the friction resistance from the total observed resistance. After subtracting the friction resistance, estimated on the basis of tests which he made by towing flat planks, Froude called what was left the residuary resistance. For corresponding ship and model speeds, where the Froude numbers were the same, he extrapolated the residuary resistance on the basis that this resistance per ton of displacement was the same for both ship and model. The expanded friction and residuary resistances were then added to give the total ship resistance.

In later years, techniques were developed for the testing of propellers, for self-propelling ship models, for determining lines of flow and wave profiles and for measuring the effects of minute changes upon the total resistance. Nevertheless, many of the old problems remain, despite all the time, thought and effort devoted to their solution. Indeed, it appears that advances in knowledge in the field of hydrodynamics raise new problems faster than the old ones are solved. In spite of this, the model-test procedure has been of great assistance to naval architects and, in general, of great engineering value. All the maritime nations of the world have ship-model testing establishments and very few large and important ships are built without first testing one or more models of them.

VI. MANEUVERABILITY

All self-propelled craft, of whatever size, shape, form or type. are required to steer a reasonably straight course in both smooth and rough water, to turn so as to change course or heading or to take emergency evasive action, to start, stop and back and to perform any other desired maneuvers. Submarines are required to maneuver similarly in a vertical plane. including the operations of diving, depth keeping, hovering in one spot and surfacing.

1. Dynamic Stability of Route. — The ease and reliability of steering of a ship depend, among other things, upon whether or not it has dynamic stability of route. A self-propelled ship that is stable in this sense will, if left to itself with no rudder angle applied, continue generally on its original course. If disturbed by some external force. it may swing slightly or moderately to a new course. whereupon it will continue along that course or route until again disturbed. Most slender ships like destroyers are dynamically stable in route. Others of fat or chubby shape, if left to themselves and then disturbed. will swing farther and farther from the original route. A sign of route instability is the persistence of the ship in swinging one way after moderate corrective or opposite rudder is applied to stop the swing. A ship of this type may become positively unmanageable in shallow water, where the sluggishness of any ship is intensified.

2. Steering and Turning. — Steering involves corrections to bring a ship back to a given course or heading after it has deviated as a result of some disturbance. Steering by hand control is easier and more efficient if instruments in front of the steersman show almost instantly when these deviations begin. Gyrocompasses are far more satisfactory than magnetic compasses for this purpose. Further, a ship that is dynamically stable in route, but not too much so, and one that is not oversteered, requires only a small rudder angle and relatively infrequent use of the rudder. Automatic steering by gyro pilot is available for all sizes and types of ships.

Turning is involved when changing course, when maneuvering in formation with other ships and when following a curved channel. However, the most important turning maneuver for any ship is to sheer off suddenly and to get clear of its original course when danger is unexpectedly sighted ahead along that course. To clear the extension of its original path in the shortest distance and the least time, assuming that the ship is going too fast to be stopped completely, requires rapid laying of the rudder to the emergency

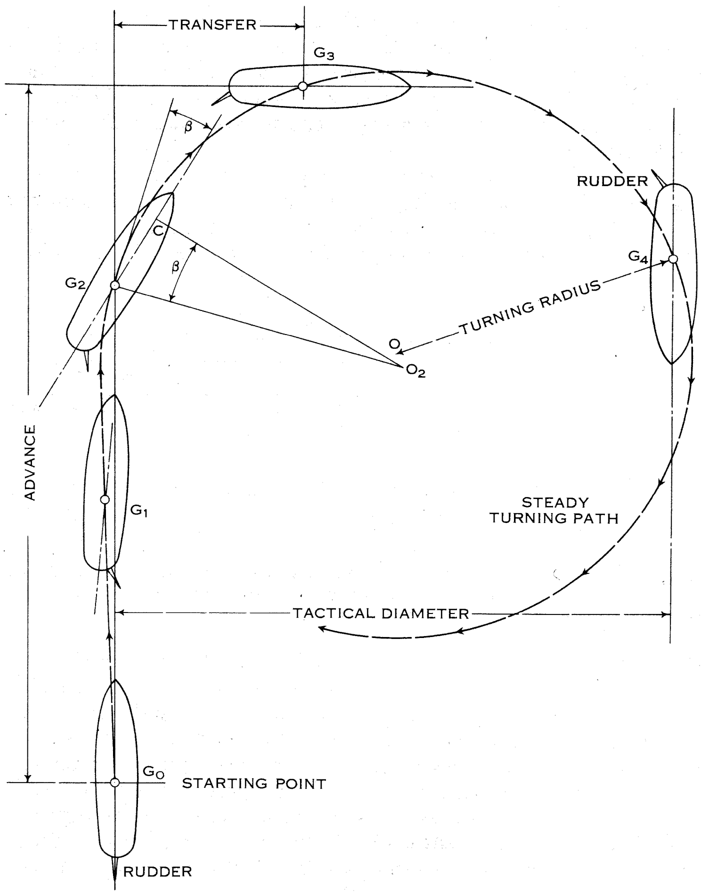


FIG. 10.— SUCCESSIVEPOSITIONS OF A SHIP WHEN TURNING

angle, rapid response of the ship in starting to turn and rapid motion of the ship to the right or left of the course to clear the danger ahead.

The rudder action serves not only to swing the ship in the desired direction but also to keep its bow pointed inside the path of its centre of gravity so that the inward-acting hydrodynamic force on the hull equals the outward-acting centrifugal force resulting from motion in a curved path. The amount by which the ship heads inside the instantaneou? direction of motion is the drift angle.

Fig. 10 shows the path, the positions and the orientation of the ship and the angles of its rudder when making a large change of heading. In the figure, the successive positions of the ship's centre of gravity are marked by G_0, G_1, G_2 . . . . At G_2 the instantaneous turning centre is at O_2. Actually, because the ship is swinging as though attached to a rotating arm. the uater seems to be approaching it along curved streamlines, nearly head on at the bow and at a considerable angle inward toward the stern. This angle of relative flow, involving cross flow at the stem from the outside toward the inside of the turn, acts to reduce the effective angle of attack of the rudder. At the point C the nominal flow about the ship is parallel to its centreline. To an observer on board, the ship appears to be turning about this point, hence it is called the pivoting point.

In the course of turning, especially with a large drift angle (β), the increased hull resistance causes the ship to slow down, sometimes involving a reduction of 40% or more of the speed with which it approached the turn. After the average ship has turned at least 90°, conditions become steady and its centre of gravity moves at uniform speed in a circular path with its centre at O.

In the steady-state portion of the turn the inward force caused by the drift angle exactly balances, in both magnitude and moment about the centre of gravity, the outward rudder force and the centrifugal force at the centre of gravity caused by the turning action. If the wind and sea were entirely quiet, the ship would continue to turn in a steady circle as long as the rudder was held at a constant angle and the speed remained constant.

Ability to steer a straight course or to turn readily is achieved in any given ship design by the use of a large rudder area. When the rudder is at zero angle, it serves as a vertical stabilizing fin. When angled, the large area provides the large swinging moment necessary for good turning.

3. Stopping and Backing.—Stopping in an emergency, as contrasted with normal coasting and gradual retardation, is achieved by slowing the propulsion device to less than driving speed and then by reversing its direction of thrust. If reversed too rapidly it is liable to overload the engine, to draw air down from the surface to the propeller in large quantities and to churn the air-water mixture into excessive turbulence without developing the maximum astern thrust. Capacity to start and stop quickly is built into a craft by providing an engine that will reverse rapidly and readily and by using a propulsion device with a large thrust-producing area. Both these features are stressed in the design of tugs.

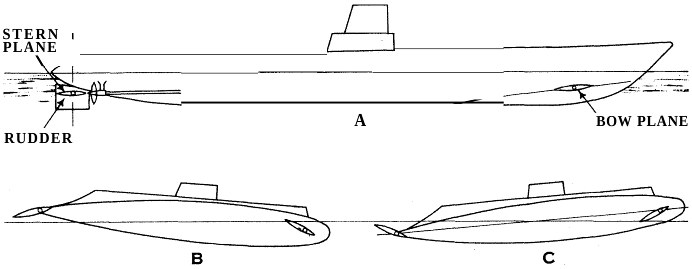


FIG. 11.—DIVING PLANE LOCATIONS AND POSITIONS ON SUBMARINES (A) IN NEUTRAL PLANE POSITION CONFORMING TO FLOW; (B) IN DIVING PLANE POSITION: AND (C) IN RISING PLANE POSITION

4. Rudders and Planes.—Rudders and other control surfaces are usually placed at the stern of a ship for several reasons. When placed abaft screw propellers, they benefit from the increased velocity in the propeller outflow jet or race. When a vertical rudder is placed at the bow, it causes the ship to turn with a smaller drift angle and hence a larger turning radius. If the rudder is attached to the bow, it is ineffective hydrodynamically in producing a swinging moment. In fact, a normal ship, 'when moving backward, steers only indifferently or not at all. The rudder also receives better mechanical protection at the stern than it would at the bow.

For craft that are required to back out of long slips, or even to back into harbour entrances, like the English channel ferries at Dover, a rudder is fitted at the bow. This becomes the trailing end when backing, and the ship steers satisfactorily with a rudder at that end.

A centreline rudder mounted between two widely spaced wing propellers benefits only little or perhaps not at all from the augmented water velocity in the propeller outflow jets. Adequate swinging effect is then achieved by mounting two rudders abreast, one abaft each propeller.

The diving planes for controlling the rise and dive angle of a submarine are placed at the stern, directly abaft the propellers, to benefit from the higher water velocity in that region (fig. 11). Bow planes, if fitted, are used principally to control the depth at which the craft runs. They are effective as control surfaces because only vertical forces, not swinging or diving moments, are desired and because they project from the hull and create up or down forces independent of the hull forces.

Control surfaces called flanking rudders are placed forward of the screw propellers on shallow-draft push boats to produce side forces when the propellers are rotating astern. They enable these craft. nhen pushing groups of barges 1,000 or more feet in over-all length, to maneuver around river bends and through channel turns.

5. Heel When Turning.—In a turn, the inward hydrodynamic force produced by the drift angle is applied at a point well below the water line. The outward centrifugal force is applied at the centre of gravity, usually located at or above the water line. This couple acts to heel the ship outward to an angle at which it is balanced by the righting moment resulting from the transverse metacentric stability. The contribution of the rudder to this pattern is a force acting to reduce the angle of heel. Thus, in a steady turn, if the rudder angle is suddenly removed, the outboard heel is momentarily increased. Ships with small metacentric stability and comparatively large rudders have capsized through this cause.

Submarines with large, highly streamlined fairwaters around the periscopes and masts heel in ard on submerged turns, especially if running at more than low or moderate speeds. This is because a large part of the inward hydrodynamic force is generated by the drift angle on the fairwater. This force acts inward at a level well above the centre of gravity, where the outward centrifugal force is applied. The outward lateral force on a rudder mounted below the main hull acts at the same time to increase the inward heel.

6. Effect of Propulsion-Device Action on Maneuverability.—The individual thrusts of independent wing propellers, with axes offset from the centre of gravity. exert a sninging moment about that centre. Ships with the rudder damaged or lost have been steered by suitable operation of the wing propellers. On some ships. pushing ahead on one screw and pulling astern on the other acts to turn the ship around almost on its oun centre. Tugs with port and starboard paddle wheels driven independently, or with rotating-blade propellers, can maneuver even more readily in this fashion.

Blades of stern propellers that encounter crossflow under the ship when swinging or yawing produce lateral forces that counteract the swinging motion and increase the diameter of the turn. If air is drawn into the upper blades of the propeller on a single-screw ship, excess lateral forces on the lower blades swing the stern in the direction that the upper blades are moving, say from port to starboard. To a certain extent these forces can be counteracted by the rudder but for the most part the operator of a single-screw ship must foresee their existence and make adequate allowance for them.

7. Maneuverability of Submarines in the Vertical Plane.—Many of the factors involved in the steering and turning of ships in the horizontal plane apply also to the depth keeping, rising and diving of submarines in the vertical plane. The problem is much more severe here, however. because of the extreme relative thinness of the layer of water between the surface and the permissible working depth. The situation is somewhat similar to that which would confront the pilot of a transport airplane if he knew that at an altitude above 500 ft. his craft would disintegrate.

The undersea craft, required to run at almost constant depth for extended periods, requires reasonable dynamic stability of route in the vertical plane. It also requires controllability at extremely low submerged speeds so that it may hover at one spot or creep along slowly, without making any noise. Should the submarine crew lose vertical control nith the craft headed for dangerous depths, a high-pressure air-blowing system serves to expel some of the water in the main-ballast tanks. The additional buoyancy thus gained checks and stops its descent.

8. Maneuvering Predictions and Model Experiments.—The ultimate aim of the naval architect is to formulate and collect rules and formulas by which a ship may be designed directly or by which its behaviour and performance may be predicted directly. The first are available in small part; some data for the second have been derived by tests under model towing carriages and rotating arms. These serve to determine the forces and

moments resulting from elementary motions such as ahead motion with yawing deviations and motion at various drift angles when the centre of gravity is moving in a circular path, simulating a steady turn. The forces and moments are then fed into the equations of motion as outlined, for example, by K. S. M. Davidson and L. I. Schiff (*Transactions of the Society of Naval Architects and Marine Engineers*, 1946) and the integrated performance is predicted therefrom. This approach has been used primarily for the determination of dynamic stability of route, which involves only fairly small angles of attack and angular velocities. When these motions become large, as they do for large course departures, this approach can be used only with large empirical corrections.

Free-running self-propelled ship models, sometimes radio controlled, can simulate turns and other maneuvers, permitting derivation of the path of the centre of gravity, changes in forward speed, rudder angles, angles of heel and related data. Self-propelled models, supplied with power and steered by distant control from a towing carriage following, provide experimental checks on steering, dynamic stability of route, effectiveness of rudders and certain maneuvers which can be performed within the limited width of a model testing basin.

VII. SHIPS IN WAVES

Considered as the environment for boats and ships of all kinds and sizes, the term sea is used to denote all waters large enough for the operation of these craft, from creeks and ponds to lakes and oceans. The wind and the ships moving across the sea create a pattern of undulations ranging from minute ripples to waves of gigantic size. The currents moving through it must also be taken into account in all ship operations and in some ship-design problems. The variations in density, resulting from the amount of salts in solution, determine the variable-ballast tank capacity of submarines and the ability of a submarine to "sit" on a layer of dense water while largely supported by a less dense layer above.

Considering the over-all surface configuration, termed the seaway, the classical concept of a train of regular waves is highly unrealistic but it has some practical uses. The normal seaway is highly irregular, with waves of different heights and lengths traveling in many directions. For analytic purposes, it may be considered as made up of a multitude of very low waves, having the actual lengths and periods of all the sea waves and traveling in the same directions, superposed in quantity to produce the actual seaway. When this is done, a promising approach is to accept a multicomponent, random nature and to use statistical methods to define the sea ay (*see* WAVES OF *THE* SEA).

The sea is also home to teeming masses of marine life, many of which are detrimental to ships. Marine borers attack wood exposed on undenvater portions of the hull. Barnacles cling to the underwater hull, roughening its surface and increasing the ship's resistance to travel through the water. Sea water is highly corrosive to most materials, and severe electrochemical effects cause rapid disintegration of submerged metals that are unprotected.

1. Ship Motions in Waves. — Treated as a rigid body, a ship partakes of six oscillatory motions in a seaway. Three are translatory motions of the whole ship in one direction: (1) surge is the oscillation of the ship fore and aft; (2) sway is the motion from side to side; and (3) heave is the up-and-down motion. The other three oscillations are rotary: (4) roll is the angular rotation from side to side about a fore-and-aft axis; (5) pitch is the bow-up, bow-down motion about an athwartships axis; and (6) yaw is the swing of the ship about a vertical axis. Yawing is not necessarily oscillatory for every service condition. All six of these motions can and do take place simultaneously in a confused sea, so the situation is most complex.

The forces and moments caused by waves are balanced by three types of forces and moments opposing them: (1) those required to move the ship and cargo and the adjacent water to which kinetic energy is imparted by the ship motion; (2) those absorbed in damping the oscillatory ship motion or reducing its extent by the generation of surface gravity waves, eddies, vortexes and turbulence; the energy required for setting up these disturbances is carried away and lost; (3) those of hydrostatic or hydrodynamic nature that act to restore the ship to a position of equilibrium as, for example, when the ship rolls to an angle greater than that called for by the exciting moment.

2. Effect of Shape and Proportions. — The most important single factor in cutting down the increased resistance of ships running in waves appears to be a small fatness ratio; in other words, a small underwater volume compared with the ship length. This slenderness is difficult to work into ships intended to carry cargo, but relatively easy for passenger ships. For reduction in the magnitude of ship motions in waves it is important that the damping forces and moments be as large as practicable. Moderate flare in the above-water sections at bow and stern, large beam compared with draft and fineness of the underwater sections all help to achieve this result. A deep-sea sailing yacht embodies these characteristics to a high degree.

To keep the ship reasonably dry while undergoing the rolling, pitching and heaving motions that remain, large freeboard is essential, especially at the bow. In fact, to prevent slamming under the bow when it lifts out of water and then drops heavily upon the surface, the forefoot under water must also be deep.

A good degree of damping is most necessary to avoid deep rolling. If this cannot be achieved by a transverse form suited to the service, such as that of a sailing yacht with a deep fin keel, it is accomplished by adding long fins on each side in the form of roll-resisting or bilge keels. When placed along the lines of flow, these keels add little to the ship resistance in calm water.

Active roll-resisting fins serve to quench the greater part of the roll on a fast ship with a reasonable expenditure of weight, space and cost. These fins, much shorter than bilge keels but extending several times as far outboard when in use, are rotated mechanically about transverse axes to produce angles of attack and girthwise forces which continually oppose the rolling motion. Since the moments of the roll-resisting forces diminish as the square of the ship speed, the active fins are ineffective at low speeds.

Active roll-resisting tanks of U shape have been built and tested in ships. In these, water or other liquids can be transferred rapidly from one side of the ship to the other to counteract the rolling motion, using controllable (and reversible) axial-flow propellers placed in ducts connecting the port and starboard tanks.

Considering the vertical accelerations involved, pitching and heaving, or a combination of the two, are the most objectionable for passenger comfort and safeguarding of cargo. Some form of passive pitch-resisting fin may be evolved mhich will accomplish its primary purpose without introducing detrimental features.

3. Hydrostatic and Hydrodynamic Loads in Service. — The naval architect must know the loads imposed upon a ship in all the conditions of its expected service in waves so that he may design the hull structure to withstand them. Aside from the static distribution of load along the length when the ship is floating at rest in calm water, there are many other buoyancy distributions in waves for exactly the same loading condition of the ship. Further, the wave action and the ship motion in waves generate dynamic forces which, under certain conditions, may be extremely important. When the bow and stern are on wave crests, with a wave trough between, the ship hull sags or bends downward in the middle. As the middle body reaches a wave crest. with the ends over wave troughs, the ship bends the other way or "hogs" and the ends droop because of the greater buoyancy amidships. Waves also produce torsional moments and the hull twists in the seaway, as when the ship is traveling obliquely through waves. Both bending and twisting actions involve shear in the structural members. as when a region that was square in shape under no load takes the shape of a rhombus when deformed. When the ship rolls, racking strains are induced in the hull because the above-water portion wants to continue to roll as the underwater portion starts to roll back the other way. Ship motions also induce inertia forces similar to those felt in elevators when starting or stopping.

It often happens that a part of the hull and an adjacent wave surface, each parallel to and approaching the other, meet with

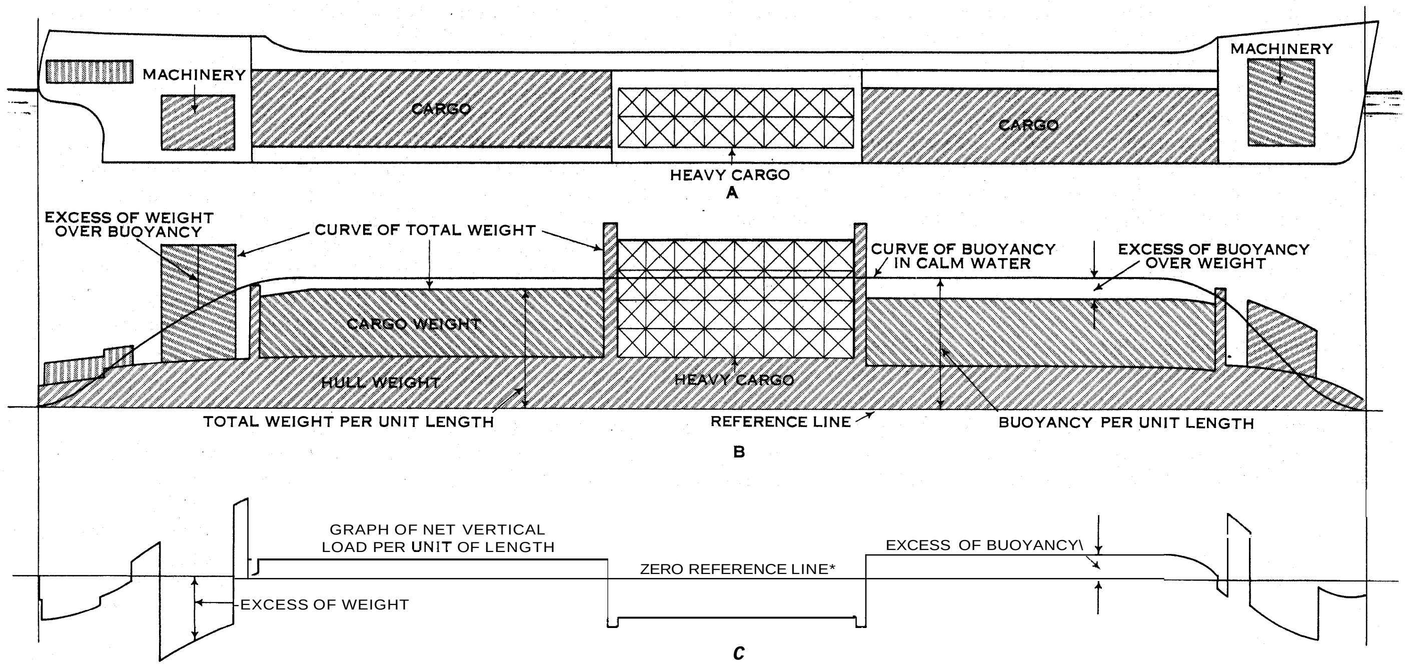


FIG. 12.— DIAGRAM SHOWING VARIATION OF WEIGHT AND BUOYANCY ALONG THE LENGTH OF SHIPS *(See text)*

a heavy shocklike impact known as slamming. This can occur if the bow of a ship emerges from the water on a violent up-pitch and drops down upon a rising wave surface. It can also occur if a large wave strikes an overhanging part of the ship, such as the flaring hull under the forward end of the flight deck on an aircraft carrier. The tremendous blow against one end of the hull causes the whole structure to vibrate in an action known as whipping. The strains thus caused may be as great as those encountered in sagging and hogging over large waves.

Other natural loads are those caused by wind and ice. Typhoon and hurricane winds may blow with velocities of 100 knots or more. In subfreezing weather the sea spray freezes on the exposed portions of the ship, thereby adding a substantial weight. Icebreakers must be able to withstand the shock of ramming thick, solid layers of sea ice and to survive the squeezing action of pack ice.

Many of these loads may be reduced by judicious operation of the ship; for example, by slowing down or heaving to in a storm. Ship structures are designed to withstand most of them, but the exercise of good seamanship significantly lessens their intensity.

4. **Variation of Buoyancy and Weight Along the Length.**—At a given draft and trim in calm water, the upward buoyancy forces vary from bow to stern in a fixed fashion because each unit length of the 'ship is supported by a force equal to the weight of water displaced by a transverse section of unit length at that point. When summed up, all the buoyancy forces on the unit lengths equal the total ship weight. The fixed or "hardware" weights of the ship structure, the machinery, the fittings, the equipment and the fuel and stores. have a somewhat different bow-to-stern distribution when reckoned by the same unit lengths (fig. 12). If the ship is loaded with cargo, so that the fore-and-aft distribution of total weight is shown by the total hatched area in fig. 12(B), some unit lengths weigh less and some more than the water displaced by the immersed volume in those lengths. Fig. 12(C) indicates the irregular nature of the net weight or buoyancy forces at all points along the ship length.

Cargo loaded at the ends aggravates this condition and creates an elastic hogging deformation, with the midship portion bent upward and the ends drooping. Cargo loaded in the middle, with the ends empty, creates a sagging of the structure, with the midship portion bent downward. As a first requirement, the ship structure must be strong enough to take care of all the nonuniform weight distribution in calm nater during normal loading and unloading. The bending caused by uneven loading, in a tanker carrying liquids and floating in still water, can be sufficient to crack the structure or to break it in two.

When the ship is in waves, the upward buoyancy forces are greatest in way of a crest and least in way of a trough while the ship and cargo weights and the distribution of these weights along the length remain the same. Since two successive waves are rarely alike, it is customary to design the hull structure to withstand the bending moments: in both hogging and sagging, produced by some assumed "standard" series of waves. One such wave has a vertical height in feet, from trough to crest: of 1.1 times the square root of the wave length in feet. This takes care of the observed fact that short waves, the most severe for small boats and ships, have height-to-length or steepness ratios greater than those of long waves. All the "standard" waves have lengths equal to the ship length.

5. **Determination of Forces and Moments.—The** maximum forces that a ship is likely to encounter in service, excluding temporarily those due to above-water or underwater explosions, are the weight and buoyancy forces that act vertically, caused by gravity. The moments of greatest interest to the designer are the maximum bending moment in the vertical fore-and-aft plane, for both the hogging and the sagging conditions on the assumed "standard" wave. Slamming forces may act in almost any direction, and they are usually applied at or near the ends of the ship. To predict them it is necessary to make certain assumptions and to use certain approximate formulas not described here.

Prediction of the forces and moments due to above-water or underwater explosions—a possible emergency load for all ship types—requires specialized knowledge and a great deal of experience, much of it of a secret or confidential status. Aside from direct or close hits, the explosive forces produce vertical and lateral bending and whipping, much as do the waves of the sea.

The procedure for determining the vertical bending moment is to consider the ship poised and balanced statically on the assumed wave. This means that the buoyancy graph in fig. 12(B) is replaced by one based on a curved "standard" wave profile instead of a straight one, with a crest either at mid-length or with two crests at the ends. The wave profile must be adjusted on the ship profile until the total buoyancy forces equal the total weight of the ship, and the centre of gravity is vertically in line with the centre of buoyancy. With the ship balanced on the wave a load curve similar to that in fig. 12(C) is drawn, showing the differences between weight and buoyancy at all stations along its length. At any transverse section, the vertical shear is determined by summing up the area under the load curve from one end of the ship to the section in question. By a process known as integration of the moments about a given station, the vertical bending moment curve is obtained.

6. Superposition of Calm-Water and Dynamic Wave Loads.—The final forces and moments which a ship structure is designed to withstand must take account of those imposed by the static loading, such as those due to cargo, fuel and stores loaded at a pier in port (fig. 12), plus those imposed by wave action and ship motion after the ship puts to sea. In fact, under some service conditions the calm-water bending moment may exceed in magnitude the wave-and-motion movement in a seaway.

VIII. STRENGTH OF SHIPS

A ship hull, of whatever materials it may be made, must be strong enough to withstand all the loads that may be imposed upon it by normal service and by any seaway that may be expected during its life. It must. in fact, have a reserve of strength to take care of excessive loads carelessly or negligently applied or of loads caused by unusually high, large or steep waves. The latter are encountered only on rare occasions, but they do occur.

The structural configuration. involving the disposition of material as well as the elasticity of that material, must be such tnat the structure does not bend or flex unduly under the specified loads. It is customary to make a ship hull much stiffer than. say, the wings of a large airplane, just as the fuselage of that plane is stiffer than its wings.

The material must be so disposed and proportioned that the hull has the minimum weight—and can be built for the minimum cost—to perform all its functions acceptably. A knowledge of how the various parts are strained. of how the applied loads are distributed among the various members and of how all of them work together is essential in order to place and proportion them in the most effective manner.

1. Strength and Stiffness.—A ship structure is sufficiently strong if it can support all the fixed loads of its machinery, fittings and equipment and all the cargo loads, and if it can withstand without permanent change of shape. cracking and fracture all the hydrostatic and hydrodynamic loads which can be imposed upon it in calm water or in any kind of seaway in which it is supposed to operate. It is sufficiently stiff if, under any of these service loads, it does not flex or deform unduly so as to interfere with the alignment of operation of machinery or aith any other function, major or minor. A bronze screw propeller of a high-powered ship, having blades that are too thin, may deform so much when generating full thrust that its shape and propulsive characteristics are changed. If the blades are permanently bent under emergency maneuvering conditions, the propeller is not strong enough.

Vibratory motion can build up to unacceptable peaks if local portions of the structure are in resonance with the periodic applied forces. In consequence, rudder plating and shell plating at the stern must be stiffened to control panting or pulsating deflections from propeller forces. The shell at the bow is also subject to panting from wave-impact loadings; this requires extra stiffeners, called panting stringers.

It is customary in ship structures and ship components to limit the calculated strains under the heaviest contemplated service loading to a certain fraction of the limiting strain for the material being used at which permanent change of shape or damage will occur. The margin thus provided takes care of unusual and emergency conditions which rarely can be foreseen at the time of design. For a submarine pressure hull the collapsing depth is calculated—or determined by model tests—as part of the original design. It is considerably greater than the working depth, at which the calculated strains are limited to values which can be endured indefinitely.

2. Structural Configurations.—The arrangement and disposition of the structural material in a hull and the proportions of the structure, all known as the configuration, are most important features. A too-shallow ship hull. like a too-shalloa bridge truss, requires an inordinate amount of steel for strength and stiffness. A hull that is too deep also requires too much steel because of its size, unless the various members are made too thin. Structural material in the form of a closed box, like a ship hull with a deck, resists vertical and lateral bending and twisting all at the same time.

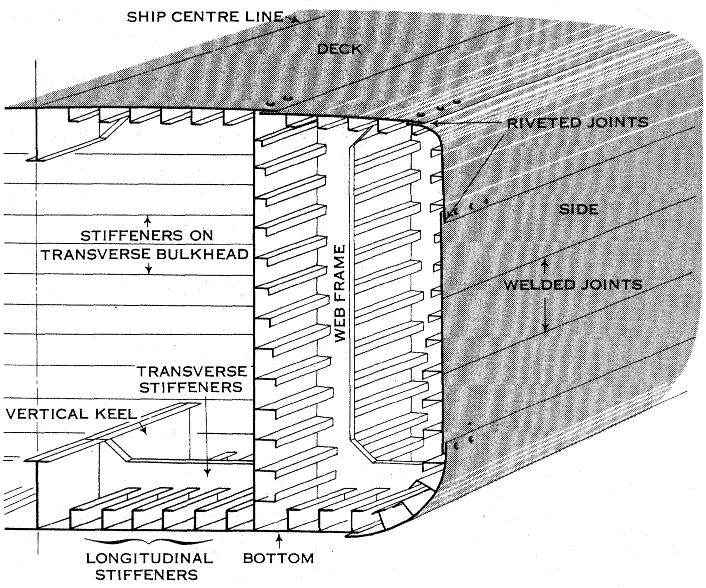


FIG. 13.—HALF SECTION OF THE STRUCTURE OF A LARGE TANKER

It is important, for cost and weight as well as for strength and stiffness. that the structural material be placed in the ship where it will do the most good. If there is too much material in the bottom structure and not enough in the decks, the neutral axis of the section (above and below which the moment of area through the structural members is the same) will be too close to the bottom.

For a given bending deformation the upper members will be unduly strained and the lower members only partly strained. It may be advantageous to make the hull girder deeper amidships, by about one deck height, where the vertical bending moment is greatest, and shallower at the ends where it is least.

Every boat or ship hull, both above and below the water, embodies a watertight boundary or shell which provides the buoyant volume to float it. Taken with a deck to which it is firmly attached. the whole forms a hollow box, a most economical and efficient principal structural member of the hull Since some part of this box is in compression for bending loads, and much of it is in shear for twisting loads, the relatively thin shell—bottom, sides and deck—must be prevented from buckling, crumpling and wrinkling nhen it is strained. This is done by stiffening it at intervals with frames and stringers of some convenient type. They hold the flat surfaces in shape and take some of the working loads as well (fig. 13).

When the stiffening system of the deck and shell plating lies predominantly parallel to the principal ship axis the ship is said to be longitudinally framed. When the majority of stiffeners lie at right angles to that axis, it is transversely framed. Whatever the system of deck and shell stiffeners, they must be supplemented by deep, web or belt frames in the first case, placed transversely (fig. 13 and 14), or by longitudinal stringers in the second case, run fore and aft. These hold the primary stiffened system in shape and help to distribute concentrated loads resulting from nonuniform placing of cargo, wave action on the outside and external blows from striking piers and quay walls and rubbing against fenders and the sides of other ships. Longitudinal framing saves hull weight because the metal in the fore-and-aft stiffeners supplements the metal in the shell and the uppermost decks in resisting the bending moments

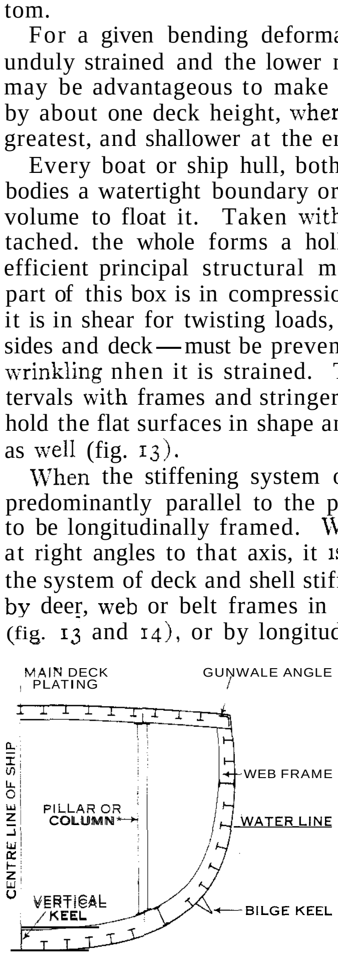


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FIG 14 — HALF SECTION OF A LONGITUDINALLY FRAMED DESTROYER

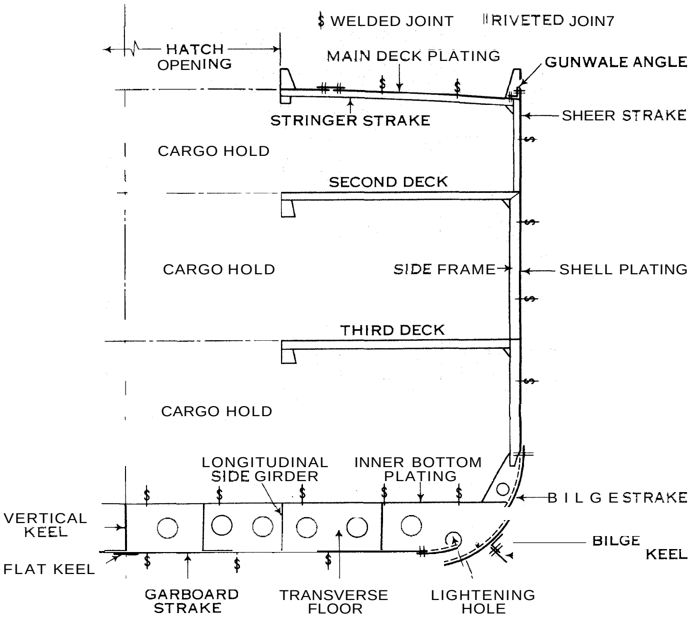

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FIG. 15.— HALF-MIDSHIPSECTION OF A TRANSVERSELY FRAMED CARGO SHIP

imposed in vertical and horizontal planes.

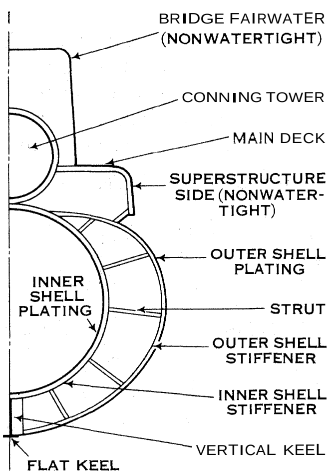
Fig. 15 shows the hull structure for a typical transversely framed cargo ship (1953 "Mariner" class, U.S.). The construction is predominantly welded. The riveted joints at bilge strake, gunwale and main deck, just outboard of the cargo hatch. function as crack arresters in case of progressive failure of the wide, flat, welded areas. The inner bottom plating forms part of the bottom flange of the ship girder; in addition, it is made watertight so that it serves as a tank top and as an additional watertight boundary if the outside plating at the bottom is pierced.

The transverse and longitudinal bulkheads required for subdivision, the internal platforms and decks required for service: access and storage and the boundaries of internal tanks for liquids are utilized for structural strength wherever practicable, to avoid unnecessary weight.

3. Scantlings and Strength Calculations.— When a structural configuration has been sketched, conforming satisfactorily to the ship arrangement, the designer selects the scantlings, defined as the size, shape, area and unit weight of the individual structural members. This is done first for the midship section, where the vertical bending moment is usually the greatest. The preliminary scantlings are chosen from experience, from a ship generally similar, from classification society rules or by a scientific analytic process.

The parts of a ship structure that make up the hull girder resisting the longitudinal bending moments must at the same time carry the more localized loadings, such as concentrated machinery loads and large external water forces. Often the latter govern the design of the part. The transverse bulkheads and the transverse web frames are designed on the basis of local loads. Watertight bulkheads are required to resist maximum water pressure when the compartment on one side is flooded.

Gun and launcher foundations present special problems. They are designed by assuming various directions of impulse or recoil to find the critical direction for each important member of the foundation.



BY COURTESY OF U.S. NAVY

FIG. 16.—HALF-MIDSHIP SECTION OF A SUBMARINE

4. Structural Design of Submarine Pressure Hulls.—The depths to which combat submarines are required to submerge and the necessity for conserving weight in the inner or always-buoyant hulls of cargo submarines call for correct proportioning of the structural elements and accurate selection of thicknesses for the various parts. The uniform pressure around the entire inner hull at working depth enables the designer to calculate the exact hydrodynamic loads, but the fact that the entire structure is loaded in compression and that the inner shell may be expected to fail by buckling more than makes up for the simplicity of loading.

The lightest pressure-resisting inner-hull form is a cylinder of circular section, stiffened by ring-shaped frames with a longitudinal spacing of from one-fifth to one-tenth or less of the diameter, depending upon the specified working depth and external pressure (fig. 16). Whether riveted or welded, the plates forming the circular sections are butted together at their fore-and-aft joints, so as to transmit the compression loads directly from one plate to the other. Theoretical formulas, supplemented and confirmed by the tests of many hundreds of scale models of steel, enable the designer to determine the plating thickness, the frame spacing, the form and size of the frames and the best method of attaching the frames to the cylindrical shell.

At each end of the submarine hull, where it diminishes in beam and depth to facilitate propulsion, the inner hull takes the form of the frustum of a cone, with circular or elliptical transverse sections of reduced diameter.

5. Detrimental Effects of Discontinuities.— The various parts of a ship hull made of elastic material are found to stretch. shorten, twist and flex as the external loads cause the whole hull to change shape. If the adjacent parts cannot deform locally by about the same amount, the heavier and stiffer members pull or push on the lighter ones.

The result may be excessive local strains, out of all proportion to the strains which would be caused normally by the principal external load. After reaching the fatigue limit the local metal may crack, buckle or break. Good structural design calls for the tapering or narrowing of members to correspond to the strength and rigidity required, and for great care in making transitions from heavy members to lighter ones along a given line of application of a load.

6. Materials of Construction.— Wood was for many centuries the most important and, in fact, the only shipbuilding material. It is still used for boats and small craft of many types, as it is easily handled and worked by local craftsmen with simple tools. However, it is a relatively weak material and is subject to rapid deterioration. Slippage along fore-and-aft flush seams is difficult to prevent. Large wooden ships had to have diagonal metal straps bolted to the planking to counteract slipping at the seams and. to keep the hulls in shape. Others made use of hogging girders or tie rods running over high vertical posts to prevent the ends of the hulls from drooping. Many modern metal ships have wooden weather decks to help insulate the spaces below and to provide a good walking surface.

The development of strong waterproof glues and techniques for building up large curved members from thin laminations has greatly improved the strength and stiffness of wooden ship structures. Checking, splitting, knots and other imperfections are largely eliminated, and many short pieces can be used. Molded plywood yacht hulls made of five thin layers glued together, with the grain running in different directions, are stiff enough to hold their shape without an internal framework.

The steels most widely used for hull structures are of the medium, high-tensile and special-treatment types. By far the greatest proportion of parts are of medium steel, where the working strains are small or moderate compared with the yield strain. Both high-tensile and special-treatment steels have higher yield points; the latter has ballistic and shock-resisting properties as well. They are used for parts subjected to high strains in order to save hull weight.

Investigations in the latter 1940s revealed that many of the fracture casualties of that period were due to the use of steel lacking in notch toughness. This term refers to the steel's ability to absorb energy by stretching in the vicinity of sharp corners, notches and cracks, particularly at low temperatures or at high stretching rates. This quality is particularly important where all the plating seams around the girth are welded. Many ship structures have several riveted seams to permit adjustment of the strains due to butt welding and to localize progressive cracking. Specifications for shipbuilding steels of the 1950s required certain minimum limits on notch toughness and on adaptability to welding.

Aluminum alloys are used for the hulls of small and experimental craft and for large shipboard elevator platforms and similar structures. They are also used for the superstructures and upper works of many cargo and passenger vessels; they form the upper parts of steel hull girders which bend elastically in service. For the last-named purpose, the increased deformation or stretch of these alloys is an advantage. For a given weight, panel plates of aluminum alloy are thicker and stiffer than those of steel. They thus provide a better appearance and for many installations they do not require painting.

Use of aluminum for large ship structures, such as the hull proper, in which appreciable savings in weight are to be achieved. requires reliable welding and riveting in large thicknesses. What is more, it necessitates the acceptance of increased bending deformations along the length and lowered natural frequencies of vibration as compared with similar structures of steel.

Hulls of heavily reinforced concrete have been used for ships and barges in times of emergency, uhen steel reinforcing rods and labour trained in building construction were available and shipbuilding steel and labour having shipbuilding skills mere not.

Plastics reinforced with glass fibre eliminate many of the joints in a hull and greatly decrease the deterioration encountered in wooden or metal hulls. They may be coloured with pigment and they lend themselves admirably to "sticking in" stiffening members and other parts and to repairs in a similar manner when damaged. Many nonstructural parts of boats and ships of all sizes and types are easily fabricated by molding in reinforced plastic.

7. Jointing, Connections and Attachments.—It is possible. with Fiberglas and similar materials, to make a small-boat hull entirely in one piece. However, as the boat becomes large enough to require a Fiberglas deck, this is made separately and attached to the hull. For larger craft. the individual planks and plates have to be joined by gluing, screwing, bolting, riveting or welding (see also RIVET; WELDING). Flush seams (fore-and-aft joints) and butts (girthwise joints) for smooth external hull surfaces are possible by gluing and melding. Screwing, bolting, riveting or melding require lapping the members over each other or the use of internal (and external) connecting straps, strips or other parts. Nailing for small-boat structures of wood is no longer favoured because of the difficulty in making repairs. If the limitations and advantages of each of the jointing methods is kept firmly in mind, it is found that practically every one of them serves well in some particular application on board ship.

Welding has the great advantage over riveting in that it eliminates excess metal and saves weight practically everywhere in a ship structure, sometimes as much as 10%. As a rule, the loads are transmitted from one member to another more directly, and the resulting structure is more rigid. Under heavy deformation, such as collision damage, the welded joints will hold together better than riveted connections. Under mild deformation they are less liable to leak. Welded shell plating is much smoother than riveted plating, with appreciable savings in friction and total resistance. On the other hand, poor welding is often undetected from the outside. One small flaw in an unfortunate position can initiate a major crack.

8. Structural Tests of Ships and Models.—Those who made the early strength calculations of iron ships in the 1850s and 1860s benefited from the studies and tests of I. K. Brunel and W. Fairbairn on the tubular or box-shaped bridges previously built in Great Britain. Fracture and loss of the fast, light British destroyer "Cobra" in the early 1900s led to tests of another destroyer, H.M.S. "Wolf." The need for information on the behaviour of similar structures when actually loaded to the buckling or fracture point led, in 1930, to full-scale tests of the U.S. destroyers "Preston" and "Bruce" and, later, of the British destroyer "Albuera."

These tests confirmed the use of the simple beam theory for large, thin, box-shaped structures, and indicated the relative effectiveness of stiffened and unstiffened material and the rigidity of riveted joints.

Fractures of welded ship hulls during the early 1940s led to a new series of extensive structural-testing programs by Great Britain and the United States on full-size ships, including tests with various load distributions in calm water.

Beginning with the German M.S. "San Francisco" in 1934, a number of ships have been instrumented to determine in heavy seaways the wave profile along the ship's side, the water pressures and accelerations resulting from ship motion, the deflection of the ship girder and the simultaneous strains in many parts of the ship structure.

After the 1920s the techniques of making and testing structural models vastly improved. The availability, after the 1940s, of the wire-resistance strain gauge, with its small size and tiny wires cemented to the metal, made possible the testing and structural analysis of models (and ships) under high-speed dynamic loads such as impacts and shocks from underwater explosions.

IX. LAWS AND REGULATIONS FOR SAFETY

Certain safety requirements have been imposed upon the normal naval architectural requirements by law, by official regulations and by international convention. These cover a wide field, involving health, hygiene, fire protection. lifesaving and communications (radio and radar) as well as seasonal loading, watertight integrity. freeboard, subdivision and other provisions to ensure that ships will remain upright and afloat. Provision for freeboard, subdivision and other major items in the present category must be made in the original layout and arrangement sketches as part of the preliminary design.

1. Freeboard.—Aside from providing reserve buoyancy when rolling and pitching and keeping the upper decks free from green water and spray, freeboard is required to keep those decks above water when the hull is partly flooded. Adequate freeboard for running in waves must be larger in proportion to its length for a small ship than for a large one, because short waves are steeper than long ones. Freeboard must increase as the ship speed increases because of the greater pitching at higher speeds.

2. Subdivision and Floodable Length.—Subdivision by watertight bulkheads is necessary to prevent extensive flooding after only local damage. A well-designed ship should, with some damage and moderate flooding, still be able to move, steer and stay afloat. In recognition of this premise the major maritime nations of the world have approved international treaties and drafted rules specifying the minimum amount of freeboard and the extent of transverse watertight subdivision.

This subdivision is expressed as a function of the floodable length of a ship. 4 convenient method of relating floodable length to the ship is by a floodable-length curve. The curve is plotted on the profile of the ship so that the vertical ordinate at each point equals the portion of the ship length, centred at that point, which can be flooded without immersing a margin line. The margin line is parallel to the uppermost deck to which the transverse watertight bulkheads extend and is several inches below it, so that in calm mater the ship can sink to this line without water leaking or flooding into other compartments.

When plotting the floodable-length curve, allowance is made for trim but not for heel since the ship is assumed to be open to the sea from side to side. The curve is used by the naval architect to help him decide where to place the transverse watertight bulkheads so they may be most effective in restricting the extent of flooding after damage.

The amount of water that can enter any compartment depends upon the ratio of the open-space volume to the total volume, known as its permeability. An empty hold can take nearly its entire volume of water, with a permeability of say 98%. If filled with coal, its permeability may be 20% or less.

3. Situation After Damage.—Any heel after damage makes a ship vulnerable. Excessive heel may be disastrous, as it was for the "Andrea Doria" in 1956. In a well-designed ship, subdivision is planned to ensure that the ship remains upright, or nearly so, no matter where it is opened to the sea, or that heel can be corrected by counterflooding on the opposite side. Unless the flooding occurs amidships, the ship trims by the bow or stern. This may render it vulnerable in a heavy sea. Compartments at the ends are usually shorter than those nearer amidships.

Because of the intact water plane lost and the free surface in the flooded areas, the partly flooded ship almost invariably loses some transverse metacentric stability. Such a ship can survive if somehow it can be kept upright. Several ships bombed in the 1940s were saved by lashing them to adjacent piers and other craft to hold them upright until they could be pumped out.

X. SHIP DESIGN PROCEDURE

The work outlined in the foregoing, together with other tasks depending upon the type and mission of the ship, is carried out in several rather definite stages, indicated by the following headings.

1. Preparation of Requirements.—When the operator decides a new ship is needed he prepares an outline of the desired requirements, often with the technical advice of a professional ship designer. The latter endeavours to embody in the specifications many features requiring decisions to be made by the owner. Settling them early avoids interruptions and delays at later stages. If these decisions are not readily made. a number of preliminary designs may be worked up to indicate the range of possibilities within the limits tentatively established by the operator. The latter is then in a better position to make his decision, or to require that further sketch designs be prepared.

2. Compromises Necessary.—A layout of the proposed ship is no sooner begun than the naval architect encounters limitations on every side. If the ship is made large enough to house all the necessary components conveniently. it becomes too large, too costly to build and consumes too much fuel. If held to a moderate size, cramping, squeezing and overlapping begin as the components are worked into the arrangement plan. The mission of the ship must constantly be kept in mind as space and facilities are pared here and there. To carry out this give-and-take process intelligently and logically, the naval architect must have a fundamental and general knowledge of all aspects of the design and an intimate knowledge of all features mentioned in this article.

Imperfect knowledge of physical laws relating to ships and their behaviour forces the naval architect to rely heavily on experimental data, empirical rules and past experience. This situation is aggravated when, as frequently occurs, he is forced to apply trial-and-error methods to certain features of the design.

3. Preliminary Design Stage.—The purpose of the preliminary stage is to present to the prospective owner one or more designs which represent a feasible and economical fulfillment of the requirements. Usually only the major features of the ship are worked out at this stage. However, an extensive knowledge of the details of ship design is called for to determine the effect of the minor features without actually designing them.

As the first step in this stage, the naval architect chooses the ship type and its size. Usually a number of existing vessels meet roughly the requirements he is trying to fulfill. With these as guides he selects combinations of hull type, machinery and structural material to form one or more parent or basic types. At other times he is faced with most unusual requirements and with design problems that appear to be entirely new to the profession. Here he must start from the beginning, with his experience, knowledge and judgment as his principal guides.

Following the roughing out of the design in small-scale sketches, the major features of the ship are laid out in three types of drawings. The general arrangement drawings show the arrangement of spaces and equipment in profile elevations and deck plans (fig 5). The line drawings depict the external shape of the underwater and above-water hulls. This is delineated by intersections of the hull with three series of planes at right angles to each other. The structural arrangement drawings embody midship sections such as fig. 13, 14, 15 and 16, together with typical sections at other stations and drawings showing other general features of the structural configuration and the principal scantlings. The latter are based upon a preliminary calculation of longitudinal strength (see *Stvength of* Ships, above).

In preparing these drawings the naval architect must determine whether each design proposal satisfies the performance and naval architectural requirements. Based on this and a weight study, the stability can be checked.

When the preliminary design studies have been carried as far on paper as existing knowledge permits, especially with respect to the power needed to achieve the given speed, one or more models are built. These models are towed and then self-propelled with a stock propeller (many of which are available at most model basins) to determine more accurately the ship's resistance and required propulsive power. Additional data can be obtained during these and other tests, concerning the nature of the flow into the propeller position, to enable the naval architect to design a final propeller, provided the hull shape and loading conditions are not changed in the meantime.

4. Contract Design **Stage.**—When a preliminary design appears to give promise of a ship that will meet all the requirements to everyone's satisfaction, the naval architect proceeds with the preparation of contract plans. These are intended to be sufficiently complete and comprehensive to enable the shipbuilders to make estimates of cost and time of construction. When combined with the detail specifications, prepared concurrently by the naval architect. there is enough information at hand to enable the successful bidder to draw the working plans, fabricate the parts and build the ship in accordance with the wishes of the prospective owner and the naval architect.

The preliminary lines, general arrangement and structural plans are drawn to a large scale and in more detail. Accompanying these are diagrammatic and arrangement plans of the main propelling and auxiliary machinery or of other major features in this category, such as the pumping machinery on a dredge or on a fireboat, prepared by marine and mechanical engineers. Calculations for strength and metacentric stability and the weight estimate are also expanded and done with more precision. Diagrammatic plans of cargo-handling arrangements, hull piping, ventilation and air-conditioning systems are prepared. Similar plans are drawn for the electrical systems and for location of the electronic equipment.

The detail specifications cover particular features and characteristics of all components of the ship which cannot conveniently be shown on the plans.

The preparation of working drawings to be used by the artisans and mechanics in the shipyard is a phase of shipbuilding and is not discussed here. *See* SHIPBUILDING (MERCHANT AND NAVAL).

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NAVAL SCHOOLS, U.S. The **U.S.** navy operates a number of schools to train enlisted men to man naval aircraft and vessels. with their complex mechanical, electrical, hydraulic and other equipment. In the early days, all navies enlisted boys who learned seamanship on board ship, as a prelude to qualifying as ordinary seamen and later as able seamen. School ships were used for a time, but modern navies have their schools on shore.

Recruit training is conducted at naval training centres at Bainbridge, Md., Great Lakes, Ill., and San Diego, Calif. Every new recruit is indoctrinated, taught military drill, instructed in caring for and firing a rifle, introduced to the elements of seamanship and the problems of damage control on board ship, while being given an idea of naval life and discipline, in a course lasting about three months. Women recruits for the WAVES have a shorter course at Bainbridge. The number of recruits trained each year is about 97,000.

The U.S. marine corps trains recruits at Parris Island. S.C., and at San Diego, Calif., for 12 meeks, followed by 4 meeks at Camp Lejeune, N.C., or at Camp Pendleton, Calif. In 1959 the marines trained about 39,000 regular recruits and 7,000 six-month reservists.

In addition to recruit training schools, there are four other types, known as class A, B, C and P, respectively. for enlisted men of the navy and two types for marines.

Class A schools are in the nature of apprentice training units. They are intended to provide elemental technical knowledge and skill to enable the student to specialize as soon as he goes on board ship or is assigned to a naval air squadron or station. Kith the training thus received, he should be able to acquire enough practical experience to permit him to qualify as a petty officer 3rd class About 45,000 men attend class A schools each year in courses varying from 9 to 26 weeks.

Class B schools are designed to give advanced instruction to 1st or and class petty officers who have reached these ratings by demonstrating leadership and supervisory ability by self-training on their jobs. In almost all instances the records of such men indicate that they are excellent chief petty officer material. About 6,000 men took class B school courses in 1958.

Class C schools are intended to provide instruction and training for a particular skill or technique which is not peculiar to any one rating, or which becomes necessary to meet a specific need. In the true sense. many of these courses are specialist courses. For example, the welding school at San Diego offers three courses: welding, 12 weeks; advanced welding. 6 weeks; and underwater cutting and welding. 6 weeks. To be eligible for the latter class a student must have successfully passed the first two and have. previously qualified as a diver. Enlisted men seeking to enter the Naval academy under the enlisted quota are eligible for the Naval academy preparatory class at Bainbridge. a class C school. Men seeking appointment to naval ROTC units in universities and colleges may also compete for this school.

Class P schools, of which only two remained in 1959, prepared men for further training. The school of electricity and electronics at Great Lakes introduces students to the fundamentals of these subjects prior to their being assigned to schools for further training. The school for stenard's mate's apprentices at San Diego trains men to care for, prepare and serve food.

The U.S. marine corps has two classes of schools for ground and aviation technical training for noncommissioned officers. In addition. they send a number of marines as students to many naval and army schools. About 18,000 marines took one or more school courses in 1958, aside from recruit training. (J. B. Hs.)

NAVAL STORES, a term that originally designated the pitch, tar, resin. flax, cordage, masts and timber used in building and maintaining wooden sailing ships but is now applied only to the products of the pine tree. These products fall into two groups: gum naval stores derived from the oleoresin (gum or pitch) of the living pine. commonly called crude turpentine, and wood naval stores obtained by processing dead pine wood.

The United States is the foremost producer of naval stores, with France ranking second. Large amounts also come from Greece, Spain, Portugal and Mexico. Pines planted in the maritime provinces of France by order of Napoleon I as a measure to control the sand dunes are the profitable source of French naval stores, its constancy assured by careful forestry. In the U.S. the industry is centred in the south. where longleaf and slash pines abound.

The raw material of the gum naval stores industry. oleoresin, is a semifluid substance composed of resins dissolved in turpentine oil, its chief component being pinene. It is extracted from the pine by cutting through the sapwood into the heartwood of the tree (where resins accumulate) and collecting the exudate that issues from the wound. Formerly, gum aas obtained by cutting a recess or box into the pine at its base and collecting the gum in a cup placed at the point of a V-shaped gash in the rear wall of the recess. Each tapping of the tree required the cutting of a new gash, leaving a succession of scars on the tree's heartwood. Boxing was destructive of tree life, many trees surviving this treatment by only a year or two. It has given way to a wiser shallow cutting with which narrow metal gutters are employed to channel the gum into collecting cups. It has been found that an application of sulfuric acid to a fresh cut induces a fuller and more prolonged gum flow, with the result that the turpentine yield is materially increased.

Turpentine is extracted from oleoresin by distillation; the residual compounds harden into the substance known as rosin. The individual farm still was once essential to the processing of gum. The farm operation consisted of subjecting the gum to heat in a brick-supported copper pot heated by a wood fire. Turpentine and water vapour were condensed in the water-cooled copper pipes of the still. and the liquid material was discharged into a container where it quickly separated into two layers with the turpentine on top. Remaining in the still was the molten rosin, combined with dirt, sand. bark, pine needles and such other foreign matter as had escaped the occasional skimmings of the pot. Although the rosin was strained through wire mesh and cotton batting, it proved upon hardening to be impure and was dark in colour.

The farm still has largely yielded to the large central cleaning and distilling plant where the gum is freed of foreign bodies by thorough washing and filtering. From cleansed and purified gum, after the extraction of turpentine by steam distillation, a pure, translucent, pale amber rosin is produced.

Wood naval stores are derived from salvaged pine wood, such as tree stumps and "downwood" or lightwood—pine from which the bark and sapwood have fallen away in decay. Although methods of treating the wood vary, generally it is shredded and subjected to heat under pressure in a digester. The volatile components—carried off, condensed and refined by fractional distillation—yield wood turpentine and pine oil, the latter product unobtainable from the oleoresin of the living tree. The residual resin retained in the shredded wood is extracted by treatment with a mineral oil solvent. The resulting resinous solution, purified and relieved of solvent by vaporization, gives wood rosin.

Sulfate wood turpentine, a by-product of the sulfate method of making pulpwood paper, is obtained by condensing the vapour from the digester in which the wood is treated. The turpentine, seriously contaminated by sulfur compounds, is purified by chemical treatment and fractional distillation. Although no rosin is recoverable in this pulping operation, the cooking liquor used in the process may be salvaged and treated chemically to yield the useful mixture of resinous and fatty acids known as tall oil.

See also RESINS: Natural *Resins;* ROSIN; TURPENTINE.

(E. L. Y.)

NAVAL STRATEGY AND TACTICS. Naval strategy embraces all phases of the planning, disposition and general employment of naval forces preliminary to their contact with an enemy force. Tactics denotes the maneuvering of naval forces during combat. Strategy must include planning and dispositions that will enable a fleet or naval force to begin fighting in accordance with tactical plans when an enemy is encountered.

Naval strategy has been described as "the art of the admiral," but naval tactics, which follow after and merge into naval strategy, are also an admiral's art. The fundamental principles of naval strategy have changed little over the years, but their application has been greatly influenced by the higher speeds and greater ranges of ships and planes and by the development of rapid methods of communication. Naval tactics have always been influenced primarily by the weapons in use and the characteristics of their carriers. (For the military aspect, *see* STRATEGY; TACTICS.)

Naval strategic planning must be carefully directed toward attainment of the national objectives as determined by the government. In supporting national policy, a navy is primarily useful as a means of obtaining control of vital sea areas so that they may be used freely or their use may be denied to an enemy. Plans for a particular naval campaign should be based on the naval forces available. and on careful evaluation of the various courses of action that are open. The planner must also consider the naval forces available to the enemy, their relative strength, their location and the possible courses of action open to them. In deciding on a definite course of action the status of fuel supplies, food, water, ammunition and other essential stores as well as repairs, medical attention, mail and other factors must be considered. As ships can operate only for a limited time without receiving replenishment, plans must provide for keeping open lines of communication by which they may be supplied.

EXAMPLES OF NAVAL STRATEGIC PLANNING

Spanish Armada.—In 1587 Sir Francis Drake argued that the best way to defend England against Spain was to attack Spanish ships on the Spanish coast. He attacked Cádiz and burned 24 or more ships. Drake wanted to attack again in the following year. The court opposed the plan for several weeks; finally consented, too late. An early attack on the Spanish coast in 1588 would probably have prevented the Spaniards from sailing north.

Seven Years' War.—During the Seven Years' War, Great Britain intended to take Canada and drive the French out of India. The Royal Navy reasoned correctly that the principal naval effort should be devoted to preventing France from sending a fleet to Canada or India. In pursuance of this strategy Adm. Edward Hawke watched Brest with a powerful fleet. while smaller naval forces were sent to Canada and India. Adm. Charles Saunders not only guarded the Quebec expedition against French naval interference (1759), but he staged a diversion which misled the French and facilitated victory. The soundness of the British strategy was proven in Nov. 1759. Weather permitted the French fleet to escape from Brest, but Hawke pursued and won a great victory at Quiberon bay.

American Revolution.—In 1776 the Royal Navy removed Gen. William Howe and his army from Boston after Washington had the city invested; it then helped the British army to capture New York city. Afterward it moved British troops to Savannah, Wilmington and Charleston. By 1778 Washington realized that the co-operation of a superior French fleet was essential if he was to win a truly decisive victory; he wrote to the Continental Congress as well as to Benjamin Franklin to this effect. He sent Col. John Laurens to Paris to join Franklin in pleading for a fleet. In May 1781 Washington learned that a French fleet would come to the coast, and the comte de Rochambeau's army was marched from Newport, to the Hudson north of New York. Washington and Rochambeau started for Virginia with their armies in August. Adm. François de Grasse displayed genuine strategic ability in taking his entire fleet north from the West Indies. He arrived in Chesapeake bay on Aug. 30. The British Adm. Samuel Hood had looked into the bay and gone on to New York, arriving Aug. 28. Adm. Thomas Graves went to sea on Aug. 31, with 5 ships and the 14 of Hood, hoping to intercept Adm. Louis de Barras who had sailed from Newport. Graves arrived at the Virginia capes on Sept. 5 and was unpleasantly surprised to find De Grasse at anchor inside. Graves made a poor strategic decision when he failed to attack the French fleet at their anchorage and force his way into the bay. This battle sealed the fate of the British army.

De Grasse showed excellent strategic judgment again the next day while both fleets repaired damages. Knowing that he had no repair facilities nearby, and reasoning that he could accomplish his objectives without a second battle, De Grasse drew the British fleet slowly southward for two more days to permit De Barras to reach the safety of the bay. Crowding on sail, on Sept 9 De Grasse returned to the Chesapeake and placed himself between Cornwallis and Graves. After three days of irresolution, Graves returned to New York. Had it not been for the presence of the French fleet, the Royal Navy could have rescued Cornwallis and his army from the combined armies of Washington, Rochambeau and Lafayette. Gen. Sir Henry Clinton, in New York, made a bitter comment: "Clinton was promised a fleet; Washington had one." (See AMERICAN REVOLUTION, THE.)

Admiral de Grasse and his fleet were able to interfere in North America because Adm. Sir George Rodney made a poor strategic decision. Admiral Hood arrived in the West Indies from England in Jan. 1781 and became Rodney's second in command. In February Rodney sent Hood with a portion of the fleet to cruise off Martinique to intercept a naval force expected from France. Hood estimated that the French could not arrive before mid-April, and he advised refitting all ships, filling with provisions and water and concentrating the entire fleet ready to inflict a decisive blow. The French outnumbered Hood and they suffered very little damage in the skirmish which occurred on April 28. As Rodney then had to refit and provision his fleet before he could act, the French fleet proceeded westward to Haiti and later went north to the Chesapeake. Thus Rodney missed an opportunity to defeat the French fleet.

War of 1812.—Northern Ohio, Indiana, Michigan and the states to the west were preserved for the United States in the War of 1812 by good naval strategy on Lake Erie. War was declared on June 18, 1812, and on Aug. 16 Detroit was surrendered to a British army. Soon afterward, Gen. Henry Procter invaded Ohio, depending for supplies on lake transportation. Commodore Oliver Hazard Perry constructed a small squadron on Lake Erie and took it to Put-in-Bay in the Bass Islands, where his presence cut off Procter's supplies. The British squadron under Capt. Robert Barclay was compelled to come out from Malden and fight before it was fully prepared for battle. Perry's victory, Sept. 10, 1813, cut the communications of the British army and compelled it to retreat. Perry then ferried the army of Gen. William Henry Harrison across Lake Erie, enabling it to intercept and defeat the British troops in the battle of the Thames. Thus, Perry's naval victory on Lake Erie forced British troops to abandon northern Ohio, Detroit, all of Michigan and western Ontario.

On Lake Champlain, Commodore Thomas Macdonough had a squadron ready in the summer of 1814. The governor general of Canada, Sir George Prevost, marched into Plattsburg, N.Y., on the lake, with 12,000 veteran troops on Sept. 5, 1814. The small squadron of Macdonough was anchored in carefully chosen positions inside of Cumberland head, and he awaited naval attack there. Prevost hurried Capt. George Downie's British vessels into battle. In the battle of Plattsburg, Sept. 11, Macdonough defeated the British squadron. Knowing that the lack of roads prevented an invasion of the United States except by water on Lakes Champlain and George, and seeing that control of the lakes was denied him, Prevost marched back to Montreal. Careful strategic and tactical planning, combined with courage and leadership, won a victory over a superior force for Macdonough.

The duke of Wellington was British ambassador in Paris, and the cabinet in London invited him to go to Canada as soon as it learned of Macdonough's victory. Wellington was offered full powers to conclude a treaty of peace with the United States. He replied, "What you need in Canada is not a general officer, or an army, but a naval superiority on the lakes."

Civil War.—The Union navy strangled the Confederacy by a blockade of the southern coast, from Virginia to Texas, in the U.S. Civil War, 1861–65. A river navy, created on the Mississippi and its tributaries, completed the blockade and cut the Confederacy in two, besides giving invaluable support to the Federal army.

World War II.—In order to bring the U.S. fleet into a position where it might be dealt a decisive defeat, the Japanese planned an attack on the island of Midway in 1942. The idea was strategically sound, but the execution exemplified poor strategic planning. Instead of holding their valuable carrier planes in reserve, ready to strike the decisive blow against the U.S. aircraft carriers, these planes were used against installations on Midway, with the result that the Japanese carriers were caught in a vulnerable position with their planes on deck. Some powerful Japanese fleet units were not brought to the Midway area, and those present were not concentrated ready to employ their effective night-fighting tactics or to fight in daylight.

NAVAL TACTICS

The art of disposing naval forces for battle and maneuvering them in battle and the methods employed to gain advantage in battle at sea are called naval tactics. Some writers insist that the essence of tactics is offensive action, but this is not invariably correct. One fundamental principle of tactics applies to battles at sea as on land: concentration of all or the major part of one force on a part of the enemy's forces is essential for winning decisive results.

Early History. — In the earliest known naval battles the fighting was done by soldiers armed with swords who defended themselves with shields. The earliest vessels were simply platforms for the fighting men. The first vessels designed specifically for naval service were the mar galleys. They were long, narrow craft, propelled by oars, which required a large number of rowers as well as fighting men, had little stowage space for food and water and were unable to remain away from port for long. Naval tacticians soon evolved two ideas: ramming the enemy ship and shearing off an enemy's oars before closing for the fighting. To counter such tactics, ship designers lined the sides of the war galleys with heavy beams at the water line to make them less vulnerable to damage from ramming. The addition of these beams made the vessels slower to maneuver and thus less able to ram an enemy or to avoid being rammed. Missile weapons of ancient times were bows and arrows, including burning arrows. Bolts and other heavy weights were discharged from crossbows and other missiles were dropped on or hurled at the enemy *(see* ENGINES OF WAR). Greek fire (*q.v.*) was developed at Byzantium and used effectively against ships and their crews.

The earliest naval battles illustrate the principle of concentration of force. In the battle of Salamis, 480 B.C., the Persian fleet outnumbered the Greeks. but the latter formed their ships across a strait, with their line protected at each end by the rocky shore, a second line in support and a rear guard. The Persians were unable to concentrate all their force on the Greeks and suffered heavy losses. At Actium, 31 B.C., the ships of Octavian evaded ramming by the larger vessels of Mark Antony and applied worrying tactics, such as dashing in to break oars and then avoiding hand-to-hand fighting. Fire arrows of blazing tow and oil were used to turn the tide. King Edward III of England defeated the French at Sluys, 1340, by concentrating his attack on a portion of the enemy and taking ship after ship by boarding. The French used crossbows. but the English archers with very rapid discharges of arrons from their longbows were much more effective. Both commanders in the great battle of Lepanto, 1571, went into battle believing that their force outnumbered the enemy. Both had formed three divisions in line abreast, with a reserve division in the rear. Don John of Austria, commander of the Christian fleet. had six large galleasses, each mounting 30 cannon and carrying a large force of soldiers armed with the arquebus or the musket. He planned to have two of these large three-masted vessels ahead of each division of his line abreast. Those in advance of the left and centre were very useful in inflicting damage on the approaching Turkish line, but the right division failed to reach its assigned position before the fighting started. The Turkish division commander, Uluch Ali, took advantage of the fact that the Christian division opposite him was not in position and he headed his vessels off to his own left, drawing the Christians after him. Giovanni Andrea Doria. great-nephew of the famous Genoese Andrea Doria, failed to grasp the opportunity presented to him by Uluch Ali. Doria might have thrown half of his division on the left flank of the centre Turkish force, already engaged, and by this concentration saved many Christian lives and hastened the defeat of the Turks. By so doing. Doria could have held half of his division in reserve to meet Uluch Ali if he returned. In fact, Uluch Ali drew Doria away from his assigned position and then turned back to fall on the exposed flank of the Christian line, where he inflicted very severe damage before being driven off. Hard fighting, the spirit of the Christians and their skillful use of firearms won them the battle in spite of Doria's tactical error. Cannon had been introduced on board ship in the latter part of the 14th century, but they were still small in 1571.

The defeat of the Spanish Armada was a clear-cut example of the value of superior tactical handling of ships. It was the first battle between large sailing fleets; the gun was the weapon used by both sides, and both were short of ammunition much of the time; there were many engagements but no fight to a finish. The English commanders understood the tactical needs of the situation, and with their lighter, more easily handled vessels they avoided giving the Spaniards any opportunity to board them, or an occasion to fight broadside to broadside. George Monk with an English fleet defeated the Dutch off North Foreland in July 1666. It had become evident by this time that a fleet must fight broadside to broadside, and Monk had no effective signaling system. nor did any navy have one for another century. Although Monk did not inflict a decisive defeat on Michael de Ruyter, he did follow up by burning Terschelling and 160 merchantmen.

The *Fighting Instructions* of the Royal Navy were issued as a result of the Dutch Wars and the doughty Dutchmen were envisioned as the enemy. These instructions were valuable and based on sound principles. but they limited the opportunities for tactical skill and prevented concentration. They led to many inconclusive battles. Meanwhile the construction of ships. seamanship and ship handling improved considerably in the period between 1666 and 1750. Hawke instituted the continuous blockade in 1758–59, and this was afterward perfected by the earl of St. Vincent and others. Prior to this time it was considered rash to keep large men-of-war out of port between September and May. Three Frenchmen, Paul Hoste. Sebastien Bigot de Morogues and Jacques Bourde de Villehuet. published treatises on fighting instructions ahich mere translated into other languages and it seemed that the naval world was accepting them as gospel. But John Clerk of Eldin (1728–1812), who began to study the subject in the middle of the 18th century. came to the conclusion that the British navy could rely on its efficiency in gunnery and seamanship and should concentrate on an enemy's rear to defeat it decisively.

In the battle off Dominica, 1782, Rodney won a decisive victory by such a concentration. Concentration was employed again by British admirals in the battles of the First of June. St. Vincent. Camperdown. the Nile and Trafalgar. Tactical skill was, of course, combined with excellent leadership.

19th Century. — This century produced no great fleet battle after Trafalgar. 1805, but it witnessed the adoption of steam poner. iron and steel for shipbuilding, armour protection, rifled guns, explosive shells, mines and the automobile torpedo. Sailing vessels nere supplanted by the battleship. cruiser, monitor, torpedo boat, destroyer and submarine. Higher speeds. longer effective ranges for guns and more powerful explosive charges modified tactical conditions from year to year. It was claimed that the torpedo had made large ships obsolete, and many tactical ideas had to be reconsidered. The U.S. Civil War nas a war of blockade, although it produced the first duel between ironclads, "Monitor" and "Merrimack." Certain Civil War events, and the battle of Lissa, 1866, led to the installation of rams on nearly all large ships. After 1866 no major warship was sunk by a ram in battle. but two large British ships were accidentally sunk by rams in fleet maneuvers.

World War 11.—This war introduced new problems in the application of time-tested tactical principles. The presence of the aircraft carrier (q v.) made a radical change in fleet tactical formations; it also resulted in naval battles in which the opposing ships did not sight each other. but employed carrier-based aircraft to bomb, strafe and torpedo their opponents. Three great naval fleet battles in the Pacific were of this type, Coral Sea. Midway and the Philippine Sea. The battle for Leyte Gulf included three actions in which carrier planes fought distant ships and two other actions in which ships fought each other with gunfire and torpedoes. One of these latter actions, in Surigao strait, involved the classical "capping of the T" against one force. The action off Samar not only involved ships in sight of each other using guns and torpedoes, but also escort carriers (CVE's) using their planes to defend themselves against enemy gunfire. The Japanese showed great tactical skill in night fighting, especially Adm. Raizo Tanaka's destroyers at Tassafaronga. ***See*** **WORLD WAR** I: *Naval;* WORLD WAR II: ***War at Sea;*** NAVIES, EARLY HISTORY OF; AIRCRAFT CARRIER; BATTLESHIP; CRUISER; DESTROYER; SUBMARINE and under names of military leaders and battles.

See also references under "Naval Strategy and Tactics" in the Index volume.

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NAVARINO, BATTLE OF, fought on Oct. 20, 182;. By the treaty signed in London on July 6, 1827 (*see* GREECE: *Modern History)*, England, France and Russia agreed to demand an armistice in the Greek War of Independence as preliminary to a settlement. Sir Edward Codrington (*q.v.*), then British commander in chief in the Mediterranean, received the treaty on the night of Aug. 10 at Smyrna, together with instructions to demand an armistice within 14 days. He at once proceeded to Nauplia to communicate with the Greeks, accompanied by his French colleague. Rear Adm. H. D. G. de Rigny. The Greek government agreed to accept the armistice. Codrington found a Turkish squadron at anchor at Navarino on Sept. 12. The Turkish government refused to accept the armistice, but on Sept. 25 an interview took place between Codrington, De Rigny, who had just arrived. and Ibrahim Pasha on behalf of the sultan, at which Ibrahim gave a verbal engagement not to act against the Greeks pending further orders. The allies, who were in want of stores, now separated again, Codrington going to Zante and De Rigny to Cervi, frigates being left to watch Navarino. The British admiral had barely anchored at Zante before he was informed that the sultan's forces intended to put to sea. He resumed his watch off Navarino, and on Oct. 13 was joined by De Rigny and the Russian squadron under Rear Admiral Heiden. Ibrahim Pasha, though unable to operate at sea, considered himself at liberty to carry on the war by land, and his men mere employed in burning the Greek villages. On Oct. 17 a joint letter of expostulation was sent to Ibrahim, but was returned with the manifestly false answer that he had left Navarino. A French officer in the Egyptian service, named Letellier, had anchored the vessels of Ibrahim and the Turkish admiral in a horseshoe formation, of which the points touched the entrance to the bay, and there were forts on the land at both sides of the entry. The allies entered in two lines and began to anchor alongside Ibrahim's fleet. Capt. Thomas Fellowes, commanding the British frigate "Dartmouth," seeing a Turkish fireship close to windward of him, sent a boat to demand that she should be removed. The Turks opened fire on the boat, and the action at once became general. Three-fourths of the Turkish and Egyptian vessels were sunk or fired by their own crews. The victory, ahich came when the Greek cause seemed lost, assured Greek independence, which was acknowledged by the sultan in 1829.

(G.A.R. C.; W. C. B.T.; C. C L.)

NAVARRE, a province of northern Spain, and formerly a kingdom which included part of France. The province is bounded on the north by France (Basses Pyrénées) and Guipbzcoa, east by Huesca and Zaragossa, south by Zaragossa and Logroño and west by Alava. It is traversed from east to west by the Pyrenees and the Cantabrian Mountains. Area 4,023 sq.mi. Pop. (1960 est.) 396,023. The highest summit is the Monte Adi (4,767 ft.). The chief river flowing toward the Atlantic is the Bidassoa, which rises near the Puerta de Maya. After flowing southward through the valley of Baztán it takes a northeasterly course, and for a short distance above its outfall at Fuenterrabia constitutes the frontier between France and Spain (Guipbzcoa); by far the larger portion of Navarre is drained to the Mediterranean through the Ebro, which flows along the western frontier and crosses the extreme south of the province. The hilly districts consist almost entirely of forest and pasture. the most common trees being the pine, beech, oak and chestnut. Much of the lower ground yields grain; the principal fruit is the apple, from which cider is made in some districts; hemp, flax and oil are also produced, and mulberries are cultivated for silkworms. Navarre is one of the richest provinces of Spain in livestock. Game is plentiful.

Besides Pamplona (*q.v.*), the capital, other important municipalities with more than 5.000 (1950) are Baztán (9.219). Corella (5,761), Estella (7,296), Tafalla (6,815) and Tudela (13.518).

History. — The kingdom of Navarre was formed out of a part of the territory occupied by the Vascones (*i.e.*, the Basques and Gascons), who occupied the southern slope of the western Pyrenees and part of the shore of the Bay of Biscay. In the course of the 6th century there was a considerable emigration of Basques to the north of the Pyrenees.

The name of Navarre is derived by etymologists from "nava," a flat valley surrounded by hills, and "erri," a region or country. It began to appear as the name of part of Vasconia toward the end of the Visigoth epoch in Spain in the 7th century. Its early history is more than obscure. The first historic king of Navarre was Sancho Garcia, who ruled at Pamplona in the early years of the 10th century. Under him and his immediate successors Navarre reached the height of its power and its extension (*see* SPAIN: *History*, for the reign of Sancho el Mayor, and the establishment of the Navarrese line as kings of Castile and Leon and of Aragon). When the kingdom was at its height it included all the modern province of the name; the northern slope of the western Pyrenees called by the Spaniards the "Ultrapuertos" or country beyond the passes. and now known as French Navarre; the Basque provinces; the Bureba, the valley between the Basque mountains and the Montes de Oca to the north of Burgos; the Rioja and Tarazona in the upper valley of the Ebro. In the 12th century the kings of Castile gradually annexed the Rioja and Álava.

While Navarre was reunited to Aragon, 1076–1134 (*see* SPAIN: *History)*, it was saved from aggression on the east, but did not recover the territory taken by Castile. About the year 1200 Alfonso VIII of Castile annexed the other two Basque provinces, Biscay (Vizcaya) and Guipbzcoa. Tarazona remained in possession of Aragon. After 1234 Navarre, though the crown was claimed by the kings of Aragon, passed by marriage to a succession of French rulers. In 1516 Spanish Navarre was finally annexed by Ferdinand the Catholic.

French Navarre survived as an independent kingdom till it was united to France by Henry IV. From 1510 until 1833, when it was incorporated with Spain, Navarre was a viceroyalty.

NAVARRETE, MARTÍN FERNÁNDEZ DE (1765–1844), Spanish historian. was born at Abalos on Nov. 9, 1765, and entered the navy in 1780. He was engaged in the unsuccessful operations against Gibraltar in 1782 and afterward in the suppression of the Algerine pirates. Ill health compelled him for a time to withdraw from active service, but he devoted this forced leisure to historical research, and in 1789 he was appointed by the crown to examine the national archives relating to the maritime history of Spain. Rejoining the navy in 1793, he was present at the siege of Toulon and afterward received command of a frigate. From 1797 to 1808 he held a succession of posts in the ministry of marine. In 1808 the French invasion led to his withdrawal to Andalusia, and the rest of his life was entirely devoted to literature.

In 1819 appeared his *Vida de Cervantes*, an appendix to the Academy's edition of *Don Quixote*. The first two volumes of his *Coleccidn de los viajes y descubrimientos que hicieron por mar los españoles desde fines del siglo XV* were published in 1825; volumes three and four appeared in 1829 and 1837, respectively. In 1837 he was made a senator and director of the academy of history and at the time of his death on Oct. 8, 1844. he was assisting in the preparation of the *Coleccidn de documentos inkditos para la historia de España*. His *Disertacidn sobre la historia de la náutica*

(1846) and *Biblioteca marítima española (1851)* were published posthumously.

NAVARRO, PEDRO (c. 1460–1528), Spanish military engineer and general. Beginning as a sailor, he became *mozo de espuela,* or running footman, to the cardinal Juan de Aragon. Later he enlisted as a mercenary in a war between Florence and Genoa and took part in the warfare between the Genoese corsairs and the Mohammedans of northern Africa. He enlisted under Gonzalo de Córdoba when he sailed to Sicily to take part with the French in the partition of Naples, and in 1500 he laid mines to breach the walls at Cephalonia without much success. He distinguished himself in the campaigns of 1502–03, by the defense of Canosa and of Taranto and by his share in the victory at Cerignola.

His mining operation against the castles of Naples, held by French garrisons, in 1503, won him fame as the first military engineer of his age. At the expulsion of the French from Naples, he received from his king a grant of land and the title of count of Olivetto. In 1508 he took Velez de Gomera, largely by means of a species of floating battery which he invented. He did excellent service in the conquest of Oran (1509) and took Bougie and Tripoli in 1510.

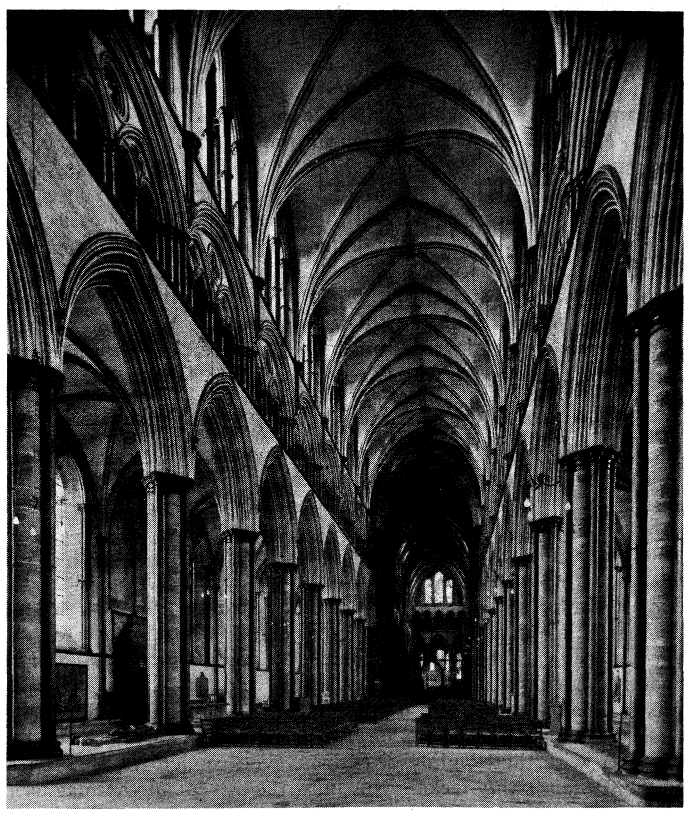
At Ravenna he covered the orderly retreat of the Spanish foot, was taken prisoner by the French and imprisoned in the castle of Loches. Ferdinand, "the Aragonese skinflint," refused to pay his ransom, and after three years of imprisonment, Navarro entered the service of Francis I in a pique. He distinguished himself in the passage of the Alps, at Marignano, at Milan and in the siege of Brescia. He was at the battle of Pavia and in 1522 was taken prisoner at Genoa by the Spaniards. He was confined at Naples till the peace of 1526 and his Olivetto estate was confiscated.

His last service was in the disastrous expedition of Odet de Foix Lautrec to Naples (1527).

See *Documentos inéditos para la Historia de España,* **vol.** XXV *(1854)*; article *sub nomine* in *Enciclopedia Universal Ilustrada.*

NAVE, in architecture, is the central and principal part of a church, extending from the main front to the transepts, or to the choir or chancel (*q.v.*) in the absence of transepts. When the nave is flanked by aisles, light is admitted to the church through clerestory windows. (*See* ROMANESQUE ARCHITECTURE; GOTHIC ARCHITECTURE.) At times, a gallery was carried above the side aisles.

Ecclesiastically considered, the nave is that part of a church appropriated to the laity as distinguished from the chancel, the choir or the presbytery, reserved for the clergy. In a 14th-century letter (quoted in Gasquet's *Parish Life* in *Medieval England,* p. 45, 1906) from a bishop of Coventry and Lichfield to one of his clergy, the reason for this appropriation is given. "Not only the decrees of the holy fathers but the approved existing customs of the Church order that the place in which the clerks sing and serve God according to their offices be divided by screens from that in which the laity devoutly pray. In this way the nave of the church . . . is alone to be open to lay people, in order that, in the time of divine service, clerics be not mixed up with lay people, and more especially with women, nor have communication with them, for in this way devotion may be easily diminished."



A F KERSTING

NAVE OF SALISBURY CATHEDRAL, ENGLAND, 1220–65

NAVEL, in anatomy, the umbilicus, the depression in the abdomen which indicates the point through which the mammalian fetus obtained nourishment from its mother through the blood vessels of the umbilical cord.

See EMBRYOLOGY, HUMAN; PLACENTA.

NAVIES, EARLY HISTORY OF. The term navy originally meant the whole of a country's shipping, whether used for war, the carrying of merchandise or fishing. In modem parlance, however, the word is generally taken to mean a nation's warships and craft of every kind maintained for fighting on, under or over the sea and the personnel manning them. The Royal Navy, for example, consists of the surface warships—battleships, cruisers, aircraft carriers. destroyers, mine layers. mine sweepers, gunboats and other auxiliary craft; the submarines; and the fleet air arm. Behind the actual fighting units there is, necessarily, a vast organization for their administration and upkeep.

See the sections *Defense* of the articles UNITED STATES (OF AMERICA); FRANCE; GERMANY and other countries for the modern history of naval establishments; *see* also NAVAL AFFAIRS (ARTICLES ON).

In early history navies took the form of the armed men of a tribe or town putting to sea in such large boats or ships as might be available to give battle to enemies similarly equipped or to raid territory from the sea. The craft themselves were for the most part those used for commerce, fishing or, when occasion served, for war or piracy. Only exceptionally were they built specifically for fighting. Later special types of war craft appeared. There are definite indications of long ships built for speed as distinguished from round ships for burden from the time of the ancient Greeks and Romans. In 483 B.C. the threat of Persian attack caused Athens to increase its fleet from 50 to 100 long ships which were paid for out of the proceeds of the mines of Laurium (*see* THEMISTOCLES). The effectof this was to make Athens the predominant partner in the league formed by the Greeks for their common naval defense. By the end of the 5th century B.C. the fleet had increased to 300 long ships and later to as many as 360. In peace these war vessels were kept on slips and under cover in sheds; in war a strategos was appointed in command and he chose the trierarchs nho were deputed to commission the vessels, partly at their own expense, under the supervision of state inspectors.

In general the organization of the Athenian navy resembled closely that of the British navy in the 16th and 17th centuries. The trierarch, who was either one of a group of citizens assisting to finance one or more war vessels or someone paid to discharge the duty, answered to the captain. There were also sailing masters, petty officers. seamen and oarsmen. Soldiers or marines formed the fighting personnel. The most ancient warships were many-oared galleys (*q.v.*), each requiring a very large number of rowers. The result was that the personnel provided to man a fleet of those times had to be a considerable one. For instance, the Roman and Carthaginian forces in the first Punic War numbered approximately 150,000 men on each side. The great rowing galleys relied for their offensive powers on boarding or ramming, and they appeared in great numbers in the Mediterranean in the war fleets of

Alexander, of Carthage, of Rome, of Byzantium, of the Italian republics, of the Arabs and of Aragon. *(See* also SHIP.)

In the naval organization of ancient Rome can be seen the beginning of the idea of an admiralty in the navy commissioners appointed in 311 B.C. It is interesting to note, too, that the Roman empire was faced, on a small scale, with the same kind of maritime problems that assumed such vast importance for the British government in the 19th century. Rome maintained a fleet to neutralize the threat arising from rival sea powers and to deal with pirates and protect its trade routes. Its naval organization, which was very complete, included two main fleets which guarded the coasts of Italy at Ravenna and Misenum. These were known as the praetorian. Other squadrons were allocated to Forum Julii, to the mouth of the Orontes, to Alexandria, to Carpathus (between Crete and Rhodes), to Aquileia (at the head of the Adriatic), to the Black sea and to Britain. River flotillas were stationed on the Rhine and Danube and, later, on the Euphrates. All these squadrons did not exist at the same time, but there was always a highly organized navy with a body of soldiers, the *classici,* specially assigned for service afloat.

The navy of the eastern empire may be said to have originated with the foundation of Constantine's New Rome on the site of Byzantium. The threat of attack from the Vandal kingdom of Carthage (from A.D. 428 to j24) compelled the emperors to attend to their fleet. but with the fall of that kingdom the navy was neglected until the rise of Mohammedan power at the end of the 7th century produced a new menace. The Byzantine navy reached a high state of efficiency under the sovereigns of the Macedonian dynasty (867–1056). It consisted of an imperial fleet commanded by the great *drungarios,* the first recorded lord high admiral, and of provincial squadrons under their strategoi. The imperial fleet was essentially a war organization, while the provincial or thematic squadrons were smaller but more permanent forces maintained for police purposes. It is interesting to note that this navy included a corps corresponding to the gunnery experts of a modern fleet. These were the *siphonarioi,* who worked the siphons used for discharging 'the Greek fire (*q.v.*).

After the disorganization of the eastern empire by Turkish invasions in the 12th century. the Byzantine navy withered. In the middle ages the Italian republics and monarchial states bordering on the Mediterranean possessed appreciable fleets, and their seamen, especially those of Genoa, were regarded as some of the finest in the world, so much so that their services were sought by the powers of western Europe and even by England. Edward III and the kings of France employed Genoese to assist them in nautical matters. The Mediterranean navies made their last great appearance in history at the battle of Lepanto, 1571 (*q.v.*). The scene of naval activity then changed and the ships and fleets took on a new form — one to fit them for ocean sailing and fighting.

(E. A.; X.)

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NAVIGATION, the process of conducting a craft from one place to another. In its widest sense the word thus embraces not only finding the way but also the avoidance of collision and the handling of the craft. The processes of navigation in general consist in defining the route, conducting the craft along it and finding the craft's position from time to time to check its progress.

The most common way of defining direction on the earth is in relation to its axis of rotation. Position on the earth's surface: or at points close to the surface. is usually expressed in terms of latitude and longitude. Position may be established by dead reckoning (the accounting of distance and direction traveled) or by independent fixes which establish that the craft lies along one or more lines of position. Methods of fixing used at sea and in the air today include visual fixes, astronomical navigation, radio systems and radar. Dead-reckoning methods include the compass and distance or speed indicators of one kind or another, inertial guidance systems and systems making use of the Doppler shift.

The methods of navigation used by the ancients can be deduced from fragmentary evidence in literature, even though there are large gaps in our-knowledge. Modern navigation, both at sea and in the air, relies more and more upon mechanical and electronic devices, even though the human intelligence remains as a vital link. In outer space, navigation is likely to be done solely by nonhuman means.

This article contains the following main sections:

I. HISTORICAL BACKGROUND

Ocean voyages well out of sight of land have been made for thousands of years in every civilization. The Minoans. for example. carried on a regular trade between Crete and Egypt and built the port of Cnossus especially for it. The Phoenicians were trading to Cornwall for tin in about 600 B.C., and 1.200 years later the Vikings were making regular journeys across the Atlantic to their settlements in Greenland and North America. There is thus no evidence for the popular supposition that all early navigators clung to the coast.

Exactly how the earliest navigators found their way must remain to some extent a matter of conjecture, but we know enough to reconstruct some of their methods. Herodotus. for example. tells us that the Phoenicians used Polaris (the pole star) to find direction. Homer has the wise goddess bid Odysseus keep Ursa Major (the Great Bear) on his left hand as he crosses the sea after leaving Calypso's island. In the Acts of the Apostles and in some of the early Norse sagas there are passages that make it clear that the sun and stars were used as guides.

Divisions of the Horizon.—North. south, east and west have always been defined by sunrise and sunset and by the direction of the sun's noonday shadow. The apparent rotation of stars around the north pole of the sky, too, would have been familiar to seamen and others nhose calling involved a knowledge of direction. The division of the horizon into more than these four basic directions first seems to have been made by the Greeks, who differentiated between the directions of sunrise and sunset in winter and summer. a difference of about 30° in those latitudes. For reasons of symmetry, no doubt. they also defined directions on either side of the north–south line corresponding to the lines each side of east and west, and so the twelvefold compass of classical antiquity developed. The Tower of the Winds at Athens, however, shows eight winds, and it seems more probable that seamen from the earliest times accepted this division based simply on dividing and subdividing the four basic directions. The Anglo-Saxons, for example, distinguished 8 "points." and the Portuguese in the great age of discovery abandoned the age-old Mediterranean wind rose, probably of Etruscan origin, for a 16-point system.

Early Sailing Directions. — All directions long were thought of as winds, and early pilot books give the courses between ports in these terms. Distances are given in terms of a day's sail. The earliest surviving pilot book is the *Periplous of Scylax,* which dates from about 350 B.C. These directions, which were the first aids to navigation, describe routes, headlands, landmarks, anchorages. currents, port entrances, etc. No doubt the information was originally handed down from father to son, as it is in some Arab lands today. It seems improbable that any sort of sea chart was used with these sailing directions. even though maps go back to the Alexandrian Greeks. Not until the advent of the magnetic compass was the construction of an accurate sea chart possible.

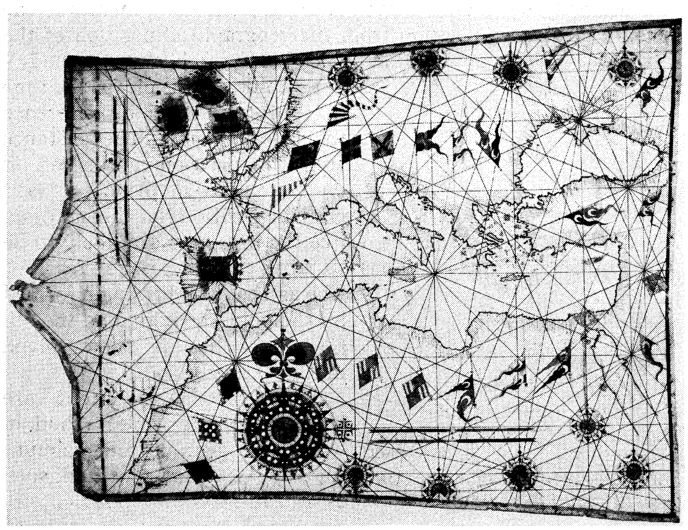
A passage from a book of sailing directions for the Arabian sea, originally written in Sanskrit in A.D. 424, gives an illuminating description of navigation before the days of chart and compass: "The pilot" it says, "knows the course of the stars and can alnays orient himself; he can evaluate the signs of good and bad weather; he distinguishes the regions of the oceans by the fish. the colour of the water, the nature of the bottom, and birds, the mountains and other indications."

The distance traveled was deduced from the speed. The first method of measuring speed was by timing the passage of a chip of wood (hence "log") dropped from the stem until it passed the poop Later a triangular piece of wood, knonn as the log ship. mas attached to a line payed over the stern from a reel, the amount of line that ran out in a given time shoning the speed. Timing was first done by such devices as repeating syllables and counting the pulse, but later the sandglass mas introduced, a 28-second glass being used for speeds up to 6 knots and a 14-second glass for speeds above that. The first suggestion that the line should be knotted (hence "knot") seems to have been made by Richard Norwood in 1637. Knots at 51-ft. intervals were used with the 28-second glass.

The Magnetic Compass.—The birthplace of the magnetic compass is sometimes disputed. The first written reference to the use of the magnetic needle for direction finding at sea seems to have been made by an Englishman, Alexander Neckam. writing in 1180. He speaks of "a needle placed upon a dart which sailors use to steer by when the Bear is hidden by clouds." Writing about 80 years later, a Dominican friar. Vincent of Beauvais. tells how seamen, when they can no longer see sun or stars to steer by, magnetize the needle with a loadstone and place it through a straw floating in water. The needle comes to rest, he says. pointing at the pole star.

The compass card. with its painted nind rose displaying the division of the horizon, was probably first attached to the needle in the 13th century. So familiar has this combination become that it is customary to think of the compass as the instrument itself, whereas the word originally meant merely the division of the horizon.

Later Sailing Directions.— The earliest surviving set of Mediterranean sailing directions, *Lo Compasso da Navigare* (1296), talks in terms of half points. that is. $\frac{1}{64}$ of the compass of the horizon It was from such directions, accumulated over generations and then collected during the 13th century into a single



BY COURTESY OF THE TRUSTEES OF THE NATIONAL MARITIME KUSEUM, GREENWICH LONDON

FIG. 1.— PORTOLANCHART OF THE MEDITERRANEAN BASED ON RHUMB LINES, ASCRIBED TO SIMON FERNANDEZ. 16TH CENTURY

volume for the entire Mediterranean. that the first marine chart was drawn. This chart, the famous Carta Pisana, was drann on sheepskin and is oriented toward the Stella Maris rather than Jerusalem (as most land maps mere). It carried a scale of miles and a pattern of rhumb lines distinguished by coloured inks, corresponding to the directions shown on the wind rose. To set a course on such a chart the pilot would draw a line between his departure point and destination and then, with a pair of dividers, pick out the coloured rhumb line most nearly parallel to it; when traced back to the parent wind rose the rhumb line would show the required course

So long as navigation nas simply by dead reckoning and was restricted to that area, the Mediterranean chart. unrelated to latitude and longitude. nas perfectly satisfactory. It ignored the magnetic variation (the angle at any place between true and magnetic north), but since sailing was by the magnetic needle the variation could be neglected. It also ignored (though not always through ignorance) the fact that the earth is a sphere and that any flat representation of it must somehow take into account the convergence of the meridians toward the poles. But here again no great harm was done so long as sailing was still a matter of going a certain distance on a certain rhumb of the wind or compass point.

When the Portuguese under the leadership of Prince Henry the Navigator ventured farther and farther south along the African coast, they encountered navigational difficulties because they assumed that the plain charts used in the Mediterranean could simply be extended. But over long distances the rhumb lines could not be taken as straight, and the chart proved completely inadequate to the new methods of checking the dead reckoning that Portuguese astronomers and mathematicians had devised under Prince Henry's patronage. These methods demanded a chart related to latitude and longitude, not one merely built upon bearing and distance. In 1569 Gerardus Mercator published his world map on a "true projection suitable for navigation." Thirty years later. Ednard Wright provided an explanation of the projection and computed tables of meridional parts so that cartographers could make use of the principle. However, a long struggle ensued between seamen who wanted to keep the "plain." simple chart and the enlightened few who saw that only a "true" chart could be free of errors. The struggle lasted until well into the 18th century

The Portuguese method of position finding involved observation of the altitude of the pole star in order to determine latitude. The star mas observed when it was "in rule." that is, when the position of the "guard" stars in Crsa Minor (the Little Bear) showed that the pole star. which circles around the pole of the sky, nas precisely at the altitude of the pole. When the navigators approached the equator, where the star of course disappears, latitude was obtained by observations of the noonday sun.

Altitude-Measuring Instruments.— The first instrument used for these observations seems to have been the quadrant, long known to astronomers The star is observed through pinhole sights and its altitude read off where a plumb bob cuts the scale. Later it seems to have become the practice to mark the scale of the quadrant directly with the altitude of the pole star at certain locales, such as Lisbon. The pilot could thus directly observe the latitude of his destination. The ship would sail north or south until she reached the required latitude and then go east or west to her destination, making continual latitude observations.

Columbus is often credited with having discovered the variation of the compass but it seems improbable that the Portuguese pilots, not only in making continual observation of the pole star but also in sailing east or nest along a parallel of latitude, could have failed to observe the phenomenon.

Another instrument used for measuring altitudes at sea was the mariner's astrolabe, an adaptation of the astronomer's astrolabe (*see* ASTROLABE). The instrument used at sea carried only the altitude-measuring alidade. normally fitted to the back of the astronomer's astrolabe. The central part of the instrument was cut anay to lessen wind resistance.

However, the mariner's astrolabe did not achieve the popularity of its 16th-century successor, the cross-stag—a simple device consisting of a staff about three feet long fitted with a sliding crosspiece that made it possible for even an unskilled observer to measure the angle of elevation of a star or the sun. The cross-staff remained in use until the 18th century despite several drawbacks, the most serious being that the sun could be observed only by looking straight at it. Coloured shades were fitted to the cross-pieces, but the major improvement came in 1594 when John Davis, a navigator famous for his Arctic explorations, invented the back-staff. This instrument, with a scale divided into two and used with the observer's back to the sun, remained popular even after the introduction of the far superior Hadley's quadrant (so called, but actually an octant). John Hadley, who was a fellow of the Royal society, described his quadrant in 1731. Its virtue lay in the use of the principle of double reflection to overcome the motion of the ship. Thomas Godfrey, a Philadelphia glassworker, independently devised a similar instrument at about the same time. The sextant, is a refinement of Hadley's quadrant, followed soon afterward and is in regular use today.

Almanacs and Tables.—Working at first from knowledge derived from translations of Portuguese and Spanish manuals, a flourishing school of instrument makers, chart makers and teachers grew up in Tudor and Stuart England. They quickly improved the theory of navigation and compiled more accurate tables. One of the earliest almanacs, which also set forth the principle of determining longitude by lunar distances, was the astronomical ephemeris of Regiomontanus, published in Nurnberg in 1474. The first purely national almanac was the *Connaissance des temps*, published in Paris, which contained tables for the crude determination of longitude from the eclipses of Jupiter's satellites. In 1675 the Royal observatory was founded in Greenwich with the specific object of providing the sailor with astronomical data of the required precision. In 1753 Johann Tobias Mayer published his tables of the motion of the moon, which heralded an enormous advance.

The Marine Chronometer.—Latitude could be observed by measuring the altitude of the pole star or the sun or any star when it crossed the meridian, but the great problem remained the determination of longitude at sea. Medieval astronomers knew that longitude differences could be determined by noting the local time of an eclipse, and in the 16th century the principle of determining longitude by comparing the readings of an accurate clock with local time was pointed out. However, for seamen the problem remained unsolved. In 1714, largely because of a number of disasters due to bad navigation at sea, an act of the English parliament established the Board of Longitude. The board offered an award of £20.000 to anyone who could discover a method of finding out longitude within 60 mi, after a voyage of six weeks. The award was ultimately won by John Harrison, whose fourth marine chronometer, made in the form of a watch, heralded the introduction of the practice of taking timed observations of heavenly bodies at sea.

The 19th Century.—Modern methods of astronomical navigation are based on two fundamental advances made in the 19th century: the discovery of the concept of the astronomical position line by an American, Capt. Thomas H. Sumner, in 1837. and the introduction in 1875 by the French naval officer Marcq St. Hilaire of the intercept method of sight reduction.

In the 20th century, radio methods of navigation at sea and in the air, from the simple direction finder to sophisticated hyperbolic systems, largely replaced older methods of position fixing.

(M. W. Ri.)

II. TECHNIQUES AND INSTRUMENTS COMMON TO MARINE AND AIR NAVIGATION

Dead reckoning (the determination of position by keeping an account of the distance and direction traveled) is common to all forms of navigation. At sea the dead-reckoning position (or "estimated position," as the position corrected for set and drift is sometimes called) is customarily maintained either by plotting with parallel rules and dividers on the chart or a special plotting sheet or by means of the traverse table which can be used to derive change of latitude and longitude for course and distance traveled. The course steered must be corrected for the effects of compass error, currents or tidal streams and drift from the wind. Distance at sea is measured by the ship's log, which records distance directly in the case of towed logs, or speed, which may be converted into distance, in the case of a pressure-type log. The magnetic compass is still standard at sea, but most large ships are fitted with a gyrocompass (*q.v.*) which indicates true north.

Various considerations render the north-seeking gyrocompass impracticable in the air, but the magnetic compass may be gyro-stabilized so that it will be unaffected by turning, acceleration and other errors. Air speed is usually measured by a differential pressure gauge that records the difference between the dynamic pressure due to the aircraft's speed and the static ambient pressure. There are a number of ways of estimating wind drift. The effect of wind on the aircraft's progress is allowed for by an application of the triangle of velocities, either by plotting or by means of a dead-reckoning computer.

The instruments used in celestial navigation are an accurate timepiece, such as a chronometer (*q.v.*) or a navigational watch used in conjunction with radio time signals, and the sextant. The marine sextant is used for measuring the altitude of a heavenly body above the visible horizon. The horizon is not normally available as a reference to the air navigator, so the air sextant is fitted with an artificial horizon in the form of a bubble that defines the vertical. To eliminate the numerous acceleration errors that affect the bubble, an integrating device that automatically averages a number of sextant observations over a run of one or two minutes is generally incorporated. Although other methods of defining a horizon in the air are in use, the bubble is the most general.

In astronomical navigation the navigator adopts the concept of the celestial sphere, in which all heavenly bodies are apparently located on the interior surface of an infinitely large sphere that has the earth as its centre. The celestial sphere appears to rotate westward about the extension of the earth's axis of rotation.

The geographical position of a heavenly body is the point immediately below it on the earth's surface. The latitude of this position is defined by the body's declination and the longitude by its Greenwich hour angle. Both these values may be extracted from the nautical (or air) almanac for a particular time. In navigation the earth and the celestial sphere are considered as two concentric spheres and, since the radius of the earth is known, any angle measured in the celestial sphere can be directly related to distance on the earth's surface. A nautical mile by definition is the length on the earth's surface of one minute of arc.

A navigator making a timed sextant observation of the altitude of a heavenly body thus (subtracting it from 90") measures the distance of his own position from the geographical position of the body. He establishes the body's geographical position for the time of the observation by reference to his almanac. The distance from this position can be laid off on the chart, in principle, as a circular position line, but in practice the distances are likely to be so large that this is not feasible. The astronomical triangle formed by the pole, the body and the observer's zenith is then solved mathematically.

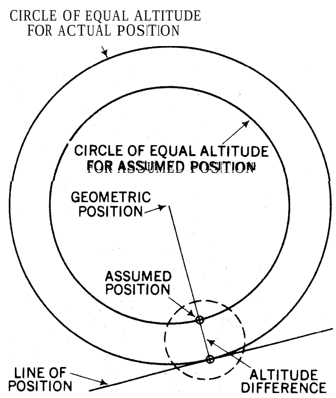


FIG 2.—METHOD OF PLOTTING DEAD-RECKONING POSITION

Most modern solutions are based on the intercept method, in which the altitude and azimuth for any convenient position, such as a dead-reckoning position, are calculated for the instant of observation and compared with the altitude and azimuth obtained from the observations. The procedure is illustrated in fig. 2. Only the portion encircled by the dotted line need be plotted on the chart. The two circles normally differ only by a few minutes of arc, which results in the encircled position being relatively small. The line tangential to the circle of equal altitude for the actual position is perpendicular to the radius of the circle at the point of tangency. No appreciable error is involved, because a straight position line may be said to correspond over a comparatively short distance to a position circle of very large radius tangential to it. An astronomical fix is obtained by the intersection of two or more astronomical position lines.

III. TECHNIQUES AND INSTRUMENTS FOR MARINE NAVIGATION

In coastal navigation the ship's position is normally established by bearings of nearby landmarks. Lighthouses are placed in prominent positions around the coast and show lights by night with characteristic phases by which they may be identified. By day lighthouses are easily recognized landmarks, and their known heights are often used to obtain the distance by sextant angle, Light vessels are generally placed offshore either to mark some danger (such as the Goodwin Sands in the English channel) or as an aid to landfall (the Ambrose lightship off New York harbour). Lighthouses and light vessels are equipped with sound fog signals and usually with radio beacons.

Buoys are used to mark channels and off-lying dangers. The colour and shape of a buoy, and sometimes its numbering. indicate on which side it should be passed. Two systems of buoyage are in use internationally: the lateral and the cardinal systems. The cardinal system is used along coasts fringed with isolated dangers and reefs, and the marks vary according to the quadrant of true compass in which they are situated with reference to the danger. Buoys may be identified at night by their light. characteristics, which are indicated on the chart.

Sailing directions or pilot books, published by national hydrographic authorities, give detailed descriptions of the coast line, landmarks, tides and currents, lights, dangers, etc., for every navigable part of a coast. They give detailed directions for entering harbours and describe the anchorages, port facilities, buoyage, etc. Light lists describe the characteristics of lights (with the exception of buoys) around the coast and the buildings that exhibit them. In strongly tidal uaters, such as the English channel, a tidal stream atlas is published to show the strength and direction of the stream for every hour.

Charts are normally issued by the national hydrographic authority. which is generally a department of the navy. The hydrographic department of the British admiralty has world coverage with some 3,500 charts. The United States Hydrographic office also has world coverage. Since 1920, the International Hydrographic bureau at Monaco, of which most maritime nations are members, has standardized chart making and acted as a medium for the exchange of hydrographic information. Most sea charts are on the Mercator projection. the great advantage of which for navigation is that rhumb lines appear as straight lines. Information to keep charts up to date is published by the hydrographic offices in the form of "notices to mariners."

The directional reference most used by modern navigators is the gyrocompass. The magnetic compass is alnays installed as a standby. and it may be the only compass in smaller ships. The advantage of the gyrocompass is that it indicates true instead of magnetic north and is subject to fewer errors. The compass is used both for steering and for fixing the ship's position by bearings.

The ship's log. which may be of the towed or submerged type. records the speed or distance steamed. The ship's speed may also be estimated from the speed of its engines.

Although the lead line, possibly the oldest navigating instrument. is still in use. sounding at any depth is normally done nith the echo sounder. which gives a continuous indication of the depth of water. In nell-surveyed areas the ship's position may be ascertained by comparing a continuous echo-sounding record of the bottom with the soundings shown on the chart.

IV. TECHNIQUES AND INSTRUMENTS FOR AIR NAVIGATION

The speeds involved in air transport call for quick navigational methods, even at the expense of some accuracy. It is largely for this reason that radio aids play such an important part in air navigation. It is also for this reason that the major decisions tend to be taken on the ground in the planning stage, so that the function of cruise control and flight control in the air is to implement these decisions.

The route and the cruising altitude are selected on the basis of the predicted weather situation and various other factors. The choice of altitude will take into account the best operating altitude of the aircraft, the winds at different heights, icing, turbulence and the demands of traffic control. The route will be chosen bearing in mind winds and the weather situation, navigational facilities and traffic control. Although the shortest distance always lies along a great circle, the great-circle route is not necessarily the least-time track because the incidence of head and tail winds will depend on the local weather pattern. There are various techniques for calculating and flying along the minimal flight path, and these are grouped together under the heading of pressure-pattern flying.

When the route and altitude have been chosen, the flight plan, which is filed at the airport of departure for transmission to the airport of arrival. is drawn up. Wind triangles for various parts of the flight are solved; the heading, true air and ground speeds for each zone of the flight are determined; and the flight time and amount of fuel needed are calculated. An alternate airport is selected in case weather makes landing at the scheduled airport unduly hazardous, and a point of no return, or equitime point. is established. The flight plan is used as a guide against which the aircraft's progress in the air is constantly checked.

In contact flight the pilot uses prominent landmarks, such as highways, bridges, railroads, mountains and lakes, to establish his position. By night he uses air beacons, generally located at airfields and at intervals along more difficult portions of the civil airways. Another useful visual aid in contact flight is the runway-approach lighting, which extends for several hundred feet from the end of the runway to help the pilot make visible contact with the ground. The intensity of these approach lights can be varied from the control tower. and different settings are used for night and day use and for different types of overcast.

The scale and the amount of information displayed on an air navigation chart will depend on its purpose. A plotting chart may be on a scale of 1:2,000,000 and. in addition to such radio facilities as radio ranges, fan markers and beacons, such a chart mill show airports, ground elevation. airways and control zones. It mould show little topographical detail and would be used for high-speed high-altitude flight. Such charts are generally draan on the Mercator or Lambert conformal projection (see MAP). The World Aeronautical series of charts. which has been recommended for international adoption by the International Civil Aviation organization, is on a scale of 1:1.000.000 and displays enough topographical and radio information for fairly high-speed pilotage. Instrument-approach-and-landing charts are designed to enable the pilot to approach and land by instruments in low visibility. The landing chart shows, at a larger scale, the airport and its immediate vicinity and is used for visual as well as instrument flying. Such a chart might be drann on a scale of 1:250.000.

The gyroscope, although not used as a north-seeking compass in aircraft, plays a considerable part in the definition of heading in the air. Gyrostabilization is used to eliminate the acceleration errors to nhich magnetic compasses are subject in aircraft and to avoid interference from ferrous metals and electrical circuits in the region of the compass. The magnetic element in the remote-indicating air compass is normally housed in a position away from magnetic interference. such as the tail or outer part of the wing. The directional gyroscope is also used in place of a compass in instrument flying and in polar regions where the magnetic compass is useless. The gyroscope is subject to wandering due to precession and slowly drifts anay from the original setting. During turns the drift is too small to be of any significance. but when used for steering the gyrocompass requires occasional resetting. In polar navigation the average drift rate, normally determined by the astrocompass. is generally allowed for in the courses steered.

To determine the effect of the wind on the aircraft's track. a drift meter may be used nhen the ground can be seen. In a typical instrument the navigator looks through an eyepiece and rotates an indicator dial until the drift lines on the reticle are parallel to the apparent motion of ground objects; a pointer on the indicating dial will then show the amount of drift. Modern drift meters are usually gyrostabilized. The gyroscopic principle is also incorporated in automatic sensing controls to achieve controlled flight.

Altitude is measured either with the barometric altimeter, which is essentially an aneroid barometer calibrated in feet or metres above sea level, or by an absolute altimeter, which employs a radar principle to measure the distance above the ground.

(H. A. PA.; M. W. RI.)

V. ELECTRONIC AIDS COMMON TO MARINE AND AIR NAVIGATION

Following the beginning of World War II, when the direction finder and its associated radio beacon and the low-frequency radio range station were the standard aids, there were enormous advances in radio aids to navigation. Systems developed during and after the war include loran, decca, consol, very high-frequency omnirange (VOR), distance-measuring equipment (DME) and radar.

Direction Finding (DF) and Omnidirectional Beacons.—The directional property of a radio antenna that is formed into a coil or loop was familiar to the earliest experimenters. As a loop is rotated horizontally its energy output, derived from the interception of a radio wave, passes through a sharp minimum that corresponds to the direction of the radio transmitter. Soon after ships were first equipped with radio, shore direction-finding (DF) stations were placed at strategic points along navigational routes and near harbour approaches. Upon receiving a request by radio from a ship, two or more shore stations determined the directions from which the ship's signal arrived by means of their loop antennas and transmitted this information back to the vessel. However. this service was limited to one vessel at a time, a serious drawback in bad weather, when demands were heavy. By reversing the process—placing the transmitter ashore and the direction finder on the ship—the system became nonsaturable and the navigator was given two further advantages: he was able to take continuous or frequent bearings on any shore beacon, and he could take bearings of any receivable signal, such as transmissions from broadcasting stations and from other vessels. This change in the system was roughly coincident with the initial growth of aviation, and the air-borne direction finder immediately became a valuable aid to air navigation.

Crossed-loop direction finders, used when it is not convenient to rotate the loop. consist of two loops mounted at right angles to each other with their terminals connected by cable to two crossed fixed coils of a goniometer; a rotatable coil in the goniometer simulates the rotation of the ordinary loop antenna. Other types of DF antennas include the Adcock (using spaced dipoles or monopoles) and spaced-loop types that have been employed ashore as navigational aids in the high-frequency and very high-frequency bands, where greater efficiency and accuracy is obtained than with the simple loop. Loops incorporating ferromagnetic cores are largely used in portable direction finders, produced principally for aircraft and small boats.

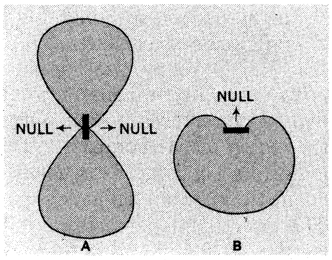


FIG. 3.—SENSITIVITY PATTERNS: (A) SIMPLE LOOP ANTENNA: (B) LOOP COMBINED WITH SINGLE VER. TICAL ELEMENT

In all direction finders there exists a basic ambiguity of 180° as to the direction of signal arrival. This is resolved by combining the output of an omnidirectional "sense" antenna. usually a single vertical element, with the output of the DF elements so that the normal symmetrical figure-of-eight sensitivity pattern (fig. 3[A]) is altered to a cardioid pattern (fig. 3[B]) to show the direction of signal arrival.

Errors in Direction *Finders.*—The accuracy of well-designed direction finders is normally within 1° to 2°. Greater and sometimes serious errors are caused by night effect, reflection and shore-refraction effects and local reradiation.

The term "night effect" originated when practically all direction-finding activity was in the 200–500 kc. band, utilizing the vertically polarized ground wave, which is uncontaminated in daytime. At night, however, the sky wave appears, arriving at the DF antenna at a down-coming angle and shifted both in phase and polarization, thus distorting the normal directional response of the antenna. At higher frequencies this effect exists even in daytime. The Adcock and spaced-loop antennas provide greater accuracy on sky waves than does the loop antenna.

Radio waves are refracted when crossing a boundary between dissimilar paths. such as a shore line, at angles less than 90°; likewise, mountains and similar masses may reflect the waves. Both of these effects cause the apparent direction of signal arrival to be other than the true direction of the transmitting station.

Metallic objects on the vessel. aircraft or at a land-based DF station may reradiate or reflect the incoming signal, thus causing the apparent bearing to be in error. On vessels, the offending objects are usually masts, rigging, metal guard rails and other antennas; on aircraft, other antennas and parts of the aircraft itself. Generally these errors are determined by observation and then either accounted for arithmetically or automatically corrected by special devices.

Automatic Direction Finders.—The direction finders installed on ships and aircraft are usually automatic adaptations of the manual single-loop or crossed-loop goniometer. Although the circuity used is fairly complex, the objective in most types is simply to maintain the loop or goniometer in a null position. This is accomplished by an electrical sensing circuit, which causes a motor to return the loop to zero voltage output whenever turning of the vessel causes the loop to depart from that position. The accuracy of such equipment is adversely affected by strong unwanted signals, and aural monitoring is necessary in order to detect such a condition. Instantaneous-bearing types of automatic direction finders are able to display several bearings simultaneously, in radial fashion, upon an oscilloscope. This is accomplished by rotating either a loop or goniometer synchronously with the deflection coil of the oscilloscope at a relatively high speed.

Radio-Beacon Stations.—The complementary part of a direction-finder navigational aid is a system of omnidirectional transmitting stations strategically located along navigational routes or on the approaches to harbours and airports. These beacons operate within the band 200–515 kc. The service distance is established by regulating the radiated power in accordance with area or local requirements. which range from 10 to 400 mi. Each station transmits its identifying code either by keying the carrier or by a tone modulation; the latter method is favoured because automatic direction finders operate more reliably on a continuous carrier. Because of limited radio spectrum space it is necessary in some areas for marine beacons to share time on the same frequency. The usual arrangement is for three stations to transmit one minute each, in close sequence, for two lo-minute periods in each hour. In poor visibility, however. a station is sometimes placed in continuous operation.

Loran (Long Range Navigation).—The loran system was developed in the United States during World War II to overcome the limitation in accuracy and distance of direction-finding and range systems. By changing from a continuous-wave (CW) bearing or directional array system to a pulse time-measuring system the night effect is eliminated and refractive and reflectional effects are minimized. In addition, because of the low ratio of "on" to "off" time in a pulse system, a very high peak power can be generated economically. The loran-A system covers most of the important trade routes of the world and is used by both marine and air navigators. It operates in the 1.800–2.000 kc. band Loran-B, a refined version of loran-X designed for extremely high accuracy at lesser distances. is intended primarily for approach and in-harbour navigation. Loran-C. operating on 100 kc., provides greater range and greater accuracy than loran-A.

Loran pulse signals are short enough so that it is possible to discriminate betneen the highly stable ground wave and the unstable sky wave. The sky wave is delayed with respect to the ground wave at any reception point because of the greater distance it must travel—up to the ionosphere and back to earth. Although the primary service of loran-A is based upon the use of ground waves with a range of *600* to *900* nautical miles. secondary service is provided by first-reflection sky waves up to *1,400* mi. The fix accuracy within the primary area is nominally 1% of the distance from the centre of the station system; within the secondary area it is 5%.

Fig. 4 illustrates the loran system. Each pair of stations—master and slave A and master and slave B—transmits signals that generate a family of hyperbolas representing lines of equal difference in time required for a signal to arrive at a given point from each station in the pair. For example. the master station transmits a pulse signal; slave A—which may be *200–600* mi. distant—receives it, waits a predetermined interval and transmits a pulse. The pulses are about *50* μ sec. in length and are transmitted at a rate of about 20 to *34* per second. The base lines are shorter in loran-B and longer in loran-C. The loran-C pulse is much longer, and special techniques are employed to use only the early or ground-wave portion; the pulse rates are *10* to 34 per second. Since the velocity of radio waves in the atmosphere is known. it is possible to convert the difference in time of arrival of the pulses at a vessel to a difference in distance from the vessel to the loran stations.

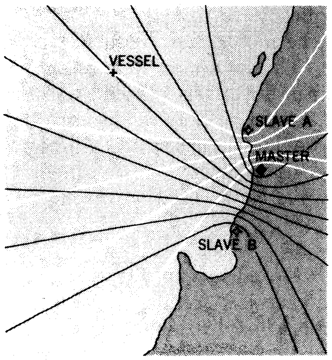


FIG. 4.—LINES OF POSITION GENERATED BY LORAN MASTER AND SLAVE STATIONS

With a conventional loran receiver, the navigator measures the time difference by observing the signals on an oscilloscope, although special equipment was developed to make the position-finding process completely automatic. On a loran chart, the hyperbolic lines of position usually are labeled in microseconds of time difference; they are spaced at convenient numerical intervals, and positions lying between lines are determined by interpolation.

Decca.—The decca system was developed in Great Britain during World War II and came into extensive use in Europe. India and Canada. Decca operates on various frequencies between *70* and *130* kc.

Like loran, decca is a hyperbolic system. Cnlike loran, the signals are not pulsed. The distance difference of a point from two decca stations is measured in wave lengths and portions of a wave length or cycle phase, and the charted hyperbolic lines of position are based upon these units. Since a wave length at decca frequencies is many times smaller than the distance between the stations, there are many repetitions of the same cycle phase differences within the service area and these repetitions must be resolved for the navigator.

The master of a pair of decca stations transmits on a precise frequency, omnidirectionally. The slave station, typically located about 70 mi. distant, receives this signal and locks its own transmission in phase with it. Thus, in the service area there exist two signals whose effective relative phase is constant along hyperbolic lines of position. Since it is impossible to separate two signals that are on the same frequency at the input of a receiver at the same time, it is necessary for the stations to transmit on different frequencies. These are chosen so that with different small multiplying factors they may be converted, after reception through separate receiver channels, to the same frequency, called the comparison frequency. The two versions of the same comparison frequency derived from the master and slave stations are then applied separately to the inputs of a phasemeter. A decca system that contains as many as three slaves phase-locked to a single master would therefore employ four different frequencies, with associated multipliers in the receiver to derive three different common-multiple comparison frequencies, each in pairs. to actuate three line-of-position phasemeters or decometers. The decca phasemeter is of the counting type; that is, the normal limit of 360° is extended many times by a geared counter. Thus, travel from any known point can be followed.

The relation between the action of the phasemeter and the movement of the vessel is understood by realizing that as movement takes place on the base line the change in distance with respect to the two stations is differential; therefore amovement of one-half wave length. or 180°. produces a 360° travel of the phasemeter. One of the several comparison frequencies, for example. may have a wave length of *3.000* ft. Since *280* half wave lengths may be contained in a base line *70* mi. long, serious ambiguities in position would result if the counting feature failed because of station or receiver trouble or if the receiver were turned on when at an unknown position. The ambiguity is resolved by temporarily shifting away from the pattern of fine half wave length lanes to coarse and intermediate lanes called zones and fine zones. This is accomplished by automatically shifting station frequencies and frequency-mixing circuits in the receiver for an instant each third minute in order to generate much lower comparison frequencies. The coarse zones are large enough to yield approximate positioning by means of ordinary navigational information. while the fine zones are small enough for identification of the fine lane.

Within the service area of a typical decca chain, line-of-position accuracies vary by day from *30* yd. at *100* mi. to *150* yd. at *250* mi. At night, sky wave contamination of the ground wave increases the error to *100* yd. and *800* yd., respectively. and the system becomes unreliable between *300* and *400* mi. Daytime accuracy is limited largely by small line-of-position crossing angles. However. these may be extended by using more than one chain of decca stations. Shore line and other refractional effects and obstacle reflections are inconsequential except when decca is employed in accurate surveys, when the relatively weak daytime sky waves must also be taken into account. A simple receiving antenna is adequate, and local reradiation is unimportant for ordinary navigation.

For hydrographic surveying a rearrangement of the conventional decca chain, in which the master station and receiver are situated in the survey ship with two stations on the coast. offers great advantages. In this system, known as two-range decca, the readings are a function of the distance from the ship to the stations ashore.

Consol.—Consol originated during World War II in Germany under the name of sonne. The system was further developed and transmitters installed with minor variations in Britain, France and the United States (under the name consolan). Consol is a long-range system employing various frequencies between *250* and *350* kc. No special receiver is required, except that a loop directional antenna is sometimes used to resolve certain ambiguities.

The consol system consists of a single station employing a directional antenna array that generates a multilobed horizontal radiation pattern. Over a period of one minute (or one-half minute in some applications) all lobes are rotated so that each eventually occupies the place formerly occupied by its neighbour in the direction of rotation. As the lobes are rotated they are keyed: one lobe transmits dots and its neighbour transmits dashes. The dots and dashes are alternate and contiguous. An observer located in the area of a dot lobe will hear only dots until the dot lobe moves away and the adjacent dash lobe approaches, the space between the dots of decreasing amplitude being filled in by dashes of increasing amplitude. When the dots and dashes become equal in amplitude the observer hears a continuous tone. The process of rotating the pattern is repeated after a short distinguishing interval. The navigator merely has to count dots or dashes in order to determine his line of position at the beginning of a sequence with respect to equisignal lines, or narrow zones. which are shown on a consol chart. The sum of dots and dashes for a single shift or sequence is *60*. and accuracy can be improved by counting both characters and symmetrically adjusting them. if necessary, to the sum of *60*. When the start of a count is on an equisignal line the count is all dots or all dashes. Semiautomatic counting devices are available.

Since there are a number of lobes and corresponding equisignal lines in the system. and the lobes enclose sectors of 10° to 15°, the navigator at times may need positive identification of the sector in which he is situated. This is accomplished by taking radio bearings on the consol station.

The range of consol is limited by spreading of the equisignal lines and by atmospheric noise that varies with latitude and season. Since sky waves are useful (more so than in direction finding) the range is greater at night. The nominal range is 1,500 mi. at night and 1.000 mi. during the day, with line-of-position accuracies ranging from 1.5 mi. at 250 mi. to 72 mi. at 1.500 mi. The accuracy is less at night over ranges of 200–400 mi. because of mutual interference between sky waves and ground waves.

Radar. — The development and application of radar progressed after World War II to make it probably the most widely used of all electronic navigational aids. Essentially, navigational radar extends the user's range of vision in darkness or poor visibility. The radar picture, however, is a symbolic one, unlike that of television, and proper interpretation requires considerable skill (see RADAR).

VI. ELECTRONIC AIDS FOR MARINE USE

Variations of Radar. — Port *radar* installations have been introduced in certain harbours to help traffic in poor visibility and for various subsidiary functions, such as checking the position of navigational buoys. In periods of bad visibility, pilots aboard the ships are advised of their positions in relation to the navigational marks or to the harbour configuration However, when traffic is heavy there is sometimes difficulty in identifying a particular ship on the harbour radar display. This may be overcome in numerous nays, one of nhich is to take bearings on the ship's radio transmitter.

Two systems that operate on radar principles but that employ active rather than passive targets are shoran and EPI (electronic position indicator). Transponder (slave) beacons, established ashore, return strong signals of identifiable characteristics that facilitate accurate measurement of distance. Shoran, operating in the 210–320 mc. band. is a line-of-sight system. EPI is effective over a greater range, by virtue of ground waves, on about 2 mc. EPI actually is a mobile loran system that is limited to the measurement of the length of the base line betneen the interrogator (master) and transponder (slave) beacons. Both systems are primarily survey tools.

Sonar is the underwater counterpart of radar; however, it employs sound naves rather than radio waves. The terms echo sounder. Fathometer and depth finder are commonly applied to equipment that is designed to measure distance downward only. The employment of horizontally directed beams is generally restricted to military applications. (See also ECHO SOUNDER.)

Radux and **Omega.**—Radux, a hyperbolic system that operated experimentally in the low- and very low-frequency bands, employed base lines of approximately 2,000 mi. Advantage was taken of the relatively high stability of sky wave propagation at these frequencies to synchronize transmitters and receivers. Phase comparison and synchronization were made on a modulation frequency of about 200 cycles. Since radux was a continuous-wave system using a single radio frequency, transmission time had to be shared among the three or more stations in a single system. This was accomplished by a synchronized system of commutation in each transmitter and receiver. Phase "memory" of the transmission that had ceased was provided by a phase-controlled crystal oscillator.

Omega evolved from the experiments with radux. Phase measurement was shifted from the 200-cycle modulation of radux on a carrier frequency of 40 kc. to direct phase comparisons of 12-kc. master and slake station carriers. The lane nidth along the base line is thus reduced from 400 mi. to 7 mi.. with an accompanying increase in line-of-position accuracies. For lane resolution a second frequency, offset from the main frequency, is transmitted alternately to give a low-frequency beat, the lane width of which is considerably greater. Together nith the improved accuracy achieved by this change there were gained the advantages of greater transmission range and superior propagation stability.

Lorac and **Raydist.**—Lorac and raydist are short-range, continuous-wave hyperbolic systems developed primarily for accurate surveying operations. Synchronization of the three or more stations is made unnecessary by using a single beat frequency generated between offset radio frequencies of the system. Both lorac and raydist operate principally on frequencies near 2 mc.

In lorac, phase measurements are made between two separate derivations of a beat frequency that is generated in the mobile receiver and also at one of the fixed stations of a pair and retransmitted to the mobile unit as a modulation of a third radio frequency. A fixing system is comprised of three or more stations. The number of frequencies required is reduced by time-sharing.

The raydist system is similar to loran, except that one of the transmitters is placed on the mobile station. Thus, raydist cap be used as a pure distance-determining device. Keither system provides lane identification; therefore. lane count from a known position must be maintained. Accuracy is limited at night by sky wave contamination of the ground wave.

VII. ELECTRONIC AIDS TO AIR NAVIGATION

Four-Course Low-Frequency Radio Range. — The four-course low-frequency radio range system was the first electronic aid to navigation to come into general use after the development of the direction finder. It is basically a homing system, although a positional fix may be obtained by finding the intersection of the course lines of two stations. The range supplies a course on which is heard a continuous tone. As the aviator strays from the course he hears either the International Morse code character A (·—) or N (—·). By referring to a special chart, he is able to determine the direction in which he has strayed.

The transmitting antenna is a crossed loop or crossed Adcock whose four-lobed radiation pattern can be shifted by adjusting the relative amplitude and phase of the two directional elements. Along the desired course the amplitudes are made equal and since the A and N characters are interleaved, a continuous tone is heard. Elsewhere the signal amplitudes are not equal, so one character or the other predominates.

No special receiver is required for the range information. Reliable service distance is limited at night because of night effect, reflections from mountains and interference from other .stations as well as from the reduction in power made to reduce that interference.

Omnidirectional Radio Range. — While the four-course range simplifies travel over established routes, the omnidirectional range serves general navigation and position-finding requirements. Historically the omnidirectional beacon had its beginning in the "talking beacon." which saw experimental service in the low-frequency band in Europe. In this device a recorded voice announced the direction of transmission of a beam, in steps of several degrees. as the beam was rotated 360°. The difficulty of generating: at low radio frequencies. the sharp rotating beam required for aural discrimination of the spoken information. together with night and refractional effects, limited the success of this system. The phase-comparison omnidirectional range, developed by the U.S. Civil Aeronautics administration on both low-frequency and very high-frequency bands, is highly sensitive to amplitude changes. It employs a rotating cardioid pattern that is compared with a fixed-phase, omnidirectional pattern the carrier of which is modulated at the speed of rotation of the cardioid. If the relative phase of the two patterns is established at 0° when the maximum amplitude of the cardioid is pointed north. then successive positions of the cardioid will produce a direct indication of bearing from the transmitting station on a receiver phasemeter.

The very high-frequency (108–118 mc.) omnidirectional range (VOR) has been widely installed in the U.S. and, to a lesser extent, in other countries. It is sometimes combined with an interrogator-transponder beacon (DME, or distance-measuring equipment), which is similar in principle to shoran.

Dectra.—Dectra is an adaptation of the nominally short-range decca system to long-range lane guidance. A master and a slave, sharing the same frequency, are situated 70 to 80 mi. apart so that asymptotic hyperbolic lines extend along a desired traffic route. A second pair is similarly set up at the opposite end of the route and shares a second frequency. The route distance and station power are adjusted so that each pair covers somewhat more than half of the route. Distance information is provided by utilizing the signals so as to establish a base line between the two pairs of stations. When signals from either end of the route cannot be received, a highly stable crystal oscillator provides a temporary "memory" signal. A transatlantic dectra installation provides accuracies of 3 mi. laterally and 6.5 mi. along the route, the lateral accuracy improving radically as the stations are approached.

Variations of Radar. — In aircraft radar equipment of special design use is made of the Doppler effect, which causes the received frequency of a signal reflected from the ground to differ from that of the transmitted signal by an amount proportional to the speed of the aircraft. Several downward beams having horizontal components in different directions may be utilized so that the forward, lateral and vertical velocity of the aircraft may be measured by automatic means. Doppler systems have been developed using either pulse or continuous-wave methods.

The radio altimeter, which utilizes radar principles, has an advantage over barometric altimeters in that it is independent of variations in sea-level air pressure. This property enables the air navigator to relate his progress to the position of high- and low-pressure meteorological centres by noting the changes in the relative readings of his barometric and radio altimeters. Since mind direction bears a fixed relationship to pressure centres, these pressure-pattern data are useful in selecting a route. (F. B. D.)

VIII. INERTIAL GUIDANCE SYSTEMS

Inertial guidance systems are self-contained, dead-reckoning devices that are most valuable for submarine navigation and missile control, although their usefulness is not limited to these applications.

The basic data upon which the inertial system depends are the amount and direction of acceleration. If acceleration from a standstill occurs for only a short period of time, after which velocity becomes constant, then velocity becomes the product of elapsed time and acceleration per unit distance per unit time. However, velocity is seldom constant. The variations in acceleration, both positive and negative, throughout the duration of motion must be integrated. The variation in acceleration is continuously determined by measuring the inertia presented by a mass to a change of velocity. This integrated information, which is proportional to velocity, is then interpreted in a second operation to yield data that are proportional to the distance traveled. All acceleration measurements and integration operations are performed automatically. It is obvious that when very small changes in velocity are involved the detection and measurement of acceleration is an extremely delicate operation and requires that the reference mass be isolated from yarying local effects. Reference axes, which are fixed with respect to iree space, are established by three spinning gyroscopes mounted on gimbals whose axes are mutually perpendicular. Deviations from this reference frame are sensed and fed to a computer, where the information is consolidated and resolved into distance and direction of travel.

In guided missiles the direction and distance of travel are preselected and thereafter automatically controlled. The effects of the earth's centre of gravity, whose direction with respect to the free space reference varies with changes in geographical position and with the earth's rotation, present problems of considerable magnitude since they introduce a component into the indicated measurement of acceleration and direction. As in any dead-reckoning method, errors are accumulative with time.

IX. INTERPLANETARY NAVIGATION

The three stages of an interplanetary flight by a high-thrust rocket may be considered to be (1) the launch, when the vehicle accelerates rapidly away from the starting point; (2) the mid-course phase, when the vehicle is in free fall, subject only to the gravitational fields of the sun and planets; and (3) the approach and landing phase. The first and last phases can be controlled by radio and radar, since the distances involved are relatively small. The mid-course phase comprises the major part of the voyage, ho ever, and presents serious navigational difficulties. During this phase the rocket will be traveling in an orbit, the shape of which is determined precisely by the speed and direction of its motion, that is, by its initial velocity on launching. The sort of difficulty involved in determining position and velocity in space is illustrated by the fact that the distances and positions of the planets themselves are not known to accuracies of more than 1,000 mi. Measures of velocity based on such data, therefore, will clearly be even less accurate. *See* also references under "Navigation" in the Index volume. (M. W. Ri.)

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NAVIGATION LAWS. Historically this expression refers to laws passed at various times and places to restrict commerce to ships of a particular nationality. But the expression is used in another sense to denote laws which lay down rules of the road and in other ways regulate the actual navigation of ships. The two classes will here be dealt with separately.

Restriction of Navigation. — In England the first Navigation act was passed in 1381. Policy varied thereafter until in 1651 a Navigation act was passed in order to strike a blow at the maritime supremacy of the Netherlands. The system set up of requiring the national trade by sea to be carried in ships under the national flag was maintained in force (with certain later statutory amendments) for a period of two centuries. By the Navigation acts ships under the national flag were required to be owned by British subjects, and shipmasters and a proportion of the seamen were also required to be British. Moreover. the national register for ships was established by Charles II in 1660 in order to ascertain which ships were to benefit from the acts.

The result of these acts was that by 1847 no produce from Asia, Africa or the United States could be imported into the United Kingdom from Europe in any ships. the object being that the trade should be direct and in British bottoms. Coastal trading around the United Kingdom could only be carried on by British ships. and colonial trade was prohibited to all foreign ships except where sanctioned by a special order in council. Various restrictions were imposed on imports not carried in British ships, and orders in council laid down differential dues and restrictions on imports carried in ships of any foreign countries imposing similar restrictions on British trade.

In 1849 the Navigation acts were repealed, subject to reservation of the coasting trade and subject to the proviso. intended to secure reciprocity, whereby if prohibitions or restrictions were imposed on British ships by other countries the privileges of the ships of those countries in British ports might be restricted. The reservation as to coasting trade was removed in 1854.

However, despite these relaxations, it is still the lam that a ship is not to be deemed a British ship unless it is owned wholly by British subjects, or by a body corporate established in some part of the sovereign's dominions. British ships are still required to be registered as such. Further, no alien can own, nor. subject to certain reservations, may he act as master or as one of the principal officers of a British ship.

In the United States a system of duties discriminating against foreign ships was adopted in 1789. Under various statutes provision was made for relief by way of reciprocity, and consequently. after 1849, British ships were admitted to the United States ports on the same terms as American ships were admitted into British trade. But coastwise trade has continued to be limited to ships of the United States. Similar restrictions are placed on coastwise trade by some other countries, including France and Portugal. But many others, for example the Ketherlands, Denmark and Sweden, permit coastwise trade to vessels of all nations which grant reciprocal privileges to ships carrying their flag.

After World War I, and in implementation of the terms of the peace treaty, conferences were convened under the auspices of the League of Nations with the object of facilitating and maintaining freedom of communications and of commerce. Several international conventions were adopted, the most important being the Maritime Ports convention, 1923, under which each of the contracting parties undertook, subject to the principle of reciprocity, to grant the vessels of every other contracting state equality of treatment with its own vessels or those of any other state whatsoever, in the maritime ports situated under its sovereignty or authority, as regards freedom of access to the port, the use of the port and the full enjoyment of the benefits as to navigation and commercial operations nhich it offers to vessels, their cargoes and passengers. This convention does not apply to maritime coastal trade.

After World War II. the Provisional United Maritime Consultative council, consisting of 18 members, including the United Kingdom, the dominions and the United States, was set up at Washington, D.C., in 1946 for the purpose, among other things, of removing all forms of discriminatory action and considering any shipping problem of international character.

In 1948 a conference was held at Geneva, Switz., at which the great majority of the members of the United Nations. with the notable exception of the C.S.S.R., were present. The conference adopted a convention for the constitution of an intergovernmental consultative organization. whose headquarters were to be in London, and whose objects were to follow the lines of those of the provisional consultative council. Its organs were to be an assembly, a council of 16, a maritime safety committee and a permanent secretariat. See also SHIPPING, HISTORY OF.

Regulation **of** Navigation. — The other class of navigation laws laying do n rules of the road and in other ways regulating the actual navigation of ships may apply (1) on the high seas; or (2) within territorial waters, ports, harbours, docks and inland navigable waters. (See RULE OF THE ROAD AT SEA; as to territorial jurisdiction in general see WATERS. TERRITORIAL.)

Customary rules of seamanship applicable to navigation on the high seas were gradually developed. In England the Trinity masters advised the judges as to the rules by which those in charge of a ship should be guided. In 1846 some Trinity house rules of navigation were made statutory. In 1889 an international maritime conference took place at Washington, D.C., the ultimate outcome of which was the drawing up of the International Regulations for Preventing Collisions at Sea. These have been adopted by all maritime nations and are thus of universal application. They are operative in respect of British ships everywhere and in respect of foreign ships when within British jurisdiction in the following way. The British Merchant Shipping acts empower the sovereign, by order in council, to make regulations of this kind. This mas done in 1896. Several further orders were made, and in 1910 the regulations were consolidated and reissued.

As a result of the international convention for the safety of life at sea which was adopted at London in 1948, new International Regulations for Preventing Collisions at Sea were compiled, to come into operation as regards the United Kingdom at the beginning of 1954 and to supersede the 1910 regulations. The collision regulations apply in general everywhere but they are subject in certain harbours and inland waters to qualifications introduced by local rules to adapt them to special local circumstances. These were made either in the same way as other national laws or by local authorities under powers given to them by the national legislature having jurisdiction over the place in question. Thus local rules are in force in many British and Irish ports and waterways, in the Danube and port of Sulina, in the Scheldt. at Gibraltar, in the Suez canal, in the United States inland waters and in the Great Lakes, both United States and Canadian.

See also SHIPPING INDUSTRY.

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NAVSARI (NAOSARI), a municipality and taluka in Surat district, Gujrat state, India, formerly in the Navsari division of the princely state of Baroda. The town is on the left bank of the Purna river, 147 mi. N. of Bombay by rail. Pop. (1951): town 44,663; taluka (283 sq.mi.) 199.165. It was an early settlement of the Parsees (*q.v.*) in Gujrat. after their banishment from Persia. It is still the home of their mobeds, or second sacerdotal class, and contains their venerated fire temple.

NAWABGANJ, the name of three towns in India and one in Pakistan. (1) The most important is the headquarters of Barabanki district in Uttar Pradesh, 17 mi. E. of Lucknow. Pop. (1951) 22,886. It has trade in sugar and cotton goods. It was the scene of a victory by Sir Hope Grant during the Indian mutiny of 1857. (2) A town in Rajshahi district of East Pakistan, on the Mahananda near the Ganges. Pop. (1961) 29,725. (3) A town in Gonda district. Uttar Pradesh. Pop. (1951) 5,822. (4) A town in Bareilly district, Uttar Pradesh. Pop. (1951) 5,663.

NAXOS, the largest of the Cyclades (161 sq.mi.), east of Paros. with which, and adjacent smaller islands, it forms an *eparchia*. In early times it was also called Dia or Strongyle.

Famous for its wine, it was a centre of the worship of Bacchus. The god found Ariadne asleep on its shore, when she was deserted by Theseus. The sculptors of Naxos were important in early Greek art. During the 6th century B.C. a tyrant Lygdamis ruled Naxos in alliance with Peisistratus of Athens. In 501 a Persian fleet attacked it unsuccessfully, but in 490 it was captured and treated with severity. Four Naxian ships joined the expedition of Xerxes, but deserted to the Greek side at Salamis in 480. Naxos was a member of the Delian league (*q.v.*); but, revolting in 471, was captured by Athens, and remained in its possession till its fall. After its capture, in A.D. 1207, by the Venetian, Marco Sanudo, the duchy of Naxos flourished till the Turks took the island in 1566. After the War of Independence it belonged to the Greek kingdom. The ancient remains of a temple (Palati), supposed to be that of Dionysus, are on an island just off the town. Naxos is rich in fruit trees, and exports corn, wine and oil, but its most important product is emery.

The population of Naxos in 1951 was 18,593.

NAXOS, the earliest Greek colony in Sicily, was founded by Theocles from Chalcis in *c.* 734 B.C., on the east coast, south of Tauromenium (modern Taormina), just north of the mouth of the Alcantara river, where the castle of Schiso stands. As there were already Sicels at Tauromenium, they cannot have offered any opposition. The adoption of the name of Naxos, the island in the Aegean sea, may show that there were Naxians among its founders. It soon founded Leontini and Catana. Kaxos was the warmest ally of Athens in the Sicilian expedition. In 403 B.C. it was destroyed by Dionysius and its territory given to the Sicels. Its exiles at last found refuge in 358 at Tauromenium.

NAYAR (NAIR), a Hindu caste of the Malabar coast, southwestern India, in the state of Kerala. Before the British conquest of 1792, the Malabar coast region included a number of small, feudally-organized kingdoms in each of which the royal and chiefly lineages, the militia and most of the land managers of villages were drawn from the Kayars, who ranked below the Nambudiri Brahmans or religious authorities. During British rule the Nayars tended to move into the professions and became prominent in politics. government service, medicine, education and law. Many were active in support of the Congress party, which won independence for India in 1947.

Unlike most Hindus, the Nayars traditionally followed matrilineal descent. This family unit, whose members owned property jointly, included a group of brothers and sisters together with the latter's children and their daughters' children. The oldest male was the legal head of the group. Rules of marriage and residence varied somewhat between kingdoms. Those in the central kingdoms of Calicut. Walluvanad, Palghat and Cochin were most unusual: a girl was ritually married before puberty to either a Nayar or a Nambudiri Brahman man. After the ceremony the ritual "husband" had no further marital relations with his "wife," who was free to receive as visiting husbands a number of men of her own or the Brahman caste. Correspondingly, Nayar men. most of whom led a mobile life as soldiers, might visit as many Kayar wives as they chose. Women were maintained not by their visiting husbands but by their matrilineal groups, and fathers had no rights in or obligations to their children. The Nayars of this area therefore. unlike most peoples, did not institutionalize the nuclear family of father, mother and children as a legal, residential or economic unit. The Nayars cannot, however, be said to have wholly lacked the concepts of marriage and paternity, for the ritual marriage was essential. and children were later required to observe ceremonial mourning at the death of their mother's ritual husband.

Early in the British period the Nayar armies were disbanded. Perhaps partly as a result of this change, plural marital unions gradually died out in the 19th century. A law passed in 1896 permitted men to register their marriages and provided that the children of such unions should inherit half of the personal property of the father. Laws passed in the 1930s enforced monogamy, permitted division of the matrilineal group's estate between its male and female members and gave children full rights of maintenance and inheritance from their fathers. After that period it became increasingly common, especially in towns, for husband and wife to leave their matrilineal homes and form separate residential and economic units with their children.

See E Kathleen Gough, "Changing Kinship Usages in the Setting of Political and Economic Change among the Nayars of Malabar," *Journal of the Royal Anthropological Institute,* vol. 82, pp 71–88 (1952); Edgar Thurston, "Nayar," in *Castes and Tribes of Southern India,* vol 5, pp. 283–412 (1909). (E. K G)

NAYARIT, a Pacific state of Mexico, until 1917 the federal territory of Tepic, bounded by Sinaloa, Durango and Jalisco. The offshore Tres Marías islands are largely undeveloped. Area. 10,547 sq mi. Pop. (1960) 391.970. The Southern Pacific railway of Mexico and the trunk highway from Nogales to Guadalajara cross Kayarit. Running southeasterly, the Sierra Madre rises steeply from the narrow Pacific littoral and cuts the state into deep gorges and narrow valleys. Outstanding features are the volcanoes Ceboruco and Sanguangiiey. Its climate is generally wet. frost-free and healthful except on the hot Pacific slope. Kayarit's coastal lagoons and marshes are well known as wild bird refuges. The main river is the final leg of the Lerma. rising on the main plateau of Mexico; under the name of Santiago it flows westward through Nayarit and empties north of San Blas, chief Pacific port. Its valley is extremely fertile.

Mining is important in the sierras, but Nayarit is primarily agricultural; its products include maize, tobacco. sugar, cotton, beans, coffee. noods and medicinal plants.

Tepic (pop. [1960] 53,499) is the capital 26 mi S E. of San Blas, with which it is connected by road. It is located in a valley 3.000 ft above sea level. and is surrounded by ranches and small farms. Tepic is a mixture of colonial charm and bustling modernity

Small villages of Cora and Huichol Indians are scattered through the sierras. (J. A. Cw.)

NAYLER (NAYLOR), **JAMES** (1618–1660), English Puritan, was born at Andersloe or Ardsley, in Yorkshire. in 1618. In 1642 he joined the parliamentary army, and served as quartermaster in John Lambert's horse. In 1651 he became a Quaker. He gradually arrived at the conviction that he was a new incarnation of Christ. He gathered round him a small band of disciples. who followed him from place to place. At Appleby in 1653 and again at Exeter in 16jj he suffered terms of imprisonment. In Oct. 1655, in imitation of Christ's procession into Jerusalem. he entered Bristol on horseback riding single—"a rawboned rude figure, with lank hair reaching below his cheeks"—attended by seven followers, some on horseback, some on foot, he in silence and they singing "Hosanna! Holy, holy! Lord God of Sabaoth!" At the High Cross he and his followers were arrested. His trial occupied the second parliament of Cromwell for several days, and on Dec. 16, 1656, he was convicted of blasphemy and sentenced to be whipped, to be branded in the forehead with "B" (for blasphemer), to have his tongue bored with a red-hot iron, to be whipped through the streets and to suffer imprisonment for two years.

On Nayler's release he was readmitted into the communion of the Quakers.

NAZARENE, CHURCH OF THE, an international religious body with headquarters in Kansas City, Mo., with over 300,000 members, largely in the United States, Canada and the British Isles, and over 50,000 members in approximately 35 mission areas. The denomination is the product of the merger of some 15 religious bodies stemming out of the 19th-century Wesleyan holiness movement. The first major merger was in 1907, uniting the Church of the Nazarene (organized in California in 1895) with the Association of Pentecostal Churches of America (with origins in the northeastern states from 1886 to 1896) to form the Pentecostal Church of the Nazarene.

The next year the Holiness Church of Christ (with origins in the southwestern states from 1894 to 1905) joined the denomination. Later mergers brought in groups from Texas, Tennessee. Scotland, North Dakota and England. The term pentecostal. because of its increasing association with "speaking in tongues," a practice foreign to the Nazarenes, was dropped from the name of the denomination in 1919.

In polity the church combines congregational autonomy with superintendency in a representational system. In worship there is emphasis on simplicity and revivalistic evangelism. In doctrine the church stands in the tradition of Arminian Methodism and regards its unique mission to be the promotion of entire sanctification as a work of grace subsequent to conversion. It is the largest of the bodies with this professed aim.

The church operates a publishing house. a theological seminary, six liberal arts colleges, several theological colleges and numerous mission schools and hospitals.

See *Manual of the Church of the Nazarene* (published quadrennially); T. L. Smith, *Called Unto Holiness, the Story of the Nazarenes: the Formative Years (1962).* (C. O. B.)

NAZARENES, a translation of two different Greek words, *Nazarenos* and Nazoraios. The first means "coming from Nazareth" (a village in Galilee) and is applied to Jesus in the Gospels of Mark and Luke. The second, of doubtful derivation. may be related to the term Nazirite (*q.v.*) and is used of Jesus in Matthew, Luke (once), John and Acts. Matthew (ii, 23) treats it as the equivalent of *Nazarenos;* in other passages its meaning is not altogether clear. According to Acts xxiv, 5 it was used of Christians by Jews.

In later times there was an Ebionite sect (see EBIONITES) which, according to the 4th-century theologian Epiphanius, consisted of Jews who traced their ancestry back to the Jewish Christians who left Jerusalem for Pella. on the other side of the Jordan. just before the destruction of Jerusalem in A.D. 70. Epiphanius differentiates this sect of Nazarenes from a purely Jewish sect which he calls that of the Nasaraei. The relation. if any, of these sects to the Jewish Christians of the 1st century cannot be determined. (R. McQ. G.)

NAZARETH, a town in Lower Galilee in Israel, on the northern border of the plain of Esdraelon, 1.600 ft. above sea level. The population in 1956 was estimated to be 23,000. A cigarette factory (with its own large tobacco plantations), stone quarries, and two mineral-water factories furnish employment for most of the inhabitants.

Nazareth is not mentioned in the Old Testament. In the New Testament it is associated with Jesus as His boyhood home, and in its synagogue He preached the sermon which led to His rejection by His fellow townsmen. Since the 6th century a number of churches and religious houses have been built there. Legends and precarious identifications persist and visitors are shown the church of the Annunciation, the workshop of Joseph, St. Mary's well, Christ's table, etc. Only for the well can authenticity be assured.

The crusaders captured Nazareth in 1099 and transferred there the bishopric of Scythopolis (Beisan). It was taken by Saladin (1187) and retaken by Frederick II (1229). On its capture by Beibars (1263), the Christian inhabitants were massacred. In 1517 it came into the possession of the Turks. In World War I Nazareth was the headquarters of the Turco-German army. It was captured by British cavalry on Sept. 20, 1918. In 1948 it was the headquarters of the Arab forces under Fawzi Kawukji until his army was defeated by the Jews when Nazareth surrendered without a fight. Under Israeli rule the town was placed under a military governor, his staff and government officials being the only Jewish residents there. It has three schools attended by about 1,500 boys and 1,000 girls. (E. Ro.)

NAZARIUS (fl. c. A.D. 320), professor of Latin rhetoric, was the author of a panegyric in praise of Constantine I, delivered at Rome in A.D. 321 during the celebrations of the third quinquennium of Constantine's reign and the fourth anniversary of the elevation of his sons Crispus and Constantine to the rank of Caesar. Nazarius had previously delivered a speech on the events of A.D. 312, which has not survived. Its identification with W. Baehrens' Oratio xii (XII Panegyrici *Latini*, 1911), delivered in A.D. 313, is untenable. Ausonius describes Nazarius as a professor of rhetoric at Burdigala (Bordeaux), and Jerome refers to his eloquence and that of his Christian daughter, Eunomia. Nazarius' own attitude toward Christianity and paganism is neutral.

See E. Galletier, *Panégyriques latins,* vol. ii (1952). (W. S. Ms.)

NAZI, a popular abbreviation for a member of Adolf Hitler's National Socialist German Workingmen's party (Nationalsozialistische Deutsche Arbeiterpartei, commonly designated by its initials, N.S.D.A.P.). The nickname originated from the German pronunciation of the first two syllables of "National." See NATIONAL SOCIALISM.

NAZIM HIKMET RAN (1902–), Turkish poet and dramatist, who exercised a strong influence on Turkish literature in the late 1930s by his mastery of language and by the introduction of a wide range of poetic themes and of a free verse technique. He was educated at Istanbul and in Moscow. Having gained some early recognition with his patriotic poems in syllabic metre, he came, in Moscow, under the influence of Russian futurists and, abandoning traditional poetic forms, he indulged in exaggerated imagery and by this means and the use of unexpected associations tried to "depoetize" poetry. Later his style became quieter and his epics on Bedreddin (the 15th-century revolutionary religious leader of Anatolia) and on the War of National Liberation show real poetic power. His plays, written in vigorous prose, are mainly Marxist inspired. His poems were translated into French by Hasan Gureh (1951).

See E. Saussey, *Prosateurs turcs contemporains* (1935). (F. I.)

NAZIRITE (NAZARITE), among the ancient Hebrews, a sacred person whose separation was most commonly marked by not cutting the hair and by abstinence from wine. In Israel's early history the Nazirite was endowed with special charismatic gifts and normally held his status for life; in later times he was a man who had voluntarily vowed to undertake special religious observances for a limited period of time, the completion of which was marked by the presentation of offerings (Num. vi; I Macc. iii, 49; Acts xxi, 24).

The early Nazirite was a holy man whose peculiar endowment. credited to his possession of "the Spirit of the Lord," was displayed in unusual psychic or physical qualities marked by spontaneity. ecstasy and dynamic enthusiasm. In this respect he had much in common with the early ecstatic prophets and with diviners such as Balaam (Num. xxii–xxiv). both indigenous to the near east. This helps to explain why Amos mentions the prophet and Nazirite together as persons whose special divine vocation had been frustrated (Amos ii, 11 ff.). Both were also close to the warrior, who was likeuise in a sacred state while on duty. After his anointing Saul exhibited the ecstatic qualities of the prophets he joined (I Sam. x, 9–13; cf. xix, 18–24), and he exhibited a similar holy fury as the warrior king who led the relief of Jabesh-gilead (I Sam. xi, 5–11). Samson the Nazirite was a holy warrior whose special power was most closely related to his unshorn locks. This association of mysterious divine power with the growth of hair and with abstinence from wine shows that the institution of the Nazirite had its historic roots in the nature mysticism of the near east. In Israel. however, such natural powers as represented by the growth of hair were no longer treated as divine force. per se, but as signs of the power of the God of Israel and vehicles for it.

The later Nazirite as described in Num. vi and in the Mishnah was not a charismatic person. He simply retained the old requirements, added the prohibition against touching a corpse, and treated them as external signs of a vow. The minimum period of the Xazirite vow was 30 days.

The priest-prophet Samuel, who was dedicated by his mother (I Sam, i, 11). did not exhibit the psychic phenomena of earlier Nazirites. In many respects he represents the bridge figure marking the transformation of the institution. The Rechabites (*q.v.*), who resembled Nazirites in abstaining from wine, also combined a voluntary vow with a life-long commitment.

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(J. C. RY.)

NDOLA, a town of the Federation of Rhodesia and Nyasaland, is situated in the copper-belt area of Western province of Northern Rhodesia, 380 mi. N.N.W. of Salisbury, the federal capital. Pop. (1956) 63.794 (including 7.384 Europeans). Building redevelopment in the central area took place in 1958 and 1959 and the new constructions include the high court, community centre. Mukuyu house (government offices), fire and police stations, multiple stores, general post office, cinema: building society and shipping offices and a Roman Catholic procathedral.

Ndola is the railhead for the copper belt and an international airport is $1\frac{1}{2}$ mi. from the town centre. There are direct rail links with the ports of Lobito bay in Angola, Beira and Lourenço Marques in Mozambique and Cape Town in the Union of South Africa and roads, with express freight services, run to main centres in the territory and to Salisbury and Bulawayo. In addition to copper refining! industries include cobalt treatment. sugar refining, brewing and the manufacture of clothing, concrete products. bricks, industrial gases, lime, and iron, steel and nonferrous castings.

The town was first settled by Europeans in 1902 when the now disused Bwana Mkubwa copper mine was pegged out, and for 24 years Ndola mas the mining centre of the territory. By the early 1930s mining activity had moved west and the town later became the commercial and industrial centre of the region. It has been the government's headquarters for the copper belt since 1924 and a municipality since 1932. (I. D. E.-B.)

NEAGH, LOUGH, the largest lake in the British Isles, situated in Northern Ireland. It has an area of 153 sq.mi. and a catchment area of 2,200 sq.mi. The hollow in which it lies was caused hy the collapse of a corner of the basalt plateau which covers much of County Antrim. Its waters are divided among the five counties of Antrim. Down. Armagh, Tyrone and Londonderry. Its shape is an irregular oblong. its extreme measurements being 18 mi. from northeast to southwest. 16 mi. from north to south and 11 mi. from east to west. The Bann river flows through the lake and is its sole outlet northward to the sea. Under the Drainage act of 1929, the ministry of finance. Northern Ireland, was established as the drainage authority for the Lough Neagh district. A big scheme was begun in 1930 for deepening and widening the Bann river along the 32 mi. from the outlet of Lough Neagh to its tidal reaches. This ensured that 700.000 cu.ft. of water per minute could be discharged and the flood level of the lake kept below 53 ft. 6 in. above sea level. (HU. S.)

NEAGLE, JOHN (1796–1865), U.S. portrait painter, was born in Boston on Nov. 4, 1796. His professional career was spent in Philadelphia. Starting as an apprentice coach painter, Neagle became a competent technician, but well below Gilbert Stuart and Thomas Sully; most of his large output is monotonous. His famous "Pat Lyon at the Forge" (Pennsylvania Academy of the Fine Arts) is well above his own average; his portrait of Stuart is the best one of that fascinating personality. He also painted a few landscapes; the only example now known is his "View on the Schuylkill" (Art Institute of Chicago). The last 15 years of Neagle's life were marked by loss of patronage and by paralysis. He died on Sept. 17, 1865.

See Virgil Barker, "John Neagle," The *Arts*, 8:7–23, no. 1 (July 1925). (VL. B.)

NEALE, EDWARD VANSITTART (1810–1892). English co-operator and Christian Socialist, was born at Bath on April 2, 1810, the son of a Buckinghamshire clergyman. He studied at Oriel college, Oxford, was called to the bar at Lincoln's Inn in 1837, became a member of the Christian Socialists in 1850 and also joined the council of the Society for Promoting Working Men's Associations. He founded the first co-operative store in London and advanced the capital for two builders' associations, both of which failed. In 1851, though strongly opposed by other members of the promoting "council," he started on his own initiative the Central Co-operative agency. similar in many respects to the Co-operative Wholesale society of a later day. The failure of this scheme, together with that of the operatives' cause in the engineering lockout of 1852 is said to have cost him £40,000. He was closely associated with the movement mhich resulted in the Industrial and Provident Societies act of 1876, and the passing of the Consolidation act of 1862 was almost entirely due to his efforts. Besides publishing pamphlets on co-operation he served on the executive committee mhich afterward developed into the Central Co-operative board. and took an active part in the formation of the North of England Co-operative Wholesale society in 1863. One of the founders of the Cobden mills in 1866. and the Agricultural and Horticultural association in 1867, he also promoted the annual co-operative congress. He was also a director of the Co-operative Insurance company and a member of the Co-operative Newspaper society. He visited the United States in 1875 with a deputation whose object was to open up a direct trade between farmers of the western states and English co-operative stores. He died on Sept. 16, 1892.

NEALE, JOHN MASON (1818–1866), English hyinnologist and scholar, was born in London on Jan. 24. 1818, and was educated at Trinity college. Cambridge. He occupies a high place as a hymnologist, but principally as a translator of ancient and medieval hymns, the best known being probably "Brief life is here our portion," "To thee. O dear, dear country," and "Jerusalem, the golden," which are included in the poem of Bernard of Cluny. De *Contemptu Mundi,* translated by him in full. He also published *An Introductzon to the History of the Holy Eastern Church* (2 vol., 1850) and other works. His *Collected Hymns* were published in 1914.

See Letters of John Mason Neale (1910), selected and edited by his daughter Mrs. C. Towle, who also wrote his *Life* (1907).

NEANDER, JOHANN AUGUST WILHELM (1789–1850), German theologian and church historian, was born at Gottingen on Jan. 17, 1789. of poor Jewish parents named Mendel. He grecized his name into Neander on his baptism in 1806. Educated under Schleiermacher, he became professor at Heidelberg in 1812 and moved to Berlin in 1813. His learning. sympathies and personality attracted many students, and he did perhaps more than any other teacher to bring a less formal spirit into Lutheran teaching. He died on July 14. 1850.

NEANDERTHAL MAN. Human populations referred to as Neanderthal man inhabited much of Europe and the lands surrounding the Mediterranean during the extended time interval of the earlier Upper Pleistocene. The name derives from a gorgelike valley above the small stream of Düssel. a tributary of the Rhine, 11 km. (7 mi.) east of Dusseldorf. There in the Feldhofer cave in 1856 workers encountered portions of a human skeleton; 14 pieces were eventually salvaged by a professor at the Realschule in Elberfeld, Johann Carl Fuhlrott. Following the description of the remains (by Prof. H. Schaaffhausen) a lively controversy arose as to whether their unusual morphology was normal, and hence indicative of an archaic variety of man. or whether it was merely a case of pathology in modern man *(Homo sapiens).* The former view was duly proved correct, especially after the discovery in 1886 of two similar skeletons in the cave of Spy (Belgium) in association with implements of chipped stone and animal bones representative of a subarctic fauna including extinct species (or extant forms no longer in the region). In the course of over a century of research on human evolution and the prehistory of man much additional information has been gained concerning these peoples, their distribution in space and time, their origin and disappearance and their ways of life. Several distinctive populations of Neanderthal folk are now recognized. These populations differ in certain aspects of their skeletal anatomy as well as in their spatial and temporal distribution.

The first recognizedly Neanderthal peoples occur during the last half of the Last Interglacial stage, certainly in central and southeastern Europe and probably also in western Asia. Among other features they were characterized by moderately small cranial capacity; a short, narrow and well-arched skull vault; large but somewhat separate and curved supraorbital ridges; moderately large cheekbones with some hollowing beneath them; gracile and straight or only slightly curved limb bones, generally lacking enlarged ends. The general pattern of the anatomy of the face and even of the skull vault of these early Neanderthal peoples was not greatly unlike that of *Homo sapiens;* this was also true of the bones of trunk and limbs. although these are not very well known. There was nonetheless a complex of skeletal features which distinguished them from modern human populations.

Far more numerous and complete skeletal remains have been recovered of Neanderthal peoples from the succeeding initial phases of the Last Glacial stage. This is probably due in large part to the marked tendency toward utilization of cave fronts and rock shelters below cliffs for habitation sites, as well as the widespread practice of deliberate burial of the dead. Such peoples were distributed, evidently as small semi-isolated populations of relatively unsophisticated hunting and gathering bands with a Mousterian stone industry, from western Asia throughout much of Europe as well as along the Mediterranean littoral of northern Africa. (There is no evidence for such peoples either in Africa south of the Sahara or in eastern or southeastern Asia; however, broadly contemporaneous peoples in these areas have been sometimes referred to as "Neanderthaloid" since certain features of their skull morphology simulates those found among Neanderthal peoples.)

Over most of this area of distribution such peoples resembled quite closely early Neanderthal populations of the preceding interglacial period. This was not the case with those groups, often called classic Neanderthals, occupying the western and southwestern periphery of Europe. Over this area, including Belgium and France and westernmost Germany, Spain and Italy, were short, stout, powerfully built Neanderthal peoples characterized by a number of distinctive skeletal characteristics which set them apart from their contemporaries elsewhere. This was true of the brain case (very large cranial capacity; long, low and wide skull vault. flattened behind; heavy biarched supraorbital ridges), of the face (projecting and large; rounded orbits; small cheekbones with no hollowing below them due to expanded sinuses; quite large teeth and palate), of the trunk (rounded broad chest; short vertebrae with large muscular processes; long slender collarbone) and of the limbs (heavy curved thigh and forearm bones; large feet and hands but short fingers and toes; arm and leg bones with enlarged ends; long heel bone). The popular conception that these people were slouched in posture and walked with a shuffling, bent-knee gait is untrue; it was due in large part to the faulty reconstruction of the skull base and to the misinterpretation of certain features of the limb bones of one of the Keanderthal skeletons discovered early in the 20th century.

Such were the peoples to whom the specific name *Homo neanderthalensis* was applied (by W. King in 1864) following the original discovery of the type skeleton in the Feldhofer cave.

(Actually two other such skulls had been found earlier in the 19th century but went unrecognized until after the Neanderthal discovery proper.) It is now apparent, however, that these peoples represented merely the western periphery of a particular range of variation within a quite widespread human species. In fact, since such peoples were considerably like *Homo sapiens* the use of the distinct species name *neanderthalensis* may be most misleading (some workers think it might be applicable to the classic Neanderthals). It is likely that populations referred to as classic Neanderthals became relatively isolated from other such peoples in the southwesterly parts of Europe as a consequence of the increasing severity of the climate during the initial phases of the Last Glacial stage. Such isolation would have greatly restricted gene flow between populations, would have enhanced inbreeding and would have tended to bring about shifts, even drift in gene frequencies, especially in certain directions because of the accidents of sampling resulting from the original population composition. Increased selection pressures under a progressively harsher environment may also have played a role, although this is still poorly understood. Since the time range of the Last Glacial is now largely within the limits of the radiocarbon (C^{14}) method of absolute dating, it is now possible to estimate the time involved in such evolutionary changes. The Last Glacial seems to have begun about 75,000 ± 5,000 years ago; a rather pronounced temperate interstadial amelioration began around 42,000 years ago and had a duration of about 10,000 years. The Neanderthals appear to have persisted fairly well into, perhaps almost to the end of, this interstadial; probably they had disappeared by about 35,000 ± 3,500 years ago. Hence the characteristics of the Neanderthals developed over a period of approximately 30,000 ± 5,000 years; *i.e.*, during 1,500 ± 250 generations.

The factors responsible for the disappearance of these and other Neanderthal peoples are unknown. In Europe nearly all cave and rock shelter sites where there was repeated human occupation reveal a sterile horizon between the last Neanderthal occupation (with Mousterian industry) and succeeding occupation by a Cro-Magnon variety of *Homo sapiens,* characteristically European in skeletal anatomy (with an early Upper Paleolithic industry). (*See* CROMAGNON MAN.) Hence it cannot be demonstrated conclusively whether these different human populations overlapped in time in the same territory, the indigenous Neanderthals being perhaps killed off by the immigrant anatomically modern peoples, or whether the Neanderthals were no longer present, presumably having already become extinct. In southwestern Asia there are several cave sites (Skhul and Qafzeh, in present-day Israel) where skeletal remains of fundamentally anatomically modern peoples, once regarded as a special variety of Neanderthal, have been found. These were broadly contemporaneous with other more typically Neanderthal folk. Some workers believe that the former, which were perhaps already coexisting with and were eventually to replace Neanderthals in southwestern Asia during the initial phases of the Last Glacial, represented the forerunners of the Cro-Magnon populations who later replaced the Neanderthals of Europe. See ANTHROPOLOGY; MAN, EVOLUTION OF. *See* also Index references under "Neanderthal Man" in the Index volume.

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NEARCHUS, one of the officers in the army of Alexander the Great. A native of Crete. he settled at Amphipolis in Macedonia. In 325 B.C., when Alexander descended the Indus to the sea, he ordered Nearchus to conduct the fleet to the head of the Persian gulf. Nearchus was then entrusted with the more difficult task of circumnavigating Arabia from the mouth of the Euphrates to the Isthmus of Suez, a project cut short by the death of the king (323). In the troubles that followed, Nearchus attached himself to Antigonus. under whom he held the government of his old provinces of Lycia and Pamphylia.

He wrote a detailed narrative of his expedition, of which a full abstract was embodied by Arrian in his *Indica.*

For the text *see* editions of Arrian by C. Müller in *Geographici Graeci minores,* i (1855), and by A. G. Roos, *Arrianus,* ii, in the Teubner series (1928); on the topography *see* W. Tomaschek, "Topographische Erläuterung der Kiistenfahrt Nearchs vom Indus bis zum Euphrat," in *Sitzungsberichte der K. u. K. Acad. der Wissenrchaften,* cxxi (1890). *See* also E. H. Bunbury, *Historv of Ancient Geography,* i, ch. 13 (1879); T. S. Brown, *Onesicritus* (1949); and ALEXANDER III, THE GREAT. For ancient authorities *see* F. Jacoby, *Fragmente der griechischen Historiker,* IIB, IID (1923 ff.).

NEATH (Welsh, *Castell-Nêdd*), a municipal borough and market town in the Keath parliamentary division of Glamorgan. south Wales, near the mouth of the Neath or Nedd, 8 mi. E.N.E. of Swansea. 54½ mi. W.N.W. of Cardiff by road. Pop. (1951) 32,284. Area 6.8 sq.mi. The Vale of Neath is known for its beauty.

The town perhaps occupies the site of the Roman *Nidum.* At the Norman conquest of Glamorgan, Robert Fitz Hamon gave the district between the Neath and the Tawe to Richard de Granville, who built on the west banks of the Neath first a castle and then in 1129 a Cistercian abbey (on the site of a cell of the Grey friars of Savigny), to whose monks he later gave all his possessions in the district. All traces of that castle have disappeared. Another castle, built in the same century, on the east bank, was held direct by the lords of Glamorgan, as the westernmost outpost of their lordship. It was frequently attacked by the Welsh, notably in 1231 when it was taken. and the town demolished by Llewelyn ap Iorwerth. The portcullis gate and a tower are all that remain; of the abbey there still exist the external walls. with parts of the chapel, vaulted chapterhouse, refectory and abbot's house. Neath is a borough by prescription and received its first charter in the 12th century from William, earl of Gloucester, who granted its burgesses the same customs as those of Cardiff. Other charters were granted to it by successive lords of Glamorgan in 1280. 1340, 1359, 1397, 1421 and 1423. By the first of these (1280) the town was granted a fair on St. Margaret's day (July 20) and as the abbey had extensive sheep walks the trade in wool was considerable. In 1685 James II granted a further charter. Copper smelting was carried on in or near the town in 1584 when the Mines Royal society set up works at Neath abbey; the industry attained huge proportions later under Sir Humphrey Mackworth, who from 1695 carried on copper and lead smelting at Melincrythan. With the development of the south Wales coalfield Neath continued its metallurgical associations and concentrated on the by-product industries, thus locally diminishing to some extent the marked depression that characterized this coalfield after the collapse of the postwar boom in 1921–22. Besides coal, the chief industries are the making of steel and tinplate, metal boxes and clothing, oil refining, brewing, shipbreaking, and the manufacture of alloys and aluminum. In the neighbourhood there are numerous collieries. The Keath canal, from the upper part of the Vale of Neath to Briton Ferry (13 mi.), passes through the town, which is also connected with Swansea by another canal. A large road bridge and viaduct, opened in 19jj over the Neath estuary between Briton Ferry and Earlswood, caused the road between Port Talbot and Swansea to bypass Neath.

NEBO or NABU ("the proclaimer"), the Accadian translation of various Sumerian ideograms for the god of wisdom and writing, the main seat of whose worship was at Borsippa—southwest of Babylon. It is because of the close association of Borsippa with Babylon after the period when Babylon became the centre of the Babylonian empire that the cult of Nebo retained a prominence only some degrees less than that of Marduk. The amicable relationship between the two was expressed by making Nebo the son of Marduk. In this case the expression of the relationship in this form was intended to symbolize the superiority of Marduk, different, therefore, from the view involved in making Marduk the son of Ea (*q.v.*), which meant that the prerogatives of Ea were transferred to Marduk by the priests of Babylon.

Nebo was the god of wisdom to whom more particularly the introduction of writing was ascribed. He takes his place. therefore, by the side of Ea as a cultural deity. The wisdom associated with him had largely to do with the interpretation of the movements in the heavens, and the priests of Nebo at an early age must have acquired widespread fame as astrologers. Assuming now, for which there is a reasonable amount of confirmatory evidence, that the priestly school of Nebo had acquired a commanding position before Babylon rose to political importance, it can be understood why the worshipers of Marduk persisted in paying homage to Nebo, and found a means of doing so without lowering the dignity and standing of their own god. If Ashurbanipal, the king of Assyria (668–626 B.C.), in the subscripts to the copies of Babylonian literary tablets invokes as he invariably does Nebo and his consort Tashmit as the gods of writing to whom all wisdom is traced, it is fair to assume that in so doing he was following ancient tradition and that the priests of Marduk likewise were dependent upon the school at Borsippa for their knowledge and wisdom.

The temple school at Borsippa continued to flourish until the end of the neo-Babylonian empire, and school texts of various contents, dated in the reigns of Artaxerxes, Cambyses and Darius, furnish the evidence that the school survived even the conquest of Babylonia by Cyrus (539 B.C.). Originally this Sumerian deity seems to have been connected with Dilmun and was often identified with the philosophic principle *mummu;* creative word. form. As such he is the son of the water god Enki (Ea), god of the first principle. water. As the god of writing, Nebo has charge of the tables of fate on which he inscribes the names of men and decides what their lot is to be. If in the systematized religious system, Marduk appears as the arbiter of human fates, the conclusion is warranted that Marduk is here imbued with the authority which originally was in the hands of his son. A reconciliation between the rival claims was effected by continuing Nebo in the role of scribe, but as writing at the dictation of the gods, thus recording what the divine assembly, gathered in the chamber of fates (known as ubshukinna) within the precincts of E-Saggila—Marduk's temple at Babylon—under the presidency of Marduk, had decided.

Nebo also does homage to his father by paying him an annual visit during the new year celebration, when the god was solemnly carried across to Babylon, and in return Marduk accompanied his son part way back to his shrine at Borsippa. Within E-Saggila, Nebo had a sanctuary known, as was his chief temple at Borsippa, as E-Zida. "the legitimate (or 'firm') house." The kings, and more particularly those of the neo-Babylonian dynasty, devote themselves assiduously to the worship and embellishment of both E-Saggila and E-Zida. In their inscriptions Marduk and Nebo are invoked together and the names of the two temples constantly placed side by side. The symbols of the two gods are similarly combined. On boundary stones and cylinders, when Marduk's symbol—the lance—is depicted, Nebo's symbol—the stylus—is generally found adjacent.

In astronomy he was identified with the planet Mercury, and with the principal star of Taurus. Aldebaran. In the official reports of astrologers and in official letters, Nebo is even mentioned before Marduk without fear of thereby offending the pride of the priests of Marduk.

His consort, known as Tashmit, plays no independent part, and is rarely invoked except in connection with Nebo.

See also BABYLON; BABYLONIA AND ASSYRIA; BORSIPPA.

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(S. L.)

NEBRASKA, styled the "Tree Planter's state" by act of the legislature, 1895, and renamed the "Cornhusker state" by legislative act in 1945, is near the centre of the United States. It is bounded on the north by South Dakota, on the east by Iowa and a corner of Missouri, on the south by Kansas, on the south and west by a corner of Colorado and on the west by Wyoming. The Missouri river flows along the eastern and northeastern border. The extreme length of the state is 428 mi. and the extreme breadth 207 mi. The area is 77,227 sq.mi., of which 615 are water surface. Nebraska was named the "Tree Planter's state" because Arbor day was originated there by J. Sterling Morton in 1872 and forestry was emphasized by the pioneers and their successors. The name "Cornhusker" originally was applied to the University of Nebraska football team. Nebraska was the 37th state to be admitted into the union, on March 1, 1867; the state capital is Lincoln. The state flower is the goldenrod, the state bird the western meadowlark and the state tree the American elm. The state flag consists of the state seal which symbolizes commerce, industry. transportation and agriculture, and the state motto, "Equality before the law," in gold and silver, on a dark blue field.

PHYSICAL GEOGRAPHY

Physical Features.—The principal topographical feature of Nebraska, which lies approximately between 40" and 43° N. lat. and 95° and 104° W. long., is a great undulating plain, sloping gradually from the northwest to the southeast, at an average of ten feet per mile. This plain is broken along its northern and eastern borders by hilly regions The highest point, 5,424 ft., is in Kimball county; the lowest point, 840 ft., is in Richardson county. The state's principal topographical regions are the loess, the sand hills, the high plains and the Bad Lands, with lowlands along the Missouri and Platte rivers.

The loess region includes about 42,000 sq.mi. of excellent farm land in the eastern and south central parts of the state. The area is gently rolling except along the Missouri and Republican rivers and at some other points where moderate hills appear. The sand hills lie west and northwest of the loess region with outliers extending to the southwest corner of the state. The main region of the sand hills includes about 18,000 sq.mi. and consists of low hills interspersed with rich valleys, lakes and fertile tablelands. The high plains, which lie west and northwest of the sand hills, include about 12,000 sq.mi. and consist of level stretches of tableland broken occasionally by deep canyons and rugged buttes. The region includes two areas of evergreen-wooded mountains, the Wild Cat range and the Pine Ridge. The Bad Lands, used as range land, occupy about 1,000 sq.mi. in the northwest corner of the state.

The state is drained by the Missouri river, a navigable stream which skirts the eastern border for approximately 450 mi. The principal tributaries of the Missouri in Nebraska are the Platte and its branches; the Niobrara; the Republican; the Big and Little Blue; and the Big and Little Nemaha. The Platte is the dominant and characteristic river, and with its tributaries drains more than half of the state. Its wide terraced valley, extending across the entire state and leading to mountain passes. made it an important highway across the continent. Its channel varies from one-half to one mile in width, and is filled with islands. In the summer use of water for irrigation leaves its middle course in the state entirely dry. The sand hills contain hundreds of small lakes, particularly the area near the headwaters of the Loup and the Elkhorn rivers, the Platte's principal tributaries. The recreational facilities provided by these lakes are augmented by reservoirs resulting from the construction of numerous multipurpose dams. Artesian water exists in at least ten different counties, and the sand hills provide a significant quantity of ground water which is discharged into the lower Platte valley to supply irrigation wells.

Climate.—The climate of Nebraska is typical of the interior of large continents, and is characterized by light rainfall, low humidity, hot summers, cold winters and wide variations. The mean annual precipitation varies from 27.58 in. in the eastern part of the state to 12.65 in. in the western part. Wet and dry years run in irregular cycles. Fortunately for the state's agriculture, approximately two-thirds of the annual precipitation normally occurs in the crop-groning season, from April to Aug., inclusive. The mean annual temperature varies from 50.5° F. in the east to 48.3" F in the west. The mean temperature for January is 22.5" in the east and 24.1" in the west; for July, it is 77° in the east and 73.8" in the west. The growing season between frosts varies from 164 days in the southeast to 122 in the northwest.

Soil.—A soil of remarkable fertility is Nebraska's fundamental asset. A soil map of Nebraska exhibits wide variations which accounts in large measure for the diversified nature of its agriculture. The principal soil associations of the United States found in Nebraska—in which soils are grouped geographically rather than taxonomically — are: prairie soils, chernozem soils, chestnut soils, alluvial soils; planosols, lithosols and sand. Except for the lithosols which occur in the Bad Lands and the sand, of the sand hills, these soils are extremely fertile and well suited to the production of cultivated crops.

Vegetation. — Grasses originally comprised the state's principal form of vegetation. Only about 3% of the state was forested, with trees occurring principally along the streams and on the low mountain ranges of the west. The grasses varied according to rainfall. In the more humid eastern part of the state, tall prairie grasses — particularly the bluestem — abounded; in the less humid western area, short grasses — notably grama and buffalo — were characteristic. Except in the range country of the central and western parts of the state, the grasslands have been converted to the production of cultivated crops. Nebraskans have exhibited great interest in planting trees since pioneer days. Arbor day was first celebrated in Nebraska, and the Nebraska national forest in the sand hills is wholly man-made. By the second half of the 20th century Nebraska still had only about 3% of its area in forest.

Animal Life. — The principal indigenous animals were those characteristic of the plains. Of these, the most plentiful was the bison, or American buffalo. Others found in great numbers were the pronghorn antelope, mule deer, coyote, kit-fox, jack rabbit, ground squirrel, prairie dog, skunk and, along the streams, the beaver. The porcupine, wood rat and red squirrel were found in the woodlands. Birds were plentiful and, in addition to hundreds of species of song birds, included the'prairie chicken, grouse and migrating waterfowl.

Historic Sites and Parks. — The principal historic sites in Kebraska are: Homestead National monument of America (created in 1936) located near Beatrice in Gage county, the site of Daniel Freeman's homestead, the first in the nation to be claimed, Jan. 1, 1863, under the Homestead act of 1862.

Chimney Rock National Historic site (established 1956), in Morrill county, an important landmark on the overland trail.

Scotts Bluff National monument (established 1919), in Scotts Bluff county, an important landmark on the overland trail; the Oregon Trail museum, associated with the monument, interprets the westward movement through the Platte valley.

Arbor Lodge State park, in Otoe county, the home of J. Sterling Morton, founder of Arbor day.

Fort Kearney State park, in Kearney county, site of Fort Kearny, an important military post and stage station on the overland trail.

Fort Robinson, in Dawes county, an important military post during the period of the Indian wars on the northern plains, and the site where Crazy Horse, famed chief of the Sioux, was killed.

Fort Atkinson, in Washington county! site of an early military post (1819–27) which furnished protection to the fur trade of the west.

Nebraska state parks, in addition to Arbor Lodge, Fort Kearney and Fort Robinson, are: Chadron, Victoria Springs, Stolley, Niobrara and Ponca. The state game, forestation and parks commission which supervises these areas also maintains more than 50 lakes and recreation grounds.

HISTORY

Historical Development. — Francisco Vásquez de Coronado, the first white man to penetrate the northern plains, probably did not reach Nebraska in his fruitless search for the mythical kingdom of Quivira in the summer of 1541, but the Coronado legend has been incorporated into the literature and pageantry of the state. Approximately two and one-half centuries before 1803 when Louisiana territory, of which Nebraska was a part, nas acquired by the United States. Spanish and French explorers and French fur traders occasionally entered the area that is now Nebraska. A small temporary trading post was erected by French traders in 1795 in what is now northeastern Nebraska.

In the half-century following the Louisiana Purchase in 1803 explorers and fur traders made known to the public important facts about the region. Almost all of the early explorers were unfavourably impressed with the area, and their reports gave rise to the belief that it was little more than a desert and entirely unfit for agriculture.

The Platte valley, the state's most important topographic feature, developed into a significant thoroughfare to the Rocky mountains and the Pacific coast. It was first used by fur traders who, from 1821 until the decline of the fur trade in the 1840s, followed the Platte river route to and from the trapping grounds of the mountain region. Beginning in 1835 missionaries to the Oregon country followed the same route. In 1841 the first group of Oregon homeseekers went through the Platte valley! to be followed in succeeding years by thousands of emigrants over what came to be known as the Oregon trail following the south bank of the river. In 1847 the Mormons, led by Brigham Young, went along the opposite bank of the Platte en route to the valley of the Great Salt lake. They likewise were followed by many thousands in succeeding years. Gold seekers bound for California (1849–50) and Colorado (1859) added to the traffic on the trail.

Nebraska territory was organized in 1854, largely as a result of agitation for a transcontinental railroad. The name "Nebraska," deriving from an Oto Indian word for "flat water," had long been used to designate the Platte river and surrounding territory. The final Kansas-Kebraska bill. providing for two territories, became the centre of an intense struggle in congress between the north and south, involving the extension of slavery, the removal of Indians and rival routes for the proposed Pacific railway. The bill, signed by Pres. Franklin Pierce, May 30, 1854, provided that the new territories should be slave or free as voted by the citizens in each territory, thus reversing the policy regarding the extension of slavery established for the Louisiana territory by the Missouri Compromise (*q.v.*) of 1820.

Nebraska territory, as organized in 1854, included the vast region from 40° N. lat. to British America, and from the Missouri and White Earth rivers to the summit of the Rocky mountains. In 1861 and 1863 it was reduced by the creation of other territories to nearly its present boundaries.

Most of the early settlements were along the Missouri river. Bellevue (1823), the oldest permanent settlement, was important as a fur trading centre, as a missionary centre and in the administration of Indian affairs. Brownville. Nebraska City, Plattsmouth, Omaha and Florence, established in 1854, soon became important territorial towns. Omaha (*q.v.*) was the territorial capital. Other towns of the period included Beatrice. Columbus, Falls City and Fremont. The Pacific Railroad act and the Homestead act, both passed by congress in 1862. aided white settlement. The railroads were particularly significant to Kebraska in that they made settlement away from the Missouri river possible.

The great industry during the territorial period was transport by the overland trail. Over it ran freight wagons, stagecoaches and, in 1860–61, the famous pony express whose services ended with the completion of the overland telegraph in the latter year. Trail transportation terminated in Nebraska with the construction of the Union Pacific railway in 1865–69.

After turning down statehood in 1860 and 1864, the voters in 1866 approved a constitution which had been drafted by the legislature and on March 1, 1867 Nebraska was proclaimed the 37th state. The South Platte region, which had always opposed Omaha as the territorial capital, had a majority in the first state legislature of 1867 and passed an act providing for the relocation of the capital. to be named Lincoln, in that section. On Aug. 14, 1867, the capital commission, appointed by the legislature, located the capital at the little village of Lancaster and renamed it Lincoln (*q.v.*). Railroad and cow towns grew up at Grand Island. Hastings and Kearney (*qq.v.*) in the 1870s and at Alliance, Chadron and Norfolk in the 1880s.

The Democratic party was the sole political party in Nebraska from 1854 to 1858. The Kepublican 'party won control in 1860 and retained it firmly until 1890. In that year the Farmers' alliance organized the People's Independent or Populist party. A three-cornered fight resulted in the Democrats getting the governorship and the Populists a majority in the legislature By fusing with the Democrats under the leadership of William Jennings Bryan. the Populists won victories in 1894, 1896 and 1898. The Populist party died out after 1900 and political control fluctuated between the Democrats and the Republicans until 1930. During the 1930s the Democrats dominated the state although George William Norris, nominally a Republican, remained in the U.S. senate from 1913 to 1943. The Republicans asserted control in 1940 and remained in the ascendancy until 1958 when the Democrats returned to power. electing a governor and two congressmen. In 1960 the Democrats elected another governor. but all congressional seats went to Republicans.

POPULATION

Nebraska's population grew rapidly from 28,841 in 1860 to 1,058,910 in 1890. After 1890 growth was slow. and between 1930 and 1940 the population declined from 1,377,963 to 1.315.834. In 1950 the population was 1.325.510, an increase of 0.7% over the population in 1940, and in 1960 the population was 1,411.330, an increase of 8.7% over that of 1950. The population per square mile in 1960 was 18.3, as compared with 49.7 for the United States as a whole.

*Nebraska: Places of 5,000 or Afore Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	1,411,330	1,325,510	1,315,834	1,296,372	1,066,300
Alliance	7,845	7,891	6,253	4,591	2,535
Beatrice	·12,132	11,813	10,883	9,664	7,875
Bellevue	8,831	3,858	1,184	695	527
Chadron	5,079	4,687	4,262	4,412	1,665
Columbus	12,476	8,884	7,632	5,410	3,522
Fairbury	5,572	6,395	6,304	5,454	3,140
Falls City	5,598	6,203	6,146	4,930	3,022
Fremont	19,698	14,762	11,862	9,605	7,241
Grand Island	25,742	22,682	19,130	13,947	7,554
Hastings	21,412	20,211	15,145	11,647	7,188
Holdrege	5,226	4,381	3,360	3,108	3,007
Kearney	14,210	12,115	9,643	7,702	5,634
Lexington	5,572	5,068	3,688	2,327	1,343
Lincoln	128,521	98,884	81,984	54,948	40,169
McCook	8,301	7,678	6,212	4,303	2,445
Nebraska City	7,252	6,872	7,339	6,279	7,380
Norfolk	13,111	11,335	10,490	8,634	3,883
North Platte	17,184	15,433	12,429	10,466	3,640
Omaha	301,598	251,117	223,844	191,601	102,555
Plattsmouth	6,244	4,874	4,268	4,190	4,964
Scottsbluff	13,377	12,858	12,057	6,912	—
Sidney	8,004	4,912	3,388	2,852	1,001
South Sioux City	7,200	5,557	4,556	2,402	889
York	6,173	6,178	5,383	5,388	5,132

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

During the period of rapid growth (1860–90) there was a heavy immigration of foreign born into the state, particularly from Germany, Sweden, Bohemia, Ireland and Denmark. In 1950, 4 3% of the population was foreign born. Of the foreign-born white population, 23.2% was born in Germany, 11.3% in Czechoslovakia and 9.5% in Sweden. The nonwhite population, mostly Negro, constituted 1.8% of the total.

Of the 1960 population, 54.3% was classified as urban, as compared nith 46.9% in 1950, 39.1% in 1940 and 35.3% in 1930. 23.7% of the 93 counties showed an increase in population between 1950 and 1960, as did all of the cities of 10.000 or more population. The percentage of the population which was under 14 years of age increased from 17.1% in 1940 to 26.4% in 1950; the percentage over 65 years of age increased from 7.9% in 1940 to 9.9% in 1950.

GOVERNMENT

Administration. — A constitution adopted in 1875 and revised by a constitutional convention in 1919–20 is the basis of Nebraska's government.

The general election, state and local, is held in even-numbered years on the first Tuesday after the first Monday in November, but municipal and school district elections may be held at other times. Judges, regents of the state university. members of the legislature and some municipal officers are elected on nonpartisan ballots.

The governor is the chief executive officer of the state, and one of the nine executive state officers chosen by direct vote of the people. The other eight are: lieutenant governor. secretary of state, auditor, treasurer, attorney general and three railway commissioners. All officers are elected for two years, except the railway commissioners who are elected for six. The governor appoints, with legislative approval, heads of the code departments, members of the board of control and other boards and a few other officers. He fills vacancies in state offices arising from death. resignation or removal.

The unicameral legislature of Nebraska is unique among state governments. Beginning in 193i in accordance with an amendment adopted in 1934, it has consisted of a single house of 43 nonpartisan legislators representing geographic areas which had about equal population in 1935. The chamber is presided over by the lieutenant governor. There is no limit on the length of sessions, and except at the governor's request or by a committee, no bill or joint resolution may be introduced at a regular session after its 20th day. The legislature meets biennially in the odd-numbered years.

Administration of justice is vested in a supreme court, 18 district courts. county courts. municipal courts and justice courts. The supreme court consists of six associate justices, elected bv districts, and one chief justice, elected at large, all for six-year terms. Each district court consists of from 1 to 9 judges (total number 35) elected for four-year terms. County courts have one judge. Lincoln and Omaha have municipal courts. Provision is made for approximately 2,000 justice courts. The district court is the court of general. original, legal and equity jurisdiction. The jurisdiction of county, municipal and justice courts is limited. Appeal to the supreme court, the court of last resort, may not be denied in any case.

Of the 93 counties, 28 are of the township or supervisor type, governed by a board of supervisors of [illegible] members, and 65 are of the precinct or commissioner type. governed by boards of commissioners of 3 or 5 members. There are about 100 incorporated cities and 400 incorporated villages. Two cities are governed by the commission plan, one by a modified commission plan, nine by the city-manager plan and all others by the mayor-council form of government. Government of villages is vested in a board of trustees consisting of five members elected by popular vote. Any city with a population of 5,000 or more may adopt a home-rule charter, although only Omaha, Lincoln and Grand Island have done so.

Other governmental subdivisions include 5 public power districts, about 40 rural electrification districts and almost 500 other units, including drainage districts, irrigation districts, reclamation districts, weed eradication districts. soil conservation districts, metropolitan utilities districts and rural fire protection districts.

Finance.—Nebraska has no state income tax and no general sales tax. The general property tax, established in 1867, is supplemented by taxes on corporations, gasoline, liquor and cigarettes, by state licences and fees and special taxes, and by contributions from the U.S. treasury. The state has no bonded debt.

EDUCATION

State School System. — Xebraska has provided free public education since 1855. Most of the support and control comes from the local school districts. From 1869 to 1955 the state exercised general supervision of education through a superintendent of public instruction, an elected official. In 1955, as the result of a constitutional amendment adopted in 1952, this supervision was transferred to the state department of education consisting of .an elected board of education and a commissioner of education appointed by the board.

The local school districts provide approximately 90% of the support of public schools, primarily from the general property tax. The remaining support is derived from educational lands and funds, state aid by direct appropriation and federal aid. In 1949 Nebraska made an effort to reduce the number of school districts in the state. As a result of these efforts, within ten years the number of districts declined from more than 6,500 to fewer than

4,500. At the same time. school expenditures increased more than 70%; enrollment increased almost 20% ; and the number of teachers increased about 17%. Approximately 14% of the children in the state attend parochial schools.

Colleges and Universities.— The University of Nebraska, at Lincoln. established in 1869 and opened in 1871. is the state's principal institution of higher education. It is governed by a hoard of six regents elected by districts on nonpartisan ballots for six-year terms. The university consists of ten colleges and three schools, as follows: colleges of agriculture. arts and sciences, business administration, dentistry, engineering, graduate, law, medicine (at Omaha), pharmacy and teachers; and schools of fine arts. journalism and nursing. The university also maintains a school of agriculture at Curtis. and agricultural experiment stations at North Platte. Valentine and Alliance.

There are four state teachers colleges: Peru (established 1867); Kearney (1905); Wayne (1909); and Chadron (1911). They are governed by the state normal board. whose members are appointed by the governor Other publicly-supported institutions of higher education are. Omaha university. supported by the city of Omaha; and junior colleges at Fairbury. McCook, Norfolk and Scottsbluff, supported by local school districts.

The privately supported colleges and universities are: Calvary Life college at Central City; Concordia Teachers college at Seward: Cotner School of Religion at Lincoln; Creighton university at Omaha; Dana college at Blair; Doane college at Crete: Duchesne college at Omaha: Hastings college at Hastings; Midland college at Fremont; Nebraska Wesleyan university at Lincoln; College of St. Mary at Omaha; and Union college at Lincoln.

HEALTH, WELFARE AND CORRECTIONS

Nebraska's original Board of Health law was enacted in 1891. It was amended over the years and in 1953 the legislature created a seven-memher board of health appointed by the governor. The board of health has responsibility for maternal and child health. local health services, preventive medical services, communicable disease control, venereal disease control, dental health. tuberculosis survey, public health nursing, public health education. laboratories, sanitation, vital statistics, hospitals, cancer control, mental health, poliomyelitis control. athletics and examining boards. There were fewer than 100 hospitals in Nebraska at the end of World War II; the number was increased by more than one-third in a ten-year period.

The board of control, consisting of three members appointed by the governor, exercises general supervision over the state's charitable, educational and penal institutions; of which there are 17, as follows: Girls' Training school. Geneva; Home for Children, Lincoln; School for the Blind, Xebraska City; School for the Deal', Omaha; Orthopedic hospital, Lincoln; Hastings State hospital; Lincoln State hospital; Norfolk State hospital; Nebraska Psychiatric institute. Omaha; Central Nebraska Mental Hygiene clinic. Hastings; state home, Beatrice; state penitentiary. Lincoln; state reformatory, Lincoln; state reformatory for Women. Tork; Soldiers' and Sailors' home, Grand Island; and Hospital for the Tuberculous. Kearney.

The division of public welfare: constituted by the same persons who comprise the board of control, administers child welfare services. crippled children's services, surplus commodity distribution and the programs of old age assistance, blind assistance, aid to dependent children and aid to the disabled.

THE ECONOMY

Living Conditions.— Nebraska, with relatively few mineral resources. has traditionally been an agricultural state. During and after World War II, however. there began a decline in the percentage of the labour force employed in agriculture. and by the second half of the 20th century about 26% was so employed. Of those not employed in agriculture about 28% were employed in trade, 20% in government. 16% in manufacturing and 11% in transportation. Total annual personal income of Nebraskans was more than $2,500,000,000 as compared with $811,000,000 in 1929. In "constant" dollars, the income was approximately twice as great as that in 1929.

Production.— Although agriculture's relative importance declined in the years following World War II. it remains Nebraska's single most important economic activity. Livestock and livestock products normally account for approximately 70% of the gross cash income from farm marketings which, in the years following World War II, usually were about S1.000.000.000. Cattle constitute the most important source of income from livestock. Other livestock include swine, sheep. poultry. horses and mules. Corn is the most important crop and wheat is the second most important. Other crops are oats, barley, rye, hay. sorghum. sugar beets and potatoes. The number of farms decreased from 121.000 before World War II to 101.000 in a 15-yr. period while, at the same time. the average size increased from 391.1 ac. to 470.9 ac.

During the first half of the 20th century the steady progress of irrigation was of particular significance for Nebraska's agriculture, notably in combating the adverse effects of light rainfall. Water for irrigation is furnished by streams, of which the Platte. Loup, Niobrara, Republican and Elkhorn rivers are the most important, and by wells. By the second half of the 20th century more than 1,600,000 ac. were irrigated.

Nebraska's leading manufacturing activity consists of the conversion of the raw products of agriculture into marketable commodities. Other manufactures include fabricated metal products, machinery, precision instruments. apparel. lumber products, chemicals and plastics, and stone. clay and glass products. There are about 1,500 manufacturing establishments in the state, and the value added by manufacture is about $400,000,000 annually.

On Nov. 1. 1939. oil was discovered in Richardson county; in July 1949 oil was discovered in Cheyenne county. The state produced 1.800 bbls. of oil in 1939 and 12,171,816 bbls. 20 years later. Natural gas was first produced in the state in 1951.

Trade and Finance.— Trade is second to agriculture as a factor in Nebraska's economy. Omaha and Lincoln are centres of wholesale trade for a large area. Numerous state and national banks and a larger number of domestic and foreign insurance companies conduct their business in Nebraska.

Transportation and Communication.— Missouri river navigation was a leading method of transportation until the construction of the railroads in the 1870s when river traffic declined to almost nothing. During the 1940s and 1950s it revived to a position of greater tonnage, if not greater relative importance, than in the earlier period. Ten trunk railways radiate from Omaha, five of them with a network of feeders over the state. Railway mileage was about 5,700 mi. in the second half of the 20th century, as compared with more than 6.000 mi. in 1930. There were numerous airports. many of them for public use, and scheduled local air service was extended to all parts of the state.

The most important transportation development in Iiebraska in the years 1920–60 was the great extension of improved highways, accompanied by a rapid increase of motor vehicles.

Radio broadcasting began in 1921, and the first television station began operations in 1950. There are 20 daily newspapers with a net paid circulatiori of 448,000, and more than 250 weekly newspapers.

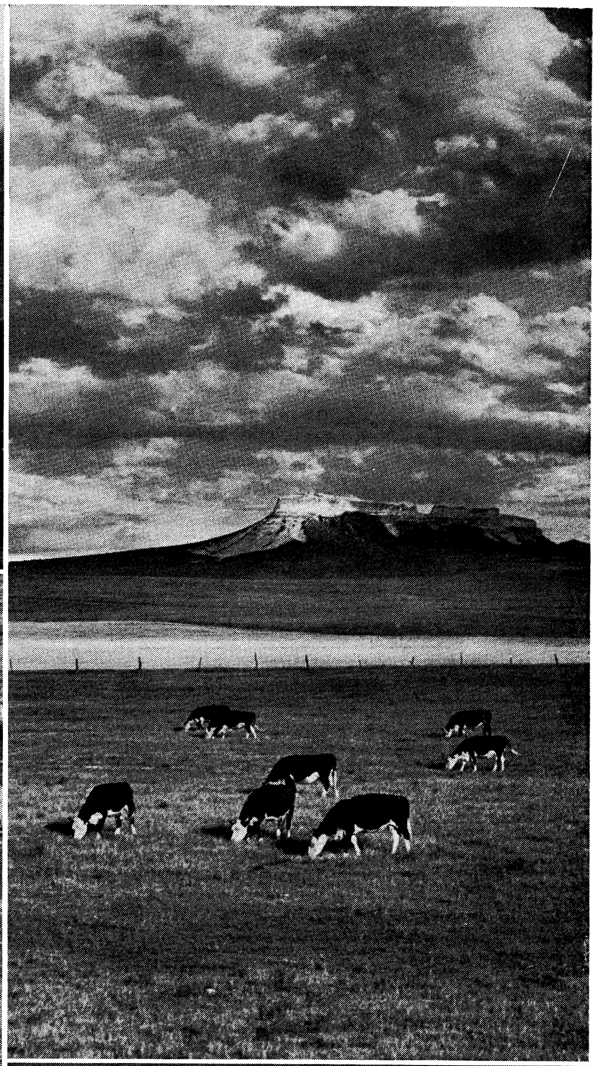
The headquarters of the U.S. strategic air command are located near Omaha.

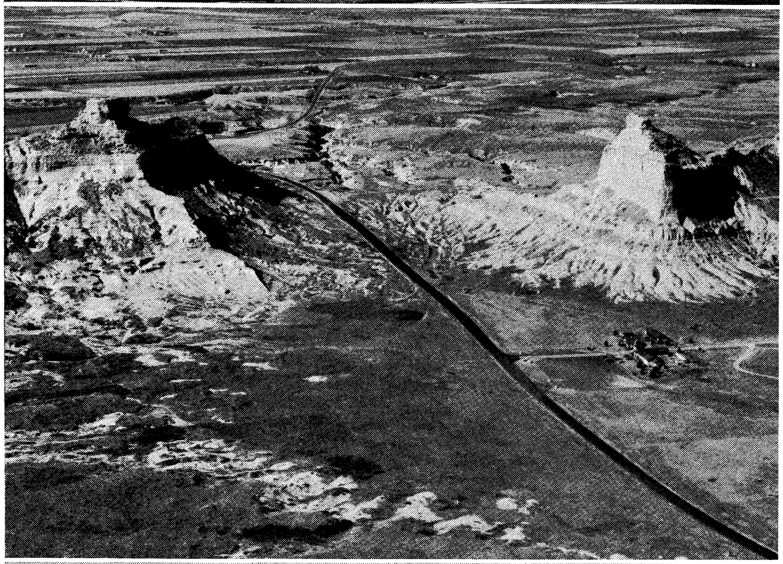
See also Index references under "Kebraska" in the Index volume.

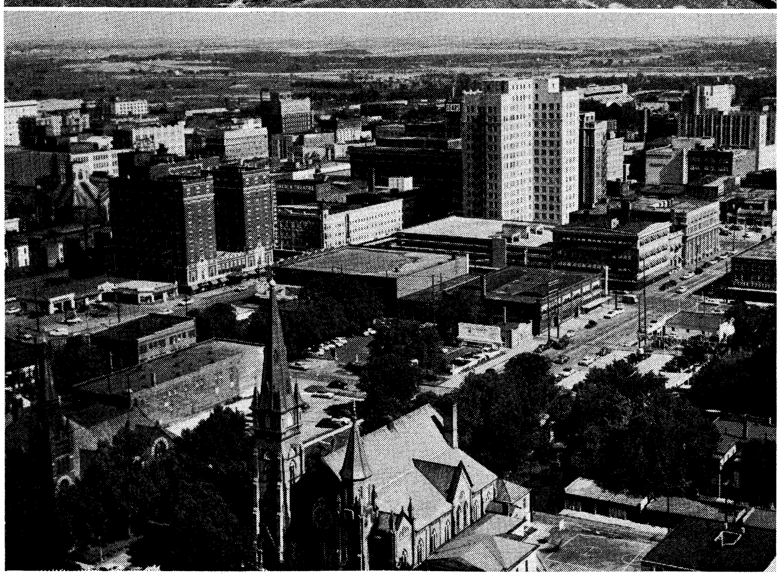
BIBLIOGRAPHY.—James C. Olson, *History of Nebraska* (1955), has "Suggested Readings" at the end of each chapter which include the principal sources of information about the state; Nebraska State Historical Society, *Proceedings and Collections* (1885 *et seq.*) and *Nebraska History* (1918 *et seq.*); *Nebraska Blue Book* (biennial, 1915 *et seq.*), is particularly valuable on government; Federal Writers' Project, *Nebraska: A Guide to the Cornhusker State* (1939).

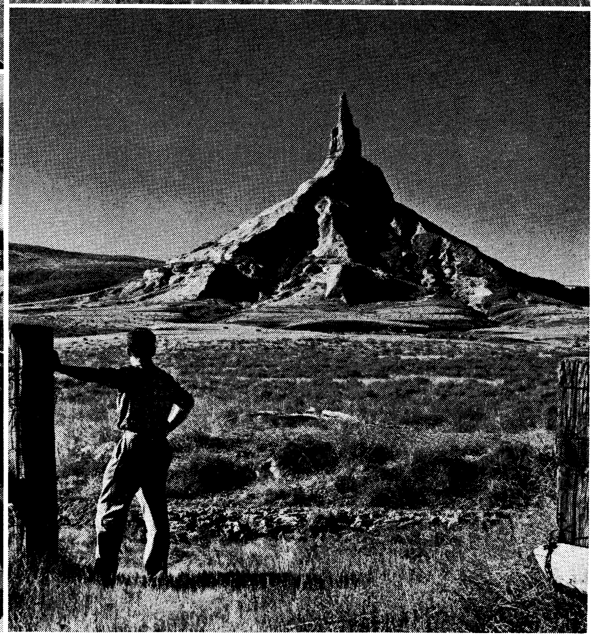
Current statistics on production, employment. industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (J. C. O.)

NEBUCHADREZZAR or NEBUCHADNEZZAR, king of Babylon. the Ναβουκοδρόσορος of the Greeks. The first and last are nearer to the original name as it is found in the cuneiform monuments, viz., Nabu-kudurri-usur, "Nebo, defend the land-









BY COURTESY OF (TOP LEFT: UNION PACIFIC RAILROAD; PHOTOGRAPHS, (TOP RIGHT, BOTTOM LEFT) H ARMSTRONG ROBERTS, (CENTRE LEFT) FAIRCHILD AERIAL SURVEYS. INC., (BOTTOM RIGHT) JOSEF MUENCH

SCENES IN NEBRASKA

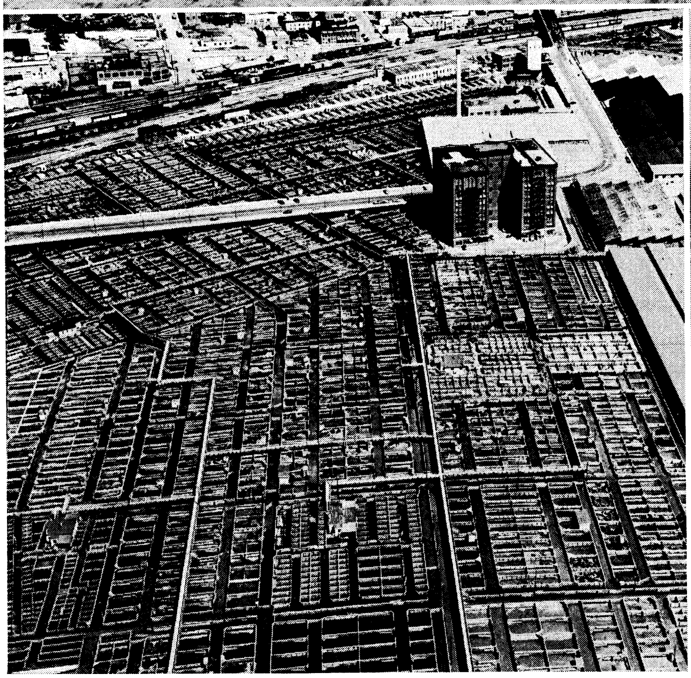
Top *left:* The state capitol building, Lincoln, a 400-ft. tower on a two-story base, completed in 1932

Top *right:* Cattle grazing on pastures at the foot of Sheridan's Gate, buttes near Hay Springs in the western part of the state

Centre left: **Scotts Bluff.** Dome Rock (**left**) rises 4,662 ft.

Bottom *left:* The business section of Lincoln seen from the capitol building. In the foreground is St. Mary's cathedral

Bottom *right:* Chimney Rock, *a* conical mound of red sandstone, rises above the route of the old Oregon Trail near Bridgeport



BY COURTESY OF (TOP LEFT) THE NEBRASKA STATE HISTORICAL SOCIETY, S. D. BUTCHER COLLECTION PHOTOGRAPHS. (BOTTOM LEFT) EWING GALLOWAY (BOTTOM RIGHT) A DEVANEY

HISTORICAL AND MODERN VIEWS OF NEBRASKA

Top: A typical sod farmhouse of the late 19th century

Bottom *left:* The stockyards at Omaha, one of the largest cattle marketing centres in the U.S.

Bottom *right:* Administration building of the Municipal University of Omaha, founded in 1908 mark." Nebuchadrezzar seems to have been of Chaldean origin. He married Amuhia, daughter of the Median king, according to Abydenus, and in 60; B.C. defeated Necho at Carchemish. driving the Egyptians out of Asia and annexing Syria to the Babylonian empire. In the following year he succeeded his father Nabopolassar on the Babylonian throne, and continued the restoration of Babylon. which he made one of the wonders of the world. His "new palace" there was built in fifteen days; temples were erected to the gods, the great walls of the city were constructed with a moat surrounding them, the Euphrates was lined with brick and a strong fortress erected. Canals were dug throughout the country and a great reservoir excavated near the capital. Only a fragment of his annals has been preserved. recording his campaign against Amasis (Ahmosi) of Egypt in his thirty-seventh year (56; B.C.) when he defeated the soldiers of "Phut of the Ionians." Tyre revolted in the seventh year of his reign. and was besieged for 13 years; a contract-tablet dated in his fortieth year shows that at that time it was under Babylonian officials.

After the investment of Tyre Nebuchadrezzar marched against Jerusalem, put Jehoiakim to death and placed Jehoiachin on the throne. Three months later Jehoiachin was deposed and Zedekiah made king in his place. Zedekiah's revolt in 588 B.C. led to another siege of Jerusalem. which was taken and destroyed in j86 B.C. (See JEWS and JERUSALEM.) His inscriptions indicate that Kebuchadrezzar was a man of peculiarly religious character.

NEBULA, in astronomy, is a traditional term used to describe any cloudy or misty celestial object that remains fixed among the stars. Nebulae may be bright or dark, but they are generally nonstellar. luminous patches. Compared with stars: nebulae appear much fainter, because their spread-out light is more difficult to see than a point source. Thus. although there are about 5,000 naked-eye stars, only four nebulae are visible to the unaided eye. These are the two Magellanic Clouds in the southern hemisphere, and the two great spiral nebulae in the northern constellations of Andromeda and Triangulum.

Like the stars, nebulae are virtually innumerable, for their number depends upon the limiting brightness to which they are recorded. Many hundreds are known in the Milky Way, or the galaxy. These are the galactic nebulae, masses of gas and dust associated with. and between. the stars of our own stellar system. Beyond the Milky Way are the extragalactic nebulae. entire stellar systems comparable to the galaxy, which populate the universe by the hundreds of millions. For both galactic and extragalactic nebulae, powerful telescopes employing photography are required for effective study (see PHOTOGRAPHY. CELESTIAL).

On the average, extragalactic nebulae have a luminosity 800,000,000 times that of our sun, the faintness of their light as we see it being due to the immensity of the distance it travels. Whereas light rays from the moon reach the earth in $1\frac{1}{3}$ sec., those from the nearest extragalactic nebula, the large Magellanic Cloud, require 200.000 years for the journey. The most remote. observable extragalactic nebulae are estimated to be at a distance of 2,000,000,000 light-years. Thus modern astronomy. in dealing with the feeblest extragalactic photons, explores with light as ancient as the oldest rocks on earth.

A widely accepted cosmological hypothesis assumes that the universe originally consisted of a small, compact mass, and that an explosion occurred approximately 5,000,000,000 years ago, thrusting the extragalactic nebulae outward in all directions. The astronomical data on which this expanding-universe theory is based are summarized in later sections of this article. (See also COSMOGONY.)

The earth, its fellow-planets and our sun—the solar system—belong to the galaxy, which is similar in form to vast numbers of spiral nebulae. As seen from another galaxy, our solar system would be located; but much too faint and small for detection, near the outer rim of the galaxy. Our sun makes a complete revolution in the galaxy in the cosmic equivalent of a year—about 200.000.000 solar years.

This article is divided into six main sections as follows:

I. HISTORICAL

Earliest Records.—Historical records of luminous patches in the sky are known to go back to Hipparchus (fl. 146–127 B.c.), who included in the earliest known star catalogue entries for the double star cluster in Perseus (h and χ Persei) and for the "Beehive" star cluster in Cancer (Praesepe). Nearly 300 years later Ptolemy (*c* A D 140) listed five "cloudy stars" in his *Almagest,* but these objects, apparently nebulous to the eye, are in reality star clusters. The earliest known record of a nebula. as distinguished from a star cluster, is the one for the Andromeda nebula given by Al Sûfi (903–986) in his Book of *the Fixed* Stars, epoch 964 The spiral in Andromeda thus shares nith the Magellanic Clouds the distinction of being one of the three nebulae discovered before the invention of the telescope. The Clouds of Magellan, which become visible to travelers to the southern hemisphere soon after the Torrid zone is entered. were known to the Portuguese navigators of the 15th century. and although not discovered by Magellan, the clouds are by common consent associated with his name to honour the great circumnavigator. Soon after the first use of the telescope on celestial objects in 1609 by Galileo (1564–1642), the Orion nebula was discovered in 1610 by the famous French patron of science Nicholas Peiresc (1580–163;). The Jesuit priest Cysatus (1588–1657) who began to survey the sky with a telescope in 1611 also discovered the same nebula (1618). It was Christiaan Huygens (1629–95), however, who not knowing of the earlier discoveries by Peiresc and Cysatus, gave in 1656 the first description and sketch of the brightest part of the Orion nebula. The Andromeda nebula also was soon rediscovered after the invention of the telescope, in 1611 by Simon Marius (1570–1624) who described it in the oft-quoted poetical words, "Like a candle seen at night through a horn."

Early Catalogues.—The first attempt to catalogue nebulae seems to have been made in 1715 by Edmund Halley (1656–1742), who listed six "luminous spots or patches:" among them the globular star cluster in Hercules, which he discovered in 1714. The next list, in this case of 16 "nebulous stars,'! was given in 1733 by the English divine W. Derham (1657–1735), apparently as a result of some observations he made in 1732, with a reflecting telescope, of such objects included in an earlier (1690) work by J. Hevelius (1611–1687). In the first extensive survey of the southern skies made at the Cape of Good Hope in the years 1; 51–54 by Nicolas Louis de Lacaille (1713–62), a total of 42 nebulae were observed and then described in another significant list of such objects published in 1755. Shortly thereafter, another Frenchman. Charles Messier (1730–1817), while following the comet of 17j8. noticed a nebulous object near the third-magnitude star ζ Tauri. His discovery. later to be called the "Crab" nebula in Taurus. is now known to be the expanding gaseous remnant of the 1054 supernova (see NOVA AND SUPERNOVA). Messier, although much more interested in comets—Louis XV nicknamed him the "ferret of comets"—found that his searches could be more efficiently prosecuted if he noted the positions of those apparently cometary objects that did not move among the stars. In this way Messier discovered most of the brighter nebulae and clusters visible from northern latitudes. and his final catalogue published in 1781 contained 103 entries.

The Catalogues of William and John Herschel.—The foregoing early catalogues of nebulae almost pale into insignificance, however, when compared with the systematic sweeps of the skies made by William Herschel (1738–1822) and his son John Herschel (1792–1871). With a reflector of his own making, the elder Herschel began his illustrious career as the founder of sidereal astronomy by observing the Orion nebula in 1774. Its appearance so amazed him that he directed his attention to other nebulae, which then became objects for his lifelong study and interpretation. Between 1786 and 1802 he discovered and catalogued, in three lists. more than 2,500 nebulae. The younger Herschel proved to be his father's ablest successor in the field of nebular observation and discovery. Like his father. he constructed in 1820 his own telescope. an 18-in, speculum metal reflector. and began in 182j to reobserve many of the nebulae found by his parent. The outcome of this second survey was a catalogue of about 2,300 nebulae, of which 525 were new. John Herschel found the field so fascinating that he resolved to extend his search to southern skies, and in 1834 he began on Table mountain near Cape Town, U. of S. Af. a four-year survey that marked a new era in the study of celestial objects visible in the southern hemisphere. The Magellanic Clouds nere for the first time subjected to a detailed examination. with the result that the larger one was found to contain more than goo member star clusters, nebulae and stars associated with nebulosity, while nearly 250 similar objects were counted in the smaller cloud. The younger Herschel catalogued more than 1,700 other nebulae in southern skies, and for a number of them he made beautiful drawings. Upon his return to England in 1838, he set about systematizing all his own and his father's discoveries of nebulae, and his labours culminated in the "General Catalogue" of about 5,000 entries published in 1864 in the *Philosophical Transactions of the Royal Society*. This great work forms the backbone of J. L. E. Dreyer's ***Sew*** *General Catalogue of Nebulae* (N.G.C.) (1888), which augmented by the *First* (1895) and *Second* (1908) *Index Catalogues* (I C.), with a combined total of more than 13,000 entries constitutes the standard reference list for nearly all modern observations of nebulae.

II. DEVELOPMENT OF NEBULAR PHOTOGRAPHY

The invention of photography and its application to astronomy revolutionized the studv of nebulae. Since the photographic emulsion has the advantage over the human eye of being able to accumulate the effect of exposure to faint light, it is therefore possible by prolonged exposure—limited mainly by the nocturnal airglow of the earth's atmosphere—to photograph nebular detail far too tine and faint to be seen visually with a telescope. Moreover, a photograph provides a permanent record that in most cases can be measured with a much higher precision than can be obtained by simple visual methods. These advantages were exploited by astronomers as soon as the practicable dry plate became available during the last quarter of the 19th century.

Early Photographs to 1900

The Orion nebula has the distinction of being the first one to he photographed, on Sept. 30, 1680, by Henry Draper (1837–82), a New England physician. Its priority as a subject doubtless was due to its brightness. which would make it visible to the unaided eye were the nebula not outshone by the involved third-magnitude group of four stars known as the Trapezium (0 Orionis). In any case, the Orion nebula was popular with pioneers, for it was also photographed in France in 1881 by P. J. Janssen (1824–1907) and in England in 1883 by A. A. Common (1841–1903), who was doubly venturesome by doing nebular photography with a series of silver-on-glass reflectors. up to mirror diameters of 60 in. The Pleiades nebulosity was first photographed in its brightest parts around the stars Merope and Maia by the brothers Paul and Prosper Henry, at Paris in 1885. About the same time in England, Isaac Roberts (1829–1904) with a 20-in. reflector began a pioneering program in nebular photography that for the first time revealed the true form and extent of many nebulae. His photograph in 1886 showed that the Pleiades cluster stars are enmeshed in complex clouds of wispy filaments, and that the Andromeda nebula has a spiral structure. This last result from a small reflector was a striking example of the power of photography, because the first discoveries of spiral nebular forms. made visually in 1845–50 by Lord Rosse (1800–67) and his associates at Parsonstown, York, required the use of large speculum metal mirrors, up to six feet in diameter.

It was J. E. Keeler (1857–1900), however, who firmly established the great advantages of nebular photography with a reflector. In 1898–1900 at the Lick observatory, at Mt. Hamilton, Calif., n-here more favourable observing conditions existed than in England, he expertly improved and operated Common's 36-in. reflector that had been donated in 1895 to the first great mountaintop observatory by Edward Crossley (1841–1905) of Halifax. Eng. Keeler's photographs recorded in finer detail hundreds of previously unknown faint nebulae beyond the bounds of the Milky Way. From study of these plates, he drew two conclusions of prime importance: (1) the number of such nebulae photographable with his equipment nas at least 120,000, compared to the catalogued number of less than 13,000; (2) most of these nebulae would show a spiral form.

Star Cameras.—It was also at the Lick observatory that E. E. Barnard (1857–1923) began in 1889 his epochal photography of the Milky Way with short-focus. large-aperture portrait lenses. These wide-angle cameras disclosed as no conventional telescopes could the immense richness and structural features of the clouds of stars, gas and dust that make up the galaxy. Likewise for the first time, dark nebulae appeared in a profusion of sizes and shapes on Barnard's photographs, and his systematic study of them opened a new field for modern astronomy. interstellar matter. Others quickly adopted this efficient survey technique. notably H. C. Russell (1836–1907) at Sydney Austr., in 1890, and Max Wolf (1863–1932) at Heidelberg. Ger.. in 1891. Russell's work on the southern Milky Way supplemented Barnard's in the north, nhile Wolf, pioneering in the photographic charting of the extragalactic nebulae, found the first rich cluster of these objects in Coma Berenices.

Nebular Photography After 1900

Thus nebular photography began to develop by two dissimilar techniques. One was with wide-field. lens-type star cameras (astrographs). the other with small-field reflectors. The two types mere the astronomical analogues of the shotgun and rifle, with photography in the role of gunpowder. Also. the beginning of the 20th century marked a world-wide mushrooming of construction and operation of both types of photographic telescopes, which increased steadily in size and number as advances were made in optics and engineering.

The Harvard College observatory, Cambridge. Mass., probably led the field in exploiting the advantages of star cameras for nebular photography. Starting about 1900 in the southern hemisphere first at Arequipa, Peru, and after 1927 at Bloemfontein, U. of S. Af , Harvard astronomers used the largest star camera—the 24-in Bruce—to chart the distribution of nebulae over large areas in southern skies, and to study in detail those extragalactic bonanzas, the Magellanic Clouds. At their northern station on Oak Ridge. Mass , similar work was done with a battery of star cameras ranging in size from a few inches in aperture up to the 16-in. Metcalf. Carried out under the general direction of Harlow Shapley from about 1930–50, these photographic surveys have yielded an immense amount of information on the extragalactic nebulae.

Reflectors.—At the Mount Wilson observatory, Pasadena, Calif., the reflecting telescope nas developed to its potential peak of perfection, along with accessory instrumentation that has immeasurably increased our knowledge of both galactic and extragalactic nebulae. It was there that G W Ritchey (1864–1945) figured to the highest optical quality the first large telescope mirror, which he also used under the most favourable conditions from 1909–17 in the 60-in Mount Wilson reflector. His nebular photographs set a new standard in photographic definition, with the result that a few of the largest and nearest spiral nebulae were resolved into their brightest stars. G. E. Hale (1868–1938) who had few peers in the perception of the value of more powerful instruments to attack fundamental astronomical problems, was able in 1919 to place in successful operation on Mt. Wilson a roo-in. reflector. Programs of nebular research with this great telescope have produced a rich harvest of results, especialiy for the extragalactic nebulae. With it, Edwin Hubble (1889–1953) discovered in 1923 the first Cepheid variable in the Andromeda nebula M. L. Humason began in 1928 his measurement of large redshifts (see *Redshifts and Expansion of the Universe*, below) in the spectra of extragalactic nebulae, and W. Baade in 1944 resolved into stars the amorphous nuclear region of the Andromeda nebula. Thus to this one telescope we owe three of the most significant observational advances in modern astronomy: (1) the first true idea of the scale of the universe, from Hubble's work on the distances and real brightnesses of extragalactic. nebulae; (2) the concept of an expanding universe, from the velocity-distance relation based on Hubble's distances and Humason's redshifts: and (3) the recognition of tno distinct stellar populations of different age and evolution, from Baade's synthesis of highest-fidelity photographs in blue and red light.

Modern Developments. — Among the many large and modern star cameras. the 20-in. Carnegie astrograph at the Lick observatory deserves special mention. Installed in 1939, its basic program proposed by W. H Wright was to provide a set of first-epoch photographs of the northern two-thirds of the sky, for the most accurate measurement of galactic stellar motions with respect to the background of faint extragalactic nebulae. The full set of 1,246 plates nas obtained in 1947–54 by C. D. Shane and C. A. Wirtanen, who began in 1948 to count the several millions of extragalactic nebulae recorded. Although this set of plates maps the sky with high precision to about the 19th magnitude, its quality as a photographic sky atlas cannot compare with that obtained by a new type of star camera.

The Schmidt Telescope. — Invented about 1930 by Bernhard Schmidt (1879–1935) at the Hamburg observatory. Bergedorf, Ger., the optical system that bears his name has revolutionized nebular photography. With pure genius, he placed a thin weakly curved aspherical lens at the centre of curvature of a spherical mirror. and in this simple but elegant way produced an optical system that would have high speed, large field, and nearly colour-free images. This was a major advance in optics. and its rapid introduction in astronomy is due in large measure to Schmidt's colleague Baade, who fully realized the importance of the discovery when he came to the Mount Wilson observatory in 1931. At that time plans and programs were being made for a zoo-in. reflector, and it was decided to build an 18-in. Schmidt camera as a pilot model survey instrument. Its immediate success led to the design. and construction after World War II, of the 48-in. Schmidt telescope on Palomar mountain. Its performance tests in 1948–49 so far exceeded all previous wide-field. faint-limit photographs that its first program was to survey all the sky observable from the northern hemisphere. From 1949–56, under the joint sponsorship of the National Geographic society and Palomar observatory, the 48-in. Schmidt was used to obtain the 879 plate-pairs — one exposure in blue light and one in red light — in this finest of all photographic sky atlases. Carried out under the critical supervision of R. Minkowski, this survey by the 48-in. Schmidt has recorded so much new information on nebulae that it will serve as a prime source of research programs for many years.

The zoo-inch Reflector. — Closely following the initial successes of the 60-in. and 100-in. reflectors, Hale in 1928 was able to initiate the project that is of incalculable value for nebular research: the building of a zoo-in. reflector. The funds were provided by the General Education board of the Rockefeller foundation, on the condition that the telescope be maintained by the California Institute of Technology, Pasadena, Calif.. and be operated in full co-operation with the Mount Wilson observatory of the Carnegie institution of Washington. A satisfactory zoo-in. mirror of a special Pyrex glass was successfully cast by the Corning Glass Co. at Corning. N.Y., in 1934, and the optical surfacing was done in Pasadena during 1936–42 and 1945–47. Under the direction of I. S. Bowen the telescope with its mirror installed was given thorough optical and mechanical tests. and preliminary astronomical trials, in 1948–49. Hubble had the honour of taking the first nebular photograph on Jan. 26, 1949, with the zoo-in. reflector. by this time named the Hale telescope. From about Jan. 1950 this great instrument has been in regular use on the Mount Wilson and Palomar observatories research programs. with discoveries that have already justified the cost. time and resources involved in its realization. Three results of extraordinary interest for nebular research are: (1) the measurement in 1950 by Humason of a nebular redshift in velocity units of 38,000 mi. per second or nearly one-fifth the velocity of light: (2) the demonstration in 1952 by Baade of the need for revision upwards, by a factor not less than 2, of the extragalactic distance scale; and (3) the identification in 1953 by Baade and Minkowski of several of the brighter astronomical radio sources as pairs of colliding spiral nebulae.

Classification of Nebulae. — As has been explained, the nebulae fall naturally into two groups designated the galactic and the extragalactic. Alternate names for the latter group — by far the largest — are nongalactic, anagalactic. or merely galaxies. Galactic nebulae are found in or near the plane of the Milky Way (the galaxy), while extragalactic nebulae or galaxies are seen, for the most part, outside the Milky Way. The division is not merely one of apparent distribution over the sky, for the two classes of objects differ fundamentally in every important respect, such as distance, intrinsic size and brightness and constitution. In fact. the two categories are so dissimilar that they should logically be separately discussed.

III. THE GALACTIC NEBULAE

These are of two types: (1) diffuse nebulae and (2) planetary nebulae. The first kind includes bright and dark nebulae. but with no clear-cut division, since the tno are often found thoroughly mixed together. The second kind has a characteristic appearance, usually a round or a symmetrical structure, with a star near the centre of the nebula.

Diffuse Nebulae

Modern work on interstellar material suggests that diffuse nebulae may be regarded from the following very general point of view. Throughout our own stellar system, of which the fundamental plane is the Milky Way, there is a thin layer of nonluminous matter. This material, a mixture of atoms, molecules, dust particles and larger masses, is not uniformly distributed, but is relatively concentrated in some regions. and extremely tenuous or absent in others. In some cases denser clouds are situated in front of a bright. starry background. They are then revealed in silhouette, and photographs such as Barnard's record them as dark nebulae. On the other hand, it often happens that single stars, or groups of stars. lie in the denser parts of the stratum. In this case the stars illuminate the surrounding cloud, much like street lights in a fog, and bright nebulae may be seen or photographed by the light coming from the particles composing the cloud. Mixed bright and dark nebulae occur in circumstances where a cloud is so large that the light from the involved stars does not penetrate to its boundaries. so that a bright nebula appears to be superposed on a larger dark one; or again, the obscuring matter may be localized in streaks or lanes, which are outlined or contrasted against the brighter and less opaque parts of the cloud.

Bright Diffuse Nebulae. — The true character of these objects became known in 1864–68 when William Huggins (1824–1910) examined several of them with his spectroscope and found their light highly concentrated into a few bright radiations, typical of a rarefied gas excited to luminescence. So many more were subsequently found to have a similar spectrum that for nearly half a century it was generally supposed all diffuse nebulae were incandescent gases. In 1912, however, V. M. Slipher of the Lowell observatory announced that the spectrum of the nebulosity around the Pleiades gave an absorption spectrum. which is a continuous, coloured band of light crossed by dark lines. Furthermore, the nebular spectrum was like that of the stars imbedded in the nebula. These results, which were later obtained for a number of other diffuse nebulae, provided evidence for the view that some nebulae shine by scattered or reflected light directly received from the stars, rather than by emitted light indirectly excited in the nebula by ultraviolet radiation from the stars. The latter mechanism was thoroughly analyzed by I. S. Bowen in 1927, and it is of great astrophysical importance (see The *Gaseous Spectrum* of *the Nebulae,* below). Before Bowen explained the origin of the nebular emission spectrum, however, Hubble in a pioneering investigation of diffuse nebulae published in 1922 discovered one of the most significant properties of these objects: whether a diffuse nebula shines by emitted light (bright-line spectrum) or by reflected or scattered light (absorption spectrum) depends upon the temperature of the star or stars concerned. Although there is some overlapping, in general it is found that stare hotter than about 20,000° C. (spectral type B1 or earlier) can excite an emission spectrum in the gases in the nebula, while cooler stars merely illuminate the nebular particles.

These results by Hubble and by Bowen stimulated an immense amount of research on the gaseous nebulae, the advance beginning about 1930 and continuing in accelerated fashion to the present. Observationally, Hubble's exploratory survey of known nebulae was followed by a large number of more detailed and extensive searches for fainter nebulae and involved stars; on the theoretical side, Bowen's explanation of the nebular gaseous spectrum led to a veritable flood of analytical papers dealing with the physical processes in the nebular gases. Taken together, this work represents a major increase in astronomical knowledge, not merely of the interaction between stars and interstellar gas and dust. but more generally of the structure and evolution of the Milky Way.

H I and H II Regions.—One of the strongest radiations from gaseous diffuse nebulae is the hydrogen alpha (Hα) line, which occurs in the red part of the spectrum at a wave length of 6,563 angstroms (Å). This is a fortunate circumstance, because red light is less absorbed than blue in the galactic dust clouds. Thus most modern photographic searches for gaseous nebulae have been made in Hα light, usually with high-speed cameras of the Schmidt type employing colour filters or objective prisms to isolate a narrow band of wave lengths around Hα. This procedure also markedly reduces the fogging effect of the night sky airglow, which chiefly limits the search for faint objects.

A notable application of this technique was that carried out by O. Struve and associates in 1937–42 at the Yerkes and McDonald observatories at Lake Geneva, Wis., and Mt. Locke. Tex. With a large and efficient nebular spectrograph of ingenious new design, they found many extremely faint Hα emission regions in the Milky Way. This observational advance was closely related to a theoretical one of high significance for galactic structure. In 1939 and in 1948 B. Stromgren at the Yerkes and Copenhagen observatories worked out and then applied the theory of hydrogen ionization (electron removal) to the case of hot stars imbedded in the galactic stratum of gas and dust. To him we owe the fruitful concept of fairly sharply bounded regions inside of which there is ionized hydrogen, H II, and outside. neutral hydrogen. H I. This theory not only accounted qualitatively for the appearance of many of the nearly circular patterns and broken arcs of gaseous nebulae, but it also gave numerical values for their radii, which depended upon the gas density and the temperatures of the exciting stars. For example, in an interstellar gas of density one atom per cubic centimetre, a very hot (30,000° C) O-star could produce an H II region about 500 light-years in diameter, but a cooler (10,000° C) A-star, one of only 1 j light-years.

The practical value of these "Stromgren spheres" became apparent as other Hα surveys of the Milky Way, in both northern and southern hemispheres, revealed new gaseous nebulae in large numbers, in a great range of sizes. and of spectacular complexity. But this puzzling pattern in general could be resolved into a hierarchy of interlocking, or overlapping, H II regions, each with its responsible one or more hot stars. In this way, important corroborative evidence was obtained of galactic spiral structure, first found in 1951 in another manner by W. W. Morgan of Yerkes observatory. For these H II regions, as shown by W. Raade's work in 1947–50 on the Andromeda nebula, follow fairly faithfully the uindings of its spiral arms.

Variable Nebulae.—These are of two kinds: (1) those associated with unusual variable stars. and (2) those observed to form around novae after outburst. The former may be termed irregular, because of their structure and variability in light, while the latter are described as expanding, because their sizes increase with time.

The irregularly variable nebulae comprise a small group of less than a dozen known members. Without exception, they occur in dark regions of the Milky Way and are close to peculiar variable stars. In appearance they are diffusely irregular, like Hind's nebula (N.G.C 1555) with T Tauri. or fan-shaped like Hubble's (N.G.C. 2261) with R Monocerotis and K.G.C. 6729 with R Coronae Australis, or double-bowed like that with R Aquarii. Although all these objects have been repeatedly photographed, there is little evidence that their parts have moved, or that their light variations correspond with those of the involved stars. Spectroscopic study of these nebulae and stars has shown that they are fundamentally different from the gaseous H II regions. for the nebular spectra are generally continuous as for reflection nebulae, while the stellar spectra are characteristic of average or dwarf stars. These results, obtained prior to 1945 mainly by V. M. Slipher and C. O. Lampland at the Lowell observatory in Arizona. and by E. Hubble and A. H. Joy at the Mount Wilson observatory in California, directed attention to stars involved in dense clouds of dust and gas in the galaxy. bfodern studies of their mutual interaction have provided information that probably bears directly on star formation (see Dark Nebulae, below).

Expanding nebulae result from probably the most violent of all celestial phenomena: the novae. These are stars that suddenly release enormous amounts of energy, when they reach a critical or unstable state in their evolution. In only a few hours a normal star may flare up until it shines with a power of thousands of suns, if a common nova. or blazes with a brilliance of millions of suns, if a supernova. These are respectively the cosmic counterparts of the terrestrial A- and H-bombs, for they explosively pour out radiation and gases at fantastically high rates. The radiation leaves the nova with the speed of light. 186,000 mi. per second, while the ejected gases move outward with velocities of a few hundreds or thousands of miles per second. Thus there is a time lapse between discovery of the nova and direct observation of its expanding gaseous nebula, which is known from spectroscopic observations to originate at the time of outburst. Depending on the amount and velocity of the gases, and the distance of the nova, the expanding nebula may not be seen or photographed until months or years after outburst. But when it can be distinguished from the fading star, measurement of the nebula's size provides one of the best estimates of the nova's distance. For the diameter of the nebula (in seconds of arc) divided by the time since outburst gives the angular rate of expansion, whereas the spectroscopic observations, by Doppler's principle, give the linear rate of expansion (in miles per second). Whenever both angular and linear values of the same quantity are known for a remote object, a simple calculation gives its distance.

In this way distances ranging from 1,000 to 5,000 light-years have been determined for some of the best-observed common novae. With these distances and certain reasonable assumptions, it has been calculated that the expanding nebulae probably have masses nearly negligible compared to the stars that produced them. Thus the common novae, despite their spectacular performance, are not disastrously affected. They merely blow off some thin, outermost atmospheric layers, which become invisible in the astronomically brief time of less than 100 years.

The Crab Nebula.—Supernovae are so rare that adequate observations of their nebular gases are available for only one of the galaxy's three known supernovae—that of A.D. 1054. Its cloud of expanding gas is the remarkable Crab nebula in Taurus, which is unique in being so long-lived and so large and bright compared to any possible stellar remnant. Studies by Baade and Minkowski in 1942 showed that the nebula consists of two distinct parts. One is a complex filamentary structure, possibly a distorted thin shell, known to be composed of ionized gas, while the other is a diffuse amorphous mas? thought to be mainly electrons. Although a central 1 jth-magnitude star, whose temperature was computed as 500,000° C.. was considered as the energy source, this interpretation has been supplanted by a much more interesting one. In 1949 the Crab nebula was found by the Australian radio-astronomers J. G. Bolton, G. J. Stanley and O. B. Slee to be one of the brightest radio sources in the sky, and in 1952–53 its light was discovered to be polarized, by the Russian astronomers M. A. Vashakidze and V. A. Dombrovsky of the Burakan observatory. They followed up a suggestion by the Russian astrophysicist I. S. Shklovsky, who proposed to account for the unique brightness of the nebula in both optical and radio regions as the radiation of electrons accelerated in a magnetic field—like that in a synchrotron. This explanation was given considerable support in a comprehensive investigation published in 1956 by J. H. Oort and T. Walraven, of Leiden University observatory. From analysis of their photoelectric polarization measurements, they concluded that the magnetic field probably lies in the filamentary structure, and that the energies of particles accelerated in it may be high enough to make the Crab nebula a strong source of cosmic rays.

Dark Nebulae. — The Milky Way contains a great number of dark patches or markings, some nearly devoid of stars. A few were first noted by the Herschels, who thought they were holes giving a view into empty space beyond. Although Barnard at first agreed with this idea, his extensive photographic surveys convinced him and others that the dark nebulae are due to nonluminous matter. Their range in apparent size is enormous. from small patches of a few seconds or minutes of arc, and long lanes of several degrees like those in Ophiuchus and Scorpius, up to the great rift that bifurcates the Milky Way for some 120° from Cygnus to Centaurus.

It might be thought that little could be learned of objects that are discerned by their apparent lack of light, but this natural impression is far from true. Much has been found out about dark nebulae from their effects on the light of stars seen through or within them. For the nonluminous material is composed of dust or smoke particles — a space smog that scatters, dims, reddens and polarizes passing photons of light, as in the familiar phenomenon of sunset in a hazy atmosphere. All these effects are susceptible of measurement, and the results give information on the distances and dimensions of dark nebulae, and, of equal importance, on the particle size, density, shape and orientation.

Max Wolf in the last decade of the 19th century was first to show how star counts around and in a dark nebula could be used to estimate its distance and absorptive power. Outside the nebula the number of stars increases steadily with faintness; inside, at some level of brightness. the number falls below that outside. The magnitude at which the deficiency appears indicates the distance, while the percentage deficiency gives the total absorption. The method is crude because of the great range in real brightness of stars, but by certain statistical refinements A. Pannekoek of Amsterdam showed that it could give reliable relative distances, and, with a count to faint limits, accurate absorptions. Most of the prominent dark nebulae have been investigated by this star-count method, and it has been found that the nearer ones such as those in Aquila and Taurus and the southern Coalsack are only 400 to 500 light-years distant, while the more remote ones like those in Cygnus, Orion and Monoceros are 2.000 to 3,000 light-years away. The total absorptions generally are in the range from 30% to 95%, although there are some dark nebulae that scarcely obscure and others that are nearly opaque.

Cosmic Dust. — The physics of finely divided material has become a subject of major importance in astronomy because of its bearing on distance estimates, and on theories of star formation and evolution. Obviously, if the intensity of starlight decreases faster than inversely as the square of the distance, as would happen for light passing through obscuring matter, then distances derived from apparent brightness would be too large. It is likewise plain that the most promising place to seek an understanding of stellar origin and early development probably is in a dark nebula, where conditions are favourable for formation of stars by condensation, contraction and accretion processes in the clouds of cosmic dust particles. In both cases, it is vital to have as much knowledge as possible of the physical properties, chemical composition and environmental conditions of this interstellar matter.

Pioneering investigators of the properties of small cosmic grains were H. von Seeliger (1849–1924) of Munich and H. N. Russell (1877–1957) of Princeton. As the result of some work on the swarms of meteorites that form Saturn's rings, Seeliger in 1901 made a theoretical study of the reflection of light from small bodies, and his formulation of the problem strongly influenced much later nork on reflection nebulae. Russell, however, in 1922 worked out a theory of submicroscopic particles for which reflection was small compared to scattering or absorption of light. He obtained formulas that gave absorption as a function of particle size, and concluded that dimming was most pronounced for a size about 1/150,000 in., or one-third the wave length of visual light. This theory was considerably extended during 1930–35 by C. Schalén of Uppsala, Swed., who included more specific particle properties in the equations. From the colours and spectra of stars involved in dark nebulae, he inferred that the chemical composition is mainly metallic, with compounds of iron, zinc and copper. Studies of bright reflection nebulae, on the other hand, notably in 1935–40 by O. Struve, J. L. Greenstein and L. G. Henyey of the Yerkes and McDonald observatories, tended to support the hypothesis of a nonmetallic make-up, with icelike compounds of the much more abundant elements hydrogen, oxygen. carbon and nitrogen.

Although there was, and still is, some uncertainty regarding the principal chemical constituents, evidence has steadily accumulated that the mixture of particle sizes is much the same throughout the galaxy. This is an extremely important result for nearly all astronomical researches involving distances beyond the range of direct survey, or trigonometric, methods. The reasons for the significance of this result, and how it was obtained, deserve to be detailed.

Space Reddening of Starlight. — Nearly everyone knows that the sun seems redder near the horizon than overhead, and that the sky around it is blue at normal altitudes. Both effects are due to atmospheric particles that absorb and scatter blue light much more than red. The process is known as Rayleigh scattering, after Lord Rayleigh (1842–1919), who found that the atmospheric absorption varied inversely as the fourth power of the wave length. For example, since deep red light has twice the wave length of deep blue, it is absorbed only $(\frac{1}{2})^4 = \frac{1}{16}$ as much, and objects observed through long atmospheric paths appear reddened by this selective absorption. Moreover, Rayleigh also showed that this particular absorption law is characteristic of particles mainly of dust size, or somewhat less than the wave length of light. Thus the particle mixture is more typical of the chemical composition than of contaminating larger-size dust particles, and it may be considered the same throughout the earth's atmosphere.

This wave length-selective effect on light that has passed through a nontransparent medium is the means by which astronomers have been able to determine a general interstellar absorption law, to estimate the sizes and kinds of particles, and to correct distances of obscured objects. For example, particle sizes of dust dimensions are estimated from colour observations of reflection nebulae, which are not nearly so blue relative to their illuminating stars as the daylight sky is to the sun; the elements composing the particles are inferred from much modern work on their abundances in stars and nebulae. To correct a distance of an obscured object, it is necessary to know the total absorption, which can be found from the selective if the absorption ratio= total/selective is known. To determine this ratio and to find out whether it is essentially the same throughout the galaxy, colour observations for a large number of objects and for a long range of wave lengths are required.

The most comprehensive series of programs that provided many of the basic data on space reddening and absorption are those carried out from about 1930–50 by J. Stebbins, C. M. Huffer and A. E. Whitford, of the Washburn observatory, Madison, Wis. By developing and applying photoelectric techniques of precision and of great sensitivity, they first determined accurate colours for more than 1,300 distant high-luminosity O- and B-stars and for most of the globular star clusters. Next, for limited lists of the brighter stars, they obtained six-colour measurements ranging from the ultraviolet to the infrared. Finally, in 1947 Whitford extended the selective absorption curve to the extreme astronomical infrared at 21,000 A, and showed that a good approximation is a law giving the absorption as the reciprocal of the wave length. Although this law had already been anticipated by previous work on reflection nebulae, and from spectrophotometry of stars in dark nebulae, it was Whitford's far-infrared work that established its validity over the entire astronomical optical spectrum. This inverse wave length law provided the basis for confident calculations of the ratio of total to selective absorption, while the six-colour observations of widely distributed stars gave assurance that it was valid in many Milky Way regions. Since a few apparent exceptions have not stood the test of time. as additional and more precise data were obtained. it may be said that the discolouring dust of space possesses a remarkable uniformity of particle-size distribution, and probably of chemical composition.

Interstellar Polarization.—A significantly new property of the particles composing dark nebulae was discovered in 1949 by J. S. Hall of the U S Naval observatory at Washington. D C. and W. A. Hiltner of the Yerkes and McDonald observatories They found by precise photoelectric measurements that the light of highly space-reddened stars is polarized. This result means that the interstellar particles are so shaped and oriented in space that they cause passing light waves to vibrate in a preferential plane. By 1956 polarization observations had been made for hundreds of stars of many kinds, in the northern Milky Way principally by Hiltner and by Hal! with A. H. Mikesell. in the southern by Elska van P. Smith of the Harvard College observatory. This work showed that: (1) the strongest polarization occurs only for highly reddened stars whose light has been strongly absorbed; (2) the orientation of polarization planes is often closely the same for fairly large regions, of the order of several hundred to 1.000 light-years; (3) there is an over-all strong tendency, along nearly the entire Milky Ray, for alignment parallel to the galactic plane. Interpretation of these results indicates, first, that the particles probably are elongated, some four to five times longer than wide, uith their major axes generally at right angles to the Milky Way plane, and second. that there is some large-scale mechanism, possibly of galactic dimensions, producing this long-axis alignment. The various explanatory theories of the phenomenon differ chiefly in the chemical composition assumed for the particles. If these are nearly nonconducting or dielectric, hypotheses involving spinning spicules and streaming gases have been advanced; if mainly metallic, a magnetic field. Although the mechanism of alignment cannot be considered uniquely identified, there is increasing evidence, such as the Crab nebula polarization, magnetism in stellar atmospheres and high-energy cosmic rays, that magnetic fields in the galaxy may be important elements in its structure.

Star Formation.—The relationship of nebulae to stellar origins has long been one of astronomy's prime problems, dating from the earliest visual observations of associated nebulae and stars. Little progress beyond philosophical speculation was possible, however, until a great deal of data on distances. dimensions, real brightnesses (luminosities). motions, masses and radiating properties became available for both stars and nebulae. These data demonstrated that the stars of highest luminosity are generally found associated with nebulae both bright and dark, that they radiate energy at such spendthrift rates they can last only a few million years and that their motions in space average among the slowest in the galaxy. Such facts point with more than strong suspicion to a nebular origin for these stars, otherwise their association would not be so close. For the age of the galaxy is reckoned a thousand times greater. and there has been sufficient time for these stars to have moved from nebulae and to dim to comparative obscurity on the cosmic scene.

While this concept seems satisfactory for supergiant stars, they represent but a small part of the galactic population. To be applicable in general, a theory of star formation needs to account for the great bulk of average-type stars like the sun, whose hydrogen mass and energy output can sustain it for several thousand million years. Since many nebulae contain clusters of stars of a wide range of brightness, it seemed reasonable to look closer at some of the fainter ones, and particularly at those whose irregular light variations seemed unique for stars in dark nebulae. From extensive studies of groupings of these fainter nebular variables, the Russian astronomers V. Ambartsumian and P. Kholopov concluded in 1950 they are young stars of unstable behavior, and termed them T-associations, after the prototype variable T Tauri, the illuminating star of Hind's variable nebula (N.G.C.1555). In 1945 A. H. Joy of the Mount Wilson observatory reported spectroscopic observations for a number of T Tauri variables that led to their recognition as a distinctive class of emission-line objects found only in dark nebulae. Subsequent surveys to much fainter magnitudes, especially by G. Haro at the Tonantzintla observatory, Mex., and by G. H. Herbig at the Lick observatory, resulted in the discovery by 1950 of hundreds of generally similar stars. without exception in dark nebulae. By 1952 Herbig's detailed studies of the emission-line objects, which comprise only a portion of the variables, revealed for these stars two significant facts that are consistent mith the hypothesis of recent formation. First. these stars appear to be rotating abnormally fast for their size and mass; second, they are abnormally bright in blue and ultraviolet light for their temperatures. Both these properties have been predicted in theories of star formation from cosmic dust clouds: as residual rotation from turbulent motions, and as excess radiation from a contracting nebula-star interaction.

Radio Observations of Dark Nebulae.—The development of radio astronomy after World War II provided a powerful new technique for the study of dark nebulae, for two reasons. First, radio waves pass through dense dust clouds that practically blot out ordinary light. Second, the relationship between the dust and involved hydrogen gas may be found as the result of a brilliant prediction in 1944 by the young Dutch astronomer H. C. van de Hulst of the Leiden observatory. He pointed out the possibility of observing radio radiation of 21 cm. wave length from neutral hydrogen, or H I, and it was first detected in the galaxy in 1951 by H. I. Ewen and E. M. Purcell. Harvard university physicists. This discovery, potentially comparable in its consequences with the invention of the telescope, has made possible detailed astrophysical investigations of some of the larger gas-dust complexes in Perseus, Taurus, Orion and Ophiuchus, notably by B. J. Bok and his younger colleagues A. E. Lilley, D. S. Heeschen and T. K. Menon. Working with the 24-ft. radio telescope at the Agassiz station of Harvard College observatory, they reported results in 1954–56 relating to the relative distributions of dust and neutral hydrogen gas, the density ratio of gas/dust and total masses. Over large areas the H I gas emission is prevalent wherever the optical obscuration by dust is evident, but the smaller darkest nebulae are not necessarily the best radio emitters—the dust is apparently more locally concentrated than neutral hydrogen gas. In the Orion-Taurus complex the gas/dust density ratio in the mean is 100, but with a big range from 3j to a50. The average value would indicate. for an estimated total H I mass of 21,000 suns, that all the dust amounts to only about zoo solar masses. These figures, however, involve a number of simplifying assumptions that are normally unavoidable in a new field. For example, the H I gas/dust density ratio could be appreciably reduced if evidence for molecular hydrogen H_2, or for hydrides like OH, NH or CH were found by improved microwave techniques and larger radio telescopes.

Planetary Nebulae

These are so named because their appearance in a telescope resembles that of planets, for they show disks with definite edges. But unlike the planets, these nebulae show no appreciable motion among the stars, since they are generally more distant than the stars seen in the same field. Compared to diffuse gaseous nebulae, planetaries are apparently and actually much smaller, and they ordinarily have a distinguishing bright-line spectrum.

Numbers and Distribution.— Planetary nebulae as a class are relatively scarce and unique in the galaxy. Only about 130 were known prior to 1940, but prismatic and Schmidt camera surveys by R. Minkowski, G. O. Abell and A. G. Wilson at Mount Wilson and Palomar observatories, by G. Haro at Tonantzintla, Mex., and by K. G. Henize at Bloemfontein, U of S Af.. by 19j6 had increased the number known to nearly 600. Many of these later discoveries appear starlike except on photographs taken with the largest telescopes, and a large majority are in heavily obscured regions. For these reasons there are probably many more undiscovered planetaries, and the galactic total has been estimated as high as 10,000, a small number compared to the stellar population of thousands of millions. Although some planetaries are found all along the Milky Way, but with much less concentration than the stars and gaseous diffuse nebulae, there is a marked grouping of many of the faintest ones in the Sagittarius-Scorpius region, as for the globular star clusters. This distribution means that the planetaries as a system cluster around the centre of the galaxy, at distances ranging up to 30,000 light-years.

Apparent Size and Structure. — In apparent size planetary nebulae range from the large Helical nebula in Aquarius, N.G.C. 7293, which is about half the diameter of the moon, down to objects of a few seconds of arc, so small they can hardly be picked out among stars, unless their spectra are available. In nearly all planetaries that are sufficiently large and bright, a central blue-white star can be found. The few exceptions are more apparent than real, because these central stars are among the hottest celestial sources. They have temperatures in the range from 50,000° to 150,000° C. so that most of the energy is radiated in the far ultraviolet where it is not only invisible but also blocked off by the earth's atmosphere. The nebular gases, however, have a much lower temperature, of the order of 10.000° C. Thus the nebula may be considerably brighter to the eye or on a photograph than the central star.

When planetaries are examined visually or on photographs taken with average-size telescopes, they tend to show a regular structure, which has encouraged classification and interpretation according to simple geometrical forms. The most common of these are shells, rings, spirals and helices. H. D. Curtis (1872–1942) of the Lick observatory pioneered in this approach with the 36-in. Crossley reflector. and found in 1918 that oblate spheroidal or truncated shells, thinner at the equator than at the poles, accounted satisfactorily for the regular appearance of many planetaries. For the brighter ones in the southern hemisphere, A. D. Thackeray and D. S. Evans in 1950 reported a similar survey based on plates taken with the 74-in. reflector of the Radcliffe observatory, Pretoria, U. of S. Af. They described the observed forms in terms of a siinple disk and ring, with central symmetry about two perpendicular axes; but for about 30% of the objects they gave the classification as irregular.

These idealized geometricdl models, although useful in the exploratory or survey stages, are found to be inadequate when confronted with the most recent inaterial obtained with the largest telescopes and improved techniques of photography and spectroscopy,, R. Minkowski's photographs taken since 1950 with the zoo-in. Hale telescope reveal in most cases a complex arrangement of filaments, knots, streamers and arcs that are difficult to fit into simple geometrical figures. These difficulties are due to at least two properties of the nebular gases. First, the ions (atoms minus electrons) of different gases are distributed differently, as shown by colour-filter photographs or slitless spectrograms that isolate individual emission lines of the various elements. Second, when the emission radiations are studied with slit-spectroscopic methods, internal motions of different amounts are found for different ions.

Internal Motions. — These were first found convincingly in 1916–18 by W. W. Campbell (1862–1938) and J. H. Moore (1878–1949) of the Lick observatory. They observed that the chief nebular lines of oxygen are not strictly single (monochromatic) in a number of planetaries. The lines appeared broadened or split into two components. which by Doppler's principle points to different velocities in the line of sight. The measured differences ranged from 10 to 60 mi. per second among the planetaries studied, and mere considered due to rotation of the nebulae. Later developments shoned, however. that the effects were produced by gases that move generally outward from the central stars, the expansion velocities being half the observed velocity differences. These observations were far ahead of their time and remained unapproached in accuracy and completeness for nearly 30 years.

In 1946 O. C. Wilson of the Mount Wilson and Palomar observatories began a systematic program of spectroscopic investigation with much more powerful equipment. First aith the 100-in. and after 1953 with the zoo-in.. he used the large-scale slit spectrographs at the coudé foci of these reflectors to obtain greatly dispersed spectra of the brighter planetaries. By 1950 he had found that no unique expansion velocity could be dssigned to the same nebula. but that instead there are systematic motions related to the type of ion: those most highly excited (produced with highest energy) show smaller velocities than those of low excitation, except for hydrogen. Despite these additional complexities, Wilson found a model that showed promising agreement with the observations. These could be accounted for if it were assumed that the expansion velocity of any ion is the same as the hydrogen-helium velocity in the region where the ion is produced. To test this and other models, it was desirable to obtain radial velocities for a large number of points in each nebula. In 1953 the 200-in. coudé spectrograph was therefore provided with a multislit. This device consists of a series of closely spaced slits by which radial velocities for as many as 31 sections of a nebula may be obtained from a single exposure. In preliminary reports to 1956, observations made this way strongly support the view that several of the regular planetaries are ellipsoidal because the expansion velocity varies in a regular fashion from the centre. It seems that the constituent gases are arranged in space according to their velocities, the fastest ones being found farthest out.

Motions in the Galaxy. — The emission-line spectrum of planetaries has made possible the fairly accurate determination of radial velocities for even the faintest ones, and to Campbell and Moore is likewise due the first extensive list published in 1918. These data were thoroughly analyzed in 1937 by L. Berman of the Lick observatory, who concluded that the planetaries participate in the general rotation of the galaxy, and that those having the highest velocities are farthest away, as expected from the simple theory of circular motion. But the location of so many of the newly discovered fainter planetaries in the region of the galactic centre suggested an alternative interpretation of the largest velocities as motions in highly eccentric orbits. These could reasonably be inferred if additional radial velocities of a large and more random character mere found for the numerous faint planetaries around the galactic centre. In 1953 a co-operative program to provide these new velocity data was undertaken at the Lick and Mount Wilson-Palomar observatories. From a preliminary report given in 1955, it seems likely that these new velocities may indicate less galactic rotation among the planetaries than formerly found, and a larger velocity dispersion in the direction of the galactic centre. Since these circumstances are similar to those for the globular star clusters, it is probable that they and the planetary nebulae belong to the same population group: Baade's type II.

Distances, Dimensions and Densities. — Planetary nebulae are so far from the sun that direct trigonometric distance determinations are useless, while statistical treatments of transverse or proper motions are unreliable, because the field comparison stars used in the measurements are at comparable distances. In an effort to minimize these difficulties. Berman derived a set of internally consistent distances from proper motions, angular diameters and galactic rotation theory applied to the radial velocities. In this way he obtained a scale of distances ranging from 3,000 to more than 30,000 light-years, but the values for individual nebulae are uncertain in some cases by factors of 2 or 3, because of the large dispersions in velocity, luminosity and diameter, and the irregular galactic absorption.

Berman's distance scale appears to be statistically of the right order, however, because of two independent but indirect checks on it. In 1950 Minkowski discussed the angular diameters of planetaries. with special reference to the more than roo newly found ones in the direction to the galactic centre. By assuming them to be at the average distance of 30.000 light-years, he obtained the distribution of linear diameters, and found agreement with the corresponding one obtained from Berman's distance scale. Then in 19jj Baade discovered several of the brightest planetaries in the Andromeda nebula, on plates taken with the 200-in. Hale telescope. These planetary nebulae in the spiral have apparent magnitudes of 22, which is very nearly the brightness to be expected if the galactic planetaries, with luminosities based on Berman's distance scale, were viewed from a distance of 2,000,000 light-years.

The average linear diameter of the planetaries discussed by Minkowski is 30,000 astronomical units (1 a.u. = 93,000,000 mi.), but this figure fails to tell the whole story of sizes of planetary nebulae. It does not include, for example, the faint outer extensions that are often observed in the nearer and brighter ones, which may reach 200.000 a.u. in size. Also, as Minkowski points out, the observed sizes represent only the ionized part of the nebular mass, and the neutral part may be much larger, as found for the diffuse gaseous nebulae in radio observations. On the other hand, there are a number of semistellar, dense planetary nebulae, whose small diameters and spectroscopic characteristics suggest comparison with peculiar stars having extended atmospheres. Thus there is in reality a great range among planetary diameters, and size may be meaningless unless it is specified in terms of a particular density, element or degree of ionization.

The densities and masses of planetary nebulae can be fairly well estimated from theories of the physical processes in gaseous nebulae, since some of the most important atomic quantities are obtainable independently of the distance. For example, the density and temperature of electrons in the nebular gas may be deduced entirely from spectroscopic observations and astrophysical theory. In fact, the procedure may be reversed and, with the addition of absolute surface brightness measurements, used to estimate distances, as first indicated by D. H. Menzel in 1931 before there was a generally accepted distance scale. For some of the best-observed planetaries, moreover, the astrophysical results derived with and without distances are in substantial agreement. Thus there is reasonable reliability for the following estimates: density of a typical bright nebula: 1,000 to 10,000 ions per cubic centimetre; mass: one-tenth to one-fifth that of the sun. In the faint outermost parts the density may be only 100 atoms per cubic centimetre. This value has been brought down to earth by L. H. Aller of the Cniversity of Michigan observatory, who has obtained and critically analyzed (in 1956) much of the best material in the field, by the statement that the density represents "a tenuity comparable to that of a few tablespoonfuls of air expanded to the size of Pike's Peak."

Origin **and** Evolution. — Planetary nebulae are so rare on the cosmic scene — less than one per 10,000,000,000 stars — that on the grand scale their evolution cannot be regarded as an important stage in general stellar evolution. Instead, planetaries serve best to draw attention to a particular process in stellar atmospheres: the ejection of material from the hottest stars. Since this phenomenon has been repeatedly observed in modern novae, it was natural to postulate that perhaps planetaries resulted from and represent the remnants of prehistoric nova outbursts. Apparent support for this view came from M. L. Humason's report in 1938 that 16 faint "old" novae are hot, blue stars like the nuclei of planetaries. This analogy, however, breaks down completely when subjected to quantitative analysis. For the gas masses, velocities of expansion and lifetimes of the nebular shells are of different orders of magnitude for novae and planetaries. Despite the many assumptions involved, reasonably computed values for a typical nova outburst are: 1/100,000 solar mass for the thrown-off gas, 1,000 mi. per second for the velocity of ejection and 50 to 100 years for the visible lifetime of the expanding nebula; corresponding figures for a representative planetary are 1/10 sun, 10 mi. per second and 10,000 years. Thus a planetary nebula requires for its origin and development a prolonged ejection process, one that may operate for a substantial fraction of the nebular lifetime. Although both novae and planetaries are transient phenomena on the general evolutionary scale of millions and billions of years for stars, the relative ages of nova and planetary nebular shells are those of an explosion and a slow burn.

The Gaseous Spectrum of the Nebulae. — The spectra of all gaseous nebulae, diffuse and planetary, are very similar in appearance, the differences consisting chiefly in the relative intensities of the bright lines. The lines in the spectra are sharp, a fact indicating a gas of low density; those of hydrogen are prominent and those of helium are usually present. But for more than 60 years following 1864, when William Huggins first observed the spectrum of a nebula, there were several lines (a wide pair in the green at 5,007 and 4,959 A. and a close pair in the ultraviolet at 3,726 and 3,729 Å), among the strongest in the spectrum, which remained unidentified. Their origin was one of the most puzzling mysteries in astronomy, and for lack of a better name, they were attributed to a hypothetical element called "Nebulium," although it was generally realized, because of advances in chemistry and physics that left no place in the table of known elements for foreign ones, the occurrence of the strange lines probably was due to some familiar element existing under conditions peculiar to the nebulae. That this explanation is the correct one was established in 1927 by I. S. Bowen. He showed on the basis of laboratory work and quantum theory calculations that the chief nebular lines are due to singly and doubly ionized oxygen atoms, which radiate light under conditions of extremely low density and long light paths — a combination unmatched on the earth.

Forbidden and Permitted Lines. — To understand why certain lines occur in the nebulae and not in terrestrial sources, it is necessary to mention a few of the fundamental principles of modern atomic theory. In this concept, atoms exist in certain definite energy states, depending on their environment. The energy states may be likened to orbits in which electrons move about the nucleus, and when an electron jumps from one orbit to another, energy is absorbed, or emitted, depending on whether the jump is from an inner to an outer orbit, or the other way around. The electrons, however, do not remain in the different kinds of orbits for equal times, and it is this property of the atom, together with its environment, which is responsible for the characteristic nebular radiations. The latter represent jumps to orbits in which electrons can move for hours and days, whereas radiations observed in terrestrial light sources correspond to transitions between orbits in which electrons remain for only 1/100,000,000 of a second. Spectral rays from long-lived orbits are called "forbidden" lines, those from the short-lived orbits "permitted" lines, and the reason only the latter are obtained in the laboratory is that collisions between atoms, even with the lowest obtainable densities, are so numerous (millions per second) that electrons are almost always knocked from the long-lived orbits before they have a chance to jump to an inner orbit, with the resultant emission of a forbidden line. In the nebulae, however, the extremely low densities and long light paths allow sufficient electrons to accumulate in the long-lived orbits (called "metastable states") to yield intense forbidden lines.

Physical Processes and Sources of Energy. — In addition to demonstrating the existence of an almost perfect vacuum in gaseous nebulae, the forbidden lines due to ionized atoms indicate the presence in planetaries of a very high-temperature source of energy. Evidence for this conclusion is provided by two apparently unrelated features of the nebular spectrum: (1) the size of a nebula is different in different radiations, and (2) only certain of the permitted lines of neutral oxygen and nitrogen are observed. The first of these properties, originally noted in 1908 by M. Wolf and later (1918) extensively studied by W. H. Wright in his classically thorough investigation of the spectra of the gaseous nebulae, shows that the smallest nebular diameters correspond to the most highly ionized atoms, and the largest to the least, in just the way to be expected from Bowen's high-temperature theory of the structure of planetary nebulae. The second feature was likewise explained by Bowen as the result of an intense concentration of energy in the far ultraviolet, characteristic of a high-temperature source, which selectively excites the observed lines by a fluorescent mechanism. That the central stars of planetary nebulae are in reality among the hottest objects known was also established by Wright's observations of the spectra of planetary nuclei. Subsequent theoretical investigations by H. Zanstra, A. S. Eddington (1882–1944) and D. H. Menzel have fully substantiated Wright's earlier deductions from observations, and Bowen's conclusions from identification of the chief lines, that the dominating physical conditions in gaseous nebulae are extremes of low density in the nebulae and of high temperature in the central stars, which are the ultimate sources of all nebular radiations.

Abundances of the Nebular Gases. — Following his explanation of the origin of the nebular lines, and the mechanism of their production, Bowen in 1934 concluded that the gaseous nebulae, like most astronomical bodies, are largely made up of hydrogen, with helium the next most abundant element. Further information on their chemical composition was obtained in 1939 by Bowen and A. B. Wyse (1909–42) at the Lick observatory. By using an especially powerful spectrograph in combination with an "image slicer" (invented by Bowen to overcome certain observational difficulties), and exposures of 12 to 20 hours, they were able to record in two planetary nebulae a number of faint radiations due to the metallic and other elements. Analysis of the intensities of these lines, and comparison of results with similar work by H. N. Russell

Abundances of Elements

Chemical Element	Relative Numbers of Atoms	
	Planetary Nebula	Star
Hydrogen	10,000	10,000
Helium	1,740	(1,600)*
Nitrogen	2.8	
Oxygen	6.6	7.5
Fluorine	(0.003)	—
Neon	1.3	11.0
Sulfur	0.65	0.25
Chlorine	0.035	0.14
Argon	0.080	0.45
Potassium	(0.008)	0.0005
Calcium	(0.010)	0.014

*Figures in parentheses are uncertain.

on the sun, led to the conclusion that the abundance of many elements in the nebulae and sun are not significantly different. Wyse in 1941–42 extended the program to include ten additional planetary nebulae and the Orion nebula, and deduced that the chemical compositions in both types of nebulae are similar to those of the sun.

This finding of a common chemical composition, especially for objects so apparently dissimilar as gaseous nebulae and an ordinary star. stimulated many modern researches on the cosmical abundances of the elements. Gaseous nebulae, and particularly planetary nebulae. continued to play prominent parts in both theoretical and observational developments. For the astrophysics of such low-density high-temperature sources are more amenable to mathematical treatment; while planetaries have the highest surface brightnesses. Thus the theory used by Bowen and Wyse was greatly extended during 1937–45 at Harvard College observatory by Menzel and his colleagues J. G. Baker and L. H. Aller; and, after World War II. further investigations of several of the brightest planetaries were carried out at the Mount Wilson and Palomar observatories by Aller, Bowen and Minkowski. In 1952–54 they used the powerful spectrographic equipment of the 100-in. and zoo-in. reflectors to obtain much new material on the wave lengths, intensities and identifications of several hundred of the fainter radiations previously only suspected or unrecorded. From these spectrochemical analyses. Aller and Minkowski in 19j6 found that the abundances of elements in seven planetary nebulae (1) do not differ significantly. and (2) the average composition is essentially the same as in stars (see table, adapted from compilations by L. H. Aller, University of Michigan observatory, Ann Arbor, Mich.).

IV. THE EXTRAGALACTIC NEBULAE

The extragalactic nebulae are found over the entire sky. except within the close confines of the Milky Way, or galaxy. where the cloudy stratum of interstellar matter blots out the light from more distant objects. This surface distribution hints of distances beyond the galaxy—extragalactic—and it is a clue reinforced by the observed ranges in size, brightness and numbers. These attributes all strongly support the suggestion of a perspective progression of objects. For extragalactic nebulae are found smaller? fainter and more numerous. as the more powerful telescopes reach ever farther into space. In diameter and brightness they range from the great 10°. 1st-magnitude Large Magellanic Cloud to the small 1-second-of-arc, 23rd-magnitude specks scarcely distinguishable from stars, even with the large 200-in. Hale telescope. Their number is enormous and depends upon the limiting brightness to which they are counted. Thus some 1,000 are catalogued to the 13th magnitude, and they increase approximately by a factor of 4 for each fainter magnitude: 4,000 to the 14th; 16.000 to the 15th, etc. If this geometric rate of increase were maintained to the optical threshold of the zoo-in. reflector, the enumerable extragalactic nebulae would total 1,000,000,000. This number, however, has to be corrected downward. because of the different quality of light from the faintest extragalactic nebulae. Although the smaller corrected number is not precisely known, it is of the order of hundreds of millions. and this figure represents a population parameter of the universe that challenges the imagination. For each one of these millions of faint flecks of light is a stellar system. or "island universe." composed of myriads of stars. Many also contain interstellar gas and dust, and some are giants in size, population and real brightness comparable to our own galaxy. Since the most numerous extragalactic nebulae are literally vanishingly faint even the largest telescopes are hard pressed to provide data much above the margin of error. The farthest reaches of the universe are accordingly only sketchily scouted observationally, and there are hosts of unsolved problems and unanswered questions at this dim astronomical horizon. Chief among these is the extragalactic distance scale, which even in 1957 was uncertain by a factor of 2. But it is a real achievement of the largest telescopes that the distances of the faintest extragalactic nebulae may be estimated reliably as to order of magnitude: about 2,000,000,000 light-years. Thus modern astronomy. in dealing with the feeblest extragalactic photons, explores with light as ancient as the oldest rocks on earth.

Classification.— The most generally accepted scheme of classification for the extragalactic nebulae is the one proposed by Hubble in 1926. It is represented schematically in fig. 1. This system arranges in a single homogeneous pattern nearly 98% of the numerous regular nebulae which are sufficiently large and bright to show appreciable structure on photographs taken with telescopes of moderate power; the remaining 2% or 3% that do not readily fall into the system are called irregular nebulae. The basic feature of the classification is, in Hubble's words, "conspicuous evidence of rotational symmetry about dominating, central nuclei."

As may be seen from fig. 1, the regular nebulae begin the sequence as elliptical nebulae. denoted by E. Their forms range from globular to lenticular. with the degree of ellipticity indicated by numerals from 0 to 7, which are obtained from the relation $10(a-b)/a$, where a and b are the major and minor axes, respectively. Statistical analysis of the irequency of occurrence

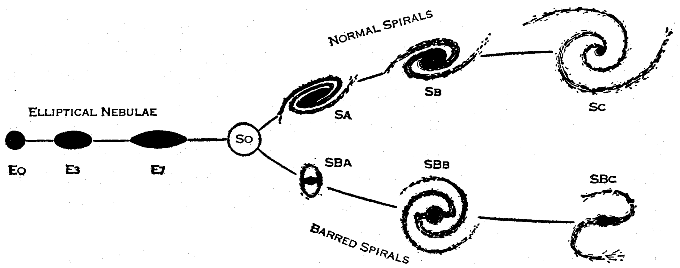


FIG. 1.—HUBBLE'S SYSTEM OF CLASSIFICATION FOR EXTRAGALACTIC NEBULAE

of the different forms shows that there are actually globular or spherical nebulae, and that not all of the apparently round ones can be accounted for as flattened nebulae with polar axes in the line of sight. The analysis shows. however. that the lenticular objects are much more common. and that there is a definite limiting ellipticity with ratio of axes 3 to 1. When the flattening becomes greater, the nebulae no longer appear as smooth. unresolved objects and. at a certain stage of the sequence, indicated by So, they begin to show structure that in general is of spiral character. Two different spiral forms are found. however. so that the spiral nebulae are separated into two groups: the normal spirals, designated by S, and the barred spirals. symbolized by SB.

Among the regular nebulae large and bright enough to classify, the spirals outnumber the ellipticals by more than 4 to 1, and this fact stresses the importance of deciding which features in spirals are best suited for further subdivision. such as central concentration, relative size of arms and nucleus or number and character of condensations. After an examination of hundreds of nebulae on photographs taken with the Mount Wilson reflectors, Hubble concluded that the most significant characteristic for classifying spirals is the degree of resolution. Depending upon circumstances, the resolution may be only into spiral structure, into clusters or clouds of stars or, at best, into individual stars. To indicate the degree of resolution the letters a, b or c are placed after S or SB: thus, a well-resolved normal spiral would be referred to as Sc, a barred one as SBc.

Distribution. — As the result of extensive counts of extragalactic nebulae on photographs taken chiefly at the Mount Wilson-Palomar and Lick observatories in the northern hemisphere, and at the Harvard college observatory station in the southern hemisphere, it is known that the distribution is nonrandom over the sky and approximately uniform in depth. This last result, of great theoretical and practical value for cosmological studies, was established chiefly by Hubble's survey that quantitatively elucidated the effects of galactic obscuration, and of several great clusters of nebulae, upon the true distribution.

Counts — Long before the advent of photography it was generally known from visual observations that the "white" nebulae, now called extragalactic, tended to avoid the Milky Way. and that there was appreciable clustering in high galactic latitudes. especially in Coma and Virgo close to the north pole of the galaxy. With the development of photography, more and ever more nebulae were counted, and the galactic zone of avoidance and the regions of clustering became more precisely defined. A number of early counts. among them those of J. E. Keeler (1899). E. A. Fath (1914) and H. D. Curtis (1918). suggested the general outlines of the distribution and gave hints as to the total number of nebulae within reach of certain telescopes, but the problem of nebular counts was not put on a firm quantitative basis until 1934. In that year Hubble published the results of surveys, made nith the Mount Wilson reflectors, in which more than 44,000 nebulae were counted in 1,300 sample regions rather evenly distributed over three-fourths of the sky. For the first time, the counts were calibrated and referred to specified limiting magnitudes. With all the data reduced to standard conditions, it became clear that the numbers of nebulae decreased in a very regular way as the Milky Way was approached. The rate of decrease, in fact, was just that to be expected from a thin obscuring layer in which the absorption is proportional to the light path in the stratum — a familiar analogy is the dimming of stars as they approach the horizon. The zone of avoidance along the galaxy is thus but the effect of looking in the plane of the stratum, where the absorption is a maximum that approaches complete opacity; toward the galactic poles, the absorption is a minimum, uith the light reduced by only 20%. The more populous areas, on the other hand, represent a conspicuous tendency for the nebulae to cluster. They occur in pairs, in small to large groups of several to 100 nebulae and in great clusters that include more than 500 members, as in the Coma and Virgo aggregations.

Hubble's classical counts to faint magnitude limits in small sample areas stimulated much interest and work in this field, but these other investigations were necessarily of a different type: they involved surveys over wider regions to brighter limits, as befitted less powerful equipment than the 60-in. and 100-in. Mount Wilson reflectors. Modern sequels in which astrographs (star-cameras) and Schmidt telescopes were used are: (1) the extensive two-hemisphere Harvard surveys carried out from about 1930–50; (2) the Palomar-Schmidt programs begun in 1937; and (3) the Lick comprehensive counts undertaken in 1948.

Harvard Counts. — In 60° diameter zones centred on the equatorial and galactic polar caps, the Harvard counts to the 18th magnitude yielded three important results for what Shapley has called the Inner Metagalaxy, a sphere of diameter 300,000,000 light-years. First, the region of the north equatorial polar cap around Polaris appears to be thinly veiled by galactic obscuring matter, as shown by subnormal counts compared to the surroundings. This result provided independent supporting evidence that some of the International Polar Sequence stars of standard brightness and colour probably are dimmed and reddened, as had previously been suspected from precise photometric work. Second, the survey of the southern equatorial polar cap containing the Magellanic Clouds gave the first clear-cut indication, from wide, continuous-are. counts, that extragalactic nebulae may have a higher degree of organization than clustering: arrangement in great, rich clouds extending throughout vast regions of space, of dimensions up to 100,000,000 light-years. Third, comparison of the counts for the galactic polar caps showed a systematic difference between them. In the southern cap the distribution is remarkably smooth over the sky and uniform in depth. But in the northern it is conspicuously irregular, with numerous clusters of both bright and faint nebulae that give an average population in the north nearly twice as large as in the south. This excess is particularly pronounced for the brighter objects, which are found in a broad band running through Ursa Minor and Major. Canes Venatici, Coma, Virgo and Centaurus, to mhich H. D. Curtis has given the apt name "Canopy of Galaxies."

Palomar Counts. — The Palomar programs, carried out by F. Zwicky and his collaborators at the California Institute of Technology, Pasadena, used photographs taken with the Palomar observatory Schmidt telescopes: since 1937 with the 18-in. and after 1949 with the 48-in. Special attention was given to the phenomenon of clustering of extragalactic nebulae, particularly as related to the question of the presence of material between nebulae, "intergalactic matter." By 1953 Zwicky had become convinced of the existence of such matter in both the "luminous" and "nonluminous" states. Intergalactic luminous matter mas inferred from a variety of faint phenomena newly discovered by the powerful Palomar Schmidt telescopes: (1) large numbers of faint blue stars distant up to 30.000 light-years from the Milky Way plane; (2) some intrinsically very faint and small dwarf nebulae, all within about 2,000,000 light-years of the galaxy; (3) hundreds of streamer-connected double and multiple nebulae out to distances of the order of 200,000,000 to 300,000,000 light-years; (4) exceedingly faint and unresolved luminous patches in clusters and groups of nebulae. Intergalactic dark matter, on the other hand, mas inferred from fewer numbers of faint background nebulae counted within foreground clusters, as if the latter contained material that absorbed the light of distant objects. Zwicky has boldly generalized these results as indicating a continuous progression of intergalactic matter ranging from a gas, through dust particles, to individual stars and dwarf stellar systems. But whether this internebular substratum comprises the major portion of the extragalactic population, as advocated by Zwicky, remained more of a question than an answer in 1957.

Lick Counts. — Begun in 1548 by C. D. Shane and C. A. Wirtanen, these represent the most comprehensive plan so far undertaken to achieve uniformity and completeness over the sky from the north equatorial pole to a southern declination of 23°. The basic material consists of a set of 1,246 astrograph plates on which nebulae could be counted to a limiting magnitude of nearly 18.5. Each plate was exposed two hours and covers an area of $6° \times 6°$. With plate-centers 5° apart, an overlapping border at least 1° wide all around each plate provided the means — duplicate counts in a common region — for reduction of the counts to a homogeneous system. Nebulae were counted in 10-minute-of-arc squares, the numbers summed by square degrees, averaged in groups of four and used to construct "contour maps" of nebular surface density. For practical reasons, the sky was divided into nine approximately equal areas! and in 1956 detailed results had been published for two of them. By 1957 the counting was 80% complete. with the final census estimated to total about 2,000,000 nebulae. This work, of monumental proportions in concept and effort, will provide, when completed, by far the best basic data for many researches in which a detailed knowledge of the distribution of extragalactic nebulae is important. Thus the partially-published counts already delineate, much more exactly than before, the extent and transparency of the obscuring clouds in and around the Milky Way; also, they confirm with a wealth of new data previous indications that clustering of nebulae is not only common but that clusters often are but subsidiary condensations in larger clouds (see sections Clusters and *Superclusters,* below).

Numbers and Distribution in Depth. — Of equal or greater importance than the delineation of regions of avoidance and of clustering is the conclusion, first reached by Hubble, that the extragalactic nebulae populate space with an approximately constant density as far as telescopes can reach. This result was obtained from counts of nebulae to successively fainter limiting magnitudes. For the brightest objects, it is only necessary to total to each limiting magnitude the number of nebulae whose magnitudes have been individually determined, as for example, in the extensive Harvard surveys reported by Shapley. For the faintest objects, on the other hand. it is much simpler to count nebulae to limiting magnitudes determined by exposures of different lengths, or by telescopes of different light-gathering power. This indirect procedure is expedient because the faintest nebulae are over-uhelmingly too numerous to estimate their individual brightnesses. With the numbers of nebulae established to increasingly fainter magnitudes, it is relatively easy to test the hypothesis of constant space density. This is done by noting whether the numbers of nebulae counted are proportional to the volumes of space in which they are found. More precisely, a simple calculation shows that the rate of increase is by a factor of four when the limiting brightness decreases by one magnitude. On the basis of all the available material, Hubble found that this condition was satisfied to about the 18th magnitude. At this point the redshifts in the nebular spectra begin to make photographic magnitudes abnormally faint, with the result that the observed number falls below that expected on the basis of a uniform distribution. The following table, obtained from Hubble's counts of faint nebulae, illustrates the total numbers involved:

Apparent photographic magnitude	18	19	20	21	22	23
Uniform distribution, millions	2.3	9.3	37	150	(590)	(2300)
Observed numbers, millions	1.8	5.6	18	57	(180)	(560)

Although the numbers in parentheses represent extrapolations beyond the actual counts, it is evident that the deficiency of the observed to the expected uniform count is by a factor of 3 to 4. In his classical treatment of the subject. Hubble in 1936 used these differences to interpret the nature of the redshift. He concluded that either there is a probable uniform distribution of nebulae in depth, with the redshift not representing recession; *i.e.*, no universal expansion, or, if outivard motion is involved, "some vital factors have been neglected in the investigation."

Subsequent developments disclosed these factors, and reopened the entire matter. In the vanguard of progress was the perfection of photoelectric methods of magnitude measurement for faint sources. New observations with this technique, made in 1947–49 by Stebbins and Whitford. left little doubt that the photographic magnitude standards available to Hubble possessed serious systematic errors. With the 100-in. reflector they were able to reach magnitude 18.5, where they found the previous standards too bright by 0.5 magnitude. Extension of the photoelectric measurements to the range of the faintest nebular counts required the use of the zoo-in. Hale telescope, and in 1955 W. A. Baum reported the determination of a stellar magnitude of 23.9. However, such observations are difficult and slow, even with the largest telescope, for u-hich Baum estimated two nights of good conditions would be required for an accuracy of 2% at magnitude 23. Nevertheless, by 19jj photoelectric standard magnitudes, in three selected areas and ranging over 10 magnitudes in two colours to magnitude 22 or 23, were reported to have been determined with satisfactory precision and freedom from systematic error. In this way the groundwork was prepared for further counts of the faintest nebulae. But by 1957 no systematic program using the largest-reflector photographs: comparable to Hubble's 1936 reconnaissance, had been undertaken. In 1952, however, J. Neyman and E. L. Scott of the Cniversity of California statistical laboratory, initiated a broad, theoretical program using statistical methods to predict the numbers of faint nebulae expected to different magnitude limits. Their formulation included a wide variety of models, with and without clustering, redshift or expansion. As a result of this work, there was available by 1956 a theoretical framework especially adapted to the comparison of forthcoming nebular counts with various theories of the distribution in depth. An example of results from the calculations is given in fig. 2. This shows that the surface density of extragalactic nebulae near the faintest magnitude limits attainable with the largest reflectors is astonishingly high—of the order of 10,000 nebulae per square degree. In the higher galactic latitudes there will thus be more nebulae than stars, as predicted

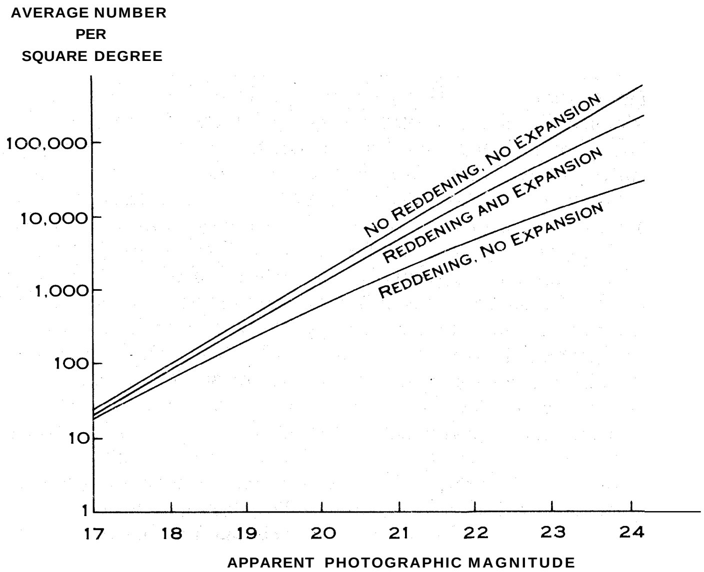


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FIG. 2.— NUMBERS OF EXTRAGALACTIC NEBULAE TO VARIOUS LIMITING MAGNITUDES, FOR DIFFERENT ASSUMPTIONS AFFECTING THE DISTRIBUTION IN DEPTH. NUMERICAL DATA FROM HUBBLE'S OBSERVATIONS. (AFTER NEYMAN AND SCOTT)

by Hubble in 1934, and verified by him with the zoo-in. reflector in 1949.

The observed distributions of the faintest extragalactic nebulae and stars therefore present complementary aspects of the sky, related to our position in the galaxy. In its plane the rich star cloud provides the limiting background of threshold sources, while at its poles the piled-up population of faintest nebclae produces the distant and hazy horizon. There, strangely as at sunset, these extragalactic beacons are aglow with a ruddy hue—the universe's "stop signal." the redshift.

Clusters.——Extensive surveys first by astrographs and later by Schmidt cameras have shown that clustering of extragalactic nebulae is by far the rule rather than the exception. The most modern program, which is F. Zwicky's uith the Palomar 48-in. Schmidt telescope, indicates that these clusters are to be counted in the thousands. He reported in 1952 that on one plate covering about 40 square degrees in Coronae Borealis nearly 100 clusters could be identified. So many clusters suggests that they, instead of individual nebulae, may be the fundamental building blocks of the universe. If this is the case, then clusters of nebulae promise to provide significant information on the structure of the universe, in addition to having served as stepping stones for Hubble's extragalactic distance scale.

On the observational side, Zwicky's extensive cluster material obtained with the Palomar Schmidt telescopes from about 1937–56, led him to a number of conclusions regarding clusters of nebulae. In 1956 he summarized these results, some of which are the following: (1) clusters exist as open clouds, medium compact swarms and spherically symmetrical condensations, with isolated nebulae clearly in the minority; (2) the richest clusters may have (a) as many as 10,000 members within the range from the brightest to those seven magnitudes fainter, and (b) an internal velocity dispersion of 1,500 mi. per second; (3) both luminous and dark clouds of intergalactic matter have been found concentrated toward the centres of large clusters; (4) clusters appear to be distributed uniformly and randomly 'in a nonexpanding universe, as inferred from studies of brightnesses and diameters of nearly 1,000 rich clusters; (5) there is no systematic clustering of clusters. Some of these and other findings by Zwicky are subject to confirmation by further, independent observations, or are susceptible of alternate interpretations. Nevertheless. Zwicky and his collaborators have shown that the Palomar Schmidt photographs are in a class by themselves as regards the recording of the faintest nebulous sources in the extragalactic regions.

On the theoretical side. J. Neyman and E. L. Scott in a series of papers beginning in 1952 assumed that all extragalactic nebulae are members of clusters. Using mathematical statistical methods. they sought to formulate the problem of spatial distribution of nebulae in such a way that as many as possible of the basic assumptions and related postulates could be tested separately by nebular counts. They found it convenient to classify the postulates into three groups: (1) those concerned with the distribution of nebulae in space; (2) those that relate events in space to what may be seen on a photograph; and (3) those connected with the unavoidable errors of counting. For the observational tests of the deductions from the theory, they used C. D. Shane's and C. A. Wirtanen's comprehensive counts of nebulae on the Lick 20-in. astrograph plates. In 1954 Neyman and Scott reached the conclusion that a hypothesis of simple clustering could represent the observations in some, but not all, respects. In particular, they found that frequencies of counts in 1° squares agreed closely with theoretical expectations, although for an unsatisfactorily large range of the observational parameters. For the same parameters, however, frequencies of counts in 10′ squares could not be reconciled with those in 1° squares. The discrepancy was in the sense of the observations showing an excessive number of clusters with small angular diameters, as compared with theoretical prediction. They suggested that the most promising modifications of the model of simple clustering in order to reach agreement with observations, appeared to be inclusion of the additional hypotheses of expansion of the universe and of multiple or superclustering, together nith a more thorough investigation of the effects due to errors of counting. They also found from further analysis that it was not necessary to assume the existence of clouds of internebular absorbing material.

Superclusters.—If only the brighter extragalactic nebulae to the 12th or 13th magnitude are considered, they show a tendency first noted in 1923 by J. H. Reynolds (1874–1949) to occur in a great-circle band around the sky. It is a belt of average width 12° that runs nearly perpendicular to the Milky Way, which it crosses in the northern constellation of Cassiopeia and again in the southern one of Circinus. The northern arc includes the Virgo cluster with its extensions to the south in Centaurus and to the north in Coma, Canes Venatici and Ursa Major. The southern part is less populous, but there are series of groups of bright nebulae in Andromeda, Pisces, Cetus, Sculptor and beyond into far-southern skies.

The possibility that these brightest nebulae may form in space an extended "metagalactic" system or cloud, which may also include the galaxy, has been suggested by a number of investigators. Chief among these are three Swedish astronomers of the Lund University observatory. K. Lundmarlr. E. Holmberg and A. Reiz. From studies during 1927–41 of single, double and multiple nebulae they concluded there is good evidence for such a large-scale organization. In shape it would be a flattened system of some tens of millions of light years in diameter and one-tenth as thick. But this interpretation of the observations depended largely upon individual nebular magnitudes that later were found in some cases, and suspected in many others, to have large errors. Also there was some doubt about the completeness of the basic data for far-southern nebulae.

In 1952 G. de Vaucouleurs, of the Australian Commonwealth observatory, Mount Stromlo, Canberra, began a thorough re-examination of the question of a local supercluster, on the basis of newer and more accurate data. He redetermined the magnitudes of many of the brighter southern nebulae, and revised to a modern photometric system the magnitudes for most of the brighter catalogued nebulae. The aim was to achieve photometric consistency and completeness over the whole sky to about magnitude 12.j. His 1956 detailed discussion of this material gave strong support to the concept of a "Local Supergalaxy': that includes our own Milky Way stellar system. He proposed a model in which the great Virgo cluster may be "a dominant condensation not too far irom its central region." If this is a valid assumption, then the galaxy, in addition to being close to the principal plane of the supersystem, would be about three-fourths of the way from the centre to the edge, since the bright nebulae in the Coma-Virgo region around the north galactic pole were estimated to be three times more distant than some groups of large spirals in the opposite direction toward the south galactic pole. The over-all size of the supersystem was computed to be. on Hubble's distance scale. of the order of 25,000,000 light-years in diameter and one-tenth as thick. As additional independent evidence for a local supergalaxy, de Vaucouleurs pointed out the similarity in position and extent of a broad maximum of cosmic radio noise, reported in 1952 by R. Hanbury-Brown and C. Hazard, of Manchester, England, and also in 1953 by J. D. Kraus and H. C. Ko, of Ohio State university.

A local supercluster of bright nebulae including the galaxy may not be unique, for among the fainter ones Shapley in 1934 reported a distant, double supergalaxy in Hercules. Moreover, de Vaucouleurs' work in the southern hemisphere led him to suspect the presence of another supergalaxy, irom a great, elongated swarm of nebulae extending through Cetus, Dorado, Fornax, Eridanus and Horologium. He estimated its distance to be only slightly greater than the Virgo cluster. and, from its apparent dimensions of 10° by 50°, a thickness and diameter of 1,600,000 and 8,000,000 light-years, respectively. De Vaucouleurs noted that the relative sizes and separations of this southern supergalaxy and the local supergalaxy appear to be comparable with Shapley's double supergalaxy in Hercules.

All the foregoing observational evidence. when added to that of the theoretical analysis of Neyman and Scott, suggests that superclustering, if not the dominating characteristic in the distribution of extragalactic nebulae, is a phenomenon that cannot be ignored in attempts to infer the structure of the universe.

V. THE EXTRAGALACTIC DISTANCE SCALE

Distances of extragalactic nebulae are most accurately determined from studies of objects within them that may be recognized and compared with their counterparts in the galaxy. These objects may be brightest stars. variable stars. star clusters, gaseous nebulae or novae. When these can be identified, their apparent magnitudes, m, are measured and compared with their absolute magnitudes, M, which are assumed to be the same as those for corresponding galactic objects. How the absolute magnitudes are obtained for the "comparison" galactic objects is a long story in itself. Here it will suffice to note that ultimately all astronomical absolute magnitudes depend upon distance determinations that in principle are equivalent to trigonometric surveying. By definition, M equals m at a distance of 32.6 light-years.

Once an extragalactic object's apparent magnitude is measured and its absolute magnitude assumed known, the distance, d, is computed from the simple formula

$$\log d = (m - M + 5) \div 5,$$

which assumes that the apparent brightness of an object varies inversely as the square of the distance. If there is reason to believe that somewhere along the line of sight to the extragalactic object there is matter that absorbs some of the light, a correction is determined or estimated for the apparent magnitude, which, of course. is made too faint by any obscuring material. Such matter may be present in the galaxy, in the extragalactic nebula whose distance is sought or, as Znicky advocates, in internebular space. Correction for its effect often is difficult to make, and there may be considerable uncertainty even by the best procedure

In practice. the use of individual objects within extragalactic nebulae for distance determinations is limited to a few hundred of the nearest and brightest nebulae. The vast numbers of extragalactic nebulae are so far and faint that even the largest telescopes cannot single out objects within them for individual study. Thus it is necessary to use other distance criteria, which may be apparent diameter, total magnitude (entire light of a nebula) and redshift. These quantities all have to be calibrated, or evaluated in terms of the distance criteria used for the nearer nebulae, before they can be used to obtain distances on an absolute scale of light years.

Hubble's Distance Scale.—In 1923 Hubble made the crucial observations with the 100-in. Mount Wilson reflector that are generally accepted as the first proof of the extragalactic nature of spiral and elliptical nebulae. He discovered in the great spiral nebula in Andromeda (Messier 31) a number of Cepheid variables. These are pulsating. intrinsically bright stars whose light varies characteristically, in periods ranging from a few days to months. Their importance as distance indicators depends upon the remarkable property that their periods are closely related to their brightnesses, in the sense that longer periods are associated with higher luminosities, as first found in 1912 by Henrietta Leavitt (1868–1921) of Harvard College observatory. She noted that for similar variables in the small Magellanic Cloud. their periods were closely correlated with their apparent magnitudes, which meant with absolute magnitudes because the Cloud Cepheids are at essentially the same distance. Hubble compared the apparent magnitudes of Cepheids in M31 with those in the Cloud. and determined an average difference of nearly five magnitudes. equivalent to a relative distance factor of 10. Thus the Andromeda nebula was found to be ten times more distant than the Small Magellanic Cloud.

The estimation of distances in light years for the spiral and Cloud, however, involved determination of Cepheid absolute magnitudes or luminosities. These had to be obtained from measurement of the motions of galactic Cepheids, and here, as became evident in 1952, was the surveying chain's weakest link. For galactic Cepheids are distant supergiant stars whose motions across the sky are so small that they are nearly lost in the errors of measurement. Nevertheless, their luminosities were estimated as early as 1913 by E. Hertzsprung of Potsdam. He had immediately recognized the significance of Miss Leavitt's discovery for the determination of greater astronomical distances. It was his analysis of the available scanty data that yielded the first calibration of the invaluable Cepheid period-luminosity law. This result meant that in whatever object a Cepheid variable could be identified, determination of its period and apparent magnitude would yield a distance estimate in light years. With this Cepheid criterion, Hubble in 1924 obtained a distance of 900,000 light-years for the Andromeda nebula.

Hubble's work on M31, and on several other large spirals and nearby systems in which Cepheids could be identified, represented only the opening gambit in his celebrated "preliminary reconnaissance of the observable region of the universe." Although he also discovered numerous novae and star clusters in the nearest extragalactic systems, and used them to supplement distance estimates based on Cepheids, he made the most far-reaching extension of the distance scale by developing two other distance criteria. These were brightest stars and total luminosities of extragalactic nebulae. The first meant what he judged to be the upper limit in luminosity for stars that could be individually distinguished on the best photographs with the largest telescopes. The second represented the average, intrinsic light of an entire extragalactic nebula.

These three criteria of Cepheids, brightest stars and total luminosities permitted establishment of the distance scale. with the 100-in. reflector, to about 1,000,000, 6,000,000 and 250,000,000 light-years, respectively. The last large leap was, of course: much more uncertain than the first small steps. Real brightnesses of entire stellar systems, unfortunately, are far from being nearly the same: they range over many magnitudes, probably as many as ten. Hubble ingeniously met the difficulty by using clusters of nebulae, for which average values of the apparent total magnitudes could be more reliably determined. He also was able to make reasonable estimates of the luminosities of the brightest cluster members. These were the only ones that could be detected at the optical limit of the 100-in. reflector: 500,000,000 light-years.

Revision of the Distance Scale.—In 1952 Hubble's colleague W. Baade reported to the International Astronomical union meeting in Rome that his observations with the zoo-in. Hale telescope indicated the previously accepted distance of the Andromeda nebula was too small, probably by a factor of 2. A larger distance of 1,500,000 to 2,000,000 light-years seemed necessary to account for the fact that the 200-in. reflector was unable to reveal the RK Lyrae or cluster-type variables in M31. To understand the reason for this result, and its significance for the extragalactic distance scale, it is necessary to describe the background of the modern Cepheid period-luminosity law, which was formulated by Shapley on the basis of variable stars in the galactic globular clusters and Magellanic Clouds.

In the over-all picture of the astronomical distance scale for objects well beyond the possibility of distance determination by trigonometric techniques, the pulsating or Cepheid variables have long occupied a prominent position. Following Miss Leavitt's and Hertzsprung's work. Shapley in 1918 repeated the calibration of the Cepheid period-luminosity law and revised it from visual to photographic magnitudes. One of his purposes was to obtain distances of the galactic globular star clusters, in which large numbers of variable stars had been found photographically by Harvard workers, beginning in 1895 with S. I. Bailey (1854–1931). The great majority of these variables, however: generally had much shorter periods, in the range from a few tenths of a day to several days, and their fast light fluctuations resembled those of the noncluster bright variable star RR Lyrae. They were accordingly termed cluster-type or RR Lyrae variables, and sometimes "short-period" Cepheids. But the globular clusters also had a few variables of longer period, comparable to the "classical" galactic Cepheids. Shapley therefore made the assumption, which seemed reasonable on the basis of all available relevant data, that the cluster-type and classical Cepheid variables conformed to the same period-luminosity law. In form, its lower luminosity (short-period) end thus was fixed by the cluster-type variables observed in galactic globular clusters, and its middle and upper luminosity (longer-period) parts by the Cepheids in the Magellanic Clouds. Its calibration. or zero point, depended upon about a dozen classical galactic Cepheids for which proper motions, or across-the-line-of-sight velocities, had been measured.

From 1918–52 this "composite" Cepheid period-luminosity law was widely used, notably by Shapley in his comprehensive globular cluster investigations that established the size and extent oi the Milky Way as a giant stellar system in which the sun was far out from the centre, and by Hubble in his extragalactic exploration that brought cosmology within the purview of observational astronomy. From time to time the details of the relationship were changed, but only slightly, by new, additional data! principally from the Magellanic Clouds. The zero point, or absolute magnitude calibration, also was intently scrutinized, without convincing conclusions that it was incorrect. But Baade's 1952 Rome report forced a re-examination of the roots of the relationship. As might be expected, the difficulty lay in the basic assumption that the same period-luminosity law is valid for both cluster-type and classical Cepheids. It was nature's sly trick to make it difficult for astronomers to find! in the same system, both types of variable star. Thus no cluster-type variables had been found in the Clouds prior to 1952, and even by 1957 Baade had not found any in the Andromeda nebula with the 200-in. This failure to find cluster-type variables at the expected apparent magnitudes, about 17.5 in the Clouds and 22.5 in M31, meant there is a much greater difference in absolute magnitude between cluster-type and classical Cepheids than assumed in the composite period-luminosity law. The related questions of how much is the difference, and whether only the absolute magnitudes of the cluster-type variables, or only those of classical Cepheids, or both, need correction, had to be answered from other observations.

Baade's 1952 negative result for cluster-type variables in M31 was accompanied by a positive one that simultaneously yielded the size of the correction to the absolute magnitudes and indicated to which type of variable it should be applied. His 200-in. observations of M31 showed that the brightest, red giant stars like those in globular clusters—his population type II—have an apparent photographic magnitude of 22.5. Now this is just the figure to be expected from the accepted period-luminosity law if the brightest nonvariable stars in globular clusters are 1.5 magnitudes brighter than the cluster-type variables. This difference had already been found to be a good average value from previous observations in many galactic globular clusters. Finally, therefore, the cluster-type variables would be expected at magnitude 24 in M31, at 19 in the Clouds, and a zero-point correction of 1.5 magnitudes—in the brighter sense—should be applied to the absolute magnitudes of the classical Cepheids.

These results were revolutionary in nature and immediately led to a whole series of investigations concerned with other and independent checks on the suggested revision, and with the consequences for many of the problems of modern astronomy. Thus Baade's younger colleagues A. R. Sandage and W. A. Baum used the zoo-in. to its limit to study in globular clusters stars so faint that they could be directly compared in colour and magnitude with similar nearby stars whose absolute magnitudes were known from trigonometric measurements. In this way they obtained in 1952–53 an apparently good check on the previously accepted absolute magnitudes of the cluster-type variables in the same clusters. Then in 1953, A. D. Thackeray and J. Wesselink discovered, with the 74-in. reflector of the Radcliffe observatory, Pretoria, U. of S. Af., the first cluster-type variables in the Magellanic Clouds, at the expected apparent photographic magnitude of 19. Finally, for the classical Cepheids, A. Blaauw and H. R. Morgan in 1954 used more accurate proper motions for 18 of these variables and obtained a zero-point correction to their absolute magnitudes of 1.4 magnitudes, which agreed well with Baade's estimate.

By 1954 it was, therefore, quite clear that distances derived from classical Cepheids needed to be doubled. However, there still remained the question of how reliable are extragalactic distances for nebulae too far for detection of Cepheids, but close enough to show separately brightest stars. Their use as distance indicators required: first, identification as single stars; second, determination of their apparent magnitudes; and third, knowledge of their absolute magnitudes. Since the latter could be estimated from counterparts in the galaxy, Magellanic Clouds and the spirals in Andromeda (M31) and Triangulum (M33), the problem was one of threshold discrimination and photometry with the largest telescopes. From observations with the zoo-in., Sandage gave preliminary reports in 1954 and 1956 that strongly suggested still greater upward correction of Hubble's distance scale. On 100-in. reflector plates, many resolved objects that appeared as stars were shown on zoo-in. plates, taken by newer colour-filter techniques, to be gaseous nebulae—Stromgren's H II regions. Also, the old scale of apparent magnitudes was found to be seriously in error at the faintest limits. Both effects combined to give too small distances. These modern observations, however, require such critically good observing conditions that in 1956 Sandage had been able to obtain revised distances for only two spirals: 9,000,000 light-years for M81 in Ursa Major, and 20,000,000 light-years for M100 in Virgo. These distances are greater than Hubble's by factors of 4 and 3, respectively. When more of the nearer systems have been similarly observed, a more reliable average correction factor will result. Then it will be possible to rederive the absolute total magnitudes of nebulae for a more precise survey of the universe to its distant limits. But enough has already been learned from the zoo-in. Hale telescope observations to demonstrate that astronomers have broken, by a significant margin, the billion (1,000,000,000) light-year distance barrier.

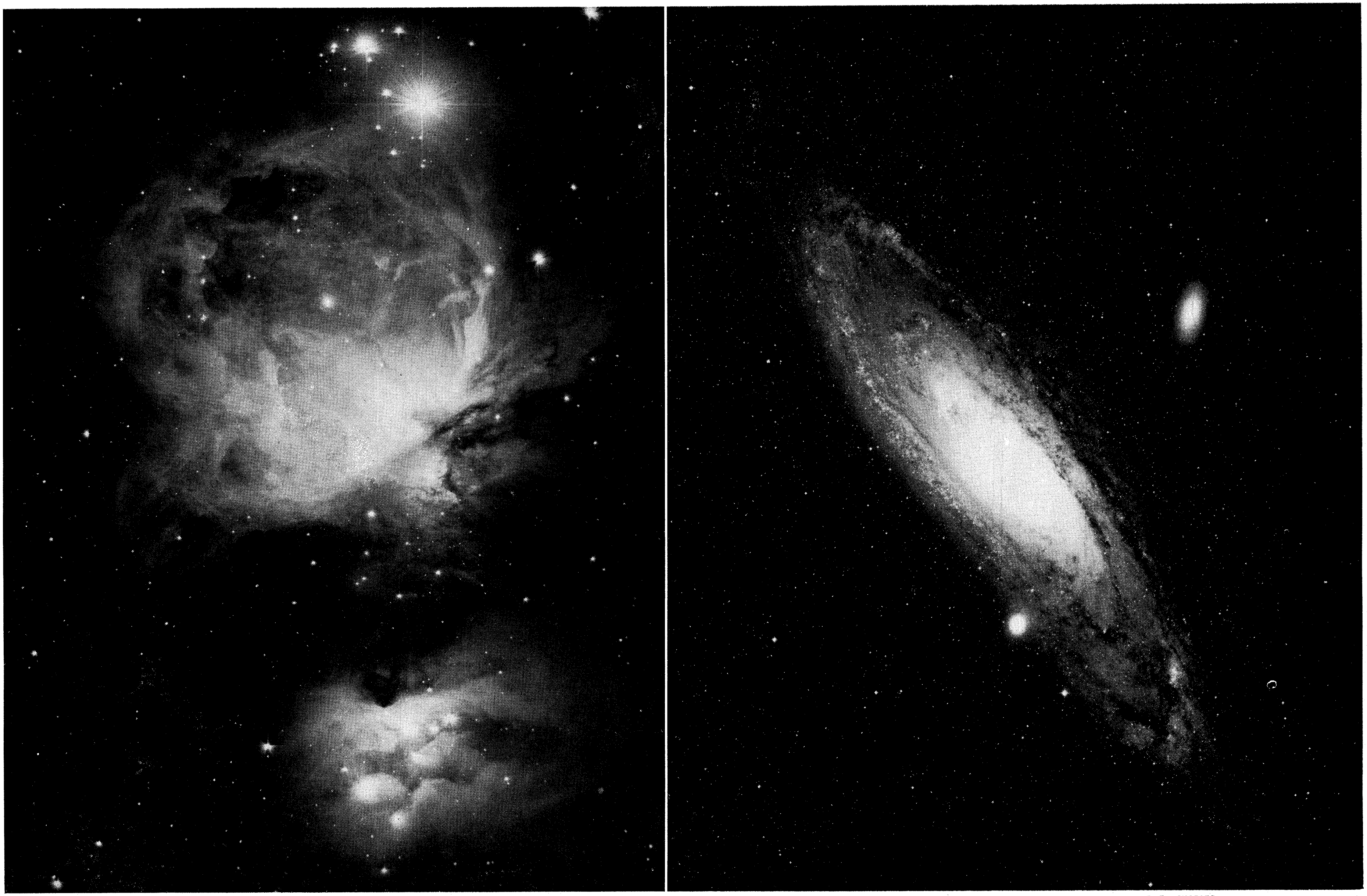
VI. REDSHIFTS AND EXPANSION OF THE UNIVERSE

In 1912 V. M. Slipher of the Lowell observatory, Flagstaff, Ariz., made the first spectroscopic observation of an extragalactic nebula for radial velocity. This is the speed in the line of sight obtained from measurement of spectral lines. According to Doppler's principle, when the lines are found to be of shorter than normal wave length, the source is approaching; when of longer, it is receding. Since the longer wave lengths are in the red part of the spectrum, a receding object exhibits a redshift of the lines in its spectrum. Because of their generally faint surface brightness, extragalactic nebulae are difficult objects for spectroscopic observations. Thus Slipher was able to obtain radial velocities for only a small number of the brightest spirals and ellipticals. At first he found radial velocities of approach and recession in about equal numbers, although the average velocity mas appreciably greater than for stars. However, when he observed some fainter ones, with exposures of 20 to 30 hr., he obtained a most remarkable result: the velocities without exception were of recession and very large, some over 1,000 mi. per second. This discovery naturally aroused much interest, and numerous attempts were made to relate the recessional velocities to other characteristics of the nebulae, such as diameters and apparent magnitudes. But no convincing correlations mere found, mainly because of the intrinsically large dispersions in these quantities. Progress toward understanding these redshifts came, as so often has happened in astronomy, from the establishment of a consistent distance scale.

Hubble's Law of **Redshifts.**—Following his discovery of Cepheids in the Andromeda nebula in 1923, Hubble used the criterion of brightest stars to estimate distances of spirals. By 1929 he had distance data for 22 objects for which radial velocities also were available, chiefly from Slipher's work. The correlation between the two quantities was so close that Hubble in 1929 reported a velocity-distance relation for extragalactic nebulae. It was in the sense that the greater the distance, the larger the velocity of recession. Such a relationship had to some extent been foreshadowed from observational correlations of fewer and less precise data discussed by K. Lundmark and C. Wirtz, and by W. de Sitter's mathematical work using relativity theory. Hubble's new approach, however, clarified an obscure situation and laid a firm foundation for a spectacular advance involving very faint and distant nebulae. From 1928–36 Hubble measured total brightnesses of numerous nebulae in clusters to obtain increasingly greater distances, while his colleague M. L. Humason determined radial velocities with a spectrograph of radically new design. The results were of unprecedented interest: a straight-line relationship out to a distance of 250,000,000 light-years, and up to a velocity of recession of 26,000 mi. per second. Since this speed is nearly one-seventh the velocity of light, Hubble preferred the noncommittal term redshift and referred to his and Humason's results as the lam, of redshifts. It meant, in their 1936 formulation, that the distance of an extragalactic nebula, in millions of light years, could be obtained by dividing its redshift, expressed miles per second, by 100. With this work, the limit of the 100-in. reflector was reached, and the possibility of following the redshift still farther into space required more powerful optical resources. These were provided with the completion of the zoo-in. Hale telescope in 1948.

In 1951 Humason resumed his redshift determinations, with the zoo-in. and a nebular spectrograph in which more efficient Schmidt cameras and diffraction gratings were used instead of lenses and prisms. With this new equipment, Humason by 1955 had observed 20 extremely faint cluster nebulae whose redshifts are in the range from 25,000 to 38,000 mi. per second, in addition to many others of smaller redshifts. As an extension of Hubble's work, A. R. Sandage during the same interval measured apparent magnitudes of many faint cluster nebulae. All this work represented a very considerable increase in the amount, precision and range of the basic redshift-magnitude data, which justified a new analysis of the problem of the expanding universe.

Expansion of the Universe.—In relativistic cosmological theories it is generally assumed that the redshifts in nebular spectra represent velocities of recession, and that the universe is therefore expanding. On this basis modern cosmologists have worked out the details of a number of "model" universes. These differ in such properties as space curvature—whether the universe is bounded or infinite—and variation with time—whether it is static or evolving. In many cases the possibility of a model agreeing with the "real" universe depends upon departures from linearity of the relationships between observed quantities. A prime example is the redshift-magnitude relation: is it linear or is it curved, and in what sense? In 19j6 Sandage reported the results of an analysis of his and Humason's data. He found that the relationship is essentially linear, except possibly at the extreme

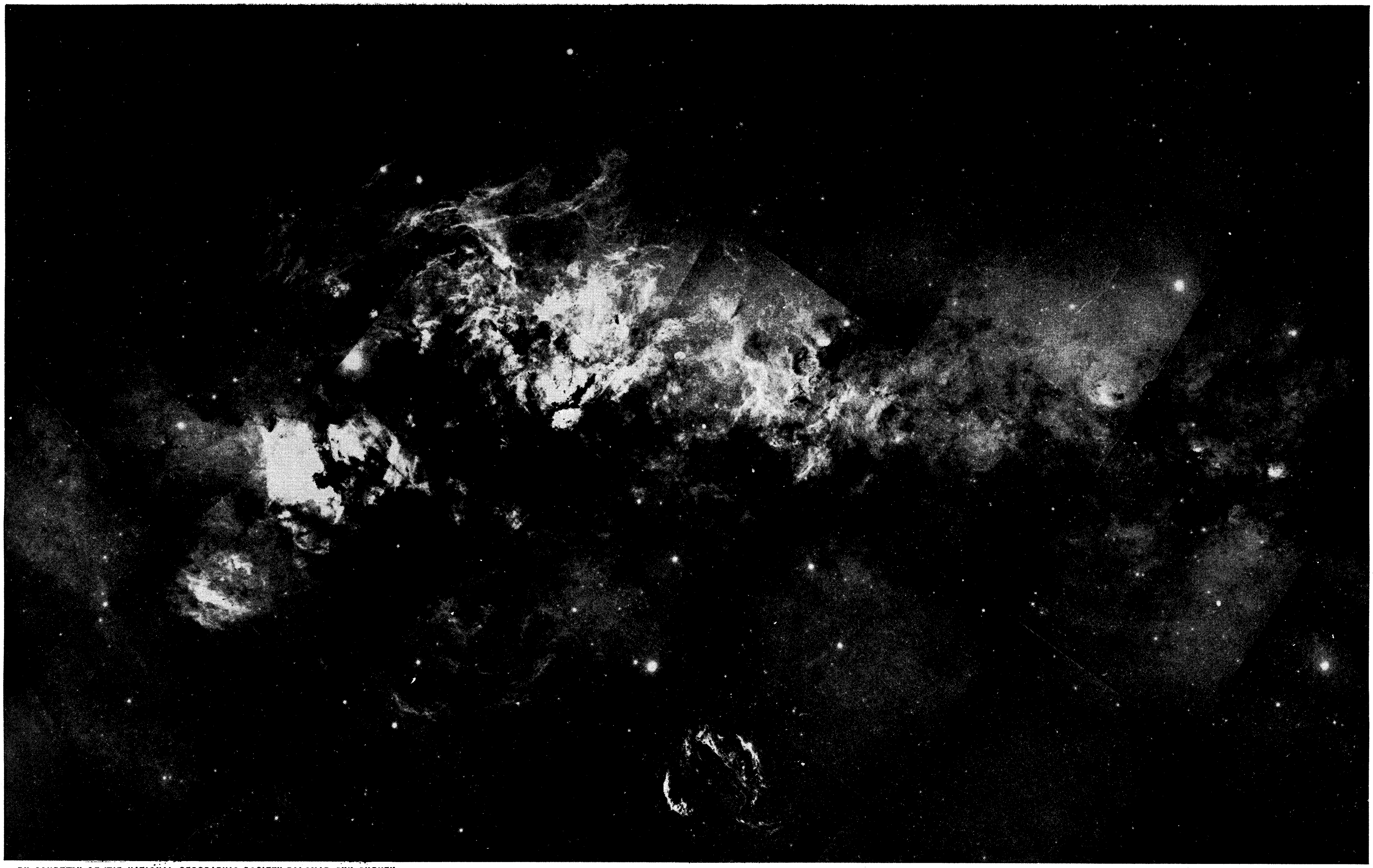


BY COURTESY OF (LEFT) THE LICK OBSERVATORY, (RIGHT) THE MOUNT WILSON AND PALOMAR OBSERVATORIES. PHOTOS ASSEMBLED WITH THE ASSISTANCE OF W. C. MILLER, PHOTOGRAPHER, MOUNT WILSON AND PALOMAR OBSERVATORIES

A GALACTIC AND AN EXTRAGALACTIC NEBULA

Left: Great nebula in Orion (M42, N.G.C. 1976). The light in this nebula consists of radiations characteristic of the atoms of hydrogen, helium, oxygen and nitrogen. These gases, highly rarefied, are excited to luminosity by ultra-violet radiation emitted by hot (20,000° C.) stars imbedded in the nebula. Approximate distance and size of nebula, 1,500 and 120 light-years, respectively

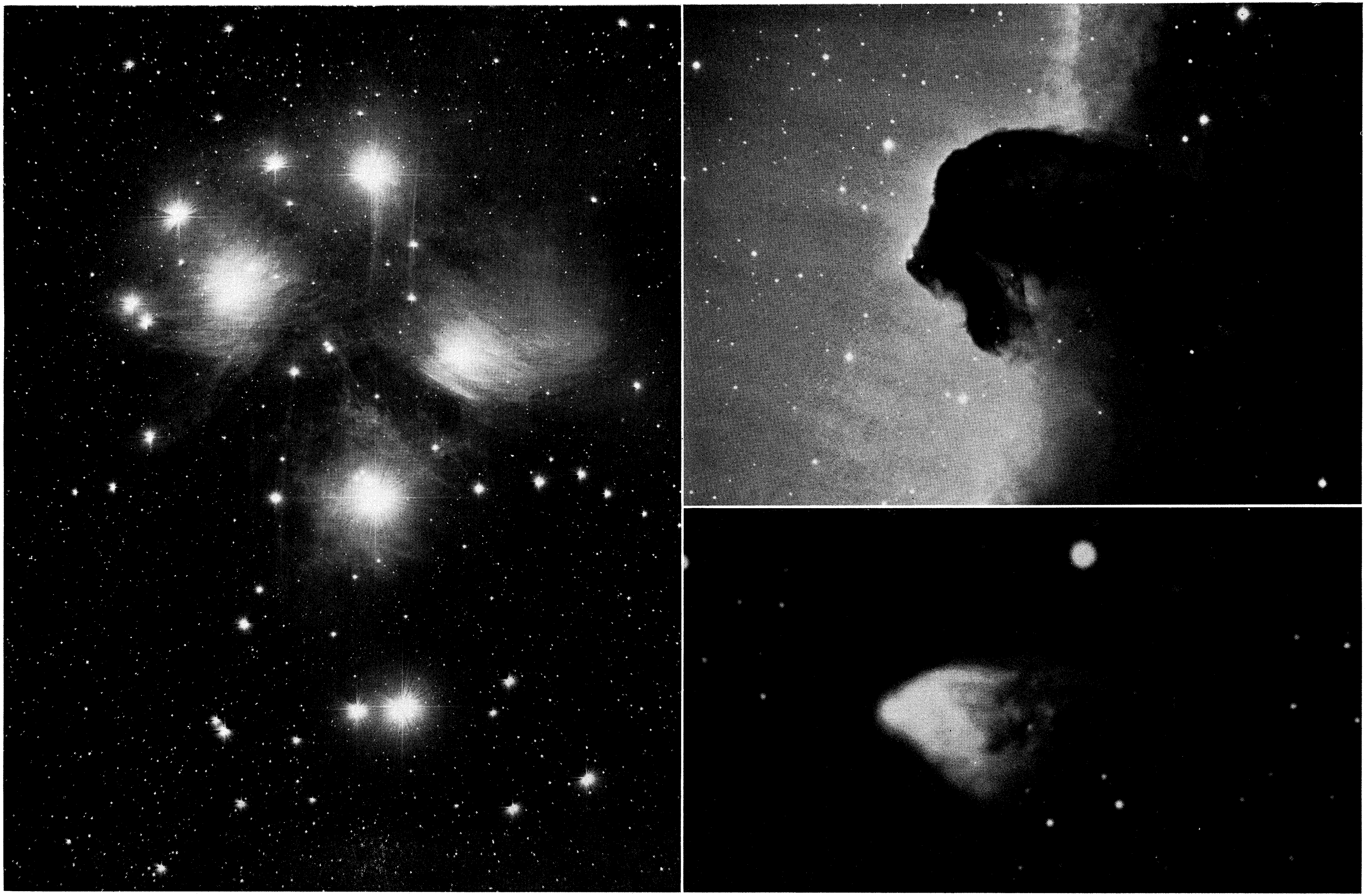
Right: Andromeda nebula (M31, N.G.C. 224). A giant spiral galaxy about 2,000,000 light-years distant and approximately 150,000 light-years in diameter. The portion shown in this photograph, however, is not over 100,000 light-years along its major axis



BY COURTESY OF THE NATIONAL GEOGRAPHIC SOCIETY-PALOMAR SKY SURVEY

PART OF THE NORTHERN MILKY WAY

A mosaic made from red light photographs taken with the 48-inch Schmidt telescope of Palomar observatory. The clouds of stars, glowing gas and dark dust lie close to the fundamental plane of the Milky Way, or Galaxy, which here—from the left and past centre—runs through the constellation Cygnus, and on the right through Vulpecula



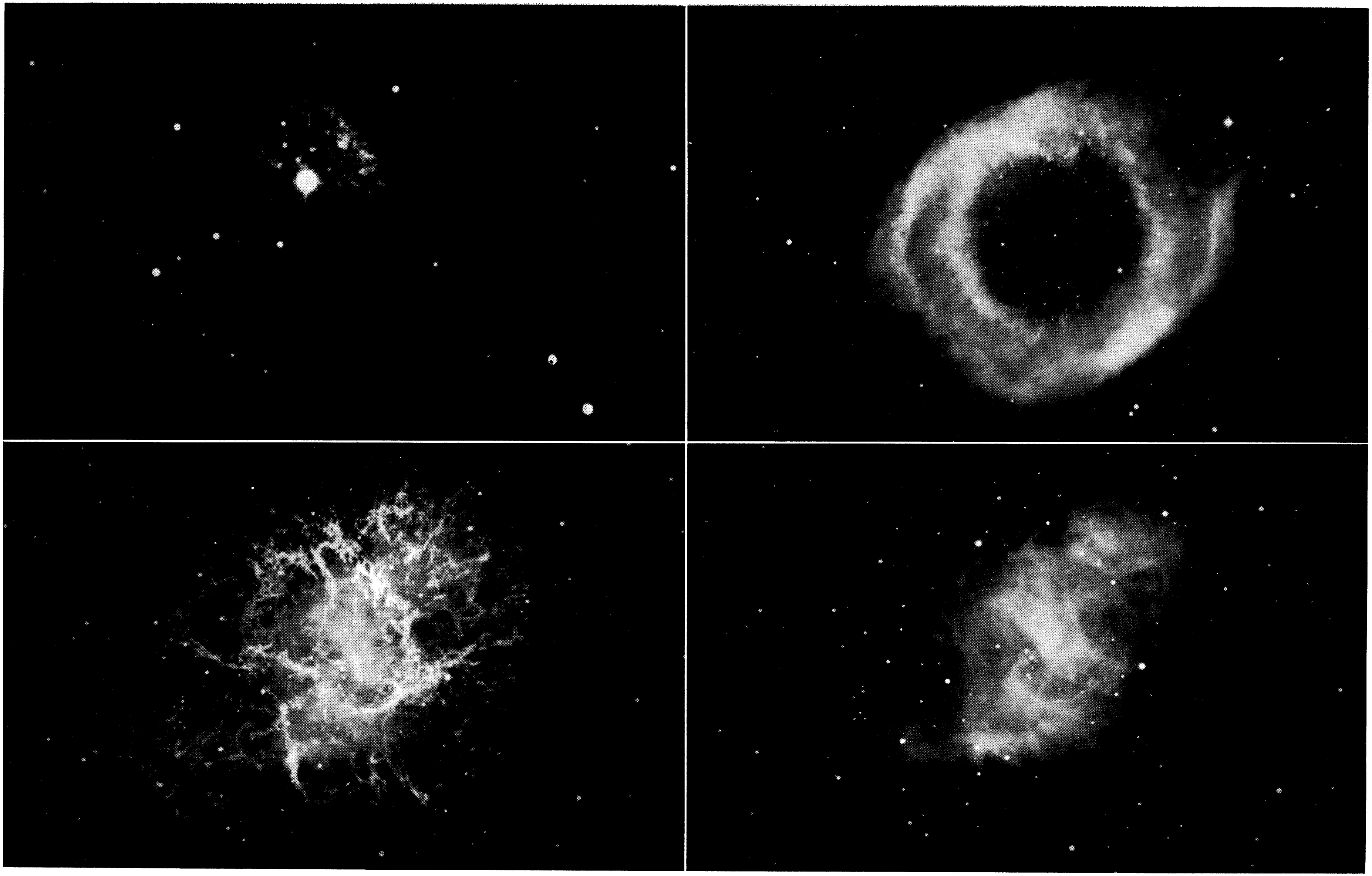
BY COURTESY OF (LEFT) THE LICK OBSERVATORY, (TOP RIGHT, BOTTOM RIGHT) THE MOUNT WILSON AND PALOMAR OBSERVATORIES

THREE TYPES OF GALACTIC NEBULAE: REFLECTION, DARK AND VARIABLE

Left: Pleiades (M45). This nebulosity is reflected and scattered starlight. Stars in the cluster provide the light, and surrounding clouds of finely divided dust particles reflect and scatter the rays from the stars. Distance to cluster, 490 light-years

***Top* right:** Horse-head nebula (IC 434) south of the star Zeta Orionis. This is a denser part of a larger dark cloud on the right that nearly blots out the light from stars behind it. The brightly illuminated edges suggest the presence of one or more stars just on the far side of the horse's neck

Bottom **right:** Hubble's Variable nebula (N.G.C. 2261) in Monoceros. One of a rare class of nebulae, this shows irregular changes in light and structure but without any evidence that its parts moved during 30 years of observation



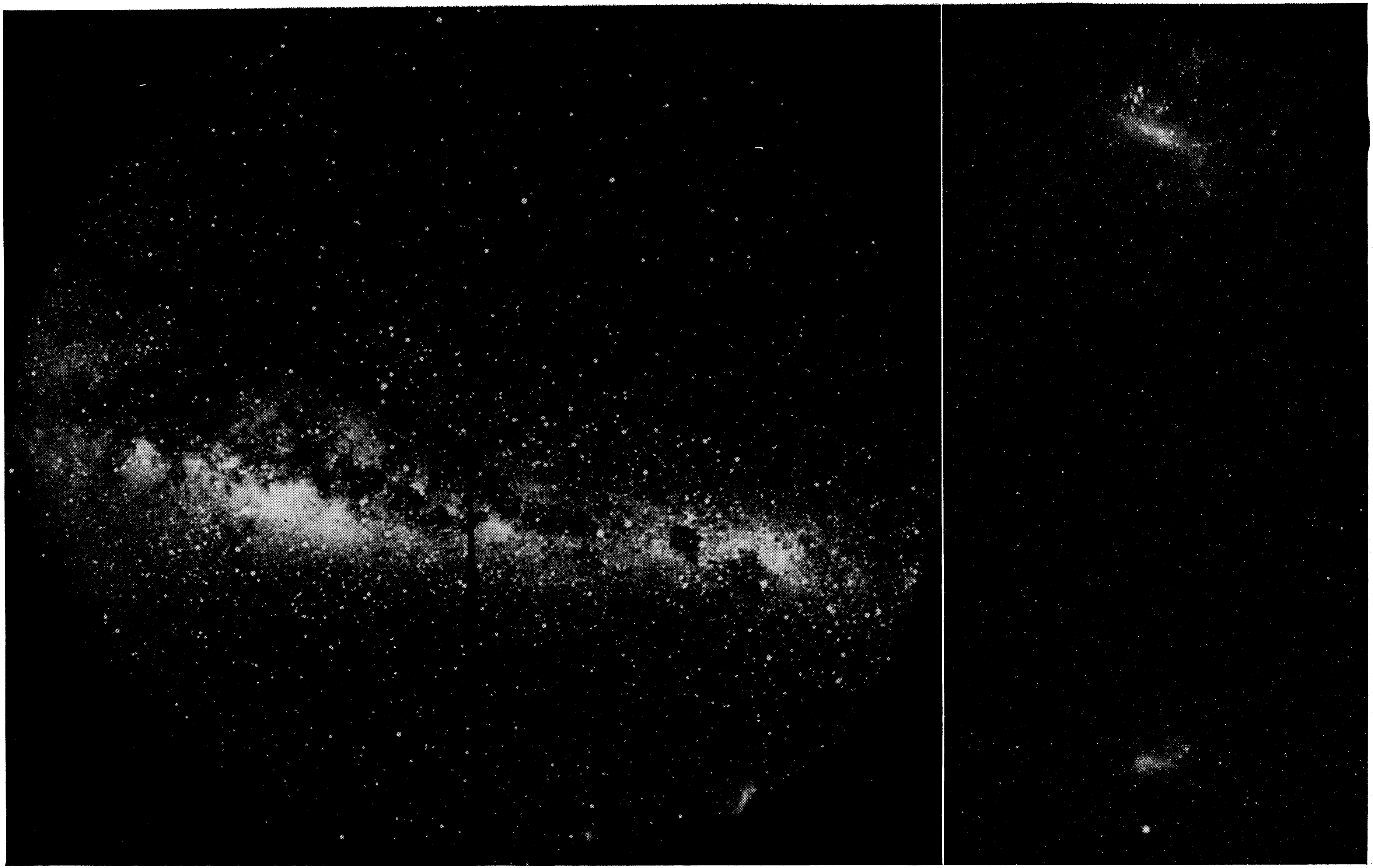
BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

EXPANDING GALACTIC NEBULAE

Top left: Nova Persei (1901) and its expanding nebula photographed in red light. A common nova which erupted in 1901 and is expanding 400 mi./sec., is 1,500 light-years distant

Top right: Helical nebula (N.G.C. 7293) in Aquarius, the largest known planetary nebula, a ring of gas made luminescent by the strong ultraviolet radiation from central, very hot stars. As suggested by the appearance of inner filaments, the gases are moving radially outward, with a speed of a few miles per second

Bottom: Crab nebula (N.G.C. 1952 M1) in Taurus photographed in red (left) and yellow (right) light. This is the gaseous remnant of the galactic Supernova of A.D. 1054 observed by the Japanese and Chinese. It was seen in daylight and was visible in the night sky for almost two years. The nebula is 5,000 light-years away and expanding 700 mi./sec.; it is a bright radio source, and part of its light is polarized. The red light photograph shows the highly filamentary structure in the light of hydrogen, oxygen, nitrogen and neon gases; the yellow light photograph indicates the amorphous and diffuse cloud of polarized light, believed to be produced by high-energy electrons accelerated in a magnetic field (synchrotron radiation)

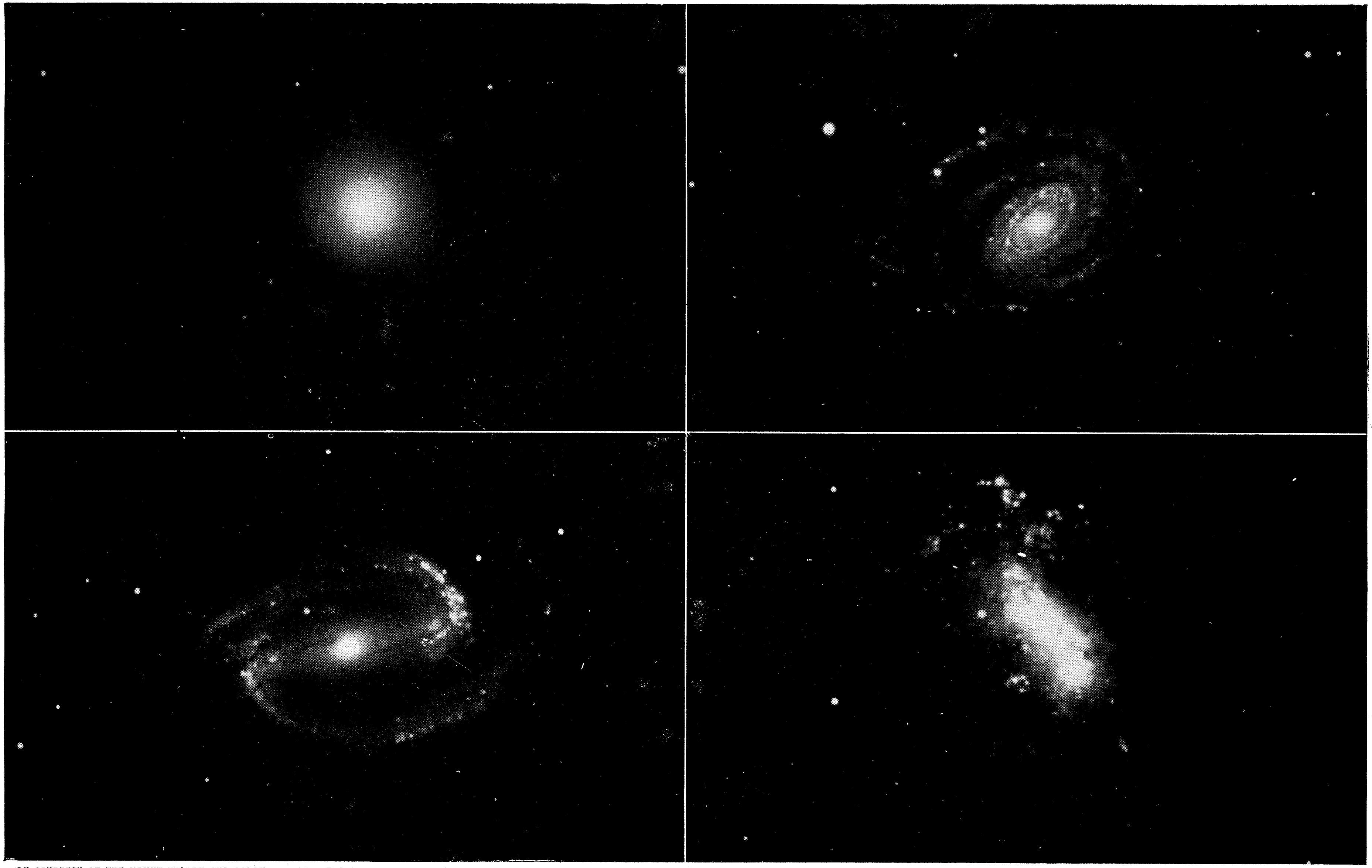


BY COURTESY OF (LEFT) A. D. CODE AND T. E. HOUCK, WASHBURN OBSERVATORY, UNIVERSITY OF WISCONSIN, (RIGHT) G. DE VAUCOULEURS, MOUNT STROMLO, CANBERRA

THE MILKY WAY AND THE MAGELLANIC CLOUDS

Left: A wide-angle (140") photograph of the centre of the Milky Way stellar system, or Galaxy, taken from the Union of South Africa. The galactic centre lies 30,000 light-years in the direction of the brightest star cloud to the left and slightly below the centre of the photograph. (The dark lines in the photograph are shadows of the photographic plate holder and its three supports). At the bottom of the picture, and slightly to the right, are the Magellanic clouds, the nearest extragalactic nebulae, 200,000 light-years away, seen beyond the foreground Milky Way stars

Right: More detailed views of the Magellanic clouds, from a short-focus camera composite picture. In this enlargement the irregular structure of clouds of stars, gas and dust — similar to the Milky Way — may be seen



BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

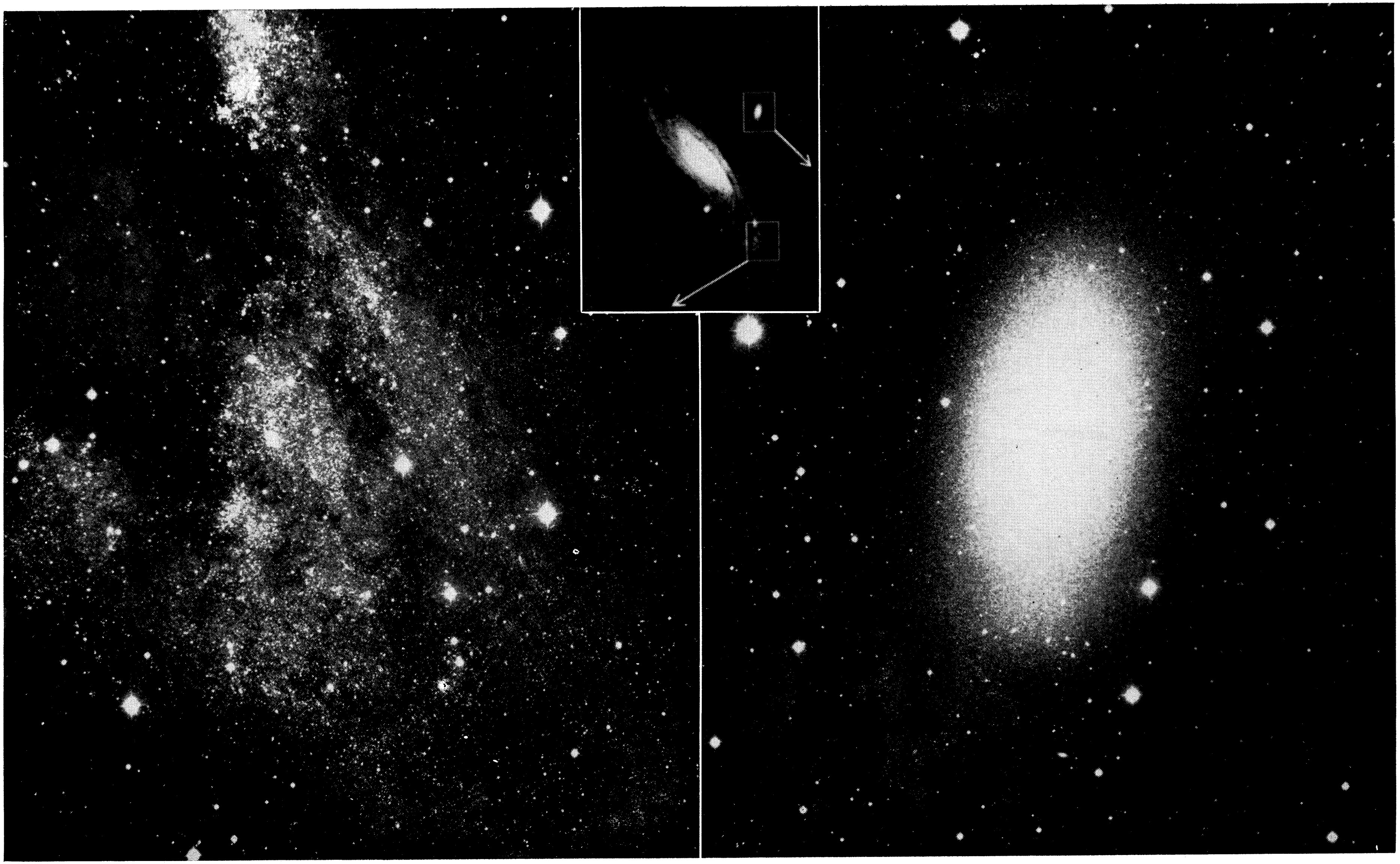
PRINCIPAL TYPES OF EXTRAGALACTIC NEBULAE

Top left: An elliptical (E) nebula, N.G.C. 4486 (M87). Except for a few of the nearest ones, these nebulae are unresolvable into stars, even by the largest telescopes. They range from the globular form shown here to the flatter lenticular shape

Top right: Spiral (S) nebula, N.G.C. 5364. This is a normal spiral, resolvable into its brightest stars under certain conditions

Bottom left: Barred spiral (SB) nebula, N.G.C. 1300. An example of the spiral that shows a bar as the most conspicuous structural feature

Bottom right: Irregular (Irr) nebula, N.G.C. 4449. Like the Magellanic clouds, this type of nebula shows little regularity of structure, although in many cases there appear to be incipient bars and spiral arms



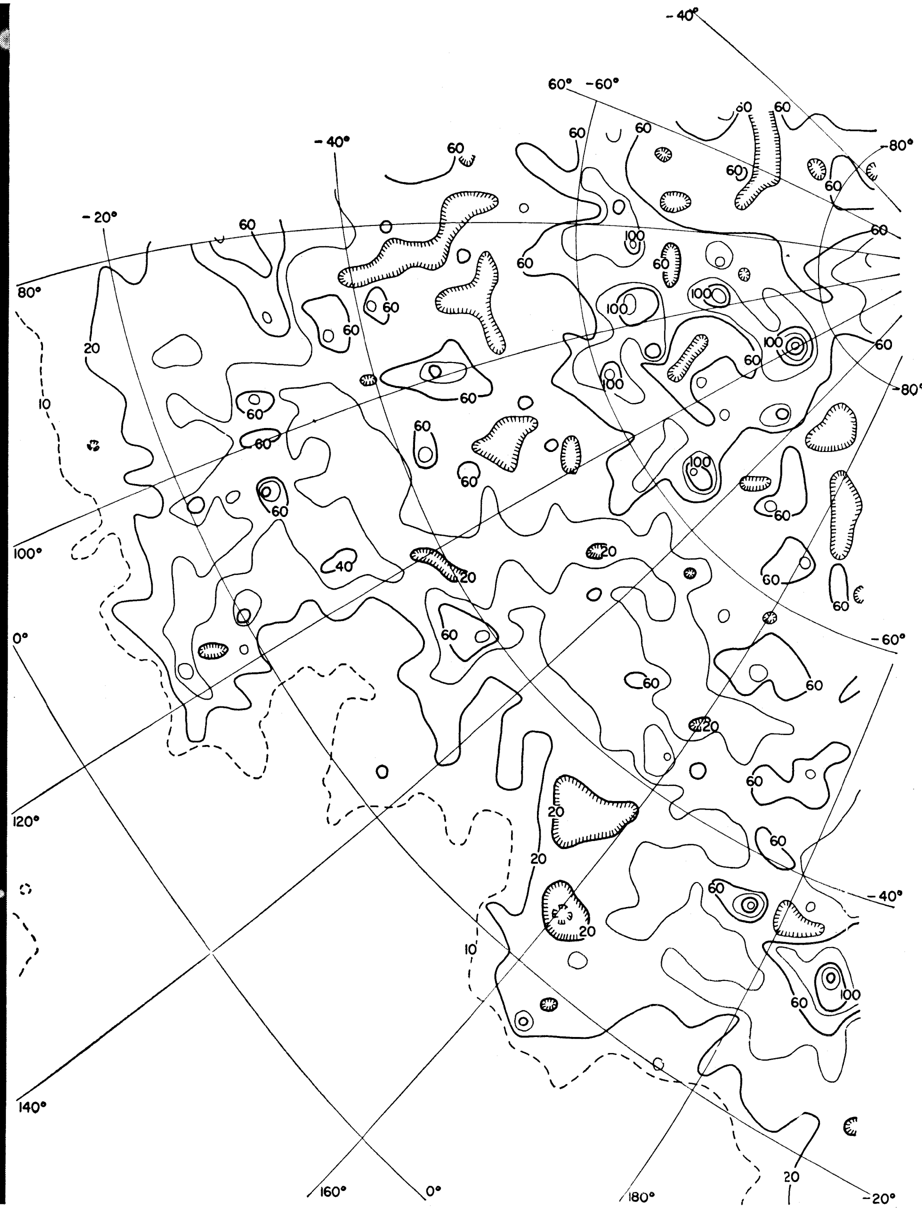
BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES

BAADE'S STELLAR POPULATIONS I AND II

Left: Detail of the spiral arms of the Andromeda nebula (inset) showing the giant and super-giant stars of Population I. The hazy patch at the upper left is composed of unresolved Population II stars. (Photographed in blue light)

Right: N.G.C. 205, companion of the Andromeda nebula (see inset), showing stars of Population II. The brightest stars are red and 100 times fainter than the blue giants of Population I. (Photographed in yellow light)

NOTE: THE VERY BRIGHT, UNIFORMLY DISTRIBUTED STARS IN BOTH PICTURES ARE MEMBERS OF THE MILKY WAY SYSTEM



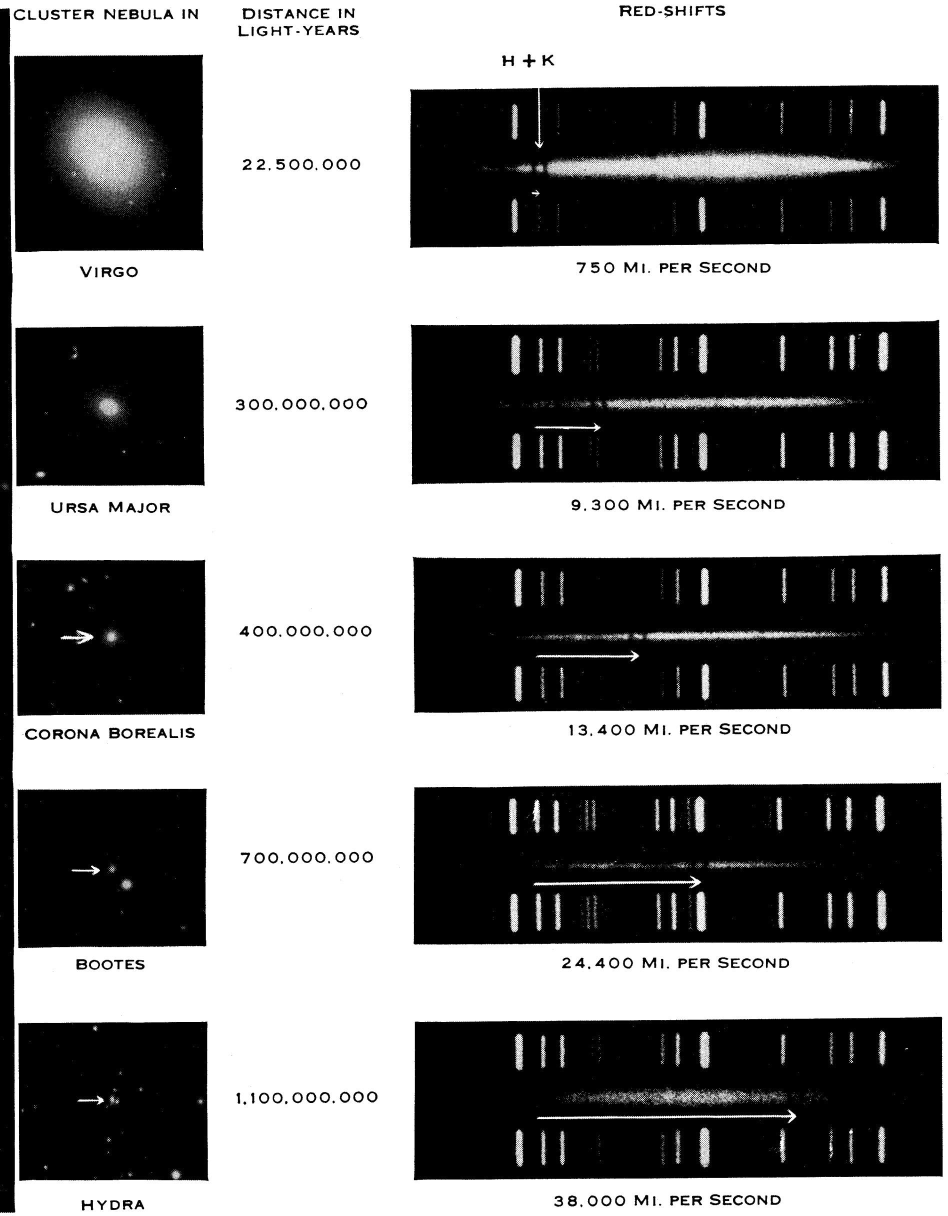
BY COURTESY OF (LEFT) THE MOUNT WILSON AND PALOMAR OBSERVATORIES, (RIGHT) C. D. SHANE, LICK OBSERVATORY

GROUPING AND DISTRIBUTION OF EXTRAGALACTIC NEBULAE

Left: Small group in Leo (left to right: N.G.C. 3185, 3190, 3187, 3193). These four members of a group about 20,000,000 light-years away show how the most diverse nebular forms are found in close association

Right: Contour chart of faint extragalactic nebulae in about 1/7 of the sky. The grid lines are galactic longitude and latitude, with a part of the Milky Way Circle (0°) shown lower left. Numbers on the contour lines represent the number of nebulae per square degree and they identify curves of equal surface-density. The white area near the Milky Way is the "zone of avoidance"; galactic dust blots out the extragalactic nebulae in the background. Outside of this zone the density of nebulae tends to increase as higher latitudes are reached, toward the south galactic pole at upper right

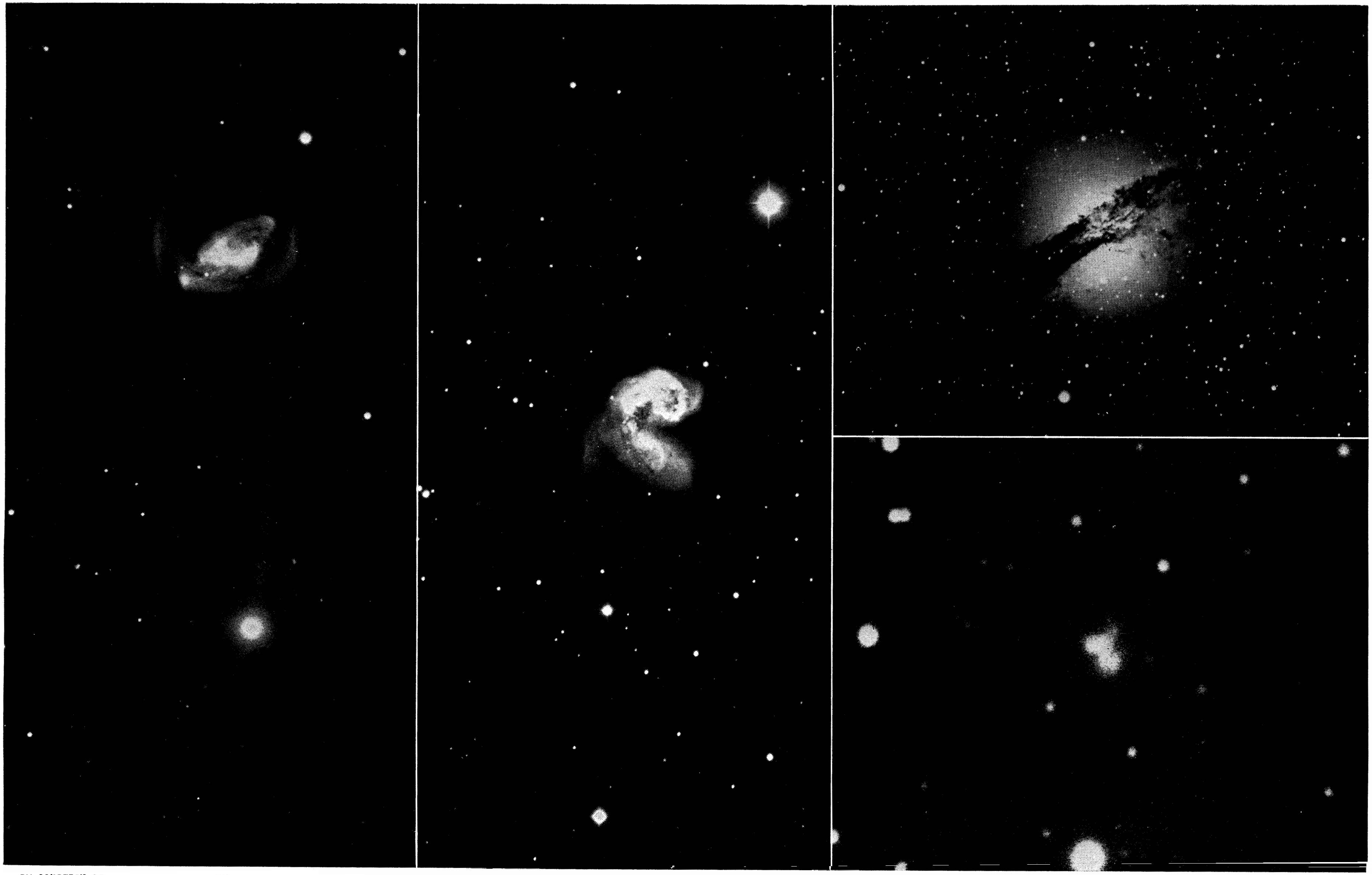
BY COURTESY OF THE MOUNT WILSON AND PALOMAR OBSERVATORIES



THE OBSERVATIONAL BASIS OF THE EXPANDING UNIVERSE

Left: Cluster of extragalactic nebulae in Corona Borealis. This cluster of several hundred nebulae is typical of those in which apparent brightness measurements are made to estimate the greatest astronomical distances, in this case 400,000,000 light-years. The arrow points to one of the brighter members whose spectrum was photographed to determine the red-shift of its spectrum lines, as indicated in the central part of the chart at the right

Right: Direct (left) and spectrum (right) photographs of extragalactic nebulae. The direct photographs indicate the decrease in size and apparent brightness as distance increases. The right-hand column shows corresponding nebular spectra, with arrows to indicate the displacement toward longer wave lengths (red) of the principal feature, the H and K lines of calcium. These red-shifts, when interpreted as motions of recession and plotted against distance, give Hubble's velocity-distance relation, which is the empirical basis for theories of the expanding universe



A CONNECTED PAIR AND THREE COLLIDING PAIRS

Left: Keenan's connected pair (N.G.C. 5216, 18), streamer-connected extragalactic nebulae. The two nebulae, one a spiral and one globular, are connected by a filament composed mainly of stars rather than gas. Distance of the pair is about 55,000,000 light-years, and the projected length of the streamer 55,000 light-years

Centre: Colliding nebulae (N.G.C. 4038-39 in Corvus). Long tidal filaments arc out from each of the irregular spirals as a result of the collision. These extragalactic collisions provide weak radio sources

Right, top: Centarus A or N.G.C. 5128, moderately strong radio source resulting from the collision of a spiral nebula (shown edge-on) with a globular nebula. The pair is about 5,000,000 light-years distant

Right, bottom: Cygnus A, the second-strongest discrete radio source known, a violent collision between two stellar systems 270,000,000 light-years away. As in other collisions, the inter-stellar gaseous material and dust are most strongly affected, the probability of stellar populations colliding being extremely small end where redshifts are of the order of one-fifth the velocity of light, and i are of i order of a billion I - At this point there was some evidence that redshifts are getting larger than expected from a straight line fitted to the rest of the observations. If the effect is real, and correctly interpreted, it would be of high cosmological interest, because an apparently abnormal acceleration in redshift with distance could imply a deceleration in the expansion. This paradoxical result follows from the fact that when we go far out in space we also go far back in time. Thus if the most distant nebulae are found to be expanding faster, compared to the near ones, then the expansion in our own part of the universe has slowed down during the lair billion years. Other important corollaries would be that the universe is not static but is still evolving, and that it is bounded rather than infinite.

Stellar Populations and Evolution.—In 1944 W. Baade, using the Mount Wilson 100-in. reflector lo maximum advantage in a sky darkened by the wartime blackout, reported the resolution for the first time of the amorphous nuclear region of the Andromeda nebula into myriads of faint stars. His technique involved the use of photographic plates very sensitive to red light, and long exposures under critically good conditions. At the same time he also resolved the several fainter elliptical companions of the large spiral. These were results of great importance, for they showed that the generally smooth and featureless light in elliptical nebulae and in nuclei of spirals comes from stars of a different kind than those forming spiral arms. In the latter the brightest stars are blue-white supergiants often enmeshed in dark matter, while in the nuclear regions and in elliptical nebulae the brightest stars are yellow-red giants. Since supergiant stars may be hundreds of times intrinsically more luminous than giants, it is easy to understand why elliptical nebulae were, and still are, so difficult to resolve into stars, even with the largest telescopes.

Although Baade's observations represented a real telescopic triumph, his interpretation of them proved to be of surpassing significance. First, he stressed the close association of blue supergiants, interstellar material and diffuse gaseous nebulae in spiral structure, which he termed stellar population I. Second, he emphasized the similarities of the spherical distributions, colours, and luminosities of the galactic globular cluster stars with the elliptical nebular and nuclear region red giants, which he called stellar popu- t i II. These two populations also have dissimilar dynamics: type 1 participates primarily in the genera! rotation in the principal plane and has a small internal velocity dispersion; type II, on the other hand, shows little tendency toward genera! rotation and has a high internal velocity range, Thus type I is essentially a disk or fundamental-plane population, while type II is a halolike population surrounding and permeating the entire system. The distinction between the two populations, however, goes even deeper than their differences in spatial distribution and dynamics, As the result of much modern work stimulated by Baade's discoveries, it is known that the two populations represent separate rages in stellar evolution: type I *is* young, type II is old, and the age difference is measured in billions of years.

The blue supergiants of population I pour out radiation at so high a rate that they consume their hydrogen fuel in the astronomically short time of a few millions or tens of millions of years. These relatively brief lifetimes mean that some supergiants are continually forming in the spiral structure, otherwise we should not see them over such a long range in time as inferred from their distances. Since their formation and fleeting cosmic existence require enormous quantities of the basic fuel, hydrogen, the conclusion is almost inescapable that they originate from the hydrogen-rich instellar gas and dust. The red giants of population II, by contrast, have reached a more mature state of life. They coolly maintain a high but not profligate standard of energy dispensation, thereby being rewarded with lifetimes hundreds of times longer. If they likewise originated from an interstellar medium, then their present properties suggest that they did so at a time far in the past when the entire parent system consisted largely of a primeval and turbulent mass, rather than of a well-defined rotating thin disk.

Consideration of the evolutionary differences between Baade's stellar populations I and II leads naturally to the more general question of how a whole extragalactic system may evolve. In particular, it may be asked whether Hubble's classification scheme corresponds to an evolutionary sequence. Our knowledge still is too scanty, however, to provide a satisfactory answer, although there are indications that the problem of nebular evolution eventually may be successfully attacked by the same procedures used i i lies of stellar evolution. For remarkable success was obtained during the decade 1947–57 by applying in astronomy the results from the rapidly developing field of physics concerned with element synthesis and atomic nuclear reacti . In this way astronomers obtained estimates of the ages of stars in galactic nebulae, open and globular clusters. Observationally, progress (lepended on the determination of precise colours and magnitudes for many stars in the group-;. and upon more detailed spectroscopic analysis of their light. But such information for extragalactic nebulae is more difficult and takes longer to obtain, rven with the largest telescopes.

This procedure involving colours, magnitudes and spectra of nebulae and their constituent parts represents a significantly different effort to understand nebular evolution. It studies the population characteristics and relates them to the observed nebular structure. Thus if the age properties of the populations are known, the structure may be related to age, arid the various kinds of structures may he arranged chronologically. It remains to be seen, however, whether the great variety of nebular forms means a great range in age, or, as seemed more probable in 1957, whether the different structures denote the presence, in different proportions, of various age groups in the same system.

Rotation of Spiral Nebulae.—The most casual glance at photographs of spiral nebulae suggests rotation, which is readily revealed spectroscopically by Doppler's principle for systems tilted toward the line of sight. V. M. Slipher and Max Wolf in 1914 and F. G. Pease (1881–1938) in 1916 pioneered in proving that the central parts of several of the brightest spirals, including the Andromeda nebula (M31), have a component of rotation in the line of sight. Because of the extreme faintness of the nebular light, further progress was slow, and even by 1950 only the two nearest and apparently largest spirals, M31 and M33, had been studied in any detail, chiefly by observations made at the Lick observatory by H. W. Babcock, L. H. Aller and N. U. Mayall. They obtained radial velocities for a number of gaseous nebulae located in the plane of each spiral, and were able to follow tilt: character of the rotst-ion out to the extreme limits shown on photographs. Except for a faster spin in a small nuclear region in M31, they found that the two spirals rotated similarly: out to a certain distance from their centres, the rotational motion increased nearly uniformly, 33 for a solid body, but that farther out the rotational velocity decreased, as for the planets in the solar system.

These two kinds of rotational motion reflect the distribution of mass: if it is more nearly spread out, solid-body rotation results; if highly concentrated toward the centre, Keplerian or planetary motion prevails. Comparison of these results with similar ones for the solar region of the galaxy, wherein an outwardly decreasing rotational motion is observed, gave additional support to the concept that the sun is located far from the galactic centre and beyond the main mass. Periods of rotation for the main bodies of M31 and M33 are 180,000,000 and 120,000,000 years, respectively, on the revised distance scale; for their outer parts, about 200,000,000 years, which is comparable to that for the sun's galactic orbit.

On the reasonable assumption of circular motion for ilia gaseous nebulae observed in rhe spirals, the latter's masses could be computed and compared with that of the galaxy. It was found that M31 and the galaxy are comparable giants, each having a total mass equivalent to 100,000,000,000 to 200,000,000,000 suns, but that M33, a more average spiral, contains mass aggregating about 3,000,000,000 to 4,000,000,000 suns. These rather crude optical observations, however, seem likely to be supplemented, or possibly replaced, by the more precise measurements made with the radio radiation from neutral hydrogen (*see* below).

Direction *of* Rotation *in Spirals*.—Closely allied with the character of the rotational motion of spirals is the question of how the movement takes place with respect to the curvature of the spiral arms; in other words, do the arms appear to be winding or unwinding? Slipher pioneered in this field, and on the basis of his rotation measures and his inferences of the true spatial orientation of the nebulae from their apparent or projected forms, he concluded that all spirals probably rotate in the same manner, namely, that the central part turns into the spiral arms like a coil spring being wound up. The interpretation of photographs of spirals to determine how the systems are located in space is not easy, however, and the criteria used by Slipher — asymmetries in the pattern of dark matter—were later (1934–40) construed in the opposite sense by Bertil Lindblad, whose theory of spiral stellar systems suggested a rotation with the arms leading instead of trailing.

The question was completely re-examined in 1942 by Hubble, whose study of the file of hundreds of large-reflector photographs disclosed four spirals suitable as test cases. In these the spiral pattern was plain, and the sense of tilt was unambiguously determined by primary and secondary dark lanes silhouetted against the bright nuclear region. From spectrographic observations of these four crucial-test spirals, made at the Xlount Wilson and Lick observatories, it was found that, in each case, the arms trailed. With supporting, but not decisive, evidence provided by similar modern observations of 11 other spirals, Slipher's earlier conclusion now may be accepted as fairly well established, namely, that all spirals rotate in the same way: as the central part turns, the arms lag behind.

Radio Observations. — A few years after the end of World War II radio astronomers found that the sky contains a number of discrete radio sources. These are distinguished from the general background of continuous cosmic radio radiation by their higher and localized intensities. But the first observations of the discrete sources gave only very crude positions and indications of size — much too imprecise to yield reliable correspondences with optical sources. The uncertainties were rapidly reduced, however, with the construction of larger antennas. and by the development of interferometer techniques. In this way the Australian radio-astronomers J. G. Bolton, G. J. Stanley and O. B. Slee in 1949 pinpointed two of the discrete sources with sufficient accuracy to make reasonably certain their correspondence with two known extragalactic objects. They suggest identification of the radio sources Centaurus A and Virgo A with two peculiar elliptical nebulae: N.G.C. 5128 and N.G.C. 4486 (M87j, respectively. The first of these is anomalous in having a great amount of lanelike dark matter, and the second is odd in showing a raylike jet extending from the nucleus. Why should these two elliptical nebulae, which are not exceptionally bright or large in the optical sky, be outstandingly bright in the radio sky? The most probable answer involves the recognition of two new phenomena in the universe beyond the Milky Way: (1) collisions between entire stellar systems, and (2) large-scale magnetic fields.

Collisions.—In 1951 F. G. Smith of Cambridge university, Eng., determined a highly precise position for one of the two brightest radio discrete sources, Cygnus A, and communicated the result to W. Baade and R. Minkowski, of the Mount Wilson and Palomar observatories. Using the 200-in. telescope, they were able to make an unambiguous identification of the radio source with an 18th-magnitude close pair of nebulae, which are among the brightest members of a faint cluster. Since close pairs of nebulae are fairly common, this particular faint pair must he most unusual in some way, in order to account for the exceptionally high radio radiation.

Spectroscopic observations provided the answer: much of the light in each component comes from masses of gas in highly ionized states. such as would be produced by collisions between clouds of gas and dust in the two systems. The stars in such an encounter would be unaffected, except for slight disturbances of their paths, because their distances apart are immense compared to those between atoms and dust particles.

This discovery by Baade and Minkowski led them to look for more cases of collisions among the brighter radio discrete sources, and in 1953 they reported two other probable examples: N.G.C. 5128 (Centaurus A) and S.G.C. 1275 (in Perseus). Again, as for Cygnus A, the decisive evidence is primarily spectroscopic, with support from zoo-in. telescope photographs. In both of these cases it appears that an elliptical or closely wound spiral nebula is being penetrated by a more open spiral or irregular nebula, and that clouds of gas are in collision. In fact, detailed spectrographic study of S.G.C. 1275 by Minkowski has shown that the two systems are only partially penetrating; part of the object shows two sets of spectrum lines, which correspond to the undisturbed parts of the two nebulae. while another part shows a single set indicating large internal motion. This is to be expected after collision, for the two sets of spectrum lines set a lower limit to the relative velocity of approach: about. 2,000 mi. per second. Moreover, Minkowski has calculated that the collision will last nearly a million years, and that it has progressed more than halfway.

These observations made by radio and optical astronomers suggest that collisions among extragalactic nebulae may be common. Even before they were made, however, Baade and L. Spitzer of Princeton university observatory calculated in 1951 that collisions between nebulae in compact clusters: like the rich one in Coma, would be frequent enough to affect the appearance of the colliding objects. They pointed out there are many nebulae in the cluster that have the right shape for spirals, but that they do not show dust and gas in spiral arms — as if successive collisions had strained out such interstellar matter. 'Their calculations for the denser central region indicated 5 to 30 collisions per member during an interval of 5,000,000,000 years. The encounters would be of various degrees of violence: from nearly direct hits, perhaps like Cygnus A. through partial penetrations similar to N.G.C. 5128 and S.G.C. 1275, to glancing blows or just close approaches. The latter would be revealed by tidally distorted spiral structure, and possibly by connecting filaments. Many such apparently irregular double and multiple nebulae are known in the optical sky. As radio telescopes improve in power and resolution, it is expected that among the fainter discrete radio sources there will be found many interesting cases of interacting systems.

Cosmic Magnetic Fields. — The discovery of polarized light from the galactic Crab nebula (*see* above) and its reasonable explanation as radiation from electrons accelerated in a magnetic field, raised the question of whether a similar phenomenon would be observed on the extragalactic scale. This possibility was considered by a number of investigators attending the International Astronomical union symposium on radio astronomy, held in 19jj in Manchester. Eng. The discussions led to a suggestion that Virgo A (S.G.C. 4486, 5187) might be another case of a cosmic synchrotron because of the high ratio of radio to optical radiation, as in the case of the Crab nebula. The suspicion for M87 was beautifully confirmed observationally by Baade. He reported in 1956 that zoo-in. reflector photographs showed the light in the raylike jet is polarized, probably to the order of 30%, and that the plane of vibration of the electric vector is nearly along the line of the jet.

Neutral Hydrogen Radiation. — The first detection in an extragalactic source of netural hydrogen radio radiation of wave length 21 cm. was accomplislied in 1953 by the Australian radio-astronomers F. J. Kerr and J. V. Hindman. They observed both Magellanic Clouds with a 36-it. antenna that resolved regions about 1.5° in diameter, which is small enough to give information for individual areas of the considerably larger Clouds. They found that the amount of neutral hydrogen (H I) is about the same in both Clouds, hut from the optical observation that there is apparently much more obscuring dust in the Large Cloud than in the Small. they concluded that the ratio of gas to dust is very different in the two systems.

The surface distribution of the H I gas in the Large Cloud was iound to be similar in extent to the stars, while in the Small Cloud it appears to extend well beyond the central body of stars, with a protuberance toward the Large Cloud. The depth distribution of the H I gas suggested an irregular and flattened disk seen nearly iace-on for the Large Cloud, and a more regular, possibly spheroidal form for the Small Cloud. They also obtained radial velocity measurements of relatively high precision that made possible detailed studies of systematic motions in both Clouds.

Radio *Observations* oj *Rotation.*—The Australian radio observations of the radial velocities of H I gas in the Magellanic Clouds were analyzed in 1955 for rotation, velocity dispersion and mass distribution by Kerr and de Vaucouleurs. From about 250 regions in the Clouds they obtained good evidence that in each system there is a rotating, flattened mass of H I gas concentrated around a iundamental plane inclined to the line of sight: 65° and 30° for the Large and Small Clouds, respectively. The high angle for the Large Cloud means that less than half of the rotational velocity is observable in the line of sight component, and that there is considerable uncertainty in estimates of its mass and period of rotation. Nevertheless, the radio observations are sufficiently accurate to give results of much interest, especially for comparison with the optically measured velocities in the Clouds and in the two nearest spirals M31 and M33. The Clouds apparently rotate like the spirals: but soinenhat more slowly. Their central or main parts turn nearly like solid bodies, with periods of the order of 150,000,000 and 350,000,000 years for the Large and Small Clouds, respectively; corresponding computed total masses are 3,000,000,-ooc and 1,000 000,000 suns.

One respect in which the Clouds differ dynamically from M31, M33 and the galaxy, however, is in the random motions: these are of the same older as the maximum observed rotational component of 20 mi. per second. This result, together with the numerous blue-white supergiants and great amount of dust and ionized gas in the Large Cloud, may indicate an early state of development, as suggested in 1950 by Shapley and advocated theoretically in 1951 by C. F. von Weizsächer and by F. Hoyle. Magellanic-type systems may in general, therefore, be young compared to spirals.

Thus the studv of nebular rotation bv radio observations of the 21-cm. radiation of H I promises to be one of the most fruitful approaches to an understanding of the dynamics and evolutionary differences among extragalactic nebulae. But similar work on systems other than the Magellanic Clouds requires the use of still larger antennas, in order to reduce the size of the area that can be resolved.

Radio **Redshifts.**—In order to test, as severely as possible by spectroscopic means, the possibility that the redshifts observed in nebular spectra are due to recession, it is desirable to measure over as long a wave length range as possible the ratio of $\Delta\lambda/\lambda$. Here $\Delta\lambda$ is the shift, and λ the normal wave length, of any spectral feature measured. Doppler's principle predicts that, if a shift is due to motion in the line of sight, then $\Delta\lambda/\lambda$ must be the same for all wave lengths. In the optical spectra of nebulae it has been possible to investigate this ratio over a range of wave lengths that differ only by a factor of 2. Although $\Delta\lambda/\lambda$ has always been found constant to within the errors of measurement, and for the largest redshifts, astronomers realized that it would be of extraordinary cosmological interest, if a fairly large redshift could be measured in the radio range of wave lengths, which are longer than light waves by a factor of several hundred thousands. Such a significant radio observation was made in 195j by A. E. Lilley and E. F. McClain of the Naval Research laboratory, Washington, D.C. They used a jo-ft. antenna to measure, by an ingenious new method, the absorption of 21-cm. H I radiation from the bright radio source Cygnus A, identified as a pair of colliding extragalactic nebulae *(see* above). They obtained a radio redshift of 10,400 mi. per second, which agrees with Minkowski's optical one as closely as the errors of observation permit.

A year later D. S. Heeschen, using the 24-ft. radio telescope of Harvard College observatory, detected 21-cm. H I radiation in emission from the compact ciuster of nebulae in Coma. He was also able to measure the average radio redshift of the cluster as $4{,}350 \pm 120$ mi. per second, which agrees satisfactorily with Humason's optical one of 4,150 mi. per second.

These observations of radio redshift greatly strengthen the interpretation of nebular redshifts as velocities of recession, for they verify the Doppler necessary condition of constancy of $\Delta\lambda/\lambda$ over an enormous range of wave lengths, 500,000 to 1. Furthermore, they suggest that radio astronomical techniques are an exceedingly powerful probe of the most distant parts of the universe. As Minkowski pointed out in 1956, existing radio telescopes could detect colliding pairs like Cygnus A that are only $\frac{1}{3{,}000}$ as intense, which offers the possibility of following the redshift to incredible distances. If radio radiation weakened only inversely as the square of the distance, the most violently colliding nebulae could be observed 50 times farther than Cygnus A, or out to 15,000,000,000 light-years. But because receding objects appear fainter, even in the radio range of wave lengths, this distance would be reduced. Even so, there appears to be an excellent chance that radio-astronomy, with the design or construction under way for 140-, 250- and possibly 600-ft. telescopes, mill contribute significantly to knowledge of the universe beyond the bounds of optical astronomy.

See also Index references under "Nebula" in the Index volume.

Bibliography.—Galactic nebulae are treated in a number of books; one of the most readable: best illustrated and semitechnical is by B. J. and P. F. Bok, *The Milky Way* (1957); more technical ones are by L. H. Aller, *Gaseous Nebulae* (1956), and by J. Dufay, *Galactic Nebulae and Interstellar Matter* (Eng. trans., 1957). For extragalactic nebulae, there is the classic by Edwin Hubble, *The Realm of the Nebulae* (1936), and the account of Harvard work by Harlow Shapley, *Galaxies* (1943); for the latter a modern, revised edition has been published as *The Inner Metagalaxy* (1957). More specialized? is F. Zwicky's *Morphological Astronomy* (1957), and articles in A. Beer (ed.), *Vistas in Astronomy,* vol. 2 (1956). On the theoretical or cosmological side, in order of increasing technicality are: G. Gamow, *The Creation of the Universe* (1952); P. Couderc, *The Expansion of the Universe* (Eng. trans., 1952); G. C. McVittie, *General Relativity and Cosmology* (1956). An excellent series of articles on the universe, by authorities in their fields, is in *Scientific American,* Sept., 1956. (N. U. M.)

NEBULAR THEORY: *see* Cosmogony.

NECESSITY: *see* Free Will.

NECK, in geology, the denuded stump of an extinct volcano (for the neck in anatomv *see* Muscle and Muscular System: Skeleton, Vertebrate). Beneath every volcano there are passages or conduits up which the volcanic materials were forced, and after the mass has been leveled by denudation there is always a more or less circular pipe which marks the site of the crater. This pipe, filled with ashes or lava, is the characteristic of a volcanic neck.

In regions of former volcanic activity necks are the most persistent of all volcanic structures because the active volcanic magma is located deep within the earth's crust and the pipe by which it rises to the surface is of great length and traverses a great thickness of strata. This extensive pipe was usually vertical and nearly uniform in diameter for great depths; when exposed by denudation it has a circular ground plan, or if shown in vertical section (or elevation) in a cliff it is a pillar-shaped mass crossing the bedding planes of the strata nearly at right angles. It terminates upward in the remains of the volcanic cone and communicates below with the reservoir from which the lavas were emitted, represented in most cases, where it has been exposed, by a large irregular mass (a batholith or boss) of coarsely crystalline igneous rock. The site of such a neck is generally indicated by a low conical hill consisting of volcanic rock, surrounded by sedimentary or igneous strata of a different kind. The low cone is due to the greater hardness and strength of the volcanic materials and is not connected with the original shape of the volcano. Two splendid sugar-loaf cones known as the Pitons of St. Lucia, in the West Indies, rising from the sea with almost vertical sides to a height of nearly 3,000 ft., are old volcanic necks. In the United States (in Texas, New Mexico, Arizona, California and other western states) geologists have observed conical volcanic hills having all the features which belong to necks. In the British Isles examples are found in Derbyshire, Fife, the Lothians and the Glasgow district with the remains of Carboniferous volcanoes in every state of preservation.

Some have the conical hills of lavas and ashes well preserved (*e.g.,* Largo Law in Fifeshire); others retain only a small part of the original volcanic pile (*e.g.,* Arthur's Seat, Edinburgh; the Binn of Burntisland); and of the larger number nothing remains but the neck.

Where the volcanic rocks are soft and easily disintegrated the position of a neck may be indicated by a cup-shaped hollow; this is the case with some of the diamond-bearing pipes of south Africa. Examples are the Kimberley diamond mines. (*See* Diamond.)

The size of necks varies considerably; the smallest may be only 20 or 30 yd. in diameter, the largest are several miles. Occasionally a whole neck is composed of solid crystalline rock representing the last part of the magma which congealed within the crater. The Castle rock of Edinburgh is a neck occupied by a plug of crystalline basalt. Necks of this kind weather down very slowly and tend to form prominent hills. A particularly famous example is Devils Tower (*q.v.*), in Wyoming.

After the eruptions terminate, gases or hot solutions given out by deep-lying masses of molten rock may find a passage upward through the materials occupying the crater, greatly modifying their mineral nature and laying down fresh deposits (*see* Metasomatism). A good example of secondary deposits within a volcsnic neck is provided by the Cripple Creek mining district of Colorado. The ore-bearing veins are connected with volcanic rocks and part of these occupy a vertical circular pipe which is a typical volcanic neck. A phonolitic breccia, greatly altered, is the principal rock and is cut by dikes of phonolite, dolerite, etc. The country rock is mostly granite and gneiss. and blocks of these are common in the breccia. A large volcano was built up in Tertiary times on the granite plateau and has since been almost entirely removed by denudation. The gold ores were carried upward by currents of hot water derived from the volcanic magma and were deposited along cracks and fissures in the materials which occupied the crater. and also in the surrounding rocks. *See* also Geology; Ore Deposits. (J. S. F.; X.)

NECKAM, ALEXANDER (1157–1217), English schoolman and man of science, was born at St. Albans in Sept. 1157, on the same night as King Richard I. Neckam's mother nursed the prince with her own son, who thus became Richard's foster brother. He was educated at St. Albans Abbey school, and became schoolmaster of Dunstable, dependent on St. Albans abbey. Later he went to Paris, where by 1180 he had become a distinguished lecturer of the university. By 1186 he was back in England, where he again held the place of schoolmaster at Dunstable. The assertion that he was ever prior of St. Nicolas, Exeter, seems a mistake, but he was certainly much at court during some part of his life. Having become an Augustinian canon, he was appointed abbot of Cirencesler in 1213. He died at Kempsey in Worcestershire in 1217, and was buried at Worcester. Besides theology he studied grammar and natural history, but his name is chiefly associated with nautical science. In his *De naturis rerum* and *De utensilibus* (the former of which, at any rate, had become well known at the end of the 12th century, and was probably written about 1180) Neckam preserved the earliest European notices of the magnet as a guide to seamen — outside China, indeed, these seem to be the earliest notices that have survived in any country or civilization. It was probably in Paris that Neckam heard how a ship, among its other stores, must have a needle placed above a magnet (the De *utensilibus* assumes *a* needle mounted on a pivot), which needle would revolve until its point looked north, and thus guide sailors in murky weather or on starless nights. Neckam has no air of imparting a startling novelty: he merely records what had apparently become the regular practice of many seamen of the Catholic world. (C. R. B.; X.)

NECKAR, a river of Germany, 230 mi. long, and a right-bank tributary of the Rhine, rises in the Hercynian gneisses of the Black Forest, near Schwenningen and close to the headwaters of the Danube. It flows north and then northeast along the foot of the Jurassic scarp of the Swabian Jura, passing Rottweil, Rottenburg and Tübingen. At Plochingen it changes its course flowing away from the scarp edge to Cannstatt near Stuttgart. The valley is very picturesque, becomes broader and deeper, is now navigable and lies between vine-clad hills being cut into the middle Trias sandstones. Continuing north past hills crowned by feudal castles, it runs by Heilbronn and Wimpfen to Eberbach. It there takes a tortuous westerly course, and the scenery on its bank becomes more romantic. Winding by Neckar-Steinach and Neckargemünd between wooded heights, it sweeps beneath the Königsstuhl (1,857 ft.) washes the walls of Heidelberg. and enters the Rhine-trough from the right at Mannheim. (*See* Rhine.)

NECKER, JACQUES (1732–1804), French statesman, finance minister of Louis XVI, was born at Geneva in Switzerland. His father was a native of Cüstrin in Brandenburg, and became a citizen of Geneva. Jacques Necker had been sent to Paris in 1747 to become a clerk in the bank of M. Vernet. He soon afterward established the famous bank of Thellusson and Necker. He became an able director of the French East India company, and defended it against the attacks of A. Morellet in 1769. Meanwhile he had made interest with the French government by lending it money, and was appointed resident at Paris by the republic of Geneva. In 1773 Necker won the prize of the Académie Française for an *éloge* on Jean Baptiste Colbert, and in 1775 published his *Essai sur la législation et le commerce des grains,* in which he attacked the free-trade policy of A. R. J. Turgot.

In October 1776 Necker was made finance minister of France, with the title of director of the treasury, which he changed in 1777 to director-general of the finances. He regulated the finances by attempting to divide the taille or poll tax more equally, by abolishing the *vingtième d'industrie,* and establishing *monts de piété* (establishments for loaning money on security). But his greatest financial measures were his attempt to fund the French debt and his establishment of annuities under the guarantee of the state. In the operation of funding Necker rather pointed out the line to be followed than completed the operation. He treated French finance rather as a banker than as a political economist, and thus fell far short of Turgot, the greatest economist of his day. His establishment of provincial assemblies was only a timid application of Turgot's great scheme for the administrative reorganization of France. In 1781 he published his famous *Compte rendu,* in which he drew up the balance sheet of France. His dismissal in the same year was not really due to his book, but to the influence of Marie Antoinette, whose schemes for benefiting the duc de Guines he had thwarted.

In 1787 Necker was banished by *lettre de cachet* 40 leagues from Paris for attacking C. A. Calonne. In 1788 the country came to believe that Necker was the only minister who could "stop the deficit," as they said, demanded Necker's recall, and in Sept. 1788 he became once more director-general of the finances. Throughout the momentous months which followed the biography of Necker is part of the history of the French Revolution (*q.v.*). Necker put a stop to the rebellion in Dauphiné by legalizing its assembly, and then arranged for the summons of the states-general. Throughout the early months of 1789 he was regarded as the saviour of France, but he regarded the states-general as an assembly which should grant money, not organize reforms. But as he had advised the calling of the states-general, and the double representation of the third estate, and then permitted the orders to deliberate and vote in common, he was regarded as the cause of the Revolution by the court, and on July 11 was ordered to leave France at once. His dismissal brought about the taking of the Bastille, which induced the king to recall him. He was received with joy in every city he traversed, but in Paris he proved himself unequal to the crisis. After his resignation (Sept. 1790) he lived at Coppet, near Geneva.

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NECROSIS is a term used in pathology to describe the death of a circumscribed area of tissue. It may result from loss of blood-supply to an area, from toxic agents, from physical trauma or from the action of bacteria. The characteristic changes of necrosis are due to the activity of intracellular enzymes and consist for the most part of a breakdown of organic material of the nucleus and cytoplasm of the cell. *See* also GANGRENE. (F. L. A.)

NECTAR, the nourishment of the gods in Homer and in Greek literature generally. *See* AMBROSIA AND NECTAR.

NECTARINE, a smooth-skinned peach (*Prunus persica,* var. *nectarina*), known for more than 2,000 years. In tree shape and leaf characteristics the peach and nectarine are indistinguishable, but the nectarine fruits look more like plums than peaches because of the smooth skin. There is an outgrowth of epidermal hairs or fuzz from the skin of peach varieties, while on the skin of nectarine varieties these hairs are absent. The stones and kernels of the two fruits are alike in appearance. Like peaches, nectarines have red, yellow or white flesh and have a characteristic aroma and flavour. They are adapted to the same soil and climatic conditions suitable for peaches and require the same cultural treatments for successful production. There are clingstone and freestone nectarines. When some peach clones are crossed or self-pollinated, the resulting seeds that carry the factor for smooth skin may give rise to nectarines, while those that do not carry this factor will be peaches. Nectarines may sometimes appear on peach trees as a result of the process of bud variation or bud sporting, a vegetative deviation from the normal. Peaches occasionally occur spontaneously on nectarine trees in the same manner.

Fruits of the nectarine are more subject to fungus diseases than peaches, particularly brown rot, and when grown in humid regions must receive frequent sprays of fungicides and insecticides to control diseases and insects.

Stanwick, Quetta, Gold Mine and Le Grande are well-known varieties in California. In the eastern United States, Cavalier and Garden State are better-adapted varieties for the humid conditions.

See also PEACH. (F. P. C.)

NEDIM, AHMED (1681–1730), Turkish poet, whose poems present a vivid picture of the wealth and elegance of early 18th-century Istanbul. Born in Istanbul, the son of a judge and brought up as a scholar, he won the patronage of the grand vizier Ibrahim Pasha, who gave him an appointment, and became a prominent figure in the so-called "Tulip age" under Ahmed III. He died in obscure circumstances in 1730, the year of the revolution led by Patrona Halil. He was that rare thing—a poet of the old school who freed himself sufficiently from its fetters to be able to express his personality in a style of great beauty. His *Kasides* (odes) and *gazels* (lyrics) are bright and colourful and he excelled in his gay and lively *sharkis,* which are still sung. His masterly handling of the language has made him the most popular of divan poets.

His *Divan* was edited by Halil Nihad in 1922.

See E. J. W. Gibb, *A History of Ottoman Poetry,* iv (1904). (F. I.)

NEEDLE. An instrument adapted for passing a thread through fabrics in sewing, consisting of a thin rod of steel, having a pointed end and pierced with a hole or "eye" to carry the thread.

The modern high quality needle is made from Sheffield crucible cast steel. The type of steel varies according to the purpose of the needle, thus hosiery needles are milder; *i.e.,* softer than sewing needles. In addition to grading the initial hardness of the steel to the particular type of needle there has also been a forward movement in the use of alloy steels for specific purposes. High chromium or stainless steels, for example, have an evident value in the case of surgical and hypodermic needles. The steel is hot rolled down into rod and the rod subsequently cold drawn into wire of the required diameter. The finished drawn wire is fed through straightening machines which also automatically cut the wire into predetermined lengths. In hand sewing needles the length cut is always that required to form two needles. A number of these blanks are heated to a uniform dull red heat, placed within two steel rings, and rubbed to and fro over a flat steel plate. The rotation of the wires within the containing rings results in perfect straightness and the gradual cooling from a dull red heat gives uniformity of physical condition. The lengths are then automatically pointed by feeding from a container and being rotated over a revolving grindstone by a wheel running at right angles to the stone. The lengths are reversed and the process repeated — thus giving a blank with two pointed ends. This automatic grinding applies to all hand sewing needles; it should be noted that machine needle points are swaged: *i.e.,* the points are formed by cold hammering between dies. The double length hand needle is fed into an automatic press which stamps the grooves at the head of each needle and in a second operation pierces the eyes of each needle and nearly separates the two. Complete separation and dressing of the head and eye are now effected mechanically.

The needle thus formed is in its soft state and as with steel cutting tools it requires hardening to bring it into service condition. Hardening is effected by quenching in oil from a red heat. The hardened needles are then tempered by heating to a blue heat in order to give resilience or springiness. The tempered needles are to some extent discoloured by the heating and the final stages are found in scouring to remove this discoloration, and polishing to obtain the silver bright finish. Scouring is effected by packing the needles in flexible containers with various mixtures all having a fine emery base and mechanically rolling the container up and down an iron roller path. Polishing is done in a similar manner with polishing reagents replacing the scouring mixtures.

(P. Lo.)

NEEDLEWORK, or work done with a needle and thread, generally implies a hand craft. Plain needlework, or sewing, is discussed in the article SEWING, HOME. Art needlework includes the decorating of fabrics by embroidery stitches or patchwork; and the various methods of forming a single thread into fabric or lace, the best known of which are knitting, crocheting and tatting.

Embroidery. — Embroidery is an art, or craft, known to all countries and periods of history, and modern embroidery, it may be pointed out, is regaining the status of an art expression. The old techniques are used with new fluidity and freedom, often with stunning effect.

The design is usually marked on the fabric first, except in tapestry or cross-stitch work, in which the commonest practice is to copy the design by counting stitches and background threads. Embroidery stitches, beginning with the basic ones (*see* fig. 1), have an infinite number of variations, combinations, uses and methods of execution. For instance: tent stitch is also the petit point of tapestry, and cross stitch (*gros* point in tapestry) looks like tent stitch crossed; the two, however, are executed differently and have distinctive needle directions. Chain stitch is commonly seen in single lines; but many oriental hangings and rugs are made of chain stitch worked in close-laid rounds or back and forth.

Satin stitch and long-and-short stitch, almost invariable additions to "white work" and eyelet embroidery, are also responsible for the most opulent silk- and metal-thread effects in church vestments, hangings, etc., as well as for the colourful crewel work and for most of the older "pictures in stitches" not done in petit point. Couching stitch allows heavy yarns, even cords, to be attached without being passed through the fabric. Buttonhole stitch is used to edge cut-out designs and form bars in cut work, done on linen.

Other forms of decoration through stitches are (1) drawn work, in which threads are pulled out of the fabric in a design (this includes hemstitching); (2) smocking, in which gathers are drawn up and assembled, with the help of decorative stitches, into groups to form a design; and (3) appliqué, in which pieces of fabric, usually in contrasting colours, are cut into designs and attached to the background with either a sewing or an embroidery stitch. (See also TAPESTRY; EMBROIDERY; TEXTILES.)

Knitting and Crocheting. — Both these forms of needlework require forming loops out of thread or yarn and drawing them through each other. The slender rods (needles, hooks; *see* below) by means of which this work is done range from wire thin (metal), used with fine thread, to finger thick (wood or plastic), for heavy yarns. Medium-sized plastic or metal needles and hooks and medium-weight yarns are most commonly used. Knitted fabrics have much more elasticity and pliability than crocheted ones. hence, knitting commonly is used for close-fitting garments, such as stockings and sweaters, and draped ones, such as dresses Crochet nork, on the other hand, offers greater variety in stitch design. The information that follows should enable a person to work from printed instructions for making a simple knitted or crocheted article. The "gauge" (number of stitches and rows per inch) given in such instructions results from the combination of size of yarn. size of needle and the tightness or looseness nith which an individual worker forms her stitches. Ideally a stitch is just loose enough to allow the needle or hook to slip through easily.

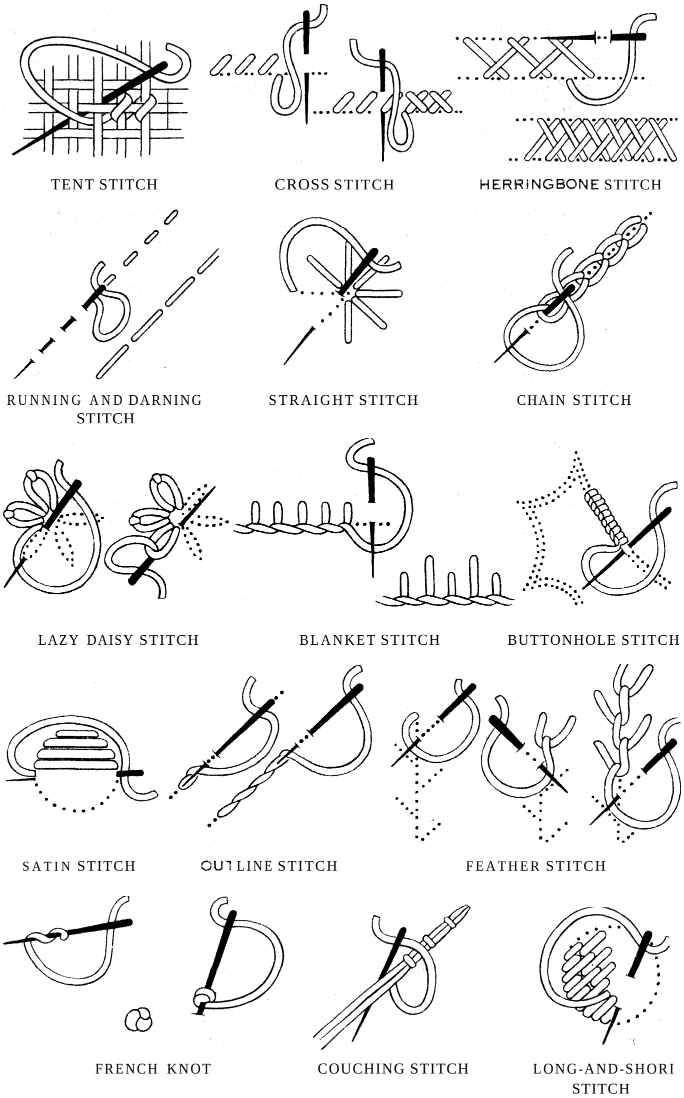

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FIG. 1.—BASIC EMBROIDERY STITCHES

Knitting. — Knitting is done with knitting needles, which come either in pairs, used for flat, back-and-forth work; or in sets of four or more, used for work in rounds, such as socks and mittens. Large circular work, such as a skirt, is done on a circular needle. Flat work is easiest, and should be practised first.

The work begins with casting on, or placing the first row of stitches on the needle. After malting the first stitch (fig. 2A) and drawing it up, proceed as in fig. 2B for as many stitches as needed. The needle with the stitches on it is then changed to the leit hand, the empty needle inserted into the first stitch (fig. 2C) and the yarn brought around (fig. 2D); the empty needle then forms a loop with the yarn and slips the old stitch off the left needle. This motion is repeated until all the stitches have been worked off the left needle and a second row is formed. The needles again change hands for the next row, and so on. This plain back-and-forth knitting is called garter stitch. Purling is knitting in reverse, the yarn being held in front and the needle going through from back to front, as shown in fig. 2E. Alternately knitting one row and

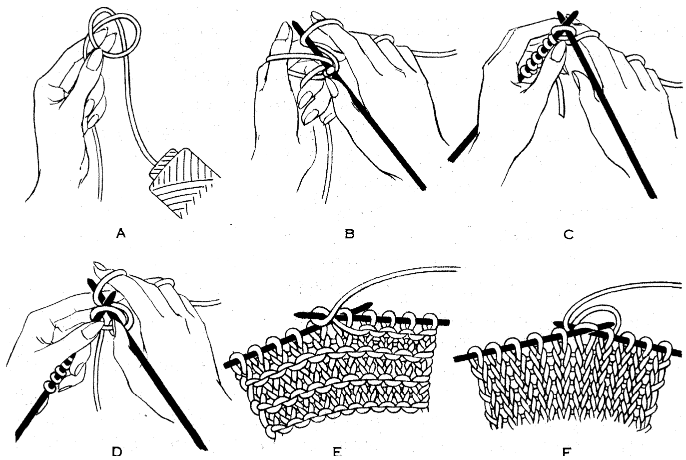

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FIG. 2.—STEPS IN KNITTING: (A) MAKING THE FIRST STITCH. (B) CASTING ON FIRST ROW OF STITCHES. (C) SECOND NEEDLE INSERTED INTO FIRST STITCH. (D) YARN BROUGHT AROUND NEEDLE TO START SECOND ROW. (E) PURLING AND (F) STOCKINETTE STITCH

purling one row is stockinette stitch (fig. 2F), the smooth-surfaced stitch of knitted fabrics.

To increase in knitting, the knitter knits two stitches in one stitch of the preceding row. To decrease, the needle is put through two stitches in the preceding row to form one new stitch. To slip a stitch means to lift it from the needle without knitting it. To pass slipped stitch over (another way of decreasing), the knitter knits one more .stitch and with the left needle brings the slipped stitch over the knitted stitch and over the tip of the needle. To cast off or hind off the knitter knits or purls two stitches and passes the first stitch over the second; knits or purls another stitch; and repeats until only one stitch remains. The yarn is then broken off and the end drawn through the loop. (*See* also KNITTING.)

Crocheting.—Crochet is the French word for "hook," the implement with which crochet work is done. The work starts with a crocheted chain (figs. 3A and B), except in cases where it is done on an existing article (a handkerchief. a garment, a covered ring, etc.). When the chain is made to the length indicated, the work proper begins. (Note: in counting stitches, the loop on the hook is omitted).

For single crochet, the hook is put through a stitch in the chain or the preceding row, the thread or yarn is caught (fig. 3C) and drawn through, then caught again (fig. 3D) and drawn through both loops on the hook. For double crochet, the thread is wound once around the hook ("thread over," fig. 3E) before the hook is

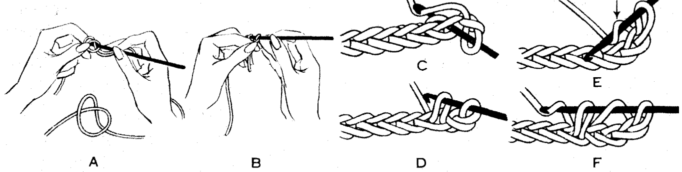

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FIG. 3.—STEPS IN CROCHETING: (A) MAKING THE FIRST LOOP ON THE HOOK: (B) STARTING THE CHAIN; FOR SINGLE CHOCHET. (C) PUTTING THE HOOK THROUGH A STITCH IN THE PRECEDING ROW TO CATCH THE THREAD AND DRAW IT THROUGH: (D) CATCHING THE THREAD AGAIN AND DRAWING IT THROUGH BOTH LOOPS ON THE HOOK; FOR DOUBLE CROCHET. (E) WINDING THE THREAD AROUND THE HOOK AND (F) CATCHING THE THREAD

put through the stitch; the thread is then caught (fig, 3F) and drawn through two loops at a time until cne loop remains on the hook. In treble crochet the thread is wound twice around the hook before it is put through. Half-double crochet starts the same way as double crochet, but after the first three loops are placed on the hook the thread is caught and drawn through all three at once.

Tatting.— Tatting, although classed as needlework, is done nith a shuttle, with nhich knots and loops are formed into designs. Braids ior upholstery and clothing formerly were done in tatting, but nowadays this work is mostly limited to fine white edgings

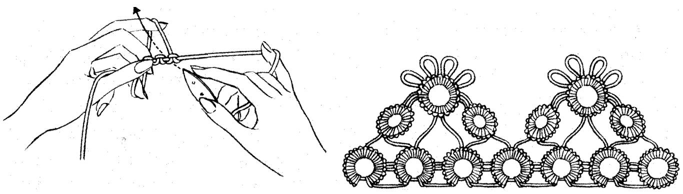

FIG. 4.— (LEFT) A CHARACTERISTIC HAND POSITION IN TATTING AND (RIGHT) A SAMPLE OF FINISHED WORK

for handkerchiefs, blouses and fine linens. Instructions cannot be given within the limits of this article; fig. 4, however, shows a characteristic hand position and finished work. *See* also LACE.

See Gladys W. Fry, *Embroidery and Needlework,* 4th ed. *(1950)*; Mary Thomas, *Book of Knitting Patterns (1950).* (SE. PE.)

ÑEEMBUCÚ, the southmestern department of Paraguay. is bounded by the Paraná and Paraguay rivers which provide a 250-mi.-long river frontage and separate it from Argentina to the south and the west. Its area (5,355 sq.mi.) of flood plain provides the terrain for a cattle-raiiing economy, but subsistence agriculture also supports the 63,875 population (1960 est.). one tenth of whom live in or near Pilar, the departmental capital. This town is linked to the Asunción-Encarnación road, but otherwise Ñeembucu lacks the transport routes which would enable its fertility to be utilized more fully. (G. J. B.j

NEENAH: *see* MENASHA.

NEER, VAN DER, the name of several Dutch artists of whom the following are the two most important.

AERT (AERNOUT) VAN DER NEER (1603/04–1677) was born in Amsterdam but as a youth was in the service of a noble family at Gorinchem. He may have begun to paint before leaving Gorinchem hut does not seem to have devoted himself to it seriously until he moved to Amsterdam. probably soon after 1630. At about this time he married Elisabeth Goverts. who bore him six children. He continued to live in Amsterdam until the time of his death (Nov. 9. 1677). but was unable to make a reasonable living from his art. From 1658 to 1662 he kept a wineshop, hut this venture ended in disaster. and he went bankrupt in Dec. 1662. being discharged the following year. Subsequently he appears to have reverted to painting, for he is described as a painter in the inventory that was made of his few belongings at the time of his death. The artists who most influenced his early period were the Gorinchem painters Govaert and Raphael Camphuysen. while another noticeable influence is that of Esaias van de Velde.

Apart from a number of accomplished winter scenes with skaters. he specialized in canal and river landscapes seen by the light of late evening or early dawn, or (most characteristic of all) by moonlight. Within this limited range he has no rival among his contemporaries. his best pictures being distinguished by his sensitive grasp of composition as well as his delicacy and tenderness in handling the problems of subdued light. with its reflections on water and in the windows of riverside houses,

He is not known to have had any pupils, but his sons JAN VAN DER NEER (1638–65) and Eglon *(see* below) must have received their first lessons from him.

EGLON HENDRICK VAN DER NEER (1634–1703), eldest son of Aert van der Neer. was born in Amsterdam. He studied first under his father and then under the genre and portrait painter Jakob van Loo, but he does not betray the influence of either of them to any extent in his own paintings. He found his inspiration mainly in the works of artists of an older generation. producing genre pieces in a manner reminiscent of, though inferior to, Gabriel Metsu and Gerard Terhorch and landscapes. sometimes with biblical or classical themes, in a style which seems with little doubt to have been based on that of Adam Elsheimer. tie married three times and traveled extensively. working at different periods in Amsterdam, The Hague, Rotterdam and Brussels.

In 1687 he was accorded the title of court painter to Charles II of Spain. He died on May 3, 1703, in Düsseldorf, where he had been appointed court painter in 1690. (R. E. W. J.)

NEERWINDEN, a village of Belgium in Liège province (pop.. 1955 est., 987), a few miles east by south of Tirlemont; gives its name to two battles, the first in 1693 between the Anglo-Allied army under William III of England and the French under the duke of Luxemburg *(see* GRAND ALLIANCE, WAR OF THE) and the second in 1793 between the Austrians under Prince Josias of Coburg and the French under Dumouriez. *See* FRENCH REVOLUTIONARY WARS: *Campaigns* in *the Netherlands.*

NEES VON ESENBECK, CHRISTIAN GOTTFRIED (1776–1858), German botanist and entomologist best known as a mycologist. was born at Erbach on Feb. 14, 1776. and was educated at Darmstadt and at Jena, where he took the degree of M.D. After practising medicine he was appointed professor of botany in Erlangen in 1816, in which year appeared his *System der Pilze und Schwämme.* In 1819 he became professor of natural history in Bonn. Nees von Esenbeck was one of the early workers on the functions of spores in fungi. In 1820 he sowed *Rhizopus nigricans* on bread and obtained ripe sporangia in three days. He discovered the spermatozoids of *Sphagnum* in 1822. In 1831 he was made professor of botany in the University of Breslau. He became one of the chief representatives of nature philosophy. His best-known works are those dealing with the fungi, the Hepaticae and the Glumiferae. He was the first to use the term "ascus" (or sac-containing spores) to characterize one of the three main divisions of iungi. For his political activities in 1848, Nees von Esenbeck was deprived of his professorship in 1851. He died in Breslau on March 16, 1858.

NEF'I (pseudonym of ÖMER; also known as NEFI OF ERZURUM) (d. 1635) is considered to be one of the leading Turkish classical poets. He was born at Hasankale, near Erzurum. Very little is known about his early life. He was in Istanbul during the first years of the reign oi Xhmed I and, after serving as a minor government official, succeeded in gaining the favour of Sultan Murad IV, himself a poet of some distinction. But he made many enemies and, in 1635, one of these. Bayram Pasha. then deputy grand vizier, secured his execution. In his satires. the *Siham-i Kaza* ("Arrows of Fate"), he attacked even the highest public figures. n-ithout mercy; sometimes with wit, but often with obscene vulgarity. These works are now interesting mainly as character sketches of the period. Nef'i's *Kasides* (odes). of which editions appeared in 1836 and 1853, are distinguished by considerable dignity of style. They show him to have been a man of vigorous personality and imagination.

See E. J. W. Gibb, *A History of Ottoman Poetry,* iii (1904). (F. I.)

NEGAPATTINAM (NAGAPATTINAM), a seaport in the Tanjore district of Madras state. India, forming one municipality with Nagore, a port 3 mi. N. at the mouth of the Vettar river. Pop. (1951) 57,854. It carries on trade with Malaya and Singapore and with other Indian ports. Peanuts, cotton goods. tobacco and vegetables are exported. Vessels lie two miles offshore. Negapattinam is the terminus or' a branch of the Southern railway. with railway workshops. and has two technical institutes. It is also a depot for coolie emigration. Negapattinam was one of the earliest settlements of the Portuguese on the Coromandel coast. It was taken by the Dutch in 1660, becoming their chief possession in India. and by the English in 1781. From 1799 to 1845 it was the headquarters of Tanjore district.

NEGLIGENCE is a concept found in all law. In Anglo-U.S. law as a basis of liability it is set off against intent on the one hand and mischance or accident on the other. It is broadly expressed as a failure to take care in view of foreseeable danger. It is determined by the standard of conduct of the ordinarily prudent man under similar circumstances—a question for jury determination unless the conduct in litigation can give rise to only one reasonable inference. In the latter case it is for the judge to draw the inference.

The negligence concept came into great importance early in the

1800s when it became the basis of the negligence action, superseding the earlier actions of trespass *vi et armis* and trespass on the case for physical injuries to person and property resulting from unintended hurts. The action arose out of highway horse and buggy collisions but was quickly extended to inland waterway traffic collisions. railway casualties, industrial master and servant cases. and by the end of the century had been extended to landowners with respect to injuries to highway travelers as well as to persons who came upon landowners' premises, to contractors, manufacturers. users of firearms, municipal corporations (especially for defective streetsj, to physicians, in some instances to charitable hospitals, and practically to all cases of unintended physical injuries to person and property. By statute it had also been extended to injuries resulting in death.

The action is not infrequently employed to recover damages for injuries resulting from defective performance of professional services, as for example those undertaken by lawyers, brokers, accountants, abstracters and the like. But. the action in these cases stems from a different source and bears little resemblance to the negligence action for physical injuries.

The displacement of the action of trespass for physical injuries by the negligence action was the most radical revolution in common-la\\- history. It was the courts' response to the Industrial Revolution. Financially weak industry and enterprise, with their dangerous and imperfect machines and processes and numerous untrained and inexperienced employees, could not do business under the strict liability of medieval tort law. The severity of the early law was completely reversed by the negligence action, under which at every point of an extended and complicated formula the burden was placed upon the victim to sustain his case. The defenses available to deiendants became so numerous and exacting that they cannot be catalogued in any brief summary. Suffice it to say that the action of negligence became a great favourite of defendants and the more skilled advocates of the profession. Doctrines were spun infinitely in the fashion of religious doctrines, architectural designs, dress. manners! oratory, writing and ornamentation of every sort of that century. Even though a victim might win a jury verdict the chances were that his verdict could not run the gauntlet of appellate review. In brief, through the doctrines of negligence law there was a practical moratorium on legal liability for unintended personal physical injuries for almost three quarters of the 19th century.

Shortly after the middle of the century a reaction set in which has continued to increase in strength. In every area of activity brought under negligence law its doctrines have undergone numerous modifications by court or by statute. Practically the whole area of injuries suffered by industrial employees was brought under workmen's compensation acts in England in 1897 and in the U.S. states in the early 1900s. Numerous immunities once enjoyed by landowners, railroads, charitable institutions, municipal corporations and other governmental divisions, manufacturers, suppliers, contractors, public service companies, physicians and surgeons have fallen by the way. Broad comparative negligence statutes in all the Commonwealth of Nations and in some of the U.S. states and limited statutes in numerous specific instances in most of the states have made inoperative many of the sweeping defenses once available to defendants. Jury trial, especial!~in England, has either been foregone in negligence cases or greatly modified, thus reducing trial errors once relied on for reversals of trial court judgments. Appellate courts by various doctrinal devices exercise an increasingly stronger hand in the disposition of negligence cases. Modern scientific techniques for rnaking proof of nervous and psychic injuries and for evaluating all injuries to the person have removed much of the guesswork in measuring damages in personal injury cases. Of importance also is the rise of a claimants' bar equal in education and training to offset the advantages so long enjoyed by the superior advocates of corporate clients.

Only in the area of motor vehicle traffic injuries has the negligence action failed to respond to the demands of modern condition;. Here is found the overwhelming mass of negligence litigation. Liability insurance is a factor in nearly every litigation following traffic casualty. In many cases there is no basis of liability; in many others the defenses are so clear that litigation would be futile; many others are settled for a pittance; some are settled equitably; the serious cases as a rule are hard fought with the results utterly unpredictable. Negligence doctrines in these cases. however modified, are too refined for juries and in many instances too complicated for trial and appellate processes. The courthouses of all the larger centres of population are choked with cases and the trial dockets are years in arrears. Much of the time and energies of appellate judges are absorbed in the examination of extended records and briefs and in writing extended doctrinal dissertations or in minute regimentation of factual detail. The negligence law that so largely had its source in the horse and buggy traffic of the 19th century has run its course as a means of litigating the motor vehicle casualties of the 20th, and some better remedy is as urgent here as it was in the industrial injuries of the early part of the century.

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NEGOTIABLE INSTRUMENT, in law, a document or other instrument purporting to represent an obligation involving so much money, and the property in which passes, like money, by mere delivery or by endorsement and delivery. Negotiable instruments arise in either of two ways: (1) by statute, (2) by custom of merchants. The most commonly recognized negotiable instruments are bills of exchange, promissory notes, bills of lading, foreign bonds, debentures payable to bearer, and endorsed share certificates, such as are issued in Canada and the United States. Negotiable instruments constitute an exception to the general rule that a man cannot give a better title than he has himself. (See BILL OF EXCHANGE.)

NEGRITOS (Span. for "little Negroes"), the name originally given by the Spaniards to the aborigines of the Philippine Islands, now applied to an ancient element of the population of southeast Asia, Indonesia and probably of Oceania. They are typically of short stature, with dark skin, closely curling hair, thick but not everted lips and broad noses. Prognathism is not marked. Skulls are generally mesocephalic or brachycephalic. Body and facial hair is scanty. They have everywhere been forced into mountain or forest terrain. Though many groups practise horticulture those feast affected by surrounding peoples. such as the Andamanese and some of the Semang, live by hunting and collecting. Their typical weapon is the bow. The Andamanese represent the type in its finest iorm. both physically and culturally; other groups show varying degrees oi mixture. These include the Aeta of the Philippines, the Semane of the Malay peninsula and probably the Tapiro, hiome and other tribes of the central New Guinea mountains, thourh the Iattcr may he the result oi local specialization oi the Papuan stock. There is evidence of a Negrito substratum in Assam, in Indonesia and perhaps in some larger Melanesian islands.

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NEGRO, the designation of a member of the Negroid race. one of the three major groupings of mankind. the others being the Caucasoid and the Mongoloid. The ultimate derivation of the word is from the Latin *niger*, "black," but its use as a term denoting a particular subgroup of mankind comes from the Spanish-Portuguese term, negro, "dark." dating from the time of the African slave trade. In addition to this biological significance is the sociological one, restricted almost entirely to the Cnited States, whereby a "Negro" is by definition one who is Negroid in appearance. or one whose ancestry in an?; part can be discerned as African, without regard for the amount of mixture with Europeans (Caucasoids) or American Indians (Mongoloids).

From this derives the use of the word. often puzzling to those outside the United States. to designate persons as Negroes who may be blond and blue-eyed. The word Negro is capitalized in the United States but not elsewhere; the word "Negress" is to be avoided.

The Negroid race is one of the most highly specialized human physical types. It includes the tallest groupings of mankind, such as the Watutsi of Ruanda-Urundi or the Shilluk of the upper Nile region, and also all pygmies, who are found in southern and central Africa, the Andaman Islands of the bay of Bengal, Malaya and the Philippines. Certain Negroid characteristics, such as the everted lips and the wiry, tightly curled hair, are also highly specialized traits. The outstanding Negroid characteristic, heavy pigmentation, is, however, not restricted to this race. Some Caucasoid populations living in India, and all the aboriginal inhabitants of Australia (sometimes classified as Caucasoid, sometimes given separate classification as Australoids) are as dark in skin colour as any Negroid group. On the other hand, it should not be forgotten that there are Negroid groups found in the Congo and West Africa who are light brown or reddish in colour. This merely illustrates the unsatisfactory nature of the classification of races by colour, a classification long ago rejected by scientists but remaining in popular terminology.

Distribution.—The Negroid race is thought of as restricted to Africa, but its actual distribution is much wider. Conversely, the northern portion of the African continent is inhabited by Caucasoid peoples, while the Sahara contains a population of mixed Negroid-Caucasoid ancestry, these two belts running roughly parallel across the continent from the Atlantic ocean to the Red sea. Negro Africa is thus sub-Saharan Africa.

To the eastward, in addition to the pygmoid peoples of India, southeast Asia and Indonesia already mentioned, is a further extension of the race, termed Melanesian Negroid, who inhabit the area stretching from New Guinea to the Fiji Islands. The population of New Guinea, called Papuans, was by no means entirely known by the latter 1950s, but continuing exploration discovered no groups that are not Negroid in their physical characteristics. The problem of the relationship between the African and Melanesian Negroids is a challenging one, but no authoritative studies of it were made. The distribution of the Negroid pygmies suggests an assumption as to the racial unity of the two branches, but does not suggest solutions of the basic question as to how, to say nothing of why, these two subunits became separated.

No such question arises as regards the westward distribution of the Negroids, who, in various degrees of admixture with other races, are found in South, Central and North America, and the islands of the Caribbean. In this case, the Negroid ancestry can be historically ascertained as derived from Africa, especially the Guinea coast and western Congo, through the circumstance of the slave trade. They were thus introduced into the new world between the early part of the 16th century and the middle of the 19th. Because of their numbers, they constitute an important segment of the Negroid race.

Subtypes.—Four principal subtypes mark off Africa south of the Sahara, with the pygmies of the Congo basin constituting a fifth. The first of these is called the true Negro, in accordance with a convention that has developed to mark the fact that this subtype represents Negroid traits in their most marked form. It inhabits the area along the western coast of Africa from Portuguese Guinea to the lower Cameroons, reaching into the interior as far as the Sahara. In colour, its members range from reddish-brown to deep brownish-black—no human group is black in the physical sense of the word. They are short and stocky, strongly built and heavily muscled, with triangular shaped torso, broad shoulders and narrow waist, and arms and legs that are slender and long in proportion to stature. The face is prognathous, with an acute facial angle, the lips thick, nostrils broad and cheekbones high, the hair wiry, tightly curled and lying close to the scalp.

From the Cameroons southeastward, in a great arc, lies the heterogenous subtype that, for want of a better designation, is grouped as Bantu-speaking peoples. They inhabit the Gabun, the entire basin of the Congo, the territory on the borders of Lake Victoria and south of a line stretching across Tanganyika from the southern point of the lake to Zanzibar. They occupy most of Angola, the Rhodesias, Nyasaland and those parts of the Union of South Africa and, aboriginally, of Southwest Africa not peopled by Hottentots and Bushmen. Their heterogeneity arises from crossing between the various types that have been in contact, both on the borders of this vast territory and as a result of interior population movements. Because of this, over-all designations are difficult. It can best be said that the basic Negroid physical type varies in departure from the true Negro as one moves away from West Africa, and the effect of crossing with the peoples to the north, northeast and south, and with the pygmies of the Congo forest, are to be seen.

The third subtype inhabited, and, to the extent it has survived, still inhabits the extreme south of the continent. It comprises the Bushmen and Hottentots, whose similarities in physical form have caused them both to be called *Khoisan* (from *san,* Hottentot word for Bushmen, and *Khoi-Khoin,* the Hottentot name for themselves). The two groups exhibit certain differences, the Bushmen being pygmoid, the Hottentot of normal human size. Both are lighter in colour than other Negroids, being a yellowish-brown, both have skins that are deeply wrinkled, and the hair of both is of the so-called "pepper-corn" type, a few strands forming a small, tightly curled ball, with the scalp showing between the individual clusters. The physical form of the Hottentot women, and to some extent the Bushman, is marked by steatopygia, an accumulation of fatty tissue on the buttocks that gives a pronounced protrusion. Other Negroid characteristics are present, such as prognathism, broad nostrils, thick lips and high cheekbones.

Northeast of the Bantu-speaking peoples is a conglomerate variously termed Hamitic, Nilotic and Nilo-Hamitic, categories that have never received precise definition. They reach from Ruanda-Urundi and northern Tanganyika through Kenya and northern Uganda into the Sudan, and eastward into southern Ethiopia, including such peoples as the Watutsi and Masai, the Nandi, Suk, Nuer, Galla and Somali. They are tall and slender, with all vertical dimensions emphasized—narrow faces, long noses, long narrow skulls, narrow shoulders and lips and, like all Negroids, long arms and legs in proportion to height, the more noticeable here for their tallness. Their hair varies from less tightly curled to almost straight; they are very dark in colour. The degree to which their less Negroid traits are the result of Caucasoid admixture is debatable; it would seem preferable to regard them as another highly specialized Negroid subtype.

Outside Africa, among the Melanesian Negroids, two subtypes can be distinguished—the Papuan, short and stocky, with more accentuated Negroid features, and the island group, which is taller and shows the results of mixture with the various waves of migrants that moved eastward to people Polynesia. Both these major subtypes, however, have hair that, unlike most of the African Negroids, while wiry and curly, tends not to lie close to the skull but forms a bushy covering to the head. No specific subtypes of new world Negroes can be designated, since everywhere mixture has occurred in varying degrees. However, in the United States sociological isolation resulted in a process of mating within the Negro population that has made for a higher degree of homogeneity than might be expected, with averages for various traits tending to fall between those for West African Negroids and the early immigrant European populations.

Origin of the Negroid Race.—The archaeological remains found in southern Africa since 1924, termed the Australopithecinae, have amassed impressive evidence that the human form may have had its early development in this area. Whether this means that the present Negroid race is thus to be accounted for is, however, quite another matter, though there are some who hold that the Bushmen are the remote descendants of these early forms. The problem of Negro origins would thus seem to be a part of the larger question concerning the differentiation of the present human races. The fact that the distinguishing traits of human groups are those which mark off domesticated from wild forms would seem to account for the observed differences. Isolation and inbreeding would be the mechanisms which, under domestication, preserved mutations which persisted under the protection of social life and traditions of desirability. Negroid features would therefore have resulted from the operation of these processes. and spread through subsequent migration to achieve the present distribution of Negroid peoples. (See also NEGRO. AMERICAN.)

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(M. J. Hs.)

NEGRO, AMERICAN. In the United States a person is popularly regarded as a Negro if he possesses any Negro ancestry, regardless of the number of white or Indian ancestors he may also possess. In states concerned with the problem of race, identification of a Negro by physical appearance or by reputation has been insufficient, and the law has defined a Negro with considerable precision. For example, the Virginia law of 1930 defined a Negro as any person in whom there is ascertainable any quantum whatever of Negro blood. That the concept of who constituted a Negro was not by any means unchanging is attested by the fact that in 1910 Virginia changed its definition of a Kegro from a person with one-fourth Negro blood to one with one-sixteenth Negro blood and then to its definition of 1930. The problem of the definition of a Negro began early in the American colonial period. The social and legal status of the children resulting from the union of whites and Kegroes, usually illegal and outside the marriage bonds, was frequently open to question. They were usually defined as Negroes regardless of the amount of white blood; and they were defined as slaves if their mothers were slaves. Efforts to control miscegenation by law were notably unsuccessful during the slave period, and although many states had laws against intermarriage in the second half of the 20th century, miscegenation persisted. The loosely defined mulatto element, the product of unions of Negroes and mulattoes as well as of whites and Negroes, continued to provide the legally defined Negro element with a range of physical types that defied any precise, scientific classification.

Population. — At the time of the first decennial census in 1790 the 757,208 Negroes in the Cnited States constituted approximately one-fifth of the total population. More than 90% of them were concentrated in the south, but within that region there were great variations in the proportions of Negroes to the white population, because of the concentration of the Negro population in the areas of the plantation economy. By 1860 the Negro population had increased to 4,441,830 and mas about one-seventh of the total population. With the spread of the plantation, there was a significant shift of the Negro population to the new states of the southwest, notably Alabama, Mississippi and Louisiana. The increase continued in the years following emancipation, the figure having reached 8,833,994 by 1900 and 11,891,143 by 1930. When the Negro population reached 15,042,286 in the census of 1950, it constituted 10% of the total population.

One of the most remarkable facts about the Negro population in the 20th century has been the movement of large numbers to urban communities in the south and out of the southern states altogether. Although the movement was rather steady, it was greatly accelerated during World Wars I and II. During the decade from 1940 to 1950 the Negro population increased by 44.2% in the northeast, 50.2% in the north central states and 237.4% in the west. As late as 1920 the proportion of Negroes living in the south was 85%, but by 1950 it was approximately 68%. In 1910 no city in the nation had as many as 100,000 Negroes, but by 1950 there were 14 such cities: Baltimore, Washington, New Orleans, Memphis. Birmingham, Atlanta, St. Louis, New York, Chicago, Philadelphia, Detroit, Cleveland, Houston and Los Angeles.

There can be little doubt that these shifts in the Negro population materially affected the relationships between the southern white population and the Negroes, while the steady urbanization of the Negro population had considerable economic, political and social consequences for the group as a whole. The migration of Negroes to the cities of the south, north and west widened the range of economic opportunities, but it also created new racial tensions in numerous social and economic areas. The wider use of the franchise in northern communities noticeably increased the political power of Segroes by giving more of them an opportunity not only to hold public office but also to affect in a very vital way the outcome of close elections.

At the beginning of the 20th century there was some thought that the Segro problem would solve itself by the gradual disappearance of the Negro as a racial group. The growth of the Negro population in the first half of the century, however, and the vigour of its participation in American life ahile retaining its separate identity seemed to indicate that this was not likely to occur. This inescapable fact made it necessary to accept the Negro as a permanent part of the body politic and to consider his status within the framework of the American social order.

THE SLAVE PERIOD

As explorers and servants with the Spanish and Portuguese, Negroes were in the new world by the early 16th century. In the beginning the European settlers gave no serious consideration to the use of Xegroes to solve the problem of the acute labour shortage. Their easy identification because of colour, the apparently inexhaustible supply and their non-Christian background convinced the enterprising settlers that Negroes would be the ideal permanent workers in the task of developing the new world. Although the precedent for Negro slavery in America had been established by the Spanish and Portuguese, the English were slow to adopt the practice. The first Negroes that landed at Jamestown in 1619 were actually indentured servants; and even after slavery was legally established in the English colonies the Negro population grew slowly. At the end of the first century there were fewer than 25.000 Negroes in Virginia. while Maryland had approximately 40,000 a century after the settlement of that colony. In the New England and middle colonies the Negro population was much smaller: with 5,000 in Massachusetts and 19,800 in New York at the time of the War for Independence.

The significant increase in the number of Negroes began with the demand for cheap raw materials, primarily cotton, created by the industrial revolution. The discovery of the short staple variety of cotton made possible the cultivation of the crop in a much larger area of the southern United States than had hitherto been possible, and the invention of the cotton gin made practicable the extensive cultivation and processing of the raw material for the factories of England and other countries. Almost immediately, the vast area that came to be known as the cotton kingdom was settled and developed; and the Negro population began to shift from the upper south to the southwest and to increase enormously. thanks to smuggling of Negroes from the Caribbean and Africa and to the encouragement given to slaves to increase their own population. This was achieved, in part. by deliberate slave breeding.

Slaveholding in the United States was always confined to a small segment of the population. Only 384,000 southerners. out of a population of more than 8,000,000, held the 3,900,000 Negroes who were in slavery in 1860. Most owners. moreover, had small numbers of slaves. Approximately 330.000 held fewer than 20 slaves. while more than 200.000 had 5 slaves or less. At the same time only 1,700 owners held as many as 100 slaves. By 1860 the price of slaves was prohibitive for all but the most affluent; the cost of a prime field hand—a healthy male between 16 and 25 years of age—had risen to $1.800 on the New Orleans market.

Because the owner had to be protected in his property and because the community had to be protected from the possibility of violence at the hands of slaves, a great body of laws commonly known as the slave codes grew up in each of the slave states. There were considerable variations, to be sure, but certain provisions were to be found in all of them. Slaves could not be away from the premises of their owner without written permission; they were incompetent to make contracts and their testimony was inadmissible in any litigation involving a white person; they could not own property; they could not be taught to read or write; and they could not assemble together unless a white person was present. These laws were not always strictly enforced. but whenever there was fear that the slaves might become ungovernable, the enforcement machinery of the state was alerted and, for a while, the laws were carefully observed.

Whether they were on a cotton, rice or sugar plantation or in urban communities (where approximately 500,000 were living by 1860). the slaves' principal duty was to provide income and comfort for the owners. Field hands. working in gangs or on task assignments. laboured for long hours in the cultivation and harvesting of the crops. House servants. tending to be more numerous than the owner actually needed, performed a variety of chores. Town slaves were engaged in many tasks which required considerable skills. as indeed were some of the plantation slaves. Geared as it was to the making of profits the slave economy was constantly in search of ways to cut production costs. Thus, only the barest, essentials for the subsistence of the slaves were indulged. Food was simple, though adequate in quantity: clothing was made of the cheapest materials or, as was frequent!? the case ior house servants, was discarded attire of the owner and his family: and housing consisted of crude huts that barely protected the slaves from the weather.

The majority of the slaves accepted their degraded lot with no outward manifestation of dissatisfaction. Some, however. such as Gabriel Prosser in 1800. Denmark Vesey in 1822 and Sat Turner in 1831, planned or executed revolts that terrorized the white population for miles around. Others registered their resentment by destroying farm implements or animals or. occasionally. by murdering their on-ners, Many more ran an-ay. either by means of the Cnderground Railroad with the help of abolitionists or by means ingeniously devised by themselves. Those who remained in hondage secured some satisfaction through improvising the spirituals that became a significant contribution to American culture. or embracing the religion of their owners. or through recreational activities provided by social intercourse with other slaves or with free Xegroes.

In 1860 approximately half of the 488,000 free Segroes lived in the slave states. where they were subjected to proscriptive laws hardly less severe than those in the slave codes. Their contact with slaves was especially frowned upon lest they contaminate them with ideas of freedom. while in the economic sphere they were carefully circumscribed. lest their activities work a serious hardship on their white competitors. In the north they were concentrated in such cities as Cincinnati, Philadelphia. Sew York and Boston. where hostility to them often resulted in riots such as those in Philadelphia in 1834 and in Sew Tork city in 1839. From the early colonial period. however, they enjoyed some educational opportunities in the north and some freedom to organize social and religious institutions of their own.

Before the Civil War many individual Segroes had made significant impressions upon American life because of their personal accomplishments. Phillis Wheatley and George Moses Horton wrote poetry that was widely read and praised. Benjamin Banneker. an able mathematician. published a series of almanacs and assisted in laying out the city of Washington, D.C. John B. Russwurm graduated from Bowdoin college, Brunswick, Me., in 1826 and in the following year founded. with Samuel Cornish, *Freedom's Journal*, the first Segro newspaper. David Walker became the first militant Segro abolitionist with the publication of his Appeal in 1829. He was followed by a large number of Negroes who vigorously fought slavery, including Frederick Douglass, who edited his own newspaper and traveled extensively in the United States and abroad; William Wells Brown, the author of several books and a lecturer for the Western New Tork Anti-slavery society; and Harriet Tubman, who is credited with having guided more than 300 slaves to freedom,

Among the Negro organizations that sprang up before the Civil War the Segro church was. perhaps, the most important. Some local Baptist groups were organized during the American Revolution in Savannah, Ga., and Petersburg and Richmond, Va. In Philadelphia, Pa., Richard Allen and others founded the African Methodist Episcopal Church in 1794, while in New York city, two years later. James Varick and his associates founded the African Methodist Episcopal Zion Church. Fraternal organizations made their appeal to Negroes through the Masons, organized by Prince Hall in 1784, and through numerous local groups such as the Boston African society, organized in 1796. Beginning in 1830 Segroes held national conventions almost annually in which they sought to make known their grievances and to plan for the future. By the time of the Civil War this typically American institution had become a most effective means of articulating the aspirations as well as the accomplishments of Segroes in American life.

CONSTITUTIONAL AND POLITICAL HISTORY

From **the Civil War** to 1900.—The political and civil rights of Segroes have been determined primarily by conflicts between the federal governinent and state governments. Since about nine-tenths of Segroes lived in southern states until 1900 and about two-thirds in 1950, most of the issues involved the federal government and these states. The conflict began immediately after the Civil War. The 13th amendment. effective as of Dec. 18, 1665. abolished slavery and involuntary servitude. But the southern states in 1866 adopted new black codes that sought to keep the freedmen close to their former servile status. Congress was dominated by radical Republicans who had inherited the abolitionist tradition and by other Republicans who wanted to maintain political control of the south and the economic superiority established during the Civil War. Congress adopted a series of laws—the Civil Rights acts of 1866 and 1875, the Reconstruction acts of 1867 and the enforcements acts of 1870, 1871—and the 14th and 15th amendments that were ratified in 1868 and 1870.

These laws and amendments gave the Segro federal and state citizenship, the right to vote. to enforce contracts. to sue. to give evidence, to deal with real and personal property. They protected him from violence, assured him accommodations without discrimination in public places and guaranteed him due process. of law and equal protection of the laws. Congress also created in 1865 the Freedmen's bureau for the rehabilitation of whites and Segroes in the devastated south. But the opposition of southerners to federal interference with their determination to keep the Segro in an inferior position and the unwillingness of some northerners to have congress regulate social and economic conditions led to its abandonment in 1372.

During the period of reconstruction. 1866–77. southern Segroes elected representatives. two senators, members of state legislatures and a few high-ranking state officials. After the organization of the Ku Klux Klan in 1866, however, southern whites used force, intimidation and fraud to prevent Segroes from exercising many of the rights granted them. By 1876 whites had largely "redeemed" their state governments from Segro participation except in Florida, South Carolina and Louisiana. A compromise agreed to by Pres. Rutherford B. Hayes in 1877 between northern and southern industrialists and other northerners and southerners who had grown weary of federal intervention in the south completed the redemption.

Congress, like most of the presidents after Hayes. continued this hands-off policy. A bill passed by the house of representatives in 1890 on the recommendation of Pres. Benjamin Harrison, but defeated in the senate. 1891, for the federal supervision of federal eiections led Mississippi to adopt in 1890 the first state constitutional amendment for the disfranchisement of most Segroes. Several decisions of the United States supreme court, especially from 1873 to 1910, also gave the south virtually a free hand in fixing the status of the Segro. These decisions virtually nullified the reconstruction laws and the clauses in the 14th and 15th amendments for the protection of the civil and political rights of Negroes. In the famous case of *Plessy* v. *Ferguson*, 1896, the court for the first time sanctioned a state segregation law on the ground that it was a reasonable use of the police powers of the state provided that the separate accommodations were "equal." The ccurt also refused to intervene against state constitutional amendments that disfranchised most Segroes. But the court did hold that state action excluding Segroes irom juries was unconstitutional.

This hands-off policy of presidents, congress and the supreme court encouraged the southern states to pursue their own policies. Early in the 20th century the southern states extended legislation, conforming to growing custom. that segregated Segroes in public places. One of the most extreme of the laws prohibited the storage together of textbooks used in white and Negro schools. By 1910 all the southern states had adopted constitutional amendments or laws that disfranchised most Negroes while permitting many equally unqualified whites to vote. Booker T. Washington, the Negro principal of Tuskegee institute, Alabama, had deemed it necessary in 1896 to seek a compromise based upon friendship with southern whites in place of federal action to provide job opportunities, schools. and a limited participation in the suffrage. While the various amendments and laws were aimed at disfranchising some whites as well as Negroes, they affected the latter more than the former. In Louisiana, for example. the number of white registrants was reduced by only about 24% from 1897 to 1900 while the number of Negroes was reduced by more than 90%. An even larger percentage of Negroes was disfranchised by an Alabama amendment. While these were extreme cases and while there had been a general trend toward nonparticipation in elections, the amendments and laws, despite Washington's plea, disfranchised the vast majority of Negroes throughout the south.

Even before the adoption of these amendments and laws, force and intimidation had so reduced the number of Negro voters that the number of Negroes in congress and in the state legislatures had steadily declined. There had been seven in the house of representatives and one in the senate, 1875–77. The largest number thereafter had been three representatives and one senator, 1877–79. After 1891–93 there had been only one representative and in 1901, George H. White of North Carolina was the last until Oscar DePriest was elected from Illinois in 1928. Whereas in 1877–78 there had been 39 Negroes in the South Carolina senate and house, at the end of the century there was only 1. In the early part of the 20th century there were no Negro members of a southern state legislature.

Since there were fewer Xegroes in the north, especially until after the migrations incident to World Wars I and II, race relations created less friction. Negroes voted more freely; they suffered less segregation, discrimination and nonrecognition of their dignity as human beings. But that they were discriminated against is evidenced by the fact that most of the cases involved in the supreme court decision of 1883 which declared unconstitutional the Civil Rights law of 1875 forbidding discrimination in public places originated in the north. Following this decision, 1 j northern states adopted new civil rights provisions against discrimination in public places and 3 strengthened existing provisions. Since the number of Negroes in the north was small, they did not have the power. as did some racial and religious blocs, to enable them to elect members of their race to congress, state legislatures and municipal councils.

The 20th Century. — World War I began to alter the status of the Negro in both the north and the south, a change that was accelerated during the New Deal: World War II and the "cold war" with the Soviet Union. The migration of approximately 2,000,000 Negroes from the south to the north reduced the proportion of Negroes in the south and thereby facilitated the acceptance by an increasing number of southerners of the changes created by the improved economic status of Negroes and by the decisions of the United States supreme court. The migration to the north provoked a few race riots but it gave the Negro the balance of power in some elections. Whites and Negroes elected a Negro as president of Manhattan borough, New York city; another was elected a judge of the New York supreme court and still another deputy mayor of Cincinnati, O. While by the latter 1950s there were no Negro senators and only four Negro representatives in congress. there were about fifty members of state legislatures and many members of municipal councils. The increased political power of northern Negroes was also reflected in the adoption of several state laws against discrimination and by the appointment of a few Negroes to such federal offices as governor of the Virgin Islands, judge of a federal court and assistant secretary of labour. Pres. Franklin D. Roosevelt issued an executive order in 1941 to reduce discrimination in defense industries; Pres. Harry S. Truman created a civil rights section in the department of justice in 1948 to protect civil rights of Negroes and, in the same year, established the President's Committee on Equality of Treatment and Opportunity in the Armed Services.

Congress, however, refused to enact legislation to enforce the 14th and 15th amendments. to abolish the poll tax as a requirement for voting, to prevent lynching or discrimination'by firms holding government contracts. The virtual disappearance after 1950 of lynching (which had taken a toll of almost 900 persons, most of them southern Xegroes, in the first decade of the 20th century) made an antilynching law less urgent. Congress did, however, provide in the Selective Service and Training Act of 1940 that there should be no discrimination against any person on account of race or colour.

Even before World War I the supreme court had begun to hand down decisions that strengthened the civil and political rights of Negroes. In 1911 it had declared that peonage violated the 13th amendment. Four years later the court for the first time ruled that the "grandfather clause," one of the devices for disfranchising Negroes, violated the 14th amendment. Shortly after the United States entered World War I, the court ruled unanimously (1917) that a city ordinance that prohibited Negroes from acquiring property in a block inhabited by a majority of whites and vice versa was unconstitutional. In 1923 the court held that a Negro did not receive a fair trial in a court dominated by mob violence.

In later years, Negro and white lawyers collaborated in the presentation of cases, generally by the National Association for the Advancement of Colored People, that resulted in further gains. Negroes could not be prevented, either by state or party action, from participating in the Democratic party primary; fraud in the counting of votes in a primary election violated the constitution; exclusion of Negroes from juries over a period of years was prima-facie evidence of state action which the state would have to prove to the contrary; denial of counsel violated the due process clause of the 14th amendment. State courts could not be used to enforce private restrictive housing covenants; all well-behaved and respectable persons had to be served in restaurants in the nation's capital. Negroes could not be segregated on buses in interstate travel, nor denied an unoccupied seat in a Pullman car or in a dining car. States had to provide substantially equal facilities for Negro and white students in state universities. When Negroes had been admitted to a southern state university, they could not be segregated in classrooms.

Beginning in 1954 an increasingly acute crisis resulted from court decisions which even more drastically threatened the southern way of life, Previous school decisions had involved the application of the "separate but equal'! doctrine at the university level. But on May 17, 1954, the supreme court unanimously ruled that, even though Negro and white public schools had been equalized with respect to buildings, qualifications and salaries of teachers and other "tangible" factors, segregation in public schools solely on the basis of race was unconstitutional. Such segregation in states violated the equal protection clause of the 14th amendment; in the District of Columbia it violated the due process clause of the 5th amendment. On May 31, 1955, the court called upon states with separate public schools to proceed "with all deliberate speed" and in "good faith" to put an end to such segregation.

Some responsible southern leaders at first accepted the 1954 decision. Others, however, soon convinced many of these moderates and most other white southerners that desegregation in public schools might result in a mixing of the races. On Nov. 7, 1955, the court ordered that Negroes be allowed to use public golf courses in Maryland and Atlanta, Ga. A few weeks later the Interstate Commerce commission forbade the segregation of interstate travelers in trains or buses, and in waiting rooms as of Jan. 10, 1956.

These decisions and rulings provoked serious reactions in the south. Since the decision, Smith v. *Allwright*, 1944, which had declared the Democratic party white primary unconstitutional, Negroes had voted in increasing numbers in most of the southern states. They held the balance of power in such cities as Savannah and Atlanta. Ga.; they elected Negroes in small numbers to city councils and to boards of education. But in 1955 some southerners, especially in Mississippi, began to use force, intimidation and fraud to prevent Segroes from voting. On March 11, 1956, 101 southern U.S. representatives and senators signed a manifesto urging "passive resistance" to the supreme court decisions against segregation in public schools. While some southern cities quietly abandoned their segregated waiting rooms. others ignored the ruling of the Tnterstate Commerce commission. In March 1956 a Virginia constitutional convention amended the state constitution to permit the use of public funds to pay tuition fees in private schools for children whose parents did not wish them to attend mixed schools. In the face of this new crisis, a few congressmen proposed bills to protect the civil and political rights of Negroes. Pres. Dwight D. Eisenhower, on Jan. 5, 1956, called for the establishment of a bipartisan commission to investigate allegations of the denial of civil rights to Negroes in some localities.

On Aug. 29, 1957, the senate approved a house bill which for the first time in 82 years sought to protect the civilrights of Negroes. It established in the executive branch a six-member bipartisan Commission on Civil Rights, with subpoena powers. to investigate alleged deprivation of voting rights because of colour, race, religion or national origin; to study legal developments constituting denial of equal protection of the laws; and to appraise Federal laws and policies regarding equal protection of the laws. The law made interference with the right to vote in federal elections actionable at the discretion of the United States attorney general under injunctive proceedings in United States district courts. The law also permitted federal judges to issue injunctions or other orders to protect the right to vote; and it maintained the courts' powers through civil contempt proceedings, without a jury. to secure compliance with, as distinguished from punishment for violation of, such orders. The commission was directed to make a final report to congress within two years. One of its members was a Negro.

The passage of this law probably strengthened southern resistance to desegregation in public schools. When nine Segro children sought to enter Central high school, Little Rock. Ark. in Sept.. 1957, Gov. Orval Faubus called out the state national guard to turn them away. (His announced intention was to prevent public disorder; his critics charged that his purpose was to delay, if not permanently void, integration of white and Negro students.) When the governor defied an order of a federal district court ordering that the children be admitted, President Eisenhower ordered U.S. army troops to ensure their admission. Governor Faubus ordered Central high school closed during the school year, 1958–59. On Sept. 29, 1958, the supreme court ruled in *Cooper* v. *Aaron* that the constitutional right of children not to be discriminated against in school admission on grounds of race or colour could not be nullified openly and directly by state legislators or state executive or judicial officers, nor indirectly by them through evasive schemes. At the beginning of the school year, 1959–60, three Xegro children were admitted to Central high school and three to the previously segregated Hall high school in Little Rock. Action by the police iorce of Little Rock dispersed segregationists who were determined to deny admission to the Negro students. Certain Little Rock segregationists abandoned an attempt to maintain privately supported schools because they were too expensive. and many business and professional men who did not enthusiastically support desegregation accepted it because industrial plants shied away from a city where discord was rife. The bombing of homes and offices of officials who accepted, however reluctantly. desegregation iurther discredited the segregationists. Governor Faubus did not call out the national guard, as he had done in 195j.

After open defiance of court orders proved unsuccessful, southern states enacted various laws to circumvent them. These devices generally included "intelligence" tests, rulings on the ability of Negro students to adjust to desegregated schools: and their residence in an area which was not part of the "white" school district. Federal courts upheld the constitutionality of such laws unless they construted subterfuges to deny the admission of Segro children. North Carolina established the pattern of "token desegregation" by which a few Negro children were admitted to formerly white schools in a few cities. Virginia grudgingly abandoned its policy of massive resistance, and a few Negroes were admitted to some schools in a few cities. On the other hand, five states of the old Confederacy—Alabama, Georgia. Louisiana. Mississippi and South Carolina — adopted new laws to strengthen segregation statutes already on the books. In 1958, 790 out of a total of 2,890 biracial school districts in border and southern states were desegregated; most of them were in the border states. In 1958 there were more than 400,000 Negro students enrolled in desegregated school systems in the border and southern states as compared with 350,000 in 1957. Hut some 2,500,000 Xegro students in these states continued to attend compulsory segregated schools. In 1959 Prince Edward county, Virginia. became the first southern community to abolish its public schools rather than comply with the supreme court decisions. In many northern cities housing restrictions often forced Segro children into de *facto* segregated schools in the most rundown sections of the city.

Several southern states sought to require the state branches of the N.A.A.C.P. to disclose the names and addresses of their members: on June 30, 1958, in *N.A.A.C.P.* v. *Alabama,* the U.S. supreme court struck down a $100,000 contempt fine imposed by Alabama because of refusal to disclose this information. Virginia passed laws which tried to restrict the activities of the S.A.A.C.P. on the grounds that it engaged in illegal barratry and unlawful solicitation of cases.

MILITARY HISTORY

Negroes fought in all the wars waged by the colonies and the United States. Crispus Attucks, a runaway slave, was the first to fall in the Boston "massacre," 1770. About 5,000 soldiers, free and slave, served in the Revolutionary army and others in the navy. especially as coastal pilots. A few were sailors in the Quasi-War with France, 1798–1800. Negro soldiers and sailors participated in the War of 1812, notably with Capt. Oliver H. Perry on Lake Erie and with Gen. Andrew Jackson at New Orleans. A very small number saw service in the Mexican War. Pres. Abraham Lincoln doubted whether the Cnion would have won the Civil War had it not been for the effective conduct of more than 178,000 Negro troops. After the war the federal government organized six separate regiments which were consolidated into the 9th and 10th cavalry, the 24th and 2jth infantry. These troops helped conquer the Indians during the 1870s and the 1880s. Along with six volunteer state regiments and four raised by the war department, they gained distinction during the Spanish-American War.

About 342,000 Negro soldiers served during World War I, approximately 100,000 overseas. Two infantry divisions, the 92nd and 93rd, fought in several important battles, especially in the Champagne and the Xrgonne sectors. Most, however, were in labour battalions that unloaded ships and sent supplies to the front. Alter World War I most of the combat troops were reduced to service units, and the navy assigned most Negroes to be mess attendants. On the other hand, largely as a result of pressure by Xegro veterans and the Segro press, the United States Military academy at West Point, N.Y., and the United States Naval academy at Annapolis, Md., which had been closed to Negroes for many years, were reopened to them. In 1940 Pres. Franklin D. Roosevelt appointed the first Negro brigadier general in the regular army.

During World War II, 1,174,000 Negroes were inducred and enlisted in the army, navy, the marine corps (for the first time in 167 years) and the coast guard. Approximately 700,000 fought in most of the theatres of war from Pearl Harbor to the surrender of Germany and Japan. Segro and white officers, except in the air force, were trained together. The number of Xegro officers rose to a peak of 7,768. Toward the end of the war a beginning was made toward integregation of Negro and white troops. Integration nas continued in al! branches of the service after the war, was increased during the Korean War and accelerated after it. The integration included almost all the public schools on military installations even in the south. Despite significant gains, however, Negro army officers as of Juiy 1, 1959, were only 2.00%

of the total; air force officers. 1.1%; navy and marine corps officers, 0.1%. Enlisted men were respectively 9.5%, 6.3%, 12.0% and 6.5%. In 1959 President Eisenhower promoted Brig. Gen. Benjamin O. Davis, Jr., of the air force to the temporary rank of major general. At the end of 1959 he was deputy chief of staff of the United States air force in Europe. Two Negroes were admitted in 1959 to the Air Force academy.

ECONOMIC LIFE

Agriculture. — The vast majority of the almost 4,000,000 slaves were field hands and domestic servants. The failure of the federal government to provide "forty acres and a mule" for most of the freedmen and prohibitions of some southern states against land-owning by freedmen kept most of them agricultural workers. In 1900, 192,993 Negroes owned farms, of which 54,017 were encumbered Three-fourths of the Negroes living on farms were tenants who paid rent or sharecroppers who received a portion of the sale of the crop Most of them. but particularly the sharecroppers, were compelled to obtain advances from the country merchants for food. clothing, tools, farm implements. etc at an increase in price from 40% to 100%. Since the value of the crops was sometimes less than the advances and since the books were kept by the merchants, many tenant farmers and croppers started the new year in debt. At the beginning of the 20th century, in some parts of the south, nine-tenths of all farmers fell into debt.

In 1920, the last census year before the depression set in. there were 700,439 Negro tenant farmers. Of these. 333.026 or 47.5% were sharecroppers. Negro farmers operated 40,884,199 ac.. or 12% of all the farm land in the south. The various measures of the New Deal to provide relief for farmers did not benefit Negroes as much as they did whites. In 1940 the number and percentage of Negro farm owners were about the same as in 1900. On the other hand. the percentage of tenants among farm operators remained about the same and the proportion of croppers among tenants increased.

The decade from 1940 to 1950 witnessed the diversification of agriculture and the growing industrialization of the south. in large part because of war. Many farm workers went to the cities. Since the agricultural revolution required capital and technical skills, it also resulted in a decline in the number of Negroes engaged in agriculture. The number of nonwhites, mostly Negroes, thus engaged dropped from 40 4% in 1940 to 29 2% in 1950, a larger drop proportionately and in absolute numbers than among whites During this decade there was an increase in the number of owner-operated farms, but Negroes did not share proportionately in the increase. More importantly, in 1920, Negro farmers operated 12% of all the land in farms in the south but in 1950 only 7% During this same period the total amount of land in farms in the south increased by more than the total amount operated by Negroes. The number of Negro tenant farmers dropped from 700,439 in 1920 to 393,962 in 1950. But the percentage of sharecroppers among tenants rose from 47 5% to 50.1%. On the other hand, the most flagrant evils of the tenant and sharecropper system had begun to disappear. After the supreme court decisions of 1954 and 1955, economic reprisals and the use of force against Negroes started a new migration especially from rural areas of some states.

Domestic and Personal Service. — The employment of Negroes in domestic and personal service increased from 21.6% in 1910 to 28.6% in 1930. In contrast, native white workers in these classes decreased slightly from 6.7% in 1910 to 6.6% in 1930; foreign-born white workers in these categories rose from 11 8% to 12.7%. In 1940 Negro domestic and personal service workers had risen to a little over 30%. The proportion of Negro women working as domestic servants decreased considerably, while those engaged in personal services, such as beauticians, cooks, waitresses, etc., increased. Between 1940 and 1950 private household servants decreased 40.5% among whites and 18.2% among nonwhites (mainly Negroes). On the other hand, during the same period other personal service workers increased by 25.2% among whites and 41.4% among nonwhites. As new opportunities opened up for women, workers of both races left domestic service.

Industrial Workers. — After the end of slavery many of the Negroes who had held skilled jobs lost them to white workers. Moreover, barbering, waiting. etc., formerly known as "Negro jobs." increasingly attracted large numbers of white workers. This displacement and the reluctance to accept Negroes in the new mechanical industries in the south spurred a limited migration to the north and the west where whites also began to take "Negro jobs." The rapidly expanding industries in the north also preferred European immigrants to Negroes, both as skilled and as unskilled workers American Federation of Labor unions denied membership to most of the fen skilled Negro workers or organized them in separate unions, thus pitting Negro and white workers against each other. The fact that Negroes were first brought into some industries as strikebreakers increased racial antipathy in the ranks of labour. The Knights of Labor in the latter part of the 19th century and the Industrial Workers of the World in the early part of the 20th century, both of which included a considerable number of Negro workers disappeared, largely because these organizations were considered revolutionary.

The first opportunity for Negroes to enter northern industry in force came during World War I. The acute need for labour, resulting from the departure of many white workers for service in the armies of European countries and the virtual cessation of immigration from them, brought substantial numbers of Negroes, many of them from the south. into new fields such as iron. steel, machinery and automobiles. Proving to be, on the whole. efficient workers. they fortified their position during the 1920s. During the depression of the 1930s, however, they were "the last to be hired and the first to be fired."

'Their plight was ameliorated by the emergence in 1935 of the Congress of Industrial Organizations which, unlike the A.F. of L., organized skilled, semiskilled and unskilled workers in an entire industry. The growing increase in the membership of the C.I.O. led the A.F. of L. likewise to liberalize its membership policies; in 1956 the number of Negro union members was estimated at 2,400,000. In 1955 these two major trade union federations merged; one of their major objectives was to double their membership of 15,000,000. The attainment of this objective would necessitate the inclusion of a large number of Negro, as well as of women, workers. The merged unions, unlike the two components, for the first time elected two Negroes to the executive council. Continued opposition was expected in the south where reaction against the supreme court decisions of 1954 and 19jj extended to economic life as well as to public schools and travel.

In June 1941 a group of Negroes proposed to march on Washington, D.C.. for the purpose of obtaining governmental action to reduce the widespread discrimination against Negroes in the rapidly expanding war industries. On June 25 Pres. Franklin D. Roosevelt issued an executive order declaring that there should be no discrimination in the employment of workers in defense industries or government because of race, creed, colour or national origin. All contracting agencies of the federal government were to include in defense contracts a provision obligating the contractor not to discriminate against workers for those reasons. The order established a Committee on Fair Employment Practice (F.E.P.C.) to receive and investigate complaints in violation of the order. Although the order met widespread opposition in the south, it resulted in considerable gains in the north. The work of the committee ended in June 1946 when congress failed to appropriate the necessary funds for the ensuing year. President Eisenhower by an executive order dated Aug. 13, 1953, appointed a committee to make recommendations to the government contracting agencies for improving and making more effective the nondiscrimination provisions of government contracts. The order also required the head of each contracting agency to take appropriate procedures to carry out the responsibility of obtaining compliance with the nondiscrimination agreement entered into by government contracting agencies. One of the members of the committee was a Negro. President Eisenhower also called in 195j a conference of representatives of about 50 of the largest firms in the Pnited States to discuss means of extending nondiscrimination in employment. In some instances contractors encountered difficulties because many trade unions refused to refer Negroes for skilled jobs. Negroes contended that the lack of skilled Xegroes was due largely to the fact that many trade unions refused to permit Segroes to become apprentices.

President Eisenhower by an executive order dated June 18, 1955, created the President's Committee on Government Employment Policy to assist the federal agencies in developing a policy to prevent discrimination on the basis of race. colour, religion or national origin in the hiring. promotion, and discharge of federal civilian employees. It served as a review board on complaints of discrimination and rendered advisory opinions to the agencies for corrective action. About 85% of the complainants were Segroes. Despite local community attitudes, especially in the south, the committee reported in 1959 that it had made progress. In 1958 a Segro became chairman of the committee.

While congress failed to pass an F.E.P.C. law to prevent racial discrimination in industries, about 18 states and 30 cities had enacted by the latter 19jos "little" F.E.P.C. laws and ordinances. In Sew York state, which adopted the first of these laws on March 12, 1945. violation of the law was punishable by imprisonment for not more than a year or a fine of not more than $500, or both. In those states which carried similar punitive provisions) Segroes obtained more and better jobs. But most of the laws and ordinances provided only for consultation and recommendation.

The National Urban league, founded in 1910, sought to organize effective community interest toward the solution of community problems resulting from inequality in employment. education and training for jobs, and family welfare. Its commerce and industry council included officers of some of the largest business corporations; and its trade union committee, representatives of many of the most powerful trade unions. It received support also from such organizations as the National Conference of Christians and Jews. Working in co-operation with the President's Committee on Government Contracts and the President's Committee on Government Policy, it helped a growing number of Segroes to obtain better jobs.

The changes in the major occupational categories of Xegro workers are indicated in the accompanying table.

Employed White and Nonwhite Persons in the United States, by Major Occupational Group, 1950 and 1940

'In thousands

Occupational group	White			Nonwhite*		
	April 1950	April 1940	Per cent change	April 1950	April 1940	Per cent change
Total	50,488	40,225	+25.5	5,355	4,663	+14.8
Professional, technical and kindred	4,752	3,429	+38.6	192	125	+53.6
Managers, officials and proprietors, except farm	4,930	3,664	+34.6	80	63	+27.0
Farmers and farm managers	3,946	4,443	−11.2	507	701	−27.7
Clerical and kindred	6,584	4,328	+52.1	192	53	+262.3
Sales	3,662	2,866	+27.8	78	39	+100.0
Craftsmen, foremen and kindred	7,349	4,989	+47.3	283	138	+105.1
Operatives and kindred	10,054	7,680	+30.9	1,000	487	+105.3
Private household	645	1,084	−40.5	812	993	−18.2
Service, except private household	3,377	2,696	+25.2	768	543	+41.4
Farm labourers, except unpaid and foremen	1,217	1,410	−13.7	345	515	−33.0
Farm labourers, unpaid family	730	856	−14.7	211	309	−31.7
Labourers, except farm and mine	2,521	2,427	+3.9	827	671	+23.2
Occupation not reported	720	351	+105.1	60	28	+114.3

*Mainly Segro.

Source: U S. Department of Commerce, Bureau of the Census, *1950 Census of Population, Preliminary Reports*, series PC-7, no. 2.

Negro Professional and Business Men.—Negroes engaged in professional service increased from 41,524 in 1900 to approximately 125,000 in 1950. In the latter year teachers constituted about 60% of the total; clergymen about 15%; doctors and dentists together less than 5%; and social workers about 4%. They depended almost entirely on a Xegro clientele. Especially during and after World War II large white firms employed a few Negro architects. engineers, scientists and salespeople. Negro banks. insurance companies and newspapers likewise greatly expanded during the first half of the 20th century. In 1950, the 65 Segro insurance companies had assets of $134,201,324, annual income of $88,779,016 and insurance in force of $1,074,179,222. The Negro banks had total deposits of $29,000,000 and capital accounts of $2,728,000. Although this expansion continued after 1950, a separate Segro economy clearly gave employment to only a small percentage of Segro workers.

EDUCATIONAL AND CULTURAL DEVELOPMENTS

Post-Emancipation **Years.**—When the 13th amendment emancipated all slaves in the Cnited States in 1865, the vast majority of Negroes were illiterate. Some free Segroes had learned to read and write. and even some privileged slaves had illegally secured the rudiments of an education. The education of the freedmen was. thereiore, one of the urgent tasks before the nation at the end of the Civil War. As early as 1862 religious and philanthropic organizations began the task oi establishing schools for Segroes. Freedmen's relief associations in northern cities and Quakers, Congregationalists and other church groups founded schools in the wake of the Cnion armies in the south. In the last year of the war at least a thousand northern men and women were teaching and caring for former slaves. In 1865 the major responsibility for educating the emancipated Negroes was assumed by the Freedmen's bureau although denominational and philanthropic agencies continued to maintain schools. By 1870, when the educational work of the bureau stopped, there were 247,333 Segro pupils in 4,329 schools; and some of the major institutions for the higher education of Segroes had been founded, including Howard university. Fisk university. Hampton institute and Atlanta university.

Meanwhile, as the Republican party established "radical" governments in the southern states and disfranchised those who had supported the Confederacy, new constitutions were written in all the former Confederate states. One of the most important features of these new frames of government, to which Segro delegates to conventions contributed, was the provision for iree public education. In some states, such as South Carolina and Louisiana, there were some experiments with mixed schools. but whites were generally opposed to them. When reconstruction ended in 1877 and "home rule" was restored. the southern whites in control of their state governments continued to support programs of public education. but they soon developed practices of discriminating against Segro schools in buildings, equipment. teachers' salaries and the like. By 1S;;, for example. Alabama was spending 50% more on the education of each white child than on the education of each Negro child. and the figure rose to 514% by 1909. It became necessary. therefore, for Segroes themselves to supplement public support of their schools through private assistance of various kinds. They were aided by numerous philanthropic agencies such as the Slater fund, the Peabody fund. the Jeanes fund, and, later. the General Education board and the Rosenwald fund. During this period new schools and colleges were established, the outstanding example of which is Tuskegee institute, founded in 1881 by Booker T. Washington.

By 1900 there were 1,500,000 Negro children enrolled in school, and there were 28,560 Segro teachers. At the same time more than 2,000 Segroes had graduated from college. while 700 were currently enrolled in institutions of higher learning. Despite the contributions of philanthropists and of Segroes themselves. schools and colleges for Segroes were unable to attain equality with those provided for whites.

During the post-reconstruction years a considerable number of Segroes left the south and settled in the north and west in search of greater opportunities for social and economic betterment. They did not altogether escape the kind of hostility they had known in the south. hut the superior advantages somewhat softened the indignities and inconveniences of their new environment. In the urban centres of the north they profited from the experiences that came from greater contact n-ith the larger community and from the gron-th in size and influence of their own social institutions.

Both in the north and in the south Xegroes had to work out their own formulas for social and cultural improvement. An important agency for rendering service in these spheres was the church. The Baptist and Llethodist denominations continued to grow, while others. such as the Presbyterians and Congregationalists, attracted an increasing number. In a few of the churches the influence of the social gospel could be seen in the establishment of nurseries, employment bureaus and evening schools. In many more, however, some attempts. much less formalized, were made to meet the social needs of the communicants. The remarkable growth of fraternal orders was another evidence of the emergence of social institutions to meet the needs of Negroes. The Masons. Knights of Pythias and Knights of Labor competed for membership among Negro men. while a veritable spate of secret benevolent societies provided social contacts and numerous services to hundreds of thousands of Negroes. Organizations founded by women such as the Colored Women's league and the National Association of Colored Women engaged in charitable enterprises. Formerly all-\\-hite organizations such as the Young Men's Christian association and the Young \\;omen's Christian association began to extend their activities to Negroes.

The intellectual growth of the Negro and his progress toward greater assimilation in American life were notably reflected in the literary activity of the post-reconstruction years. Frederick Douglass, who had first published a sketch of his life in 1845, issued the final version of his autobiography in 1882 under the title, *The Life and Times of Frederick Douglass*. In 1901 Booker T. Washington brought out his *Up From Slavery*, which rapidly became one of the classics of American biography. The first outstanding Negro historian was George Washington Williams, whose quite readable volumes. *History of the Negro Race in America* and *History of the Negro Troops in the Rebellion*, were published in 1883 and 1887 respectively. In 1896 W. E. B. Du Bois began his long and distinguished career as a historian and sociologist by issuing his *The Suppression of the African Slave Trade*.

The Negro writer of fiction who made the greatest impression was Charles W. Chesnutt, whose short stories and novels were widely read and generously praised. Between 1899 and 1905 he published *The Conjure Woman, The House Behind the Cedars, The Wife of His Youth, The Marrow of Tradition* and *The Colonel's Dream*, all of which displayed his abilities to execute vivid character portrayals and lively narratives. Although Paul Laurence Dunbar wrote some novels, he was best known for his lyric poems. His *Oak and Ivy* (1893), *Majors and Minors* (1896) and *Lyrics of Lowly Life* (1896) caused many critics to refer to him as the poet laureate of the Negro people.

Meanwhile. Negro editors of newspapers and magazines were preoccupied with the problem of fighting for the greater acceptance of Xegroes in American life. Magazines like the *Southern Workman*, published at Hampton. Va., after 1872, and the *A.M.E. Church Review*, which was begun in 1884 in Philadelphia. Pa.. were concerned primarily with educational. literary and religious matters. Newspapers addressed themselves largely to economic and political problems. In Boston, in 1901, George Forbes and Monroe Trotter began publication of the *Guardian*, which demanded full and immediate equality for the Negro. The majority of the 150 weekly Negro newspapers published in 1900 were doing the same thing in a greater or less degree.

The 20th Century.— In the 20th century the intellectual and cultural growth of the American Negro was significant. An important factor in this development was the steady increase in educational opportunities. due in part to the large migration of Negroes from the south to the north and west. Although in many instances they were forced into ghettos, with substandard housing and generally unsatisfactory living conditions. the opportunities were greater than any they had known in the south. Northern schools were vastly superior to those of the south, and Negroes who lived on the fringes of white neighhourhoods or among whites had the opportunity to attend mixed schools. The results of thesk new advantages were to be seen in the emergence of a group more culturally assimilated and more capable of assuming the responsibilities of citizenship.

In the south the struggle to secure greater opportunities assumed large proportions during World War I and in suhsequent years. Here, as in the effort to secure the franchise and greater justice in the courts, the fight was led by the National Association for the Advancement of Colored People. Gaining their spurs in their victory in 1917 over city ordinances that segregated Negroes and whites by blocks. they began to press for equal educational opportunities for Negroes. It was not until the middle of the 1930s that the fight began in earnest. By this time a generation of Xegroes. schooled in the ideas of freedom and equality advanced during World War I and more aggressive in the demand for their rights, began to call for full equality. They were outraged by the increasing disparity of expenditures for the education of white and Negro children. In 1900, for every $2 spent for the education of Negroes in the south. $3 was spent for whites. But in 1930 $7 was spent for whites to every $2 spent for Negroes. The first successful attack on these disparities was made in 1940, when the United States circuit court of appeals ruled in a case arising in Norfolk, Va., that a double salary standard based on race was an unconstitutional discrimination.

New educational opportunities began to unfold in 1935 when the Maryland court of appeals ruled that a Negro should be admitted to the state university's law school because the out-of-state tuition grants were a violation of the law. In 1938 the United States supreme court confirmed this ruling in a case arising in Missouri; the court held that such grants were a denial of equal protection and that substantially equal facilities must be provided within the state. Southern states began feverishly to set up graduate and professional schools for Negroes and to strengthen and improve the public schools and colleges for Negroes in the hope that the court would approve their efforts to maintain the doctrine of "separate but equal." Their efforts were futile, for in 1950 the supreme court ruled that Negroes had the right to attend the same professional schools that whites attended. Four years later the court declared unconstitutional the doctrine of "separate but equal." On May 31, 1955, the court ordered the southern states to desegregate their schools "with all deliberate speed."

The years following World War II saw the breakdown of segregation in numerous other spheres. bringing with it significant advances in cultural and social opportunities. The movement of Negroes was greatly facilitated by the outlawing of segregation in buses, train coaches and dining cars. Recreational opportunities were increased by court orders that opened public parks, swimming pools and golf courses. Southern libraries began gradually to open their facilities on a segregated or integrated basis. Professional organizations in some communities began to let down their bars and admit Negroes. Between 1940 and 1959 Negroes were appointed or elected to state and local boards having to do with health, recreation. education and public welfare. A few white churches desegregated, while an increasing number of white religious bodies spoke out against legally enforced segregation. There was substantial, even bitter opposition to these and other similar developments. At best, however, the opposition delayed action rather than preventing it altogether.

Long before the walls of segregation began to crumble Negroes gave evidence of moving toward intellectual and cultural maturity in the Cnited States. This came in part from the steady improvement of facilities and opportunities in the north and even in the segregated south. There was, moreover, the accumulation of a tradition of responsible citizenship and pride in achievement as a larger number in each succeeding generation secured an education and assimilated and contributed to the heritage of America. Finally, improved economic conditions among Negroes provided some means and leisure for the pursuit of education and culture.

As Negroes attained intellectual maturity they began to make contributions to many fields of learning. George W. Carver, Percy Julian, Elmer Imes, E. E. Just, William A. Hinton, Daniel Williams and Charles Drew became outstanding scientists. Charles S. Johnson and E. Franklin Frazier gained international reputations with their sociological studies, while Carter G. Woodson, John Hope Franklin, Abram Harris and William Dean achieved distinction as historians and economists. The outstanding political scientist at mid-20th century was Ralph J. Bunche, whose work as a United Nations mediator won for him the Nobel peace prize for 1950.

In no area was the intellectual maturity of the Negro expressed more clearly than in literary activities and the fine arts. In the years following World War I the number of recognized poets. essayists and novelists was so large that together rhey constituted what came to be known as "the Harlem Renaissance." Bitter. cynical and race conscious, they protested the numerous injustices and indignities to which Segroes were subjected. Many of them published their first pieces in *Crisis* and *Opportunity,* which were edited by W. E. B. Du Bois and Charles S. Johnson respectively; and in 192j Alain Locke heralded the new development in his *The New Negro.* Du Bois, already the leading Segro scholar and publicist, wrote fiction, essays and poems. James Weldon Johnson, who had published *Fifty Years and Other Poems* in 1917, brought out *The Book of American Segro Poetry* in 1922 and continued to write until his death in 1938.

Among the younger poets was Claude McKay, who wrote some of his best pieces during this period and published them in *Harlem Shadows* in 1922. Other leading poets and their works were Georgia Douglas Johnson, *Bronze* (1922); Jean Toomer, *Cane* (1923); Countee Cullen. *Ballad of the Brown Girl, Cooper Sun* and *Caroling Dusk* (1927); and Langston Hughes. *Weary Blues* (1926) and *Fine Clothes to the Jew* (1927). In later years other poets appeared. Sterling Brown published his *Southern Road* in 1932; Margaret Walker's *For My People* came out in 1942; and Owen Dodson's *Powerful Long Ladder* appeared in 1946. Gwendolyn Brooks. whose *Street in Bronzeville* appeared in 1945, won the Pulitzer prize ior poetry in 1950 with her *Annie Allen.*

Among the writers of prose was Walter White. who penned a tragic story of Segro life in the south in *Fire in the Flint* (1924) and *Rope and Faggot: A Biography of Judge Lynch* (1929). Another was Rudolph Fisher, whose *The Walls of Jericho* appeared in 1928 and *The Conjure Woman Dies* in 1932. The leading women writers and their works were Jessie Fauset, *There is Confusion* (1924), *Plum Bun* (1929) and *The Chinaberry Tree* (1931); and Nella Larsen, *Quicksand* (1928) and *Passing* (1929).

In later years Xegro writers increased both in numbers and popularity. Xrna Bontemps wrote, among other things. historical fiction, two examples of which were *Black Thunder* (1936) and *Drums at Dusk* (1939). Richard Wright gained wide recognition with his *Uncle Tom's Children* (1938), *Native Son* (1940), *Black Boy* (1945) and *The Outsider* (1953). Ann Petry's *The Street* (1946) and *The Narrows* (1953j placed her among the best-known American writers. Willard Motley, using non-Negro materials, achieved considerable standing with his *Knock on Any Door* (1947) and *We Fished All Night* (1951). The most widely read Xegro novelist was Frank Yerby, who brought out his *Foxes of Harrow* in 1546. His fast-moving historical romances captivated millions of readers and movie-goers in many parts of the world. Ralph Ellison and James Baldwin were advance-guard psychological novelists: and Langston Hughes established himself as the Harlem "O. Henry."

Negro proiessors in increasing numbers received temporary appointments to the faculties of some of the leading northern. midwestern and western universities; a few served as heads or chairmen of their departments. Some 1.000 Segroes attended "white" southern tax-supported institutions, and another 1.000 were students of scuthern private institutions of higher learning. A small number attended the University of Virginia before a few public schools were desegregated; some attended Louisiana State university although public schools in that state were will segregated.

Especially after Ghana became independent in 1957, some Negroes were counted among the rapidly growing number of American Xfricanists; many others manifested a sentimental interest in the emerging African states. The visits to the United Stares of presidents: prime ministers and other leaders of these states gave many Segro Americans a sense of pride which they had not previously known.

The Segro press flourished among members of the Negro community that looked in vain in the white press for accounts or' activities of immediate interest to them. The *Age-Defender* and *Amsterdam News* (New York city), the *Afro-American* (Baltimore, Md.), the *Journal and Guide* (Norfolk, Va.), the *Pittsburgh Courier* (Pa.) and the *Chicago Defender* (Ill.) enjoyed large national circulations, while hundreds of small weekly papers sen-ed their respective communities. In 1956 the *Atlanta World* (Ga.) and the *Chicago Defender* were the only daily Segro newspapers in the United Slates. Meanwhile. the John H. Johnson publications: especially *Ebony* and *Jet,* became the leaders among the Segro magazines.

In the dramatic arts, as subject, playwright and actor, the American Negro played a significant role. Plays with Negro themes, such as *Uncle Tom's Cabin,* based on the novel by Harriet Beecher Stowe, and *The Octoroon,* by Dion Boucicault, attracted wide attention in the last half of the 19th century. After World War I. Eugene O'Neill. Ridgely Torrence, the DuBose Heywards, Emily Hapgood and Paul Green employed the Segro theme with great effectiveness. Segro playwrights also made a bid for recognition. Garland Anderson wrote *Appearances* in 1925, and Eulalie Spence's *The Fool's Errand* was staged in 1927. In later years *Mulatto* by Langston Hughes and *Native Son* by Richard Wright had fairly successful runs on Broadway. In the 1940s and 1950s most of the writing of plays by Negroes was done by teachers of dramatics in Negro colleges.

At the end of World War I Charles Gilpin emerged as the leading Segro actor with his portrayals in John Drinkwater's *Abraham Lincoln* and O'Neill's *The Emperor Jones.* In 1924 Paul Robeson won acclaim in the leading role in O'Neill's *All* Cod's *Chillun Got Wings* and, later, in *Othello* and in numerous roles in motion pictures. Richard B. Harrison as "De Lawd" in Marc Connelley's *The Green Pastures,* Rose McClendon, Frank Wilson. Abbie Mitchell and Rex Ingraham made reputations on the legitimate stage. Meanwhile. an increasing number of Segroes, including Ethel Waters. Lena Horne, Dorothy Dandridge. Louise Beavers, Fredi Washington, Hattie McDaniel. Harry Belafonte and Juan Hernandez. won reputations before the motion-picture cameras and on radio and television.

From the time that Bert Williams and George Walker reached New York city in 1896 and introduced their highly successful vaudeville team, Negroes played a considerable part in providing light entertainment for American audiences. Musical revue.; such as *Shuffle Along, Blackbirds* and *Carmen Jones* were highly successful, while the dancing of Bill Robinson and "Pegleg" Bates and the music of numerous jazz bands and blues singers were among the nation's favourites for many years. In later years the Howard players won acclaim. especially in Norway, for their performances of Ibsen's plays and of Segro folk dramas.

In the 20th century the early American Segro music—predominantly folk music and spirituals—was given a new vogue on the concert stage by Harry Burleigh. Roland Hayes. Paul Robeson. Marian Anderson and other Segro singers. The spirituals are said to be a fusion of African music. Christian music and Christian sentiments. Based on primitive rhythms. they went beyond African music through a higher melodic and an added harmoni development. They also assumed new and more sophisticated forms in new arrangements and in new compositions. The outstanding composer of symphonic music was William Grant Still, whose works were performed by many of the major orchestras of the United States. The number of Segro singers who achieved distinction increased with each year. Three Segroes, Marian Anderson, Mattiwilda Dobbs and Robert McFerrin. signed contracts with Sen· York's Metropolitan Opera association. Meanwhile. other Segroes won opportunities in the George Gershwin folk opera. *Porgy and Bess,* in the DePaur Infantry chorus and in other musical aggregations.

The Howard University choirs, under the direction of Dean Warner Lawson. were highly praised, especially for joint concerts with the Washington National Symphony orchestra. The Negro's role in the development of jazz has been conspicuous. Among the sources of jazz are Negro folk music, both secular and spiritual ragtime, and the marching band music of New Orleans. Negroes played key roles in the origin of jazz: King Oliver. Louis Armstrong, Ferdinand "Jelly Roll" Morton and W. C. Handy: in its evolution into swing: Fletcher Henderson, Duke Ellington. Jimmy Lunceford, Cab Calloway and Count Basie; and in the advance-guard styles of "bebop," "progressive" and "cool" jazz:

Charles Parker and John B. ("Dizzy") Gillespie. Noted among the arts as one of the most democratic, jazz was no longer chiefly the American Negroes', but was the national music, and because of its international popularity was one of the state department's most valuable art forms for export. Sterling A. Brown through his lectures at the Library of Congress and the Newport, R.I., Jazz festival notably brought folk music and jazz to the attention of serious critics of the arts.

In painting several Negroes were outstanding. Henry O. Tanner's pictures were winning medals as early as 1900, and by mid-century many of them were in the leading galleries of Europe and America. After World War I Aaron Douglass began to receive recognition for his black and white drawings and illustrations, Laura Wheeler Waring painted scenes from life among upper-class Negroes, while Edward A. Harleston contented himself with genre painting. Later, Hale Woodruff and Charles Alston of New York city and James Porter and Lois Jones of Washington, D.C., proved to be both careful students as well as skilled and versatile artists. E. Simms Campbell and Romare Bearden achieved positions as outstanding illustrators and caricaturists. In the field of sculpture Meta Warrick Fuller, who won recognition before World War I, continued to do significant work. Elizabeth Prophet and Augusta Savage executed pieces that reflected the successful use of Negro subjects in this difficult medium. Sargeant Johnson enjoyed success as a decorative sculptor, while Richmond Barthe became the foremost sculptor and was commissioned to do the bust of Booker T. Washington for the Hall of Fame at Kew York university.

HOUSING

In the late 1950s housing emerged as a major problem, especially for Negroes, in many communities: north and south. Even before the early 1950s upper- and middle-class whites had begun a "flight" to the suburbs and beyond. The migration of Negroes from southern rural areas to southern and northern cities gave impetus to the exodus. Low-income whites and Negroes moved into blighted and slum areas which were frequently in the centre of cities. But high taxes in suburbs with few industries, traffic problems and other inconveniences led to a return of some of the upper- and middle-class whites to cities. Former blighted and slum areas gave way to modern apartment buildings, both private and public, with high rentals. The previous occupants crowded into new ghettos which aggravated problems of juvenile delinquency and children born out of wedlock. Teenagers began to drop out of school before they had acquired skills for employment. These "drop-outs" frequently formed gangs which engaged in criminal activities because they were rejected by the community. Social workers who sought understanding of these problems were criticized as "do-gooders."

In New York city especially, the influx of Puerto Ricans aggravated the problem despite a city ordinance which attempted to prevent discrimination in housing. Weliare rolls in Chicago were 80 to 85% nonwhite; in other cities there was also a disproportionately large number of Negroes receiving relief.

SPORTS

Negroes held boxing championships in all weights for many years. In 1947 Jack R. ("Jackie") Robinson became the first recognized Negro to play on a major-league baseball team. Within a decade Negroes were playing or had played on all these teams; others were on all professional basketball teams and on all except one of the professional football teams. In amateur sports, Althea Gibson had won the women's singles championship in tennis in 1957 and Negroes continued to win acclaim on most of the leading northern, midwestern and western college football teams. Negroes in post-season football games in some southern cities were also distinguished for their performances. Telecasts of. proiessional and collegiate and other amateur sports demonstrated to increasing numbers in north and south the contribution of Negro athletes on the highest levels in competitive sports.

See also references under "Negro, American" in the Index volume.

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NEGRO MINSTRELS: see MINSTREL SHOW.

NEGRO RIVER (Río NEGRO), one of the principal tributaries of the Amazon (*q.v.*), about 1,056 mi. long. Its principal headwater affluents, the Vaupés (Uaupés) and the Guainia, rise in the rain forest of eastern Colombia. After turning southward the latter forms the Venezuela-Colombia border for more than 100 mi., becoming the Negro where it joins the Casiaquiare canal at San Carlos. Manaus, regional capital of the Amazon valley and a port for ocean-going vessels, is located on the high left bank of the Negro 12 mi. above its junction with the Solimões or Amazon. Near Manaus the Negro is an island-free estuary 4 mi. wide and at least 100 ft. deep, but farther upstream it is up to 20 mi. wide and filled with a labyrinth of lenticular islands formed by deposits of materials derived from its silt-laden, left bank tributaries.

The clear, jet-black water of the Negro, from which it derives its name, contrasts dramatically with the yellowish, silt-laden water of its major tributary, the Rio Branco, and with that of the Amazon. As it carries no sediment in its lower course the Negro has no flood plain. The low marginal areas (igapós), which its waters cover during much of the year, are forest covered. Dissolving humic acid, derived from the decomposition of organic matter in the soils of these bordering swamps, gives the Negro its black colour.

Most of the drainage area of the Negro is of subdued relief, interrupted by occasional monadnocks reaching from 300 to 1,200 ft. above the forested plain. Through that strange natural waterway, the Casiaquiare canal, the Negro appears to be capturing the headwaters of the Orinoco system. (Js. J. P.)

NEGROS OCCIDENTAL, a province on the western and northern sides of Negros Island, Republic of the Philippines, facing the Island of Panay across Guimaras strait. Area 2,989 sq.mi.; pop. (1960) 1,332,017. The province has a large coastal plain built from sediments eroded from the igneous mountain mass in the interior.

The northern and northeastern portions of the province are less level. with really rolling hills; the southern end is part of a grassy plateau that is shared with Negros Oriental. Mt. Canlaon (8.087 ft.) is an impressive volcanic peak near the centre of the island and Mt. Maldalgan (6,165 ft.), is the principal mountain in the north. Negros Occidental is the wealthiest province in the republic and probably the province with the greatest political influence in the national government. It has more miles of paved road than any other province.

Negros Occidental produces between 55% and 60% of the Philippine commercial sugar. There are ten modern *centrals:* Binalbagan, Victorias, La Carlota, Hawaiian-Philippine (near Saravia), Talisay-Silay, Ma-ao, Bacolod-Murcia, San Carlos, Lopez (at Sagay) and Danao (near Escalante). There is a large modern lumber mill at Fabrica, but the workable forests in that area have been largely exhausted. Other crops include coconuts; rice and corn. There is a minor coal deposit near Escalante.

Bacolod, the capital and principal urban settlement: is a regional commercial centre and in the 1960s it was beginning to rival Cebu and Iloilo as a centre of political influence in the Visayans. Pop. (1959 est.) 124,259. *See* BACOLOD, CITY OF. (AN. C.)

NEGROS ORIENTAL, a province on the eastern and southern sides of Negros Island, Republic of the Philippines. Area 2,053 sq.mi.; pop. (1959 est.) 543,260. Peopled principally by Cebuanos and separated from the nearby island of Cebu by narrow Tañon strait, it is more closely related to Cebu both culturally and commercially than to the other side of Negros, from which it is separated by a rugged mountainous core of volcanic origin. The southern part of the province is principally a grassy plateau and is sparsely populated. The eastern portion grades from a discontinuous coastal plain into rolling limestone hills and then into forested mountain slopes. The principal crops are corn, rice, sugar cane and coconuts.

Dumaguete city (pop. [1959 est.] 30,428) the capital, is a minor regional centre with regular air service. It is a port of call for both interisland ships and ocean freighters. The community is probably best known as the site of Silliman university, a mission school with an excellent liberal arts college.

Siquijor Island (130 sq.mi.), a subprovince of Negros Oriental, lies directly opposite Dumaguete. Bais, 2j mi. N. of Dumaguete. is the site of a large sugar central, the only one in the province, with a distillery for converting the by-product molasses into industrial alcohol and a paper mill using bagasse (sugar-cane fibres) as its raw material. Other municipalities are Tanjay, Guihulñgan, Calamba. Zamboanguita and Siaton. (AN. C.)

NEHEMIAH (in the Douai version of the Bible, NEHEMIAS), governor of Judaea under Artaxerxes (*q.v.*), who was generally thought to be Artaxerxes I (465–424), although he could possibly have been Artaxerxes II (404–359 B.C.). The book of Nehemiah (II Esdras in the Douai version) forms the concluding portion of the great compilation, Chronicles–Ezra–Sehemiah. Nehemiah's own account! written after 432 in the first person, and confined to ch. i–iv, is the only authentic information which remains in regard to his life and work.

See further EZRA AND NEHEMIAH, BOOKS OF; JEWS: *Exile and Restoration: Nehemiah.*

NEHRU, JAWAHARLAL (1889–), Indian statesman, became the first prime minister of the republic of India. Born on Nov. 14, 1889, at Allahabad, U.P., India, by caste a Kashmiri brahmin, he was taken in 1905 to England, sent to Harrow school, and later studied natural science at Trinity college, Cambridge, and law at the Inner Temple, London. The son of an Anglophile family, he thus became even more thoroughly at home in the English and European milieu, writing a distinguished style of English and becoming conversant with European literature and history. In 1912 he returned to India to practise at the Allahabad bar, like his father Motilal Nehru (*see* below). He joined the then moderate Indian National Congress.

The Amritsar massacre of 1919 radically changed the Nehrus' outlook. Jawaharlal abandoned his successful law practice and was soon a notable follower of Mahatma Gandhi. eventually coming to be second in rank to him. The vicissitudes of the national struggle brought him several times into prison, first in 1922, lastly in 1942–45. While there he wrote many letters to his daughter Indira, later collected as *Letters from n Father to his Daughter* (1930) and *Glimpses of World History* (1934; 4th ed. 1949). In 1929 he succeeded his father as president of the now extremist Congress, an office he occupied again in 1936–37, 1946 and 1951–54. Always loyal to Gandhi, he did not share his traditionalist, conservative and pacifist views. Deeply concerned to secure agrarian reform and the betterment of the masses! he found all enthusiastic following among Indian youth. He studied Marxism and Taoism, and paid several visits to the U.S.S.K. and to China. Nehru was appointed vice-president (premier) of the interim government of 1946, and when India became an independent dominion the next year he became prime minister and minister ior external affairs. He was confirmed in power at the declaration of the republic on Jan. 26. 1950, and by the Congress victory in the first general elections, 1951–52, and again in 1957.

Nehru's foreign policy was characterized by "anticolonialism," advocacy of Communist China's place in world councils, "nonalignment" with either Soviet or western blocs, and friendship for all. This last was based on his *panch sila* ("five points"), originally prefaced to the 19j3 Sino-Indian treaty: respect for sovereignty, nonaggression, noninterference with internal affairs, equality and mutual benefit. and peaceful co-existence. Following border disputes with Communist China and incidents in which Indian troops were killed, Nehru announced late in 1959 that his government would meet incursions with firmness and strength; he also reaffirmed in 1960 his policy of nonalignment.

His sister VIJAYA LAKSHMI PANDIT (1900–). nee Swarup Kumari Nehru, was also very active in the nationalist movement, being three times imprisoned by the British. She entered municipal and provincial government before World War II. becoming in 1936, as United Provinces minister of local government and health, the first Indian woman to hold a cabinet portfolio. She was leader of the Indian United Nations delegation. 1946–48; Indian ambassador to Moscow, 1947–49, and to Washington, 1949–51; president of the UN general assembly, 1953–54; and Indian high commissioner in London from 1954.

Jawaharlal Nehru's father MOTILAL NEHRU (1861–1931), at first an Anglophile and a moderate advocate of home rule, followed his son into a more extreme nationalism in 1919. He was the leader of the Swaraj (self rule) party, merged in Congress in 1926.

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NEISSE, three rivers of central Europe. (1) The Glatzer Neisse (Pol., Nysa Rlodzka), located in Poland, rises in the Sudetes mountains at an altitude of 1,400 ft., near the Czech border. It flows north past Glatz (Klodzko), turns eastward past Paczkow and Neisse (Nysa) until it joins the Oder between Oppeln (Opole) and Brieg (Brzeg). (2) The Lausitzer or Gorlitzer Neisse. 159 miles long, rises near Reichenberg (Liherec) in Bohemia, Czech., on the south side of the Riesengebirge, flows north past Reichenberg, Gorlitz, Forst and Guben, and enters the Oder above Fürstenberg. Parts of the Lausitzer Neisse and Oder rivers form the *de fncto* Polish-German border. (3) The Wütende Xeisse (Pol., Nysa Szalona). located in Poland, is a tributary of the Katzbach (Kaczawa).

NEISSER, ALBERT (LUDWIG SIEGMUND) (1855–1916), German dermatologist and venereologist, discoverer of the bacterium that causes gonorrhea, was born at Schweidnitz (now Świdnica, Pol.) on Jan. 22, 1855, the son of a Jewish physician. After grsduating at Breslau (now Wroclaw) in 1877, he worked as assistant in the university department of dermatology arid at the age of 24 announced the discovery of the gonococcus, now called *Neisseria gonorrhoeae*. Neisser was appointed associate professor and director of the university skin clinic in 1882, and was promoted full professor in 1907. The German climate was found unsuitable for the monkeys used for the experimental transfer of syphilis: so Neisser conducted his studies of immunity to the disease in Batavia, Java. Collaborator with A. von Wassermann and C. Bruck in a paper, "Eine serodiagnostische Reaktion bei Syphilis" (1906), he did much of the work which preceded the introduction of the blood test known as the Wassermann reaction. He treated syphilis with mercury and, when Salvarsan became available, used the two drugs in combination. A cultured and amiable man fond of music and art, Neisser spent almost the whole of his professional life at Breslau, where he died on July 30, 1916. (WR. R. B.)

NEJD, a province of Saudi Arabia, occupying the core of the ancient land block of Arabia. The old block has been uptilted on the west, consequently Nejd tends to slope very gradually from west to east. The name itself implies an upland, and this is its distinctive character as compared with the adjoining coastal districts of Hejaz and Hassa, representing the shelving down of the plateau on the west and east respectively. Nejd has an area of 650,783 sq.mi.

In general elevation Nejd varies from 5,000 ft. on its western border to 2,500 in Qasim in the northeast, and somewhat less in the southeast. In the north Jabal Shammar, and in the east J. Tuwaiq and J. 'Aridh rise about 1,500 ft. above the general level, but, on the whole, Nejd may be described as an open steppe, of which the western and southern portion is desert, or at best pasture land only capable of supporting a nomad population; while in the north and east, because of a greater abundance of water, numerous fertile oases are found with a large settled population. (*See* ARABIA.)

Nomadic tribes, following their flocks and herds over the steppe, have roamed over the territory from time immemorial, raiding the settled dwellers oi the oasis in times of difficulty or scarcity. The four most prominent tribes of Bedouin are the Shammar, Harb, 'Utaiba and Mutair. The first-named represent that part of the great Shammar tribe which has remained in its ancestral home on the southern edge of the Nufud (the northern branch long ago emigrated to Mesopotamia); many of its members have settled down to town life, but the tribe still retains its Bedouin character. The Harb are probably the largest of the Bedouin tribes in the peninsula, and are divided into a number of sections. Their territory is the steppe between Qasim and Medina. The 'Utaiba territory extends from near Mecca along the road to Qasim. The Mutair occupy the desert from Qasim north toward Kuwait.

Nejd became nominally a dependency of the Turkish empire in 1871, when Midhat Pasha established a small garrison in Hassa, and created a new civil district under the government of Basra, under the title of Nejd, with headquarters at Hufuf. Its real independence was not, however, affected, and the emirs, Mohammed Ibn-Rashid, at Ha'il, and 'Abdallah Ibn-Sa'ud, at Riyadh, ruled in western and eastern Nejd respectively, until 1892, when the former, by his victory at 'Unaiza, became amir of all Nejd. His successor, 'Abd-al-'Aziz Ibn-Rashid, was, however, unable to maintain his position, and in spite of Turkish support, sustained a severe defeat in 1905 at the hands of Ibn-Sa'ud, who thus became the dominant power in Nejd. By 1914 Ibn-Sa'ud with his Wahhabi followers had wrested the province of Hassa from the Turks, and his power thus reached the Persian gulf. Remaining inactive during World War I, Ibn-Sa'ud in 1920 had captured and annexed Abha and other parts of 'Asir, leaving only the coastal strip. In 1921, Ha'il and the dominion of the amir of Jabal Shammar were in his possession, and by the end of 1925 he had overthrown the new Hashimite kingdom of the Hejaz. He was proclaimed at Jidda, in 1926, as king of Hejaz and sultan of Nejd. From Riyadh, Ibn-Sa'ud, until his death in 1953, ruled over the new kingdom called, after 1932, Saudi Arabia, comprising Hejaz, 'Asir, Nejd and Hassa.

A few simple taxes on cattle and possessions are collected. The chief administrative regions are: 'Aridh, with the town of Riyadh (one of the two capitals of Saudi Arabia); Wadi Dawasir; Aflaj; Kharj; Sudair; Mahmal; Washm; Qasim; Jabal Shammar, with the town of Ha'il; Jauf; and many scattered oasis groups, each ruled by an amir.

Of the towns, Riyadh has a population of (1956 est.) 150,000; Buraida has about 50,000; Ha'il, Hauta, 'Unaiza, Jauf, Mubarraz, Shaqra and Sakaka have populations between 10,000 and 20,000. The entire population of Nejd is estimated at 4,000,000. Besides the population of the towns mentioned above, and the nomadic tribes, there are many villages in hollows of the valleys of the tableland, wherein is concentrated the fertility and much of the population of Nejd.

The products of Nejd include dates. wheat, barley, hides, wool, fruit, *samn* (clarified butter), camels, sheep, horses, etc. The export of camels to Syria and Egypt has been much reduced. Tea, coffee, sugar, rice. motor vehicles and piece goods are imported.

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NEKRASOV or NEKRASSOV, **NIKOLAI ALEXEYEVICH** (1821–1877), Russian poet, was born on Nov. 22 (O.S.), 1821, in Podolia, the son of a landowner in the government of Yaroslav, where the boy was brought up. He studied at St. Petersburg, against the will of his father, who left him to his own resources. At the age of 19 he published a small volume of poems (*Dreams and Sounds*), most of which had appeared in periodicals, and in 1846 he bought from Pletnev the *Sovremennik,* which in his hands became from 1856 onward the favourite organ of young radical writers. It was suppressed in 1866, but in 1868 Nekrasov acquired, with Saltykov, the *Otechestvennye Zapiski,* in which the traditions of the *Sovremennik* were maintained. He died at St. Petersburg on Dec. 27 (O.S.), 1877.

Nekrasov was a people's poet, and expressed the sorrows and sufferings of the common people in poems which made him the idol of the reformers, and the joy and humour of everyday life in admirable adaptations of folk song, and in charming poems for children. Among the most famous of his works are *The Red-Nosed Frost* (1863), depicting a heroic peasant woman, and the great satirical work *"Who can be happy and free in Russia?"* (1879, Eng. trans. J. M. Soskice, 1901). The latter is a species of *Canterbury Tales*, though with a definite purpose running through the series. Seven peasants make their way on foot throughout Russia to solve the question of who is happy. They are told a series of tales, by typical characters, landowners, priests, peasants and others, and Nekrasov concludes on a note of hope for the future. This last canto, due to the censorship, did not appear until 1881. His work includes love poems, elegies and narrative poems. The most recent edition of his poems was published in 2 vol. in 1919, and they have been translated into German by H. J. Köcher (2 vol. Leipzig, 1885–88). English translations of some of his poems, including *The Red-Nosed Frost,* are to be found in C. T. Wilson's *Russian Lyrics* (1887); and J. Pollen, *Rhymes from the Russian* (1891). *See* also a French translation of some of his poems, *Poésies populaires,* by E. Halperine-Kaminsky and C. Morice, with a preface by E. M. Vogüé.

NELEUS, in Greek legend, son of Poseidon and Tyro, brother of Pelias. The two children were exposed by their mother, who afterward married Cretheus, king of Iolcus in Thessaly. After the death of Cretheus, the boys, who had been brought up by herdsmen, quarrelled for the possession of Iolcus. Pelias expelled Neleus, who migrated to Messenia, where he became king of Pylos (Apollodorus i. 9; Diod. Sic. iv. 68) and ancestor of the Neleidae, who are historically traceable as the old ruling family in some of the Ionic states in Asia Minor, after the Dorian migration. By Chloris, daughter of Amphion, Neleus was the father of 12 sons (of whom Nestor was the most famous) and a daughter Pero; *cf.* MELAMPUS. According to Pausanias (ii. 2. 2, v. 8. 2) Neleus restored the Olympian games and died at Corinth, where he was buried on the isthmus.

NELLORE, a town and district in Andhra Pradesh, India. The town is on the right bank of the (northern) Pennar river, and on the east coast line of the Southern railway, 95 mi. N.N.E. of Madras city. Pop. (1951) 81,480. It is the see of a Roman Catholic bishop and there are Lutheran and American Baptist missions. An undergraduate and a Sanskrit college are connected with Andhra university.

NELLORE DISTRICT has an area of 7,955 sq.mi. It comprises a tract of low-lying land extending from the Eastern Ghats to the sea. Its general aspect is forbidding: the coastline is a fringe of blown sand through which the waves occasionally break. Farther inland the country rises, but the soil is not naturally fertile, nor are means of irrigation readily at hand. About one-half of the total area is cultivated: the rest is either rocky waste or is covered with low scrub jungle. Large mica deposits have been found. Nellore, with the rest of the Carnatic, passed under direct British administration in 1801. The population in 1951 was 1,795,-632. The principal crops are millets, rice, and pulses. The breed of cattle is celebrated.

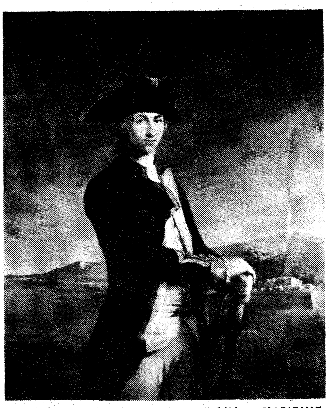
NELSON, HORATIO NELSON, VISCOUNT (1758–1805), duke of Brontë in Sicily, British naval hero, was born at Burnham Thorpe, in Norfolk, on Sept. 29, 1758. His father, Edmund Nelson, was rector of the parish arid his mother, Catherine Suckling, was related to Sir Robert Walpole (1st earl of Orford). His uncle, Capt. Maurice Suckling, later became comptroller of the navy.

Early Life.—Horatio Nelson, who was educated at Norwich, Downham and North Walsham, was entered in the "Raisonnable" n-hen Captain Suckling was appointed to her in 1770 on an alarm of war with Spain. The dispute was settled and Captain Suckling was transferred to the "Triumph," the guardship at Chatham, taking his nephew with him. In order that the lad might have more practice than could he obtained in a harbour ship, his uncle sent him to the West Indies in a merchant vessel, and on his return gave him constant employment in boat work.

In 1773 Nelson served with Captain Lutwidge in the "Carcass," in an expedition to the arctic under the command of Captain Phipps (later Baron Mulgrave). On his return from the north he was sent to the East Indies in the "Seahorse," in which vessel he met his lifelong friend Thomas Troubridge. At the end of two years he was invalided home. In later times he spoke of the depression under which he laboured during the return voyage, until "after a long and gloomy reverie, in which I almost wished myself overhoard, a sudden glow of patriotism was kindled within me, and presented my king and my country as my patron. My mind exulted in the idea. 'Well then,' I exclaimed, 'I will be a hero, and, confiding in Providence, I will brave every danger.'" He spoke to iriends of the "radiant orb" which from that hour hung ever before him and "urged him onward to renown."

On his return he served during a short cruise in the "Worcester" frigate, passed his examination as lieutenant on April 9, 1777, and was confirmed in the rank next day. He went to the West Indies with Captain Locker in the "Lowestoff" frigate, was transferred to the flagship of Sir Peter Parker and was then promoted in rapid succession to the command of the "Badger" brig and the "Hinchinbrook" frigate. By the last appointment, which he received in 1779, he was placed at the age of 20 in the rank of post captain (from which promotion to flag rank was by seniority).

Active Service.—In 1780 Nelson saw arduous active service in an expedition to San Juan in Nicaragua; he became very ill with fever, and once more was invalided home. In 1781 he was appointed to the "Albemarle" frigate, and after some convoy service in the North sea and the Baltic, was sent to Newfoundland and then to the North American station. From there he sailed for the Rest Indies, where he made the acquaintance of Admiral Lord Hood. The admiral presented him to the duke of Clarence (afterward William IV), as an officer well qualified to instruct him in "naval tactics"—a marked compliment to a young officer from one of the greatest exponents of the art. He appeared, said the prince, "to be the merest boy of a captain I ever beheld; and his dress was worthy of attention. He had on a full-laced uniform: his lank unpowdered hair was tied in a stiff Hessian tail of an extraordinary length; the old-fashioned flaps of his waistcoat added to the general quaintness of his figure, and produced an appearance which particularly attracted my notice; for I had never seen anything like it before, nor could I imagine who he was or what he came about. My doubts were, however, removed when Lord Hood introduced me to him. There was something irresistibly pleasing in his address and conversation; and an enthusiasm, when speaking on professional subjects, that showed he was no common being." The slight oddity of appearance, the power to arouse affection, and the glow indicating the fire within, are noted by all who ever looked Nelson in the face.



BY COURTESY OF THE NATIONAL MARITIME MUSEUM GREENWICH

PORTRAIT OF NELSON AS A CAPTAIN BY J. F. RIGAUD

The peace of Versailles (1783) gave Nelson leisure to visit France, and in 1784, when most naval officers were condemned to idleness on shore, he had the good fortune to be appointed to the command of the "Boreas" frigate, for service in the West Indies. While on that station he insisted on enforcing the navigation laws against the Americans, who by becoming independent had become foreigners. He called the attention of the government to the corruption prevailing in the dockyard of Antigua. His line impressed the admiralty as somewhat assuming, and his strong measures against the interloping trade brought on him lawsuits, which caused him much trouble.

In the West Indies on March 11, 1787, Xelson married Frances Nisbet, the widow of a doctor in Nevis. The union was one of affection and prudence.

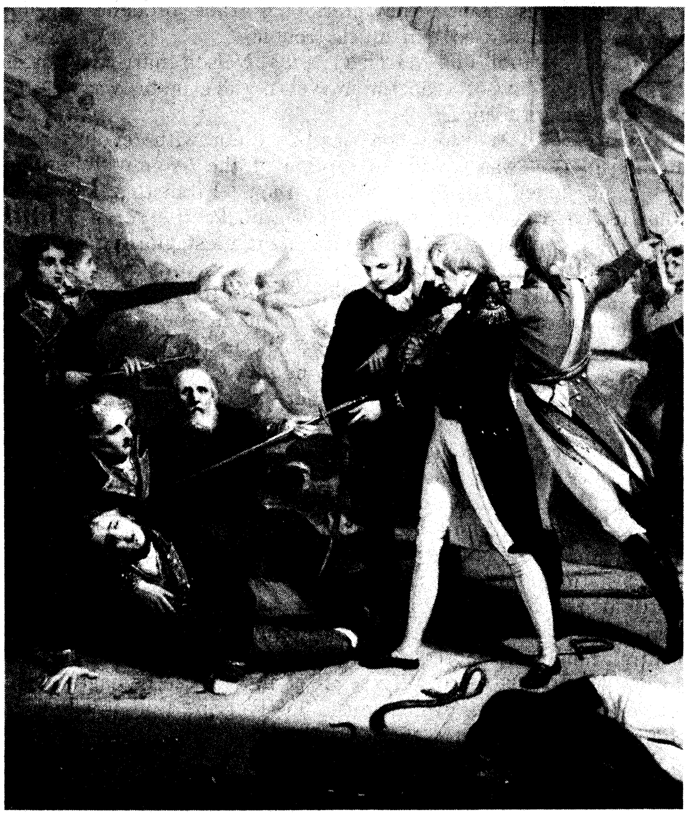
Outbreak of War.—When war broke out with revolutionary France, Nelson was appointed captain of the 64-gun "Agamemnon," and joined his ship on Feb. 7, 1793. From this date until June 1800 he was engaged on almost continual active service. This period is the most varied, the busiest, the most glorious and the most debated of a very full career.

It subdivides naturally into three: (1) From the date of his appointment as captain of the "Agamemnon" until he was disabled by the loss of his arm in the unsuccessiul attack on Santa Cruz de Tenerife on July 24, 1797, he served as captain or commodore, under successive commanders in chief in the Mediterranean. (2) After an interval of nine months spent at home in recovering from his wound: he returned to the Mediterranean and was at once sent in pursuit of the great French force which sailed from Toulon under the command of Napoleon for the conquest of Egypt. His victory of the Nile, on Aug. 1, 1798, placed him in the foremost rank among the warriors of a warlike time and made him a national hero. (3) From his return to Naples after the battle of the Nile until his return to England in the summer of 1800, he was immersed in Mediterranean affairs which tended to centre around the shores of Naples and Sicily.

The Mediterranean.—The first of these three passages in his life is full of events, which must, however, be told briefly. In June 1793 he sailed for the Mediterranean with Admiral Hood, and was engaged under Hood's orders in the occupation of Toulon by the allied British and Spanish forces. In September he was dispatched to Naples to arrange for troops to contribute toward the garrison of Toulon. It was on this occasion that he made the acquaintance of Emma Hamilton (*q.v.*), the wife of Sir William Hamilton, minister at the court of Naples. References to Lady Hamilton begin to appear in his letters to his wife, but, as might be expected, they indicate little beyond respectful admiration, and he makes a good deal of her kindness to his stepson, Josiah Nisbet, whom he had taken to sea.

After the allies had been driven from Toulon, Nelson was mainly employed in the operations connected with the occupation of Corsica. In April and May 1794 he was engaged in the capture of Bastia; in June, July and part of August in the taking of Calvi. During the operations at Calvi, Nelson received a wound in his right eye which healed without leaving disfigurement, though the sight faded. From the date of the occupation of Corsica until the island was evacuated (1794–96) he was incessantly active. He served under William (later Baron) Hotham, who succeeded Hood in the command, and was engaged in the indecisive actions fought by Hotham in March and July 1795. The complacency of the new admiral fretted the eager spirit of Nelson, who declared that, for his part, he would never think that the British fleet had done well if a single ship of the enemy escaped while there was a possibility of taking her. Happily he was detached to the Riviera of Genoa, where, first as captain and then as commodore, he had an opportunity to prove his qualities for independent command by harassing the communications of the French and co-operating with the Austrians.

In Sir John Jervis, who superseded Hotham, he found a leader after his own heart. When Spain, after first making peace with France. declared war on England, and the fleet under Jervis withdrew from the Mediterranean, Nelson was dispatched to Elba on a hazardous mission to bring off the small garrison and the naval stores. He sailed in the "Minerve" frigate, having another with him. After a smart action with two Spanish frigates and a narrow escape from a squadron of Spanish line-of-battle ships, he fulfilled his task and rejoined the flag of Jervis on the eve of the great battle (Feb. 14, 1797) off Cape St. Vincent. (See ST. VINCENT. BATTLE OF.) The judgment, independence and promptitude he showed in this famous engagement revealed him as one of the heroes of the navy.



BY COURTESY OF THE NATIONAL MARITIME MUSEUM. GREENWICH

NELSON RECEIVING THE SURRENDER OF THE "SAN JOSEF," FEB. 14, 1797. OIL PAINTING BY RICHARD WESTALL

Blockade of **Cadíz.**—A few days after the victory Nelson became rear admiral by seniority, but continued with Jervis, who was made a peer under the title of earl of St. Vincent. Nelson's own services were recognized by his being made a knight of the Bath. During the trying months in which discontent in the fleet was developing toward the mutinies at Spithead and the Nore, he remained with the flag and in the blockade of Cadiz.

In July 1797 he was sent to Santa Cruz de Tenerife and made a desperate attempt to capture it. The enterprise was, in fact, rash in the last degree, for no troops were available for the service. and a fortified town was to be taken by man-of-war boats alone. The Spaniards were on the alert and the attack, made with the utmost daring on the night of July 24, was repulsed with heavy loss. Some of the boats missed the mole in the dark and were stove in by the surf, others being shattered by the fire of the Spaniards. Nelson's right elbow was shot through and he fell back into the boat from which he was directing the attack. The amputation of his arm was performed in haste and in semi-darkness. He was invalided home and spent months of extreme pain in London and at Bath. In April 1798 he returned to the fleet off Cadiz as rear admiral, with his flag in the 74-gun "Vanguard."

Nelson was then one of the most distinguished officers in the navy. Within the next six months he was to raise himself far above the heads of his contemporaries. A great armament was preparing at Toulon for some unknown destination. To discover its purpose. and to defeat it. the British government resolved to send a naval force into the Mediterranean, and Nelson was chosen for the command.

Command in the Mediterranean.— Having joined the flag of Lord St. Vincent outside the straits of Gibraltar on April 30, Nelson was detached on May 2, with three line-of-battle ships and five frigates, to discover the aim of the Toulon armament Napoleon had, however. enforced rigid secrecy, and beyond the fact that a powerful combined force was collected in the French port, Nelson could learn nothing. On May 20 the "Vanguard" was dismasted in a gale. "I ought not." wrote Nelson "to call what has happened by the cold name of accident; but I believe firmly that it was the Almighty's goodness to check my consummate vanity." The "Vanguard" was saved from going on shore by the skill of Captain Ball of the "Alexander," for whom Nelson had henceforth a peculiar regard.

The frigates attached to his command had returned to Gibraltar. in the erroneous belief that the big ships would be taken there to make good the damage suffered in the gale. In June Nelson was off Toulon again, only to find that the French were gone. Deprived of his best means of obtaining information by the disappearance of his frigates. he remained cruising until he was joined by Captain Troubridge with ten sail of the line. He then started on his fierce pursuit of the enemy, seeking him in the dark. for there were no scouts at hand: exasperated at being left without the eyes of his fleet; knowing that St. Vincent would be blamed for choosing so young an admiral; but resolved to follow the enemy to the antipodes if necessary. From Sardinia to Naples, from Naples to Messina, from Messina to Alexandria, from Alexandria, where he found the roadstead empty. back to Sicily and then. when at last a ray of light came to him, back to Alexandria—he suept the central and eastern Mediterranean.

Unlike most admirals of his time. he freely discussed his plans with his captains. He had his reward in their devotion and perfect comprehension of what he wished them to do. At the same time he acquired an absolute confidence in the efficiency of his squadron, the magnificent force which had been formed by years of successful war and by the careful training of his predecessors. The captains were the band of brothers he himself had made them.

The great victory of Aug. 1, 1798 (see NILE, BATTLE OF THE), brought Nelson yet another wound. He was struck on the forehead by a shot and had for a time to go below. For this victory he was made a baron.

Blockade of Naples.— After providing for the blockade of what remained of the French in Alexandria, Nelson set sail for Naples and arrived there on Sept. 22. Pitt's second coalition against France was then on the point of completion. and Naples, naturally enough in view of the French behaviour on its borders. was preparing to side with Austria and Russia in the defense of monarchy; indeed Naples was already organizing an army, but no decision as to how the troops should be used had as yet been arrived at. Nelson immediately tried to enliven the proceedings and suggested what should have been a perfectly feasible plan. by which the Neapolitan army was to advance northward against the French front. while the fleet was to capture Leghorn, thus cutting the French communications.

Leghorn was duly taken, but the army showed little aptitude for fighting, soon becoming a disorderly rout. pursued by the French. This had the effect of rousing all the Jacobins in the country, which was soon in such an uproar that the royal family found it necessary to retreat to Palermo—an evacuation carried out by Nelson and his ships. From Palermo. Nelson kept up a double blockade—one squadron under Captain Ball was detached to Malta and another, under Captain Troubridge, was sent to the bay of Naples to operate against the Neapolitan Jacobins.

The king and queen, however, found this method of pressure too slow, and determined to appeal to the conservative instincts of many of their subjects through the agency of an ecclesiastic, Fabrizio Cardinal Ruiio. Ruffo landed in Italy, and his appeal for an "Army of the Faith" mas soon answered by thousancis. While these events were taking place. a French fleet of 26 vessels. under Admiral Bruix, set out from Brest and was joined by 17 Spanish warships at Cartagena. Such a force constituted a threat to Nelson, who called up his ships from Malta and Naples and prepared for resistance. He managed. however—and this was important in view of Ruffo's successful beginning—to maintain the blockade of Naples by means of a squadron of small ships placed under Captain Foote.

The Franco-Spanish threat proved an idle one and the allied fleet soon retired. but, in the meanwhile, Ruffo was driving all before him and finally shut up the French in the castle of St. Elmo, in the city of Naples, and the native insurgents in the sea-washed castles of Uovo and Nuovo. From this commanding position he began to parley with the enemy, and the king, hearing of this. and nervous of what the cardinal might do—he had not been empowered to make terms of peace—asked Nelson to proceed to Naples and take matters into his own hands.

Ruffo's Treaty of Peace.—Nelson sailed for Naples. with Sir William and Lady Hamilton on board. on June 21. and arrived on the 24th to find the white flag flying from the castles and from his own flotilla. Supposing this to indicate an armistice. he at once made signal for the resumption of hostilities, only to be informed by Captain Foote that matters had gone further and that a treaty of peace had been signed by which the native insurgents were to be allowed to leave their strongholds with all the honours of war and mere to be carried by ship to countries that would be willing to receive them.

In making such a treaty there can be no doubt that Ruffo had exceeded his instructions, though it is probable that he was actuated by motives of humanity. since his control over his bloodthirsty army was incomplete. Nelson refused to listen to Ruffo's arguments or to admit the validity of his undertakings. He agreed to let the armistice run its course. but let it be known that at the end of it he would expect unconditional surrender. This he received. and the rebels were placed in boats. One. Carraciolo, reached the hills. only to be caught at last and brought to Ruffo. He in his turn, because Carraciolo was a naval officer. handed him over to Nelson, who at once convened a court-martial of Neapolitan officers to try the rebel. The court sentenced Carraciolo to death by a majority vote, and this sentence was immediately carried out.

For refusing to carry into effect Ruffo's peace terms and for not interfering to delay the execution of Carraciolo! Nelson has been violently attacked. The whole matter is too involved to be fully discussed here: the conclusions which have been reached by scholars on either side have almost invariably reflected the political prejudice of the writers.

The whole question of h'elson's conduct at Naples is of course bound up with his friendship with Lady Hamilton. No one denies that it was then that Nelson's friendship for this woman ripened into the intimacy that was eventually to separate him from his wife. But that a private attachment seriously warped his judgment in public matters no one has yet shown, nor has anyone explained why it should.

Return to England.—These events were shortly followed by the reduction of the French and by the restoration of the Neapolitan royal family, while in the same month Nelson laid himself open to a sharp rebuke from the admiralty for disobeying the orders of Lord Keith. who had been appointed to succeed Lord St. Vincent in the Mediterranean command. Keith, puzzled as to the objective of a combined Franco-Spanish fleet, decided that Minorca was in danger and ordered Nelson to its defense. Nelson decided that it was not in danger and did not go. His judgment was correct, but his disobedience was inexcusable.

On Jan. 20, 1800. having in the meantime been created duke of Brontë by the king of Naples, Nelson joined Keith at Leghorn, and in February captured "Le Généreux," which had escaped him at the Nile. Shortly afterward he obtained leave to go home and, not being spared a battleship, he traveled overland with Sir William and Lady Hamilton. being fêted on the way. He landed in England in November of the same year.

Battle of **Copenhagen.**—Nelson's leave. which promoted the final separation hetmeen him and his wife, was short. He became vice-admiral on Jan. 1, 1801, and soon after was offered the post of second in command to Sir Hyde I'arker in the fleet which was to hreak up the armed neutrality of the northern powers. It is difficult to see why such a brilliant man was subordinated to one of such ordinary gifts as Parker. Nelson, however, treated Parker with such tact that the admiral's reserve toward him disappeared. Indeed Nelson had his commander in chief to some extent under his thumb hy the time they reached Copenhagen, and so was permitted to carry out his famous attack on the city and its defenses that resulted in the battle of Copenhagen (*q.v.*). This battle showed Nelson's ability to hit upon the weak point in a defensive scheme and is famous for his action in putting his telescope to his blind eye when. in the middle of the fight. his attention was directed to Parker's signal ordering his withdrawal. It was an order that could not be obeyed without losing all chance of decision.

In May, Parker was recalled and Nelson given the command, but the armed neutrality was dissolved and this left him little to do. His health. too. was bad and in June he went home. his services having been recognized by the bestowal of the title of viscount. In the months before the peace of Amiens he was in command of a flotilla of small ships that were to combat Napoleon's threat of invasion. More in the hope of satisfying public opinion than for any other reason, an attack was launched on Boulogne with the object of destroying the flat-bottomed boats stationed there. The port, however, was too strongly defended even for a Nelson.

During the short period of the peace of Amiens (1802–03), Nelson, in company with Sir William and Lady Hamilton. lived at the house and estate that he had purchased at Merton in Surrey. This, probably the happiest period of his life. was all too short. War reopened in May 1803, and Kelson was at once appointed to the Mediterranean command.

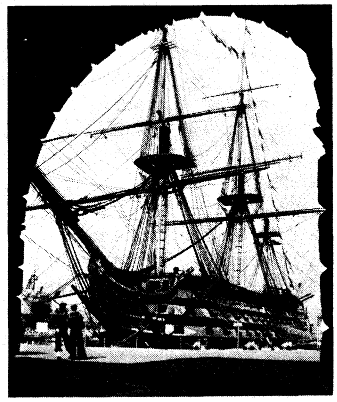
The Mediterranean Command, **1803.**—Nelson arrived off Toulon in July 180.3 and instituted a strict blockade of that port. The French under Latouche-Tréville continually tried to lure him into indecisive actions in which. by damaging some of his ships, they might force him to withdraw, but Nelson consistently refused such offers and the French admiral. writing to Napoleon, stated that he had offered battle but the English had withdrawn. Kelson declared that if he captured Tréville he would make him eat the letter, but he never had the chance to fulfill his boast, even figuratively, for Tréville died and was succeeded by Villeneuve.

In the spring of 180 j the French eluded the blockade and made for the West Indies. This move was part of a large scheme directed toward the invasion of England. The series of naval movements arising from it are known as the Trafalgar campaign, and the whole matter is dealt with under NAPOLEONIC CAMPAIGNS. Nelson, after searching the Mediterranean. decided that Villeneuve had gone to the West Indies, and thither he followed him. On hearing of his enemy's arrival, Villeneuve returned precipitateiy to Europe. again pursued by Nelson. and got into Ferrol and then into Cadiz where he was blockaded by Collingwood.

Nelson meanwhile had gone home on leave to enjoy the delights of Merton. His respite was brief. No sooner had the news reached England that the allied fleet. was in Cadiz than. with the approval of Lady Hamilton. he offered his services; "to give M. Villeneuve a drubbing." They were immediately accepted, and he left Merton for the last time on Sept. 13, and on the 28th was off to Cadiz.

Trafalgar.—The victory of Trafalgar (*q.v.*) which followed on Oct. 21 set the seal on Nelson's fame. Tactically it was a masterpiece. and his famous signal "England expects that every man will do his duty." made as the fleet moved into battle. together with his death in the moment of victory, added, and still add, to its lustre.

The "Victory," after passing through the French line, was engaged with the "Bucentaure" and the "Redoubtable." and Nelson. as he walked up and down his quarter-deck nith his flag captain. Thomas Hardy. was struck by a bullet from a sharpshooter firing from the top of the "Redoubtable." His spine was broken and he was carried below to the cockpit, suffering great pain: There, amid the din and racket of battle, he lingered for a few hours To the last he retained his interest in the battle. and Hardy came to him from time to time to tell him of its progress. As his sight grew dimmer and he felt the end approaching he asked Hardy to kiss him "Now I am satisfied," he said "Thank God I have done my duty."



BY COURTESY OF THE VICTORY MUSEUM, PORTSMOUTH; PHOTO. BRITISH TRAVEL AND HOLIDAYS ASSOCIATION

THE "VICTORY," NELSON'S FLAGSHIP, MOORED AT PORTSMOUTH, ENG.

Nelson's body was taken home and buried in St. Paul's.

So died the most famous of English seamen. He was more than merelv a tacticallv brilliant commander: he was a true leader of men—and men of all types, for the common seamen trusted and venerated him as much as did his officers. The seamen were. in their turn. trusted by him and were ever in his confidence. No officer under Nelson could ever complain that he went into action not knowing his commander's plans and intentions—and it is as much to this as to his tactical ability that his successes were due. It has been said that he was vain, liked flattery and was an egotist. In fact. he had faults common in genius.

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(D. H.; O. M. W. W.)

NELSON, a city in British Columbia. situated at the head of navigation on the west arm of Kootenay lake. Pop. (1956) 7,226. It is the commercial and administrative centre of a mining. lumbering. fruit-growing district and is the headquarters of the Kootenay division of the Canadian Pacific. It is also a station on the Great Northern railway. Chief manufactures include match blocks, wire. veneers. jams. doors. beer. machinery.

NELSON, a municipal borough (1890) in the Nelson and Colne parliamentary division of Lancashire, Eng., 28 mi. N. of Manchester by road. Pop. (1951) 34.384. Area 5.4 sq.mi. The area of Marsden was entirely agricultural until the 18th century when a small wool factory was established from which developed the present industrial town specializing in silk and cotton weaving. The coming of the railway caused the change of name from Marsden to Nelson (after the Lord Nelson inn) to avoid confusion with Marsden in Torkshire.

NELSON, a seaport of New Zealand. the seat of a bishop and capital of a provincial district of the same name; at the head of Tasman bay on the northern coast of the South Island. Pop. (1956) 17,707 (urban area 22.503). It has a mild climate. Christ Church cathedral is finely placed on a mound which was originally intended as a place of refuge from hostile natives. The harbour is protected by the long and remarkable Boulder bank, whose southern portion forms the natural breakwater to that anchorage. The chief industries are meat and fruit preserving and timber milling. The district produces all the tobacco and hops and two-thirds of the apples in the dominion. Nelson is connected by steamer and air service with Wellington. The settlement was established by the New Zealand company in 1842.

NELSON, a hold in wrestling. See WRESTLING.

NELSON RIVER, in Manitoba, Can., drains the waters of Lake Winnipeg and discharges into Hudson bay near Port Nelson, 400 mi. to the northeast. falling 713 ft. in the process. The catchment area of Lake \\-innipeg extends from the Rocky mountains to Minnesota, so that the Nelson, discovered in 1612 by Sir Thomas Button and named for another member of the expedition, has a total drainage basin of 443,000 sq.mi., extending more than 1,600 mi. from the Bow river in the Rockies and including the North and South Saskatchewan rivers; the Assiniboine and the Red River of the North. Chief tributary of the Nelson proper is the Burntwood. Norway House, at the source of the Nelson, is a Hudson's Bay company trading post and York Factory. near its mouth, operated as a trading post from 1682 to 1957. The Nelson is navigable for about 80 mi. from its mouth and power development along the river is under the control of the Manitoba Hydro-Electric board. (AN. KR.)

NEMATHELMINTHES, a term employed in zoology to denote a phylum of animals comprising the roundworms (Nematoda, *q.v.*) hookworms (Acanthocephala), Nematomorpha (*q.v.*), to which are sometimes added the arrow-worms (Chaetognatha, *q.v.*), and various other groups of minor importance and doubtful affinities. Nemathelminthes is probably, even in its most restricted sense, an artificial group.

NEMATODA, a group of unsegmented roundworms (threadworms) formerly placed with the Xcanthocephala and Nematomorpha (*qq.v.*) in a phylum Nemathelminthes, now ranked as a distinct phylum related more closelv to the Rotatoria and Gastrotricha. Nematodes vary in size from one-fourth of a millimetre to a metre in length. Free-living soil and aquatic species are mostly small (not more than 5 mm. long), while species parasitic in animals tend to be larger. Microscopic species are commonly called eelworms. this terminology being highly descriptive of the general body form and mode of locomotion.

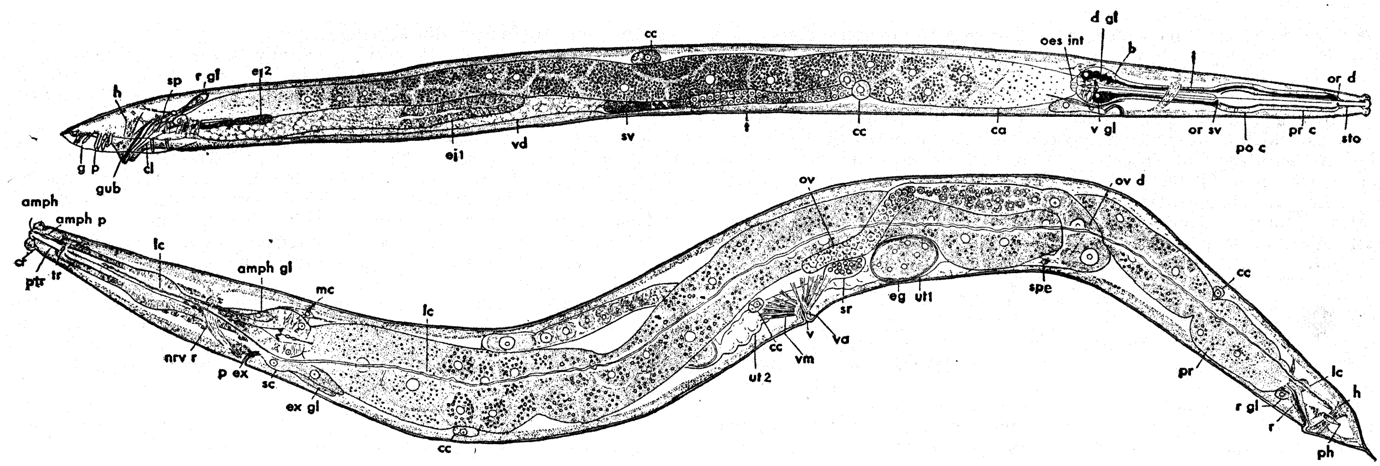
Nematodes are of practically universal occurrence; nearly every sample of soil or natural water. nearly every plant and nearly every animal has its nematode inhabitants. Thousands of species in the oceans. streams. woods and cultivated fields are harmless saprophytes, or prey upon other microscopic soil fauna. However, a few hundred species have become widely known because of intimate association with man or his domestic animals and plants. The vinegar eel. *Turbatrix aceti,* is a harmless saprophyte used as class material in laboratories. The wheat eelworm, *Anguina tritici*, is best known for its ability to remain dormant in the dry wheat kernel, having been revived after 20 years of dormancy. The Guinea worm. *Dracunculus medinensis*, is the most ancient known parasite of man, since the plague of fiery serpents visited upon the Israelites (Num. 21:6–9) is supposed to have been caused by this parasite. The Guinea worm reaches several feet in length, and at maturity it is coiled just under the skin where it causes a blister. To avoid blood poisoning, treatment involves extraction of the nematode without breaking. Moses is supposed to have set up the brass serpent to impress upon his people the need for complete extraction.

General Morphology.—Basically cylindrical animals; form of gravid females sometimes modified. *i.e.*, fusiform, saclike. or pear-shaped; bisexual, males commonly less numerous and smaller than females.

External covering, a simple or complex, noncellular cuticle, striated or annulated in some forms and often bearing setae (free-living forms!. Beneath this layer there is a cellular or syncytial hypodermis, which commonly projects into the body cavity in the form of lateral and median chords; the latter contain the longitudinal nerves and the lateral excretory tubes. Laterally or sublaterally situated unicellular hypodermal glands may empty externally through cuticular pores.

Aquatic species usually have a terminal caudal pore through which caudal glands extrude an adhesive thread. A single layer of longitudinal unstriated muscle cells is situated beneath the hypodermis and between the chords, Thus the body wall is composed of three layers, the cuticle, hypodermis and somatic musculature. The body cavity is not segmented but is often traversed by specialized muscles, *i.e.*, male copulatory muscles, vulvar muscles and somato-intestinal muscles.

Pieudocoelomic membranes and mesenteries form an incomplete lining of the body cavity. covering musculature to a greater or lesser extent and supporting the reproductive system and digestive tract. which otherwise floats freely in the liquid-filled body cavity. There is no circulatory system.



FROM CHITWOOD AND CHITWOOD, "AN INTRODUCTION TO NEMATOLOGY"

FIG. 1.—RHABDITIS STRONGYLOIDES

amph, amphid
amph gl, amphidial gland
amph p, amphidial pouch
b, bulb
ca, cardiac region
cc, coelomocyte
cl, cloaca
cr, cheilorhabdion
d gl, dorsal gland
eg, fertilized egg
ej1, ejaculatory gland (cement gland)
ej2, (supplementary rectal gland)
ex gl, excretory gland
g p, genital papillae
gub, gubernacuium
h. dilator ani
i, isthmus
lc, lateral canal
mc, mesentericl cell
nrv r, nerve ring
oes int, oesophago-intestinal valve
or d, orifice dorsal gland
or sv, orifice subventral gland
ov, ovary
ov d, oviduct
p ex, excretory pore
ph, phasmid
po c, metacorpus
pr c, procorpus
pr, prerectum
ptr, protorhabdions
r, rectum
r gl, rectal gland
s c, sinus cell
sp, spicule
spe, sperm
sr, seminal reservoir
sto, stoma
sv, seminal vesicle
sv gl, subventral gland
t, testis
tr, telorhabdion
ut, uterus
v, vulva
va, vagina
vd, vas deferens
vm, vulvar muscles

The tubular digestive tract consists of the anterior terminal oral opening, the mouth cavity or stoma, oesophagus, oesophago-intestinal valve, intestine, intestine-rectal valve, rectum and ventral or subterminal anus in the female. In the male the rectum and gonoducts empty into a common cloaca. All parts of the digestive tract except the intestine are lined with cuticle, which is apparently of ectodermal origin.

The oral opening is usually surrounded by three or six lips bearing six groups of tactile papillae and two lateral pores, the amphids, which are supposed to be chemical sense organs. In some forms the oral opening is directly followed by the oesophagus, while more commonly there is a cylindrical, prismoidal or capsuliform stoma. The stoma may contain a protrusible hollow spear or stylet. In other forms the stoma may contain variously formed teeth. The oesophagus is basically a triradiate, syncytial, muscular, sucking organ often equipped with a valvular sucking bulb. Digestive glands and nerve cells are situated within the syncytial musculature. The oesophageal glands open into the lumen of the oesophagus. The general form of the oesophagus and the position of oesophageal gland orifices are much used in taxonomic work. The intestine is composed of a single layer of low cuboidal to columnar epithelial cells usually bearing an internal "bacillary border," homologous with cilia in other organisms. Usually the intestine is a simple tube, but occasionally there are outpocketings or caecae, and rarely it becomes atrophied or is transformed into a solid storage organ, the trophosome. Rectal or cloacal glands usually empty into the digestive tract just posterior to the intestine-rectal valve.

The female reproductive system is composed of two, one, or rarely three to many tubular ovaries continuous with uteri opening into a single vagina with vulvar orifice on the ventral side of the body, between the excretory pore and the anus. Sexes are usually separate but occasionally parthenogenic or hermaphroditic forms occur, in which latter case sperm are produced by ovarian cells and males are not necessary in reproduction.

The male reproductive system is composed of one or two tubular testes continuous with seminal vesicle, *vas deferens* and ejaculatory duct, opening ventrally with the rectum into a common cloaca. Secondary male sexual organs, the paired (or single) sclerotized spicules, are formed in the dorsal wall of the cloaca. These are inserted into the female during copulation. Sometimes the cuticle of the caudal region of the male is expanded in the form of caudal alae or a bursa (supported by muscular rays), which aids in copulation.

The nervous system is composed of a group of ganglia in the cervical region joined by a perioesophageal ring or commissure, from which six nerves extend anteriad to tactile cephalic papillae and to the amphids or chemoreceptors. The ventral nerve, situated in the hypodermis, extends posteriad from the nerve ring to the anal region and contains several ganglia; it is connected by hypodermal commissures with the dorsal and lateral nerves which are also situated in the hypodermis. Sublateral and caudal or genital tactile papillae are often present, and in one class. the Phasmidia, there is a pair of posterior lateral chemoreceptors, the phasmids.

The excretory system may take the form of a single ventral gland cell or a more complex closed lateral tube system, but in either case it opens ventrally through a cervically situated excretory pore.

Development.—Nematodes may be oviparous, viviparous or ovoviviparous; cleavage is determinate, each of the first few cells being destined to form a specific part of the body. The larva, at hatching, commonly resembles the adult except in those forms of parasites in which the stoma and oesophagus of the free-living saprophytic larva become modified in keeping with new feeding habits in the parasitic stages (*e.g.*, hookworm, *Ancylostoma* duodenale). Growth is marked by a series of cuticular moults (usually four), without internal reorganization. The gonads develop in the body cavity and attain connection with the vulva in the female and cloaca in the male at the time of the last moult. Free-living nematodes tend to produce only, a few young, one at a time; each uterus usually contains from one to ten eggs, and borh uterus and ovary are relatively short tubes with not more than one flexure. As parasitism becomes more advanced, there is an increase in egg production correlated with extensive coiling and complexity of the ovaries and uteri.

Plant-parasitic nematodes may remain dormant in soil, passing the winter in the egg stage, hatching in the spring to infect new hosts (the root knot nematode, *Heterodera marioni*); the eggs may be encased in a cyst formed by the body of the dead mother (the golden nematode of potatoes, H. *rostochensis*), in which case they may remain dormant five to ten years in the absence of the proper host plant; in other cases it is the fourth-stage larva which has the ability to lie dormant (the wheat eelworm, transmitted in the seed itself). Plant parasites all appear to have some period in their life in which stopover privileges are provided.

Animal-parasitic nematodes usually have a period of development outside the final host. The eggs may have a period of incubation outside the host, after which they hatch when swallowed with contaminated feed or water (*Ascaris lumbricoides*); they may hatch in faeces, feed as saprophytes passing through required growth stages and then infect the final host by active penetration of the skin (*Ancylostoma duodenale,* cause of ground itch), or they may be taken in orally with contaminated feed (grass in the case of trichostrongyl parasites of ruminants). The life history is said to be direct if only one host is required. Development is indirect when eggs or larvae must first enter another or intermediate host, there undergoing required growth stages before infecting the final host. This is the case in the Guinea worm, whose larvae infect the water flea, Cyclops, and are finally acquired by man when he swallows the infected Cyclops in drinking water. Finally there is the type of indirect development represented by Wuchereria hancrojti (cause of filariasis in man) and *Dirofilaria immitis* (cause of heartworm in dogs); in these cases the parasites pass their larvae into the blood stream, from which they are acquired by biting insects (mosquitoes), and, after passing growth stages in the intermediate host, re-enter the final host through the skin. Animal parasites may immediately take up residence in that part of the final host in which they mature (Enterobius *vermicularis,* the pinworm of man), or they may. go through extensive migrations, from the intestine, through the blood stream to the lungs, then be coughed up and swallowed before settling down in the intestine (*e.g., Ascaris lumbricoides*). Some of the most extensive damage is done to the host in the migrations.

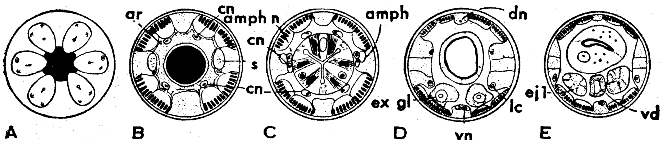
Classification. — Class Phasmidia. Nematodes with lateral caudal pores, phasmids, simple porelike amphids, a tubular excretory system. Hypodermal glands, setae and caudal glands absent.

Order Rhabditida.—Oesophagus essentially consisting of three parts: corpus, isthmus and bulbar region (at least in larval stages).

Suborder Rhabditina.—Vagina transverse, simple reproductive system. Free-living primitive parasites of animals, all plant parasites.

Superfamily Rhabditoidea.—Stoma not styletiiorm, oesophagus three-part in adult stage. Saprophytic (Rhabditidae, Cephalobidae, Cylindrogasteridae, Diplogasteridae [*Turbatrix aceti*]); parasites of molluscs and amphibians (Angiostomatidae), parasites of earthworms (Drilonematidae), of insects (Steinernematidae), and parasites of vertebrates with alternation of generations, one generation saprophytic, other parasitic (Rhabdiasidae, Strongyloididae).

Superfamily Tylenchoidea.—Stoma styletiiorm, oesophagus three-part in adult stage, but musculature often degenerate. The family



FROM CHITWOOD AND CHITWOOD, "AN INTRODUCTION TO NEMATOLOGY"

FIG. 2.—RHABDITIS STRONGYLOIDES (CROSS SECTIONS. DIAGRAMMATIC)

A — Head; B—Stomatal region; C—Oesophageal region; D — Anterior intestinal region; E — Posterior region of male. *ar*, arcade; *cn*, cephalic nerve; *s*, sensilla of amphid; *dn*, dorsal nerve; *ex gl*, excretory gland cell; *lc*, lateral canal of excretory system; *vn*, ventral nerve; *ej1*, ejaculatory gland; *vd*, *vas deferens*; *amph*, *amphid*; *amph n*, amphidial nerve

Tylenchidae includes all known plant-parasite nematodes, the better-known being the root-knot nematode, Heterodera *marioni* (with more than 1,000 host plants); the stem-and-bulb eelworm, *Ditylenchus* dipsaci; the chrysanthemum nematode, Aphelenchoides *oleisistus*; and the wheat eelworm, *Anguina* tritici. This group ieeds by inserting the stylet into plant cells and sucking the juices. Economic losses caused by the nematode parasites of plants probably exceed those due to animal parasites, though they are less spectacular. There is scarce!? a single cultivated crop in any part of the world that is not limited in its production or extensive use because of injuries sustained or anticipated from plant-parasitic nematodes. "Land sickness" is oiten due to building up of heavy nematode soil populations. The Tylenchoidea also include the Allantonematidae, which are parasites of insects, the insects becoming infected through the ingestion of eggs or larvae and the larvae then penetrating the intestinal wall to reach the body cavity or gonoducts, where they reach adulthood.

Suborder Strongylina.—Vagina tubular, reproductive system highly developed. Oesophagus of adult never terminated by bulbar swelling, lips usually rudimentary. Parasites oi vertebrates in adult stage, young larvae usually saprophytic in soil or iaeces, final host iniected orally or through skin. Earthworms, molluscs and arthropods occasionally act as vectors.

Superiamily Strongyloidea.—Stoma well developed, body usually thick. Families Strongylidae and Ancylostomatidae (inhabit intestine, *e.g.*, hookworms), Syngamidae (urinary or respiratory system, *e.g.*, gapeworms), Cloacinidae and Diaphanocephalidae (intestine of marsupials and reptiles, respectively).

Superiamily Trichostrongyloidea.—Stoma rudimentary, body thin. Parasites of digestive tract of all groups of vertebrates. Families Trichostrongylidae and Heligmosomidae.

Superfamily Metastrongyloidea.—Stoma rudimentary, body thin. Parasites of respiratory system of mammals. Families Metastrongylidae and Pseudaliidae.

Suborder Ascaridha. — Vagina tubular, reproductive system highly developed; oesophagus of adult usually terminated in bulbar swelling; three or six lips, generally well developed. Parasites of digestive tract of arthropods or vertebrates in adult stage; infection usually direct. Families Thelastomatidae and Rhigonematidae (parasites of arthropods); Oxyuridae (*e.g.*, Enterobius *vermicularis*, pinworm of man), Atractidae, Cosmocercidae, Kathlaniidae, Heterakidae, Quimperiidae and Ascarididae (*e.g.*, *Ascaris lumbricoides*), include parasites of all groups of vertebrates.

Order Spirurida.—Oesophagus divisible into two regions, a narrow muscular anterior part and a wide, glandular, posterior part; vagina tubular; adults parasitic in vertebrates, larvae in arthropods.

Suborder Camallanina.—Oesophageal glands uninucleate, phasmids of larvae pocketlike; intermediate hosts, copepods. Families Camallanidae and Cucullanidae, with well developed stoma, parasites of digestive tract of fish, amphibia and reptiles; families Dracunculidae (*e.g.*, Guinea worm) and Philometridae, with rudimentary stoma, tissue parasites of vertebrates.

Suborder Spirurina.—Oesophageal glands multinucleate, phasmids of larvae porelike; intermediate hosts, arthropods. Parasites of all parts of body of all groups of vertebrates; those with a well-developed stoma or lips usually inhabit digestive tract in adult stage (families Thelaziidae, Spiruridae, Acuariidae, Gnathostomatidae and Physaloplteridae), and are usually transmitted by scavenger insects or copepods; those with rudimentary stoma and lips inhabit tissues or the blood stream and are transmitted by sucking insects, *i.e.*, mosquitoes, stable flies (families Dipetalonematidae, Stephanofilariidae, Desmidocercidae and Filariidae, *e.g.*, heartworm).

Class Aphasmidia.—Nematodes without lateral caudal pores (phasmids), amphids often externally modified, excretory system absent or not tubular; hypodermal glands, setae and caudal glands commonly present; caudal alae usually absent.

Order Chromadorida.—Amphids basically spiral or circular, subventral oesophageal glands opening in mid-region of oesophagus, posterior part of oesophagus not greatly elongated, usually bulbar. Free-living in soil, fresh water or marine, rarely commensal.

Suborder Monhysterina.—Oesophago-intestinal valve vertically flattened or circular, ovaries outstretched or reflexed. Amphids uni- or dispiral, ovaries reflexed, ends of oesophageal lumen tuboid: families Plectidae and Camacolaimidae. Amphids spiral, ovaries outstretched, ends of oesophageal lumen tuboid: families Axonolaimidae and Comesomatidae. Amphids circular, ovaries outstretched, ends of oesophageal lumen convergent: families Monhysteridae, Linhomoeidae and Siphonolaimidae.

Suborder Chromadorina.—Oesophageal-intestinal valve basically triradiate; ovaries reflexed; amphids circular spiral or vesiculate. Includes families Desmoscolecidae and Greeffiellidae, with vesiculate amphids, coarsely annulated cuticle and tubular gland setae; families Desmodoridae, Epsilonematidae and Draconematidae, with basically spiral amphids, and annulated cuticle; and families Chromadoridae, Cyatholaimidae, Microlaimidae and Tripyloididae, with basically spiral amphids, cuticle punctate or finely striated.

Order Enoplida.—Amphids pocketlike or porelike (parasites), oesophagus cylindrical, conoid or greatly elongated posteriad.

Suborder Enoplina.—Dorsal oesophageal gland opens into stoma, sublateral rows of somato-intestinal muscles absent. Free-living, aquatic or terrestrial. Includes families Enoplidae, Oncholaimidae and Ironidae, with subventral glands opening into stoma; and families Tripylidae, Mononchidae and Alaimidae, with subventral glands opening into mid-region of oesophagus.

Suborder Dorylaimina.—Mouth with protrusible stylet, sublateral rows of somato-intestinal muscles absent, dorsal and subventral glands opening into mid-region of oesophagus. Includes families Dorylaimidae, Leptonchidae and Diphtheroporidae, which are free-living, usually terrestrial or fresh water, with well-developed oesophageal musculature. Families Mermithidae and Tetradonematidae, larval stages parasitic in arthropods, adult free-living in soil or fresh water but do not feed; oesophagus degenerate, glands reduplicate in double chain of cells. Families Trichuridae, Trichinellidae (Trichinella *spiralis*) and Cystoopsidae, adults parasitic in vertebrates, posterior part of oesophagus degenerate with reduplicate glands usually in single chain; with direct life history, eggs infective (*Trichuris*); with indirect life history, arthropods or annelids serving as intermediate hosts (*Cystoopsis*, Capillaria); with indirect life history, larvae in muscles of first mammal, orally infective to second mammal (man), in which adult matures and larvae migrate from intestine to muscles (Trichinella spiralis).

Suborder Dioctophymatina.—Dorsal and subventral oesophageal glands opening into stoma; four sublateral rows of somato-intestinal muscles. Adults and late larval stages parasitic in vertebrates, young larval stages parasitic in arthropods. Families Sobolophymatidae and Dioctophymatidae (*e.g.*, Dioctophyma renale, kidney worm of man). (B. G. C.)

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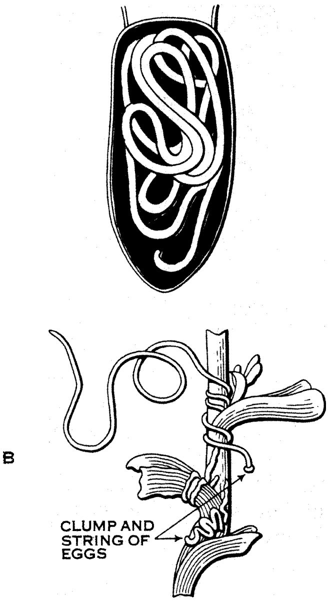
NEMATOMORPHA (Gordiacea), a class of elongate, threadlike, unsegmented worms belonging to the phylum Aschelminthes, which phylum includes also the roundworms (class Nematoda), rotifers (class Rotifera) and other mostly small to microscopic animals. Nematomorphs—called gordian worms, after their tendency to tangle together in loose writhing masses or knots, and horsehair worms, after the myth dating to the 14th century that these hairlike forms are transformed horsehairs — vary in length from a few inches to two or three feet, and in diameter from about $\frac{1}{100}$ inch to about $\frac{1}{10}$ inch. The free-living adults are often seen wriggling in quiet, shallow fresh waters throughout the world — ponds. streams, rain puddles and water troughs (occasionally in wet soil)—where they are indeed suggestive of horsehairs come to life. They vary in colour from buff or yellowish through shades of brown to black; the tip of the head end is almost always whitish bordered by a dark ring. The larvae are parasites of arthropods, chiefly insects.

The body wall consists of: (1) a stout cuticle, with an outer layer (smooth. or rough with minute nipples (areoles) sometimes bearing spines or bristles) and an inner layer of obliquely crossed fibres; (2) a single subcuticular layer of cells; and (3) a layer of longitudinal muscle fibres. Most of the space within the body wall is filled with soft, jellylike connective tissue (parenchyma) in which the internal organs are embedded. The alimentary canal is more or less degenerate in all horsehair worms; in most cases there is no mouth, so that the taking in of food at any time seems improbable. Instead, nutriment is absorbed through the skin and only when the immature nematomorph has become established in a host. What there is of an intestine opens along with the genital ducts into a common posterior chamber (cloaca). No circulatory or excretory organs are known. There is a single ventral nerve cord, with anterior and posterior ganglia.



FROM "THE CAMBRIDGE NATURAL HISTORY" (MACMILLAN)

HORSEHAIR WORMS (MAGNIFIED)
(A) Abdomen of a beetle, with the back covering removed, showing a horsehair worm within: (B) female horsehair worm depositing its eggs on a water plant

The sexes are separate, the males being usually smaller than the females and in some genera distinguishable by having a forked tail. The tail of the female is usually undivided, but in *Paragordius* it has three prongs. The gonads are paired in both sexes, and are continuous with their ducts.

Cpon emergence from their insect hosts, usually in spring or early summer, they are sexually mature and copulation and egg-laying occur. In the pregnant female the ovaries give off thin-walled lateral pockets, which ultimately break down and discharge the ova into spaces in the parenchyma. The eggs, held together by a cementlike substance, are laid in strings or masses, usually on plants or stones under water. The first larval stage is a minute creature armed with spines and having a boring organ anteriorly, by means of which it enters the flesh of almost any aquatic animal; it must, however, find an appropriate host before it can fully develop. In species which attack insects such as grasshoppers, the second larval stage may apparently be reached without change of host. In others it may develop in a second host, usually a beetle, which preys upon the first. The second larval stage is elongate and wormlike: and develops directly into the adult form. Pigment is developed, and the larval cuticle shed, just before emergence from the host. This usually takes place on contact with water. the worm bursting its way out through a soft place in the host's body wall.

The Nematomorpha includes two orders; Gordioidea and Nectonematoidea. The main genera of the former are *Gordius, Paragordius, Chordodes, Parachordodes* and *Gordionus.* Nectonematoidea comprises only one genus *Sectonema,* a form provided with rows of bristles and inhabiting the open ocean (pelagic).

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(H. A. B.; X.)

NEMEA, BATTLE OF, 394 B.C. This was the decisive battle. in the sense that it broke the force of the hostile offensive, of the "Corinthian War," against Sparta, waged by the coalition of Thebes, Corinth. Athens and Argos, but instigated by Persia. In its initial pattern it was the typical frontal battle of the time, and both lines as they advanced experienced the characteristic "drift" to the right, so that each right wing overlapped the opponent's left wing. Thus on one flank the Spartans dispersed the Athenians, and on the other Sparta's allies were shattered by the Argives and Corinthians. Then, however. the Spartans, instead of pursuing blindly ahead like Clearchus and his men at Cunaxa, checked their pursuit and caught in flank three successive bodies of the enemy as they were marching back to their base. With this success the menace to Sparta waned, and the initiative in further operations passed to her. *See* further CUNAXA, BATTLE OF, 401 B.C.; CORONEIA, BATTLE OF.

NEMERTINA (NEMERTEA). The nemertines, or nemerteans, commonly called ribbon worms, which constitute the invertebrate phylum Nemertina. are characterized by the soft, extensible, ciliated body without external indication of segmentation and without distinct body cavity, the internal organs being separated by gelatinous parenchyma; the body is provided with a highly specialized eversible proboscis and a usually straight intestine opening at the posterior end of the body (fig. 1). There are no external appendages except the caudal cirrus, sucker and tentacles, found in a few species.

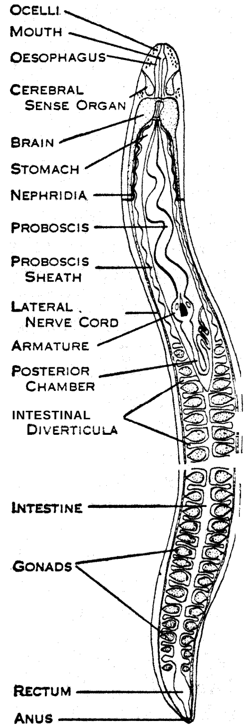

FIG. 1.—ORGAN SYSTEMS OF A HOPLONEMERTINE

Nemertines vary greatly in size and shape; some are long, flattened and ribbonlike and may grow to a length of one to four metres (fig. 2); others are threadlike and from a few millimetres to several metres in length when mature: some are cylindrical (fig. 3); and others are broad and flat. In nearly all forms the body may be contracted to a small fraction of the length it has in full extension. In some species of nemertines the proboscis is coiled and is longer than the body.

Most of the species are marine and littoral; many of them burrow in sand or mud; others hide beneath stones or creep about among algae and other growths between tide marks or in shallow water. The members of the tribe Pelagica are strictly bathypelagic, with flattened, gelatinous bodies adapted for floating idly or swimming sluggishly far beneath the surface of the deep oceans. A few species inhabit fresh-water streams and lakes; others have migrated to the land, living in moist earth or beneath fallen logs. stones or dead foliage. Certain species live as commensals in the mantle cavities of pelecypods or of tunicates, in the canals of sponges or beneath actinians; and finally several species are parasitic on the gills and among the egg masses of crabs.

The nemertines are all carnivorous, feeding on protozoa, turbellarians and other worms, mollusks, crustaceans and the young of all the invertebrates with which they come in contact. Some have such distensible mouths that they can devour animals of almost their own diameter. Others have small mouths and suck in only the juices of their prey.

When food is not obtainable the nemertine is able to live for a long time upon the nourishment to be obtained from its own tissues. Individuals of some species may thus survive starvation for

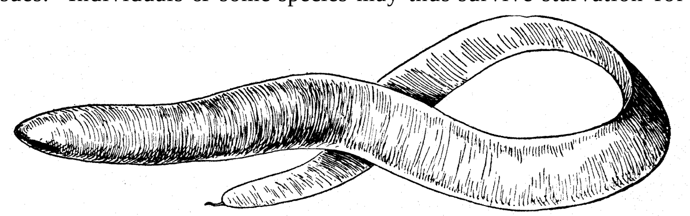

FIG. 2.— A HETERONEMERTINE. *CEREBRATULUS MELANOPS*

a year or more. In the meantime the body may have shrunk to $\frac{1}{20}$ or less of its former size. Some of the small forms may survive unfavourable conditions by coiling their bodies in a firm cyst of secreted mucus, to resume activity at a later time.

Many of the species are brightly coloured in life, with shades of red, orange, yellow, green, gray and brown predominating. Some have a uniform coloration, while others have definite patterns or markings of contrasting colours, with rings, longitudinal lines, spots or reticulations. The physical basis of the colour patterns consists of pigment granules secreted within the epithelial cells of the integument or in the underlying connective tissue cells or both.

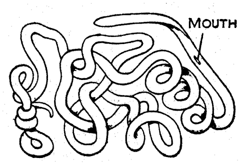

FIG. 9-A PALEONEMERTINE. PROCEFHALOTHRIX SPIRALIS

Morphology and Physiology. — The morphological characteristics of a nemertine are shown in fig. 1. Although there is no external indication of segmentation, most of the internal organs are arranged metamerically. The body is covered with a layer of ciliated epithelial cells, interspersed with mucous and sensory cells. The epithelium is supported on a basement layer of firm gelatinous tissue, beneath which, in the Heteronemertina, is a thick layer of mucous glands and connective tissue, the cutis. The musculature of the body wall consists of two or more layers of circular, spiral and longitudinal muscles that enable the worm to carry on rapid changes in body form. Locomotion is accomplished by creeping or gliding, by alternate elongation and contraction, by twisting spirally or, in a few species, by swimming. The proboscis is sometimes used as an aid in creeping or burrowing.

Proboscis. — The proboscis is formed by an invagination of the anterior body wall and consequently has essentially the same muscular and epithelial layers but in reverse order. In its normal position within the body it lies within the proboscis sheath, which forms a closed, saclike cavity, the rhynchocoel, filled with a corpusculated fluid. In a few species of hoplonemertines the sheath is provided with paired diverticula. The anterior end of the proboscis is anchored firmly into the tissues of the head near the brain, while the posterior end commonly terminates in a long retractor muscle attached to the proboscis sheath or in some species to the musculature of the body wall in addition. The proboscis is everted through the rhynchodeum by the combined action of its own muscles and such contractions of the musculatures both of the sheath and body walls as will exert pressure on the fluid in the rhynchocoel. It is withdrawn by reducing this pressure, aided by its own musculature and by the retractor muscle: if present. In the Anopla the tenacious mucus and paralyzing secretions of the everted proboscis aid in capturing the prey, while in the Enopla the stylet is also used. Most of the Enopla have two or more pouches of accessory stylets which may replace the central stylet if lost or broken (fig. 4). In the heteronemertine *Gorgonorhynchus* the proboscis is dichotomously branched.

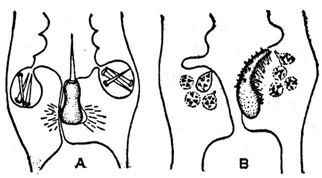

FIG. 4.— PROBOSCIS ARMATURE IN (A) AMPHIPORUS GRISEUS, A REPRESENTATIVE OF THE MONOSTYLIFERA AND IN (B) PELAGONEMERTES BRINKMANNI, A REPRESENTATIVE OF THE POLYSTYLIFERA

Digestive System.—The digestive system consists of an anterior mouth, which may either open ventrally posterior to the brain or terminally in connection with the proboscis opening. In the Bdellonemertina and some Hoplonemertina the mouth joins the rhynchodeum to form an atrium. The mouth leads to a slender esophagus and thence to a more spacious stomach. The intestine continues as a straight tube, usually with numerous paired lateral diverticula, from the stomach to the rectum, which opens at the posterior end of the body (fig. 1). Some forms have a large caecum, with caecal diverticula, which extends forward from the anterior end of the intestine, while in some of the Paleonemertina and all of the Bdellonemertina there are no intestinal diverticula whatever (fig. 5). Digestion of the food materials is accomplished mainly by enzymes secreted into the stomach and intestine, although the fats are taken by phagocytosis directly into the cells of the lining epithelium. In these cells also the nutrients are stored in vacuoles until needed in the body metabolism.

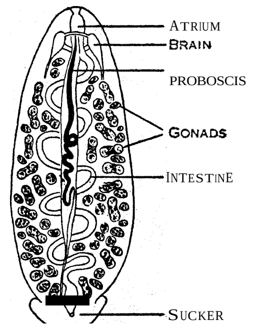

FIG. 5.—ORGAN SYSTEMS OF A BDELLONEMERTINE

Circulatory System.—The circulatory system consists typically of three longitudinal blood vessels, united at both ends of the body, and in most species with reservoirs, or lacunae, in the head and esophageal region and with numerous anastomosing cross branches throughout the body.

Excretory *System.*—The excretory system is highly diversified. Typically there is a pair of profusely branching nephridia in close proximity with the lateral blood vessels and having one or more pairs of efferent ducts leading to the exterior of the body (fig. 1). Each of the numerous minute branches originates from a multinucleate terminal organ (metanephridium) or from a single cell (protonephridium) with long flagella which draw fluid from the surrounding parenchyma into the nephridial canal. Other cells in the walls of the canals excrete metabolized waste products. In the terrestrial nemertines (*Geonemertes*) there are several thousand separate nephridia, each with its own efferent duct. Excretory organs have not been found in any of the bathypelagic species.

Nervous System.—The central nervous system consists of a four-lobed brain, from which a pair of large lateral nerve cords extend to the posterior end of the body. Many species have in addition a dorsomedian and a ventromedian nerve with branches communicating with the lateral nerve cords. Connected with the central nervous system are one or more pairs of proboscidial nerves and numerous. often paired, peripheral nerves associated with the muscular and digestive systems, integument, ocelli and such other sense organs as may be present.

Sense Organs. — In addition to the sensory epithelium everywhere present in the integument. some of the species have other specialized sense organs, including ocelli, cerebral, lateral and frontal sense organs, cephalic grooves and pits. In a single family (Ototyphlonemertidae) there is a pair of statocysts connected with the brain. With the exception of these organs of equilibrium and the ocelli very little experimental evidence has been obtained as to the precise nature of the sense. organs. Chemical senses, including the recognition of food substances, positional sense, tactile sense and a certain degree of light sense must be located in the epithelium on all parts of the body, for headless fragments respond to the corresponding stimuli.

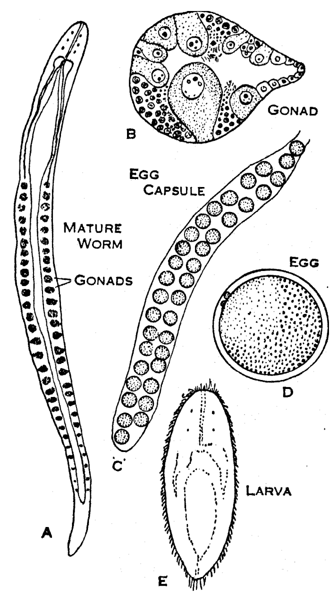

FIG. 6.—DEVELOPMENT WITHOUT METAMORPHOSIS IN A HOPLONEMERTINE, PROSTOMA RUBRUM

Reproduction. — In most nemertines the sexes are separate, although a few species are hermaphroditic. The gonads are simple sacs which usually alternate with the intestinal diverticula and may therefore be very numerous (fig. 1 and 6). In most species the sexual cells from each gonad are discharged directly into the water. Fertilization is thus external except for the few cases of viviparity in which the development of the embryo takes place within the body of the parent. In a few of the bathypelagic nemertines the spermaries have been shifted to the head, and in the parasitic *Carcinonemertes* there is a common sperm duct which opens into the rectum.

Embryonic development may be direct. leading to the formation of a larva similar to the adult (fig. 6), or it may be indirect, with a free-swimming, hemispherical larva of complicated pattern known as the pilidium (fig. 7). The young worm later develops by metamorphosis within the pilidium. Increase in length occurs by constant additions to the posterior end of the body.

Regeneration.—Enemies are numerous: particularly annelids, crustaceans and fishes. Contributing to survival, however, is the tendency of most individuals with long bodies to break in fragments whenever any part of the body is seized. If only the posterior portion of the body is lost the missing parts are soon restored by regeneration. In certain species, any small fragment of the body. with or without the head, will regenerate into a minute worm of normal proportions (fig. 8). Fragmentation thus becomes a method of asexual propagation. Only a few species. however, have the capacity of restoring a missing head, hut a lost or injured proboscis is promptly replaced.

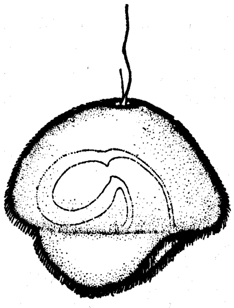

FIG. 7.—PILIDIUM OF A HETERONEMERTINE. CEREBRATULUS

Geographical **Distribution.**—Nemertines are found along all the seacoasts of the world and off the shores to depths of hundreds of metres. Some of the species are circumpolar. extending southward along the coasts as far as Madeira. southern New England, California and Japan. A few species live in both the northern and southern hemispheres. Some are limited to the polar seas and others to the tropics. Some of the bathypelagic species live at depths of 1,000–2,000 m. or more and the population may be carried for thousands of miles by the deep ocean currents. reproducing generation after generation in their endless circuits throughout the great oceans, or the individuals may congregate in eddies among the currents.

Classification.—Approximately 600 species of Nemertina have been described. Nearly 200 of these are found along the coasts of Europe. 1jo on the Pacific coast of North America and Japan, 60 on the Atlantic coast of North America and 70 are bathypelagic, floating far beneath the surface of the oceans.

The phylum is conveniently divided into two classes, each of which consists of two orders.

Class I. ANOPLA. Mouth posterior to brain; central nervous system imbedded in body wall, either between the muscular layers or external thereto; and proboscis not armed with stylets.

Order 1. PALEONEMERTINA. Body musculature of either two or three layers; cutis absent. Example, *Procephalothrix* (fig. 3).

Order 2. HETERONEMERTINA. Body musculature of three layers, to which a thin inner circular and an outer spiral layer are sometimes added; cutis well developed. Examples, *Lineus* (fig. 8). *Cerebratulus* (fig. 2).

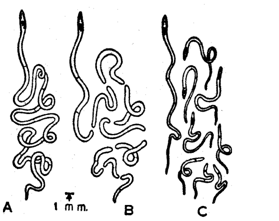

FIG. 8.— ASEXUAL REPRODUCTION BY FRAGMENTATION. LINEUS SOCIALIS

Class II. ESOPLA. Mouth anterior to brain; central nervous system situated in parenchyma internal to body musculature; and proboscis (except in Bdellonemertina) armed with one or more calcareous stylets.

Order 3. HOPLONEMERTINA. Proboscis with armature; intestine straight, with paired lateral diverticula; and sucker absent.

Suborder 1. Monostylifera, with single stylet on awl-shaped basis. Examples, *Amphiporus* (fig. 4A), *Prostoma* (fig. 6).

Suborder 2. Polystylifera, with several stylets on curved basis.

Tribe 1. Reptantia, adapted for creeping or burrowing.

Tribe 2. Pelagica, adapted for swimming or floating in the ocean depths. Example, *Pelagonemertes* (fig. 4B).

Order 4. BDELLONEMERTINA. Proboscis without armature; intestine convoluted, slender, without diverticula; with sucker at posterior end of body; and commensal in marine pelecypods. Example. *Malacobdella* (fig. 5).

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NEMESLANUS, MARCUS AURELIUS OLYMPIUS (fl. *c.* A.D. 280), Roman poet, born in Carthage, who wrote pastoral and didactic poetry. There survive four eclogues and an incomplete poem of 325 hexameters on hunting (*Cynegetica*). Two small fragments on bird catching (*De aucupio*) are generally attributed to him. The four eclogues were usually printed along with the seven eclogues of Calpurnius Siculus (*q.v.*); in 1854 M. Haupt established the difference of authorship and date. They are in the Vergilian tradition. influenced also by Calpurnius, purely imitative and of conventional form and imagery, and yet attractive because of their smooth diction and melodious movement. The *Cynegetica* gives instruction about dogs, horses and hunting equipment; it is a gracefully written piece in the literary genre of the *Georgics* and of the *Cynegetica* of Grattius.

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NEMESIS. 1. A goddess worshiped at Rhamnus in Attica. She is closely connected with Artemis. probably a local form of her or of some other very similar goddess. In mythology (post-Homeric; the story is told in the cyclic *Cypria*) she is loved by Zeus who catches her after a transformation race; she lays an egg, from which Helen (*q.v.*) is hatched out, generally by Leda (*q.v.*). It is a disputed point whether Leda or Nemesis is the mother of Helen in the original form of the story. There seems also to have been a legend (Catullus. lxiv. 393) that on some occasion (Marathon?) she appeared in person to encourage her worshipers in battle.

2. The indignant disapproval felt at wrongdoing; in particular, such disapproval on the part of the gods, and the consequent punishment of a sinful (or overprosperous) man, hence (first in Hesiod) that disapproval personified. There was an old cult of "the Nemeseis" at Smyrna (Pausanias, ix, 35–36), but whether of this abstraction or of the fertility goddess of Rhamnus, is not clear. However, the fact that the abstraction was worshiped. at least in later times. is beyond doubt; a fragment of Antimachus (in Strabo, xiii, 1, 13) says that Adrastus was the first to erect an altar to her. In Rome. especially, her cult was very popular, particularly among soldiers, by whom she was worshiped as patroness of the drill ground (Nemesis campestris); associated with Fortune, she seems also to have been adored as presiding over races; she had a cult association, the Nemesiaci.

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NEMESIUS (fl. *c.* A.D. 390), a Christian philosopher, author of a treatise "On Human Nature" (Eng. trans. by W. Telfer, 1955), was, according to the title of his book, bishop of Emesa (in Syria). His book is an attempt to compile a system of anthropology from a Christian standpoint, using as sources various Greek philosophers and men of science. His interest in medicine is marked, the information being in great part derived from Galen, whom, however, he corrects in some details. He first explains the unique position of man as a creature halfway up the scale of beings, who is endowed with a rational soul and shares the nature of the divine and of the perishable; next describes in detail the human frame, the powers of the soul and the emotions; and finally defends in Aristotelian fashion the belief in human responsibility in opposition to fatalism and astrology. (D. J. A.)

NEMIROVICH-DANCHENKO, VLADIMIR IVANOVICH (1858–1943), Russian novelist, playwright and producer, and a founder of the Moscow Art theatre, was born at Ozurgetp, Georgia, on Dec. 23, 1858. In 1890 he took over the drama classes of the Moscow Philharmonic society, and by the end of the 1890s he was already the author of a number of best-selling novels and successful plays. As a writer of the "psychological" school, he laid particular stress on bringing out the psychological undertones in the acting of his pupils, and his first great success in this line was the production at his school of Ibsen's *A Doll's House* in 1896. A year later he had an 18-hour meeting with Constantin Stanislavsky (*q.v.*), at which they laid the foundations of the Moscow Art theatre. It was Nemirovich-Danchenko, too, who was chiefly responsible for introducing Chekhov's plays into the theatre's repertory. In the 1920s he organized the Moscow Art Theatre Musical studio, and he toured the United States in 1925. His work as producer is chiefly remarkable for the adaptation of *The Brothers Karamazov* and *War and Peace* in 1910, and for an operatic version of M. A. Sholokhov's *And Quiet Flows the Don* during the last years of his life. He died in Moscow on April 25, 1943. His autobiography has been translated as *My Life in the Russian Theatre* (1936). (D. Mk.)

NEMOPHILA, a genus of North American herbs of the waterleaf family (Hydrophyllaceae), comprising some 20 species found chiefly in the Pacific coast region, 13 of which are native to California. They are more or less diffuse annuals, with parted, divided or lobed leaves, and delicate blue or white flowers, blossoming in early spring. Several are grown as border plants, especially the baby blue-eyes (*N. menziesi*) and the five-spot (*N. maculata*).

Other interesting species are the climbing nemophila or fiesta flower (*N. aurita*), the small white nemophila (*N. heterophylla*) and the small flowered nemophila (*N. parviflora*), the last named ranging from California to Washington.

NEMORENSIS LACUS (mod. Nemi), a lake in the Alban hills, is an extinct subsidiary crater in the outer ring of the ancient Alban crater, east of the Lake of Albano. It is about 3½ mi. in diameter and about 110 ft. deep; the precipitous slopes of its basin are over 300 ft. high and are mainly cultivated. In ancient times it was included in the territory of Aricia and bore the name "Mirror of Diana." The worship of Diana there was originally celebrated with human sacrifices; even in imperial times the priest of Diana was a man of low condition, a gladiator or fugitive slave, who won his position by slaying his predecessor in fight, having first plucked a mistletoe bough from the sacred grove. The temple itself was one of the richest in Latium; Octavian borrowed money from it in 31 B.C. The remains of its precinct are situated a little above the level of the lake, on the northeast—a large platform, the back of which is formed by a wall of concrete, with niches, resting against the cliffs. Excavations (now covered in again) led to the discovery of the temple itself, a comparatively small building, 98 by 52 ft., containing objects none earlier than the 4th century B.C. A road descended to it from the Via Appia from the southwest. The lake is drained by a tunnel about 2 mi. long.

On the west side of the lake remains of two ships (really floating palaces moored to the shore) have been found, one belonging to the time of Caligula (as is indicated by an inscription on a lead pipe), and measuring 210 ft. long by 66 wide, the other even larger, 233 by 80 feet. The first was decorated with marbles and mosaics and with some very fine bronze beamheads, with heads of wolves and lions having rings for hawsers in their mouths (and one of a Medusa), now in the Museo delle Terme at Rome. Various attempts have been made to raise the first ship, from the middle of the 15th century onward, and the ancient emissarium has now been cleared in order to lay bare the remains of the ships. Caesar had a villa constructed there.

NEMOURS, LORDS AND DUKES OF. In the 12th and 13th centuries the lordship of Nemours, in Gâtinais, France, was in possession of the house of Villebeon, a member of which, Gautier, was marshal of France in the 13th century. The lordship was sold to King Philip III. in 1274 and 1276 by Jean and Philippe de Nemours, and was then made a county and given to Jean de Grailly, captal de Buch in 1364. In 1404 Charles VI. of France gave it to Charles III. of Evreux, king of Navarre, and erected it into a duchy in the peerage of France (*duché-pairie*). Charles III.'s daughter, Beatrix, brought the duchy to her husband Jacques de Bourbon, count of La Marche, and by the marriage of their daughter, Eleanor, to Bernard of Armagnac, count of Pardiac, it passed to the house of Armagnac. The duchy reverted to the French crown in 1505, after the extinction of the house of Armagnac-Pardiac. In 1507 it was given by Louis XII. successively to his nephew, Gaston de Foix (d. 1512), Guiliano de Medici and his wife Philiberta of Savoy in 1515, to Louise of Savoy in 1524, and to Philip of Savoy, count of Genevois, in 1528, whose descendants possessed the duchy until its sale to Louis XIV. In 1672 Louis gave the duchy to his brother Philip, duke of Orleans, whose descendants retained it until the Revolution.

The title of duc de Nemours was afterward given to Louis Charles, son of King Louis Philippe, who is dealt with separately below.

The following are the most noteworthy of the earlier dukes of Nemours.

James of Armagnac, duke of Nemours (c. 1433–1477), was the son of Bernard d'Armagnac, count of Pardiac, and Eleanor of Bourbon-La Marche. As comte de Castres, he served under Charles VII in Normandy in 1449 and 1450, and in Guienne. Louis XI loaded him with honours, married him to his goddaughter, Louise of Anjou, and recognized his title to the duchy of Nemours in 1462. Sent by Louis to pacify Roussillon, Nemours felt that he had been insufficiently rewarded for the rapid success of this expedition, and joined the League of the Public Weal in 1465.

The king's patience eventually became exhausted by his intrigues; his château at Carlat was attacked, and he was condemned by the *parlement*, and beheaded on Aug. 4, 1477.

See B. de Mandrot, *Jacques d'Armagnac, duc de Nemours* (1890).

Charles Emmanuel (1567–1595), son of James, duke of Nemours and Anne of Este, widow of Francis, duke of Guise, was called in his youth prince of Genevois. Involved in political intrigues by his relationship with the Guises, he was imprisoned after the assassination of Henry, duke of Guise, and his brother the cardinal of Lorraine, in 1588, but escaped. He was governor of Paris when it was besieged by Henry IV. After quarrelling with his half-brother Charles of Lorraine, duke of Mayenne, he withdrew to his government of Lyonnais, where he endeavoured to make himself independent. He was imprisoned, however, in the château of Pierre-Encise by the archbishop of Lyons. After his escape he attacked Lyons, but was defeated because of the intervention of the constable de Montmorency. He died at Annecy in July 1595.

His brother Henry (1572–1632), called originally marquis de Saint-Sorlin, succeeded him as duke. In 1588 he took the marquisate of Saluzzo from the French for his cousin, the duke of Savoy. The princes of Guise, his half-brothers, induced him to join the league, and in 1591 he was made governor of Dauphiné. He made his submission to Henry IV in 1596. After quarrelling with the duke of Savoy he joined the Spaniards in their war against Savoy. After peace had been proclaimed on Nov. 14, 1616, he retired to the French court. He died in 1632, and was succeeded by his eldest son, Louis, and on the death of the latter in 1641 by his second son, Charles Amadeus (1624–1652), who served in the army of Flanders in 1645, and in 1646 commanded the light cavalry at the siege of Courtrai. In 1652 he took part in the war of the Fronde, and was wounded at the Faubourg St. Antoine. On July 30, 1652, he was killed in a duel by his brother-in-law, François de Vendôme, duke of Beaufort. He had two daughters, Marie Jeanne Baptiste (d. 1724), who married Charles Emmanuel of Savoy in 1665; and Marie Françoise Elisabeth, who married Alphonso VI, king of Portugal, in 1666.

His brother Henry (1625–1659), archbishop of Reims, withdrew from orders and succeeded to the title.

In 1657 Henry married Marie d'Orleans-Longueville (1625–1707), daughter of Henry II of Orléans, duke of Longueville. This duchess of Nemours is a famous personage. At an early age she was involved in the first Fronde, which was directed by her father and her stepmother, Anne Genevieve de Bourbon-Condé, the celebrated duchesse de Longueville; and when her husband died in 1659, leaving her childless, her life was mainly spent in contesting her inheritance with her stepmother. She left some interesting *Mémoires,* which were published by C. B. Petitot in the *Collection complète des mémoires* (1819–1829).

NEMOURS, LOUIS CHARLES PHILIPPE

RAPHAEL, Duc de (1814–1896), second son of the duke of Orléans, afterward King Louis Philippe, was born on Oct. 25, 1814. In 1830 he became a chevalier of the order of the Saint Esprit and entered the chamber of peers. As early as 1825 his name was mentioned for the throne of Greece, and in 1831 he was elected king of the Belgians, but Louis Philippe declined the honour for his son. In Feb. 1831 he accompanied the French army which entered Belgium to support the new kingdom against Holland, and took part in the siege of Antwerp. He accompanied the Algerian expeditions against the town of Constantine in the autumn of 1836, and again in 1837, taking it by assault on Oct. 13. He sailed a third time for Algeria in 1841, and served under General Bugeaud. On his return to France he became commandant of the camp of Compiègne. He had been employed on missions to England in 1835, 1838 and 1845, and to Berlin and Vienna in 1836. His marriage in 1840 with Victoria, daughter of Duke Ferdinand of Saxe-Coburg, was marked by a check to Louis Philippe's government in the form of a refusal to bestow the marriage dowry proposed by Thiers in the chamber of deputies. The death of his elder brother, Ferdinand. duke of Orléans, in 1842 gave him a position of greater importance as the natural regent in the case of the accession of his nephew, the young count of Paris, but he was not popular. On the outbreak of the revolution of 1848 he held the Tuileries long enough to cover the king's retreat, but took no active measures against the mob. He followed his sister-in-law, the duchess of Orléans, and her two sons to the chamber of deputies, but was separated from them by the rioters, and only escaped in the uniform of a national guard. He then settled with his parents in England. His chief aim was a reconciliation between the two branches of the house of Bourbon, as indispensable to the re-establishment of the French monarchy in any form. These wishes were frustrated on the one hand by the attitude of the comte de Chambord, and on the other by the determination of the duchess of Orléans to maintain the pretensions of the count of Paris. Lengthy negotiations ended in 1857 with a letter, written by Nemours, in which he insisted that Chambord should adhere to the tricolour flag and to the principles of constitutional government.

Nemours had lived at Bushey house after the death of Queen Marie Amélie in 1866. In 1871 the exile imposed on the French princes was withdrawn, but he only returned to Paris after their disabilities were also removed. In March 1872 he was restored to his rank in the army as general of division, and placed in the first section of the general staff. In 1881 new decrees against the princes of the blood led to his withdrawal from Parisian society. He died at Versailles on June 26, 1896, the duchess having died at Claremont on Nov. 10, 1857.

See R. Bazin, *Le Duc de Nemours* (1907); Paul Thureau-Dangin, *Histoire de la monarchie de juillet* (4 vols, 1884, etc.).

NEMOURS, a town of France, in the *département* of Seine-et-Marne, on the Loing and its canal, 26 mi. S. of Nelun, by rail. Pop. (1954) 5,558. Nemours derives its name from the woods *(nemora)* in which it formerly stood, and discoveries of Gallo-Roman remains indicate its early origin. It derives its historical importance from the lordship of Nemours.

NENADOVITCH, MATIJA (1777–1854), Serbian priest and patriot, the first diplomatic agent of his country. His father, Aleksa, was killed by the Janissaries in the massacre that provoked the Serbian revolt of Feb. 1804. In Sept. 1804 Matija was sent on a mission to Russia, and there convinced the imperial government that the insurgents were worth helping. He also went on several other important missions to Constantinople and Vienna, trying in vain in 1814–15 to get the powers assembled in congress at Vienna to intervene on behalf of his people. Matija had little influence on Karageorge and the other leaders fighting the Turks and seeking to govern Serbia, but he, more than any other Serb, forced his hitherto almost unknown people on the notice of Europe. In his naïve and yet shrewd *Memoirs,* he gives a fascinating account of the course of the first insurrection and of early attempts to establish a native government in Serbia. (J. Pz.)

NENAGH, a town of County Tipperary, Ire., near the river Nenagh, 98 mi. S.W. of Dublin by road. Pop. (1956) 4,450. The chief town of north Tipperary. Nenagh is an agricultural centre with some industry, *e.g.,* aluminum ware and chemical products. Of the old castle, Nenagh Round, dating from King John, there exists the circular donjon or keep. There are no remains of the hospital founded in 1200 for Austin canons, and only slight remains of the Franciscan friary, founded in the reign of Henry III. Nenagh was one of the ancient manors of the Butlers, who received for it the grant of a fair from Henry VIII.

NENNIUS (*fl.* 796), a Welsh writer to whom we owe the *Historia Britonum,* wrote in Brecknock or Radnor. His work exists in 30 manuscripts, the earliest of which is not much earlier than the year 1000. All are defaced by interpolations which give to the work so confused a character that critics were long disposed to treat it as an unskillful forgery. A new turn was given to the controversy by Heinrich Zimmer, who, in his *Nennius vindicatus* (1893), traced the history of the work and, by a comparison of the manuscripts with the 11th-century translation of the Irish scholar, Gilla Coemgim (d. 1072), succeeded in stripping off the later accretions from the original nucleus of the *Historia.* Zimmer follows previous critics in rejecting the *Prologus maior* (§§ 1, 2), the *Capitula,* or table of contents, and part of the *Mirabilia* of the concluding section. But he proves that Kennius is the compiler of the *Historia* proper (§§ 7–65). The only part of the *Historia* which deserves to be treated as a historical document is the section known as the *Genealogiae Saxonum* (§§ 57–65). This is merely a recension of a work composed about 679 by a Briton of Strathclyde. The author's name is unknown; but he is. after Gildas, our earliest authority for the English conquest of England. Nennius himself gives us the oldest legends relating to the victories of King Arthur; the value of the *Historia* from this point of view is admitted by the severest critics. The chief authorities whom Nennius followed were Gildas' *De excidio Britonum,* Eusebius, the *Vita Patricii* of Murichu Maccu Nachtheni, the *Collectanea* of Tirechan, the *Liber occupationis* (an Irish work on the settlement of Ireland), the *Liber de sex aetatibus mundi,* the chronicle of Prosper of Aquitaine, the *Liber beati Germani.* The sources for his notices of King Arthur (§ 56) are unknown.

See J. Stevenson's edition of the *Historia Britonum* (English Hist. Soc., 1838), based on a careful study of the manuscripts; A. de la Borderie, *L'Historia Britonum* (Paris and London, 1883), which summarizes the older negative criticism; H. Zimmer, *Nennius vindicatus* (Berlin, 1893); T. Mommsen in *Neues Archiv der Gesellschaft fur ältere deutsche Geschichtskunde,* xix, 283. (H. W. C. D.)

NEOCLASSICAL ARCHITECTURE: *see* Baroque Architecture.

NEOCLASSICAL ART refers to the dominant style of the late 18th and early 19th centuries. Various phases of its course can be distinguished. In France, there are the rococo neoclassicism of the reigns of Louis XV and XVI, the developments of the revolutionary transition including the Directory, consulate and first empire and that of the Bourbon restoration until the July Revolution of 1830. In England, the style is found in the late Georgian phase of the Adam school beginning in the 1760s, in the United States, in the federal style (about 1785–1820), and internationally, in the romantic neoclassicism of the Roman and Greek revivals. Thereafter its waning influence is felt throughout the 19th century in the academic neoclassicism in painting and sculpture, and as a component of the eclectic style in architecture.

The beginnings of neoclassicism are found in the decline of the rococo in France and the Georgian style in England. J. G. Soufflot's Panthéon (1754–1790) in Paris, with its chaste Corinthian portico and Roman detail, reflects the shift in taste, as does Jacques Ange Gabriel's design for the Petit Trianon (1762–66) at Versailles, with its neat geometrical balance of horizontal lines and vertical pilasters surmounted by a classical entablature. Under Louis XVI the Pompeiian influence further curbed rococo decorative extravagances and purified the sense of design. In the work of Robert Adam, who returned to England in 1760 after studying the excavations of Diocletian's palace at Spalato, the Palladian influence gave way to a more authentic neoclassicism. His interiors for private houses show his enthusiasm for the discoveries about Roman domestic architecture at Pompeii. His preferences ran to Roman stucco decoration with such classical motives as scrolls, vases, festoons and candelabra.

In the pictorial arts the reaction to the rococo was evidenced by the unparalleled popularity of Piranesi' prints of ancient Roman ruins and in the paintings of J. M. Vien in France, A. R. Mengs in Germany, and B. West in England. With the great success of J. L. David's "Oath of the Horatii" (1785) neoclassicism was in full swing. David's archaeological enthusiasm led him to model the faces and figures in his pictures after antique busts; and his announced intention was to make the backgrounds and details of his pictures so faithful to the ancient world that if an old Roman should suddenly come to life, he would find himself completely at home.

Neoclassical art reflected an important aspect of the life and thought of the pre- and post-revolutionary generation, especially in France and British-colonial America; and the brave new revolutionary world figuratively dressed itself in the ancient toga.

At this time of swift and violent social and political change, the rising middle class began to assume a more active leadership in public and private affairs, and the straightforward simplicity and uncomplicated forms of neoclassicism made a strong appeal to the stoic and austere taste of the revolutionists. After the chaos and confusion of these years, American and French citizens felt the need for the disciplined orderliness, economy of means and logical predictability inherent in neoclassical forms. As monarchical rule was overthrown in the United States and France, the citizenry discovered an emotional identification with the forms and images of the ancient republics. To them Greece and Rome were not dead civilizations, but the living birthplaces of freedom and democracy. Their affinity with the ancient world not only gave them a sense of heroism and glory, but it also furnished convenient precedents for the new governments in America and France, and to a certain extent the British constitutional monarchy. The ancient Athenian commonn-ealth and Roman republic became the symbols of liberty and the new order. The senior legislative houses in the United States, France and later in the Latin American republics, were named senates after the old Roman prototype.

George Washington was acclaimed as the father of his country, in emulation of the ancient Roman honorific *pater patriae.* The new U.S. capital was destined to be built on classical, rather than baroque, colonial or Georgian, models; and the new legislature was to be housed on Capitol hill, a site named after one of the seven hills of Rome.

'This was a generation that built new government buildings, municipal offices, public libraries, art museums, national repertory theatres, concert halls; hospitals, hotels, banks and railroad stations. The Roman revival was perhaps strongest in Paris, which Napoleon envisaged as a new Rome replete with temples of glory, triumphal arches, and monumental commemorative columns. In the United States the federal style also followed Roman models; Thomas Jefferson designed the Virginia state capitol after the Maison Carrée at Nîmes, and his residence at Monticello and the Rotunda of the University of Virginia after the Roman Pantheon. The Greek revival generally found a foothold in the countries least sympathetic to Napoleon's new Roman empire. More chaste and correct than its Roman counterpart, the style is seen in the following: the Brandenburg gate at Berlin (1788–91), modeled after an archaeological reconstruction of the Athenian Propplaea; the semicircular Corinthian colonnade of the Hall of Representatives (1803–17) at Washington, D.C., inspired by the Monument of Lysicrates in Athens; St. Pancras' church (1818–22) and the Ionic façade of the British museum (1823–47) in London, after the Erechtheum; and the Valhalla (1830–42) at Regensburg, Bavaria, after the Parthenon.

In spite of their deeper penetration into the classical spirit, the neoclassicists still suffered from a lack of detailed knowledge about antiquity. Winckelmann's ideal statues were the Apollo Belvedere and the Laocoon, both late Hellenistic examples rather than those of the earlier and superior Hellenic style. Sculptors left the irises and pupils of eyes uncarved because they did not know that the ancients painted in such details. A. Canova and B. Thorvaldsen both turned the human body into the cold marble of antique statuary instead of molding marble into a semblance of living flesh, as the great Greek sculptors had done. Josiah Wedgwood imitated the Greek vases of the fifth century B.C., which he mistakenly took to be Etruscan.

After David and his successor J. A. D. Ingres, French neoclassical painting degenerated into the sterile academicism of the later 19th century as exemplified by Thomas Couture's once-popular "Romans of the Decadence" (1847), Adolphe Bouguereau's "Birth of Venus," and the stereotyped pictures of Puvis de Chavannes. Alexandre Cabanel and Marcus Collin. Neoclassical architecture nevertheless continued in various modified forms until it was supplanted by the new materials, building methods and aesthetic viewpoints of the machine age.

The popularity of neoclassicism can be traced to several sources. A series of publications stimulated a shift in taste toward a new and more authentic interpretation of antiquity. Among the early histories was Montesquieu's *Considerations on the Causes of the Greatness of the Romans and of their Decadence* (1734), an important precursor of Gibbon's monumental *Decline and Fall of the Roman Empire* (1776–1788), which reached a wide public and focused attention on ancient Rome. Winckelmann's *Thoughts on the Imitation of Greek Works in Painting and Sculpture* (1755) and his epoch-making *History of Ancient Art* (1764) made a clear distinction between Roman and Greek styles and brought forth cogent arguments to prove that Greek art was superior to Roman. Besides being the founder of modern systematic classical archaeology and the one who divided Greek art into logical periods, Winckelmann formulated the neoclassical aesthetic with its professed ideals of pure beauty, noble simplicity, and quiet grandeur. Winckelmann's ideas and conclusions were further expanded and applied to drama and the other arts by G. E. Lessing in his brilliant critical study, *Laocoön.*

Some important archaeological discoveries were made. After the discovery of Herculaneum in 1719 and Pompeii in 1748, the subsequent excavations attracted wide attention. Other expeditions followed; R. Wood published his findings about the Roman ruins at Palmyra and Baalbek (1737–57), and in 1769 his *Essay on the Original Genius and Writings of Homer, with a Comparative View of the Ancient and Present State of the Troade.* J. Stuart and N. Revett visited Athens and published their drawings and comments on the acropolis buildings in *Antiquities of Athens Measured and Delineated* (1762). The London Society of Dilletanti continued their archaeological work and later expeditions were published in *Ionian Antiquities* (1769) and *Unedited Antiquities of Attica* (1817).

C. L. Clérisseau in turn brought out his study of the Roman remains at Nîmes, and thereafter the archaeological work gained momentum with such major events as Lord Elgin's shipment of the Parthenon sculptures to London, H. Schliemann's excavation of Troy and Mycenae in the 1870's, and the discovery of the Mausoleum at Halicarnassus and the great Altar of Zeus at Pergamum (Bergama). All these books were concerned not only with the existing ruins but also with restorations of the ancient structures based on detailed measurements and as much knowledge as they could muster. Thereafter throughout the 19th century, all the scattered information and isolated discoveries were collated by scholars, documented and made available.

The romantic movement became increasingly popular. The idealization of the Greco-Roman world was as much a form of romantic escapism as that of the middle ages. The noble Greek and virtuous Roman embodied the romantic longing for a past golden age quite as much as the image of the pious medieval knight in armour. Later, when the romantic spirit became identified with the various struggles for national independence, the cause of Greek liberation from the tyranny of the "terrible Turks" symbolized the struggle of classical ideals against the ugliness of the contemporary world.

The emotional espousal of Greek independence that was prevalent all over Europe and the U.S. was actively expressed in letters and the arts. Both classical countries — Greece and Italy — were under the yoke of foreign tyrants, and intellectuals and poets passionately championed their cause. Byron's *Isles of Greece,* Shelley's *Hellas* and *Prometheus Unbound,* Friedrich Holderlin's

Hyperion, Victor Hugo's *Les Orientales,* and Vittorio Alfieri's tragedies, all upheld these liberation movements. Beethoven's ballets, *Ruins* of *Athens* and *Prometheus,* and Delacroix' painting, *Massacre at Chios* were based on incidents describing the oppression of the Greek people. Finally the whole movement was dramatized by Byron's quixotic death in one of the Greek skirmishes against the Turks. .

Education, based on the study of classical languages and literatures spread to an ever-widening circle. From the Renaissance through the 19th century. education was constantly closing the gulf between scholars and the public as a vast new reading puhlic was brought into being. The heart of education was the study of the classics, which were considered indispensable for a gentleman. So also was the grand tour to Italy to view the ruins of antiquity. it classical orientation in the arts followed quite naturally, and a common set of symbols drawn from ancient literature, mythology and art brought about an intellectual unity that transcended the barriers of language, creeds and national frontiers and brought all the nations of western civilization together in the last completely international style — neoclassicism.

See Fiske Kimball, "Romantic Classicism," *Gazette des Beaux Artes,* xxiv:313 (1944); Louis Hautecouer, *L'art Classique* (1957). (WM. F.)

NEODYMIUM [symbol Nd, atomic number 60, atomic weight 144.27, stable isotopes Nd^{142} (27.09%), Nd^{143} (12.14%), Nd^{144} (23.83%), Nd^{145} (8.29%), Nd^{146} (17.26%), Nd^{148} (5.74%) and Nd^{150} (5.63%)] is a metallic element belonging to the rare-earth group. It was discovered by Carl Auer von Welsbach (1S58–1929) in 1885 when he separated salts of what was thought to be an element "didymium" into two fractions (neodymium and praseodymium). Neodymium occurs along with the other rare earths in the minerals monazite, cerite, allanite, etc.; it is also found among the fission products oi uranium, thorium and plutonium. It may be separated by the fractional crystallization of the double magnesium nitrate from water solution; many other procedures have been used but all involved long continued fractionation processes. After 1945 efficient methods were developed for its separation by means of ion-exchange columns. The oxide (Nd_2O_3) is usually obtained as a light blue powder; traces of praseodymium impurity give a yellowish-brown tint. The oxide is readily dissolved in hydrochloric and nitric acids, giving a reddish-violet solution which shows a characteristic absorption spectrum. Neodymium is trivalent in its salts, and the solutions are paramagnetic. The metal can be prepared by the electrolysis of the fused halides or by thermoreduction of its salts by alkali metals or alkaline earth metals. It is slowly oxidized by air and is gradually attacked by cold water. It melts at 1,040° C. and undergoes a transition at 868" C. The crystal structure of the high temperature form is unknown but shows little long-range order. The room temperature form is close-packed hexagonal structure with a double c axis (stacking arrangement ABAC), a, = 3.658Å, c_0 = 11.80Å, calculated density 7.007 g. per cubic centimetre. It boils at about 3,450° K. and the heat of vaporization is approximately 65 kg.cal.; room temperature resistivity 64.3×10^{-6} ohm-centimetres. Its salts have been used in the ceramics industry for colouring glass and glazes; the glass made with didymium is particularly useful in goggles employed in glass-blowing because it removes the D-lines of sodium. Neodymium is a component of the alloy misch metal *(see* CERIUM) which has many applications.

See RARE EARTHS. (F. H. SP.)

NEOGRAMMARIAN is the name of a school of linguistics flourishing in, and spreading from, Germany (*Junggrammatiker*) after 1S; j. The founders and leaders. August Leskien, Hermann Osthoff. Karl Brugmann and Berthold Delbriick. had numerous disciples in all countries. They proposed that the living languages (as opposed to the dead languages, *i.e.,* those not spoken any longer by native speakers) should be given stronger emphasis than hitherto accorded them by philologists. and that greater attention should be paid to the psychological forces in language. And they stated that every historic sound change occurs according to rules, so-called sound laws, which "suffer no exceptions.'! This means that every occurrence of the phoneme /x/, at a certain moment in the history of a language, under certain phonetic conditions. is represented by the phoneme /y/ in a later stage, and that every apparent deviation from this law is to be explained, not as fortuitous "exception," but as a consequence of some overriding interference. Viewed thus, the often voiced objection against the "exceptionlessness" of the sound laws appears groundless. One of the chief causes cited by Neogrammarians as capable of neutralizing a sound law is analogy, which they considered a psychological force causing speakers to adhere to patterns, especially paradigmatic, whereby the expected regular development seems canceled. For example, Latin *amo* "I love'! regularly becomes French *(j')aime;* but although the infinitive *amare,* with the stress not on the first but the second *a,* should regularly give *amer,* the word is in fact *aimer,* with the *ai-* extended by analogy to all forms of this verb regardless of the place of the stress. Apart from analogy, the programmatic statement concerning the importance of psychology scarcely bears fruit in neogrammarian practice. Also the theoretically required emphasis on living languages has little practical consequence in the Neogrammarians' works (except insofar as some were also dialectologists): they deal mainly. and masterfully, with dead languages and the reconstruction of unattested proto-languages.

Despite often bitter attacks on neogrammarian theory (justifiably addressed to some incomprehending malpractitioners), all historical linguists implicitly accept and operate with the principle of regular change.

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NEO-HEGELIANISM, a term applied, generally by unsympathetic critics. to the doctrines of the idealist school of philosophers which was prominent in Great Britain and in the United States between 1870 and 1920: its use is sometimes extended to cover other philosophies of the period which were Hegelian in inspiration, for instance those of Benedetto Croce and of Giovanni Gentile (*qq.v.*). Neo-Hegelianism in Great Britain developed originally as a natural sequel to the semipopular work of S. T. Coleridge and Thomas Carlyle. Its exponents sought to give phiiosophical expression to a widely felt antipathy to the prevailing materialism and utilitarianism and turned to the writings of the German school as containing penetrating, if oracular. statements of an alternative view.

The ideas of Kant, Fichte. Schelling and Hegel were at first all used for this purpose. but closer knowledge led to a more reserved attitude to Kant and to an increasing tendency to look to Hegel for the elements of a really sound philosophy. There was, however. always a certain reluctance among the best-known members of the school to let themselves be described as "Hegelians": T. H. Green and F. H. Bradley both issued disclaimers on this point and both in fact were influenced by British ways of thinking which they shared with the opponents whom they criticized. It remains true, nevertheless. that the outlook of each was determined by Hegel more than by any other writer and that their work can be regarded as an attempt to tackle the philosophical problems of their time from a standpoint which was broadly Hegelian.

What Green described as "the vital truth which Hegel had to teach" was put by him in 1880 in the following terms: "That there is one spiritual self-conscious being. oi which all that is real is the activity or expression; that we are related to this spiritual being. not merely as parts of the world which is its expression. but as partakers in some inchoate measure of the self-consciousness through which it at once constitutes and distinguishes itself from the world; that this participation is the source of morality and religion" (reprinted in *Works,* vol. iii, p. 146 [London. 1888]). These words might well be taken as expressing Green's own personal philosophical creed and as indicating the central tenets of the Neo-Hegelian school as a whole. The Neo-Hegelians were opposed to materialism and to naturalism in metaphysics; to analyses of consciousness in terms of sensation and of the association of ideas in theory of knowledge: to psychologism (*q.v.*) and to formalism in logic; and to the "greatest happiness" principle as well as to the doctrine of duty for duty's sake in ethics. In politics they dissociated themselves from the prevailing individualism and tended to look on the state as a living community rather than a mutual benefit society. Their attitude to religion was ambiguous, for though they were in general sympathetic to religious claims, they made no secret of the fact that they could not accept them at their face value. Much of the popular attraction of their philosophy, indeed, sprang from its seeming to provide a rational alternative to the religious beliefs which. with the spread of scientific knowledge and the shock of Darwin, men found it increasingly difficult to hold; and one reason for its decline may have been that, as religious difficulties ceased to be a central preoccupation. less need was felt of such a substitute for religion as this philosophy offered.

The earliest representative of this way of thinking in Great Britain was J. F. Ferrier (1808–64), a professor at St. Andrews, who was, however. influenced as much by George Berkeley as by German writers. Ferrier's *Institutes of Metaphysics* appeared in 1854, but it was not until somewhat later that the ideas it expressed gained general currency. The creation of an idealist "school" was due to two men in particular: T. H. Green (1836–82), who taught at Oxford from 1860 onward, and Edward Caird (1835–1908), professor of moral philosophy in Glasgow from 1866 to 1893. Green was notable for his moral earnestness, personal integrity and intense interest in contemporary life. Caird for the breadth and thoroughness of his scholarship; and both were highly effective teachers. Neither had the philosophical insight and originality of their younger contemporary, F. H. Bradley (1846–1924), in whose works Neo-Hegelianism reached its intellectual high-water mark. The sceptical cast of Bradley's mind was, however, uncongenial to many who shared his general outlook; much misgiving was caused by the ruthless dialectic and apparently negative conclusion (which Caird described as "a manifest self-contradiction") of his *Appearance and Reality* (1893).

The fierce logical criticism to which Neo-Hegelian doctrines were subjected, notably by G. E. Moore and Bertrand Russell, in the opening years of the 20th century, may be said paradoxically to spring directly from Bradley's own work, with its insistence on subjecting all ideas, however seemingly sacrosanct, to remorseless scrutiny. Though Bradley himself and his polished but less gifted colleague Bernard Bosanquet (1848–1923) did their best to meet the attack, their efforts in the end were of no avail.

Neo-Hegelianism in the United States sprang from the work of the Boston Transcendentalists, whose knowledge of German philosophy was, however, mostly secondhand; it owed much of its advance to the efforts of W. T. Harris (1835–1909) and to the *Journal of Speculative Philosophy* which he founded in 1867. Its most distinguished and determined proponent was Josiah Royce (1855–1916), professor at Harvard from 1882, though Royce's idealism, with the special place that it assigned to the will, was closer to the ideas of Fichte than to those of Hegel himself. Royce's distinguished contemporaries C. S. Peirce and William James both repudiated his metaphysics; yet Peirce had described himself as an "idealist" in his early life, and even James had experienced the Hegelian influence to some extent. The same was true of James's successor John Dewey, who began life as a Hegelian and, despite his antipathy to absolutes, retained certain Hegelian features in his thought, notably a tendency to denounce abstractions and a reserved attitude toward the claims of formal logicians.

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(W. H. W.)

NEO-KANTIANISM. The philosophical movement called Neo-Kantianism commenced in Germany in the 1860s. Beginning with certain epistemological inquiries, it extended gradually over the whole field of philosophy. The individual thinkers who belong to this movement differ from each other in their interpretation of the Kantian doctrine as well as in the results which they reach from the Kantian premises. But, notwithstanding differences of detail, there is a certain methodical principle common to all of them. They all see in philosophy not merely a personal conviction, an individual view of the world, but they inquire into the possibility of philosophy as a science with the intention of formulating its conditions. They take their cue from the most general statement of the Kantian problem in the preface to the *Critique of Pure Reason* and in the *Prolegomena.* But in returning to the fundamental aim of Immanuel Kant, to lead philosophy "into the safe road of a science," Neo-Kantianism finds itself confronted with a new task inasmuch as it must face a different state of science itself.

Helmholtz.— The first decisive impetus toward the reception and revival of Kant's fundamental ideas started within the circle of natural science itself. Hermann von Helmholtz' particular mentality and his significance for the development of natural science in the 19th century are determined by the fact that he was both a physicist and a physiologist. His main work, the *Handbuch der physiologischen Optik* (1856; 3rd ed., 1909–11), shows both methods of inquiry in their mutual interdependence and ideal union. Here the fundamental problem of Kant's *Transcendental Aesthetics,* the question of the epistemological significance of space and spatial perception, is emphatically restated. For the solution of this question, Helmholtz goes back to the researches and results of Johannes Miiller in the field of the physiology of the senses.

In his *Vergleichende Physiologie des Gesichtssinns* (1826), Miiller had developed the doctrine of the "specific energy" of sense organs; he had shown that the quality of the individual sense data—the constitution of colour, tone, smell, etc.—is not to be explained from the constitution of the external stimulus, but from the peculiarity of the organ that conveys the sensation. This result is taken up by Helmholtz in his lecture *Über das Sehen des Menschen* (1855) and interpreted as an empirical confirmation of that which Kant had determined by general a priori considerations. The true and permanent achievement of Kantian philosophy, according to this interpretation, consists in having shown the participation of the innate laws of the mind in the formation of our ideas.

This interpretation was accepted by contemporary philosophers, especially by Friedrich Albert Lange (1828–1875). Lange, in his *History of Materialism* (1866), propounds as the essence of Kantian philosophy the proposition that what we call the "reality" of things is in truth nothing but their "appearance for the human species." Thus, the concept of causality, for instance, being rooted, according to this theory, in our psychophysical organization, is prior to all experience, an a priori disposition of the human mind. Accordingly, it has within the field of human experience unlimited validity; but beyond this no significance whatever. By extending this interpretation to all parts of the Kantian system, Lange arrives at the conclusion that not only is the concept of the "thing-in-itself" the "concept of a perfectly problematical something" having significance only as a "limiting term" (*Grenzbegriff*), but that even the "intelligible world," which was used by Kant as the foundation of ethics, is a "world of poetry." This poetry, to be sure, is, according to Lange, "a necessary fruit of the mind, issuing from the inner and most vital roots of the species." But in this very implication, which threatened to transform the Kantian transcendental idealism into a fictionism of the type developed later by Vaihinger, the deficiencies of the empirico-physiological interpretation of Kantian apriorism became clearly apparent.

Zeller.—In the meantime, the attempt had already been made in German philosophy to put Kantian apriorism on a basis broader and more solid than that which the doctrine of the specific energy of sense organs was capable of affording. In a lecture which Eduard Zeller had delivered in the year 1862 as an introduction to his course on logic and epistemology in Heidelberg, he had pointed out that epistemology formed the formal basis of philosophy as a whole, that it was epistemology "from which the final decision on the correct method in philosophy and science generally had to come." Hegel's *Wissenschaft der Logik* and his *Phanomenologie des Geistes* had been the last grandiose attempts to comprise the whole of knowledge in its content and to develop it constructively from one unifying idea. Zeller tries to show that the attempt did not reach its goal and could not reach it, "because it overlooks the conditions of human knowledge, for it purports to grasp with one swoop from above the ideal of knowledge which, in reality, we can approach only gradually through complicated labour from below." But the magic circle of the Hegelian system—so he says--will not allow itself to be broken, so long as the presuppositions of the latter are not investigated anew and more thoroughly than before; and this very investigation necessarily leads back to Kant.

What is here expressed as a purely programmatic idea, Otto Liebmann (1840–1912) tried to carry out in his main philosophical writings. The very first of Liebmann's writings, *Kant und die Epigonen* (1865), attempts to show that the successors of Kant all missed the way which he had clearly recognized and indicated. In an intensive criticism of the "idealistic," the "realistic" and the "empirical" tendencies of post-Kantian philosophy, Liebmann tries to point out that all these movements-the system of Fichte, Schelling and Hegel, as well as the systems of Herbart, Fries and Schopenhauer--suffer from a common fault. They all assign to the concept of the "absolute" or of the "thing-in-itself" a central place and make it the iundamental concept of metaphysics, whereas Kant's doctrine, if rightly understood and further developed, implies the very opposite, namely, that this concept is *a* nonconcept, that all cognition moves within the realm of mere relationships, but can never grasp or positively determine an "absolute."

Hermann **Cohen.**—However, it was only in Hermann Cohen (1842–1918) that neo-Kantianism reached its climax. In his three great works on Kant, *Kants Theorie der Erfahrung* (1871; 2nd ed., 1885), *Kants Begründung der Ethik* (1877; 2nd ed., 1910) and *Kants Begründung der Aesthetik* (1888), Cohen gave for the first time a critical interpretation of the entire Kantian system which, with all its penetration into the specific detail of Kant's fundamental doctrines, sets, nevertheless, one single systematic idea into the centre of the investigation. This idea is that of the "transcendental method."

From Friedrich Albert Lange, with whom Cohen was closely connected by ties oi personal friendship, Cohen diiiers especially in that he rejects any psychological interpretation of Kant's apriorism, any explanation of the a priori by the "psychophysical organization" of man.

In his study *Das Prinzip drr Infinitesimalmethode und seine Geschichte* (1883) he tries to prove that the concept of the "infinitely small," as it was established in the Leibnizian differential calculus and in the Newtonian calculus of "fluxions," is, at the same time, the indispensable and basic intellectual means for any scientific cognition of "reality." Reality is never "given" in any sense, neither in sensation nor in mere intuition, but it must be produced by means of pure thought. The various ways and directions in which thought moves in this "production oi the object" are the problems which logic has to trace. This idea iound its development in Cohen's main systematic work, the *Logik der reinen Erkenntnis* (1902; 2nd ed., 1914), to which were added, as a second and third part of his system of philosophy, the *Ethik des reinen Willens* (1904) and the *Aesthetik des reinen Gefühls* (1912).

Natorp.—In closest personal and scientific contact with Cohen, Paul Natorp (1854–1924) further pursued and carried out the fundamental methodical idea of "critical idealism." For him, too, the object of knowledge is not given in itself as a ready-made thing, but "becomes" only in the eternal process of knowing, in a constantly renewed production of objects. This process never lies completed before us, as a firm and final result, an "absolute" in the dogmatic-metaphysical meaning of the term; it is, however, possible to recognize the direction in which it moves, the general form of the production of the object. Natorp developed this main idea oi his theoretical philosophy especially in his study *Die logischen Grundlagen der exakten Wissenschaft* (1910) and in a more concentrated survey in the essay *Philosophic, ihr Problem und ihre Probleme* (1911). Of special importance, furthermore, is his *Allgemeine Psyrhologie nach kritischer Methode* (1912), which established an entirely new view of its aim and method and anticipated in decisive points Edmund Husserl's phenomenology.

Riehl.—Cohen's insistent reierence to the doctrine of Kant as the basis of all scientific philosophy and his account of the "transcendental" had a great effect even on thinkers who ultimately differed from Cohen in the conception of the critical system. Thus, ior instance, the main work of Alois Riehl, *Der philosophische Kritizismus und seine Bedeutung für die positive Wissenschaft* (1876, 1879, 1887), is in its first edition still under the influence oi Cohen's view of the transcendental.

Riehl, too, emphasizes that the question of the objective stock and the objective validity of knowledge should not be confounded nith the question of the formation of ideas within the subjective consciousness. Kant's decisive achievement, according to Riehl, consists just in this, that he distinguished clearly the two questions, the "transcendental" and the "psychological." that he separated the problem of the objective significance of knowledge from the genetic question of its derivation.

But this idealism of the general forms of pure intuition and pure understanding constitutes, according to Riehl, only one phase of the Kantian doctrine. which has its counterpart in another equally legitimate and equally indispensable one. For the particulars of experience, the definite spatial and temporal order of empirical phenomena, as well as the specific causal laws subsisting between them, are never to be deduced from those general forms. Here we find ourselves necessarily referred to that other factor which Kant called the "material" factor of knowledge. The concepts of understanding as well as the pure iorms of space and time give only the universal and necessary form of experienced reality, while its content can never be given to us otherwise than through sensation, through immediate sense perception. Thus the latter forms the specific and indispensable basis of our conriction regarding the reality of things.

Riehl characterizes this view as "critical realism" and sees in it the specific kernel oi Kant's teaching. "For the specific and definite iorms of things as given in empirical intuition, that is. the position, shape, size, the definite and determinate duration and sequence of things, there must be, according to the explicit teaching of Kant, a source in the things themselves. For they cannot be derived irom the universal form of intuition which originates solely in the mentality of the subject. . . . The things-in-themselves, with their proportions as expressed in the specific forms oi intuition and the empirical laws of nature, are for Kant a presupposition just as essential as the a priori elements of cognition. The necessary combination of both, their union in experience, is the upshot of his teaching. Our knowledge of things is a mediate cognition of the things themselves through the appearances of the things to our senses."

The Positivistic View.—Among all the thinkers of the Neo-Kantian movement, Kiehl is the one who is most strongly inlluenced by the positivistic view of the nature and the task of philosophy. Scientific philosophy is for him almost synonymous with pure epistemology and the methodology of the special sciences.

Hence, there remains no special field of study reserved as its proper domain; rather it is merely the texture and the logical structure of knowledge, of scirnce itself, with which philosophic reflection can be concerned. However, through this confinement of philosophy to the pure science of knowledge, Kiehl ends by allowing the theory of values to fall out of it entirely.

To be sure, Kiehl admits that there must be a "teleology of human life" for which mere knowledge of nature is not sufficient; but he himself did not study systematically the problems of this teleology. especially the ethical and aesthetic problems and the philosophy of history; he touched upon them only occasionally. "Views of the world" — so he declares explicitly—-are not a matter of mere understanding; and they are for that reason subjective in the main; they do not belong to science but faith. This separation of knowledge irom iaith carried with it the danger that scientific value was attributed to natural knowledge exclusively, while the pure sciences of the mind, the sciences of the historical reality of man's mental achievements, were deprived of their specific methodical foundation.

Windelband and **Rickert.**—Here lies the problem from which started that tendency of Neo-Kantianism which was founded by Wilhelm Windelband and carried on by Heinrich Kickert. The epochal works of Wilhclm Dilthey (1833–1912) had led the attention of 19th-century German philosophy back to the ioundations of the historical world in the sciences of the mind. In trying to present, and to solve, this problem in the spirit of the strictly critical philosophy. it was first of all necessary to draw a sharp line between the iorm of science exemplified by history and that represented by natural science.

This is the task which Windelband sets himself in his address *Geschichte und Naturwissenschaft*. The pure "sciences of laws" are here contrasted with the "sciences of events," the "nomothetic" procedure of natural science with the "ideographic" procedure of history. Kickert elaborates this distinction in his work *Die Grenzen der naturwissenschaftlichen Begriffsbildung,* which he calls a logical introduction to the historical sciences (1896–1902; 2nd ed., 1913). In this justification, the isolated place which the pure science of knowledge had received with Kiehl is abolished.

For Windelband and Kickert the theory of knowledge, too. is included in the group of the sciences of values, because it is a science of "oughts," oi the universally valid norms of truth. In this respect, it stands on the same level as the other studies of values, especially with ethics and aesthetics. Philosophy, as a general theory of values, as the science of the "consciousness oi norms," is essentially a philosophy of culture. Its task may be said to consist in establishing a connection between the realm of "reality" and the realm of values. It is only the concept of value that makes history possible as a science, for only through the values attached to culture can we obtain a definite principle of selection within the infinite maniiold of the historical facts, and thus establish the conception of a historical individuality which is capable of description. Thus the Neo-Kantian movement has gradually encircled the total orbit of knowledge by trying to advance more and more irom the general principles of knowledge to the specific content of mental culture. (E. Cr.)

NEOLITHIC.

In 1865 'Sir John Lubbock, in describing cultural evolution, termed "Neolithic" those remains of prehistoric man that included stone tools shaped by polishing and that appeared in the archaeological record before the beginning of metal, or the Bronze Age. He thus distinguished the Neolithic from the Paleolithic or age of chipped stone that preceded. Since Lubbock's definition, the term Neolithic has taken on many additional meanings and there is no consensus in the use of the word. Three criteria are most often included in definitions. Neolithic archaeological assemblages are those having (1) polished stone tools; (2) pottery; and (3) agriculture and/or domestication of animals.

These criteria and combinations of them are used in specific ways by specialists who work in certain restricted areas. Thus in Europe, Neolithic usually means that the prehistoric people had polished stone hoes and axes and had an economy based on agriculture supplemented by hunting and sometimes fishing. Some groups had permanent villages whereas others regularly moved to new farm land. Extensive trade in luxury items such as amber and sea shells was prevalent. By contrast, workers in western U.S.S.R. call assemblages Neolithic when they contain no metal but do have pottery. The people lived by hunting and fishing very much as people had done in the Paleolithic. Again. by contrast, in the Americas the term Neolithic is rarely used when referring to the indigenous cultures even though they may satisfy all three criteria.

One can assign no specific time to all archaeological assemblages that might be called Neolithic. To use one criterion, for example. agriculture had begun by 7000 B.C. in the near east while Europe was "Mesolithic" (*q.v.*) and did not reach Europe in force until 3000 B.C. In the near east by 3000 B.C. urban civilizations had begun and these archaeological assemblages are no longer referred to as Neolithic. In many parts of the world agriculture replaced a hunting economy only in the last few centuries.

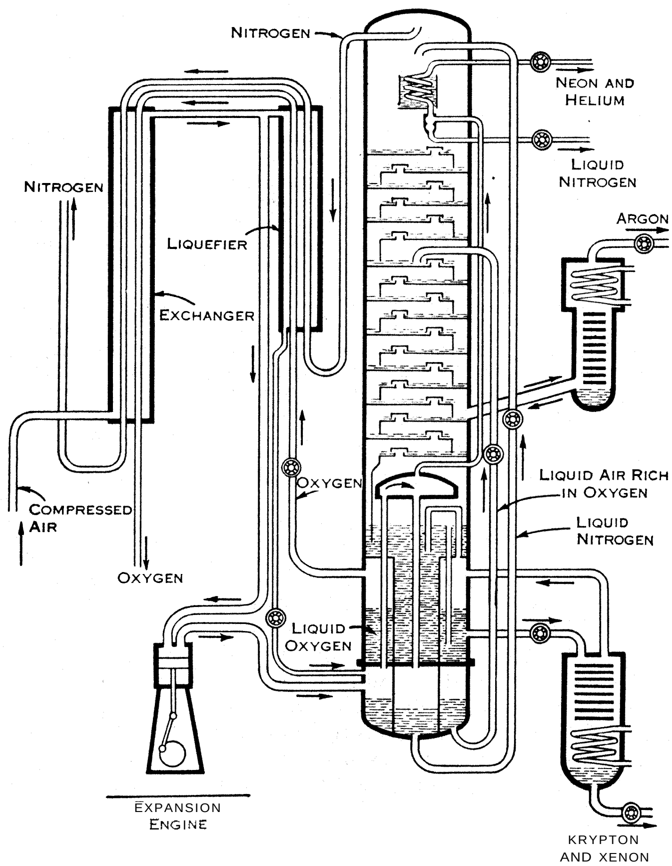
Without careful definition the use of the term Neolithic is misleading. Since Lubbock's time archaeologists have discovered that man's prehistory is too complicated to be described by single terms describing unilinear evolution.

See also Index references under "Neolithic" in the Index volume.

(F. A. HE).

NEON is a rare inert gas of the atmosphere (*q.v.*) represented by the symbol Ne. It is the second member of the helium family of elements, composed of helium, neon, argon, krypton, xenon and radon, which comprises Group zero of the periodic system.

Neon is used in a variety of lamps and other electrical devices which take advantage of its unusually high electrical cohductivity and light-emissive power. The brilliant orange-red light emitted from "neon tubes" in which an electrical discharge passes through



FROM METZGER IN "INDUSTRIAL & ENGINEERING CHEMISTRY"

EQUIPMENT FOR THE FRACTIONAL DISTILLATION OF LIQUID AIR TO ISOLATE NEON AND OTHER GASES OF THE ATMOSPHERE

the gas under a pressure of a few millimetres of mercury first became a familiar sight in the 1920s. Most gaseous conduction lamps and fluorescent lamps contain neon as a component of the gaseous mixture which carries the electricity. Other neon-tube devices include lightning arresters, high-voltage testers and negative glow lamps. The latter can be built with electrodes in the form of figures or letters suitable for display purposes.

Neon has an atomic number of 10 and an atomic weight of 20.183. Its stable isotopes, listed in order of decreasing abundance, have mass numbers of 20, 22 and 21. Short-lived radioactive isotopes of mass numbers 18, 19. 23 and 24 have been reported. Electrons of the atom occupy and fill the K and L ($2s^2$, $2p^6$) shells.

The element was discovered in 1898 by Sir William Ramsay and M. W. Travers as a component of the most volatile fraction of liquefied crude argon obtained from air and was given a name meaning "the new one."

Neon is widely distributed in nature and occurs in traces not only in the atmosphere but also in gases trapped within the earth. The content in dry air is close to 0.0018% by volume. Industrial production of the element is accomplished by fractional distillation of air using equipment such as that shown in the figure. The most volatile fraction taken from such a still is composed of helium, neon and nitrogen. The latter gas is removed by chemical absorption and the neon is then separated from helium by selective adsorption on activated charcoal at low temperature.

The following physical constants have been selected from technical literature, most of the values being taken from a table critically compiled by F. P. Gross: density of the gas at 1 atm. pressure and 0° C., 0.8999 g. per litre; density of the liquid at its boiling point, 1.204 g. per millilitre; normal boiling point, −246.09° C.; freezing point, −248.61° C.; critical temperature, −228.75° C.; critical pressure, 26.86 atm.; heat of vaporization at the normal boiling point, 20.8 cal. per gram; heat of fusion, per gram, 3.97 cal.; ionization potential for first electron, 21.5 v.; solubility in water (neon at 1 atm. pressure) at 25° C., 0.0101 ml. (measured at 1 atm. pressure and 0° C.) per millilitre of water; at 15° C.. 0.0108 ml. of neon per millilitre of water. Since the ratio of the specific heat of the gas at constant pressure to that at constant volume is 1.642, it may be concluded that a single atom of the element comprises a molecule.

Neon forms no stable chemical compounds and appears to attract other atoms only by the relatively weak interatomic action known as van der Waals forces. Procedures for the analytical determination of neon provide for measuring the gas after it has been isolated by chemical absorption of reactive gases on hot calcium or other reagent and separation of helium, argon, krypton and xenon by physical means. Such a physical separation is usually accomplished by fractional desorption from cold activated charcoal or by diffusion (of helium) through hot quartz. The element is recognized by its characteristic spectrum which contains many beautiful red lines.

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(*G.* H. CA.; X.)

NEO-ORTHODOXY is the American name for a theological movement known in Europe as Crisis Theology and as Dialectical Theology. Of these three names, perhaps Crisis Theology is the most appropriate, because the movement began as and remains a Protestant response to the crisis of Christendom after World War I. Two world wars in the 20th century, the rise of totalitarian regimes, the decline of Christian humanism in western culture, together with a premonition of disasters yet to come, led to the view that Christendom is under divine judgment and at the parting of ways; that is, in a state of crisis The phrase Dialectical Theology refers to the preference of the theologians under consideration for stating their insights in terms of paradox; for instance, that the Bible is the Word of God to man and man's words about God, or that man is at once creature and sinner, good as creature and evil as sinner. Apparently contradictory statements are made in the interests of "truth" so as to suggest both the mystery of human life and the limits of human thought. According to this theology, this is the only proper way to speak about God and man. The meaning of Neo-orthodoxy will appear in the rest of this article.

The origins of Neo-orthodoxy, as of existentialism in philosophy, are usually traced to Soren Kierkegaard (1813–55), who saw the western culture of his day, including its religious institutions, as destructive of humanity. He wrote against objectivity as lacking in seriousness and declared, especially against Hegel and orthodoxy, that "truth is subjectivity." Friedrich Nietzsche, who attacked Christendom as having lost its soul and cried out "God is dead," and Fëdor Dostoevski, who in his novels celebrated the freedom of man as well as uncovering his bondage, both came to make a prophetic impression upon European thought. The anti-idealistic and antiscientific writings of existentialist writers such as Karl Jaspers and Martin Heidegger must also be kept in mind. Further, the Marxist criticism of capitalism exerted considerable influence upon Neo-orthodoxy, and so did depth psychology. In short, Neo-orthodoxy was occasioned by the spiritual shock experienced by the European mind under the impact of the 20th-century age of anxiety and commotion.

Neo-orthodoxy first responded to the age with a negative judgment upon it. In *The Theology of Crisis,* a series of lectures given in the U.S. in 1928, Emil Brunner repudiated modern European culture by attacking idealism, scientism, rationalism, evolutionism, romanticism, immanentism and liberalism. What he saw in all this was man's pride and self-deification which he regarded as at the root of all evil in the modern world. Man had repudiated his finitude and responsibility before the God of the Bible. He had thus put himself in a fundamentally false position, and lived and acted on the basis of a lie which could not but be, as it was, his undoing.

In the same year a series of essays by Karl Barth appeared in English under the title *The Word of God and the Word of Man.* These essays, written between 1916 and 1923, are built upon the contrasts between the righteousness of God and the righteousness of man, the Bible and western culture, the preaching of the gospel and the preaching of religion. At every turn the discontinuity between God and man is set forth and it is made clear that unless Christendom once again listens to the biblical word of God addressed to it from beyond its religion, philosophy and ethics, it is lost.

The same theme was worked out by Barth in *The Epistle to the Romans* (1918, 1921 *et seq.*, trans. from the 6th ed. by Edwyn C. Hoskyns, 1933), which made a profound impression upon Protestant thought in Europe. Here Barth took up Kierkegaard's theme of "the infinite qualitative difference" between God and man. and declared that there is no way from man to God. Me wrote of God's self-revelation in judgment and mercy, and called the church to repentance. However, this early writing of Barth was inspired in the main by a vision of the collapse of European culture.

The Epistle to the Romans led Christian thinkers, above all Barth himself, to re-examine the Bible and the faith of the Christian church. Men's eyes were opened to the "strange new world within the Bible" and to the hardly less strange theologies of the Protestant Reformation with their doctrines of justification by faith alone and God's sovereignty over His creation. They began to speak and write seriously of God who is not man and of the word of God to man, of Jesus Christ the Lord, of revelation and faith. The outcome of the process was the rediscovery of theology itself as an intellectual activity growing out of the church's concern with its faith and obedience in Jesus Christ.

In 1932 Reinhold Niebuhr published his *Moral Man and Immoral Society.* This book marks the beginning of Neo-orthodoxy in the United States. It administered a telling blow at a Christianity whose "gospel of love" had made it inept in dealing with the realities of political life in which coercion is a constant and operative factor. Niebuhr struck at idealism, rationalism, optimism and the like, and argued that the amoral and immoral character of nations and classes requires justice through the use of force as well as through religion and enlightenment. He began to speak forcefully about sin and repentance, and insisted that Christianity is above all a critical principle which brings western culture under the judgment of God. Gradually Niebuhr turned to the Bible and to Augustinian theology for insight into "human nature and destiny," and elaborated his views in a number of books as well as innumerable articles which constitute the chief body of Neo-orthodox writing in America. Niebuhr's competence as a political observer gave unusual authority to his theology which he elaborated in constant debate with secular culture.

Other important Neo-orthodox theologians include Friedrich Gogarten, who collaborated with Karl Barth in the early years of the movement; Rudolf Eultmann, who combined Crisis Theology with the existentialism of Heidegger; H. Richard Niebuhr, who made important contributions to the study of Christianity and culture; Nikolai Rerdyaev, who was at once a radical critic of western culture and the author of numerous works in which he elaborated a personalism of his own as against "objectivity" in western philosophy; and Paul Tillich, who criticized the dominance of "technical reason" in modern society and elaborated a "philosophical theology" in which "depth of reason" and faith entered into a much debated alliance.

These theologians are called Neo-orthodox because they speak the traditional language of the Christian church as found in the Bible, the creeds and the main line of orthodox theology. They have written of the Trinity, the Creator, the fall of man and original sin, Jesus Christ the Lord and Saviour, justification, reconciliation and the Kingdom of God. The language is the language of orthodoxy but, as the orthodox were quick to see, the meaning of the language has undergone radical changes. The new theologians repudiated the literalism of later orthodoxy. According to them the world was not created in six days. There mas no man by the name of Adam who listened to a wife who listened to a serpent and thus sinned and plunged mankind into ruin. Jesus was not born of a virgin and He did not walk on water. The Bible itself was not written under the dictation of the Holy Spirit and it contains much that is not literally true. In short, the new theologians, assuming modern man's aversion to "physical miracles," refuse to go back to supernaturalism. In this they are modernists. The miracles of the Christian faith to them is Jesus Christ and His gospel proclaimed in the church for the salvation of the world.

To Neo-orthodoxy the controversy between science and religion, which occupied a prominent place in the 18th and 19th centuries, resulted from failure, on the part of both defenders and opponents of Christianity, to understand the nature of the Christian faith. It presents this nature as having to do with faithfulness to God and man in this world and not with opinion about the world in itself as envisioned by scientists.

Neo-orthodoxy in the main is concerned with the problems raised by modern culture and not by the modern sciences. On the other hand, scientism as an aspect of culture itself is subjected to radical criticism. Neo-orthodoxy does not deny the evolution of the species but it rejects evolutionism as an optimistic view of history having a dubious logical basis in biology. It does not repudiate the scientist's self-forgetfulness as a person when occupied with observation and experiment, but it rejects objectivity in human relations. It does not deny logic as integral to scientific explanation, but it rejects the kind of determinism that makes freedom in any sense illusory. Scientism is understood by the Neo-orthodox as incompatible with their fundamental thesis that man is a responsible being and that unless he is understood as such, he is not properly understood as a human being. Neo-orthodox polemics against science, reason, autonomy, with repeated charges of pride and self-idolatry against modern man, are directly or indirectly related to the conviction that modern culture, as largely dominated by science and "technical reason," has become blind to humanity itself as response to persons. In this way, as in others, Seo-orthodoxy is itself related to existentialism. It is also related to liberalism in its aversion to orthodox literalism and authoritarianism and in its humanistic concern for the dignity of persons in the machine age.

Neo-orthodox theology may well be regarded as a set of variations on the theme of man's existence as a responsible being.

1. God as the sovereign Other is the Person who places man under an inviolable responsibility. God transcends man as Creator and Redeemer, and therefore as the Source of responsibility which is neither in man nor in his world. God speaks His Word to man, and in this peculiarly personal act He lays His claim upon man and obligates him to respond to Him and thus to exist as a human being. He addresses man in His freedom and love as God, through the freedom and love of Jesus the man which constitute His humanity and illumine our own existence as fellow men.

2. Neo-orthodox preoccupation with Jesus Christ as the Son of God in whom the Father reveals Himself to man is understood most readily in the light of Christian humanism. It includes a polemic against natural theology, which argued from nature to God, and in doing this not only obscured God who speaks but also man who is contradistinguished from nature in that he exists in his response to God and to his fellow men. In singling out Jesus Christ as the self-revelation of God, Neo-orthodoxy also singled out man and his responsiveness and recognized a unique dignity in him.

This in part explains also the emphasis upon the humanity of Jesus which is characteristic of Neo-orthodoxy. In the responsibility of the man Jesus, man comes into his own as a person and a fellow man. Thus Jesus acts as the Word of God to man and as man who exists in hearing God's Word.

3. Jesus Christ is, according to this theology, the Word become flesh for our salvation. Therefore, it places a new and searching emphasis upon man the sinner. God reveals Himself in the freedom and love of Jesus, and in His forgiveness. But forgiveness reveals man's sin. Therefore, man knows God and himself as a sinner; without such knowledge he knows neither God nor himself. Man knows himself as a person only as he knows himself as a sinner under God's forgiveness. Thus, the knowledge of sin is an occasion for acknowledging at once "the misery and the grandeur of man," and it is integral to personal existence. It is the antidote both to despair and to pride, and to the degradation of human culture that follows upon these twin evils.

Sin for Neo-orthodoxy is the violation of persons as seen in contrast to the love of God in Jesus for sinners. It is man's rebellion against his limited life and powers which comes both before and after his repudiation of responsibility, which in turn is the sign of death both for the individual and for the community. From it come dehumanization and the consequent evils of egotism, stupidity and guilt, as well as the loneliness, the loss of the meaning, anxiety, enmity and cruelty which plague human life. The Neo-orthodox defend such a view of sin as biblical and in line with a realistic knowledge of the condition of man.

4. Neo-orthodox criticism of modern culture led its theologians to examine political and economic institutions with a new awareness of their significance for responsible human existence. In this they have been influenced both by Marxist criticism of western capitalism and by new insights into the influence of social institutions upon personal life and relations. These theologians argue that religion, ethics, economics and politics are aspects of a larger whole which is the culture of a society, and that they cannot be understood and dealt with separately. Therefore, they assume a peculiar responsibility to concern themselves with social institutions and problems and to take a "Christian" attitude toward the controversial issues of the day, such as Communism, race and nuclear weapons. There is no unanimity among them as to answers to these perplexing public problems, but they are one in seeing the Word as addressed to the total present human situation.

Neo-orthodoxy is a political theology. It is illumined by politics and is a response to it. But it seeks to interpret politics in terms of biblical and Reformation theology: in terms of creation, sin and reconciliation, of God's self-revelation in Jesus Christ.

5. Neo-orthodoxy, especially in its European form, lays new emphasis upon the doctrine of the church as the community of believers. The church is spoken of as the Household of God, the Realm of Redemption, the Body of Christ. This phase of Neo-orthodoxy has been especially evident in the World Council of Churches where the several non-Roman churches have debated the nature and the responsibility of the church. Much has been written to the effect that the church is the place where God realizes in the world His saving work of restoring man to his true nature as person in community. These discussions have been once again biblical and according to traditional theology, but their empirical validity is apparently in doubt. Much has also been written which is strongly critical of the churches and presents them as dim lights in the world. There is no certain method by which the churches might become a more palpable influence toward the recovery of humanity. Thus a link is missing between theology and politics; and this, on the presuppositions of Neo-orthodoxy, is a great problem.

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NEOPHYTE, a word used in the Eleusinian and other mysteries to designate the newly initiated, and in the early church applied to newly baptized persons. These usually wore the white garments they received at their admission to the church (see BAPTISM) from Easter eve till the Sunday after Easter, but they were subject to strict supervision for some time longer.

NEOPLATONISM is the name given by historians of ideas to the last school of Greek philosophy (the ancient philosophers who are generally classified as Keoplatonists called themselves simply "Platonists." as did the philosophers of the Renaissance and the 17th century whose ideas derive from ancient Neoplatonism). After a long preparatory development it was given definitive shape in the 3rd century A.D. by the one great philosophical and religious genius of the school, Plotinus (*q.v.*). From that time onward Neoplatonism dominated the thought of that dying ancient world within which the Byzantine and western Christian cultures were already coming to birth. Pagan Greek philosophy was Neoplatonist till it faded out in the 6th century A.D. Many of the greatest Christian thinkers of this period, the great formative period of Christian theology. were deeply influenced by Neoplatonism, as were later the great Moslem philosophers. The influence of Keoplatonism mediaeval thought was very great and has continued to influence men's minds. In modern times Neoplatonism was long despised and little understood; yet without some knowledge of this philosophy it is impossible to understand a great deal in the cultural tradition of Europe.

General Characteristics of Neoplatonism.—Neoplatonism began as an extremely complex philosophy and took varied forms in the course of its history, and it is therefore not altogether easy to generalize about it. But the leading ideas in the thought of philosophers who can properly be described as Keoplatonists seem always to include the following:

1. There is a hierarchy of reality, a plurality of spheres of being arranged in descending order. the last, lowest and least comprising that which exists in time and space, the being perceptible to the senses.

2. Each sphere of being is derived from its superior; this derivation is not a process in time or space.

3. Each derived being is established in its own reality by turning back toward its superior in a movement of contemplative desire, which is implicit in the original creative impulse of outgoing that it receives from its superior: so that the Neoplatonic universe is characterized by a double rhythm of outgoing to return. The movement of return is the most important, that which constitutes each level of reality.

4. Each sphere of being is an image or expression on a lower level of the sphere above it, and each individual reality an image or expression of a corresponding reality in the higher sphere. The relation of archetype and image runs through the whole of the Neoplatonic universe.

5. Degrees of being are also degrees of unity; in each subsequent sphere of being there is greater multiplicity, more separateness, increasing limitation of each reality till we arrive at the atomic individualization of the spatio-temporal world.

6. The supreme sphere of being, and so the whole of reality, is derived from a principle which as the source of all being cannot be described as being. "Being" to the Neoplatonist always means "being *x*," being this or that. Thus the inexhaustible source of being, which has no limitations, as it is not confined to being this or that but is in the fullest sense infinite, cannot be said to "be"; it is "beyond being" As it has no limitations, so it has no divisions, attributes or qualifications; it cannot really be named but may

be called "the one" to designate its complete simplicity or lack of determination. It may also be called "the good' as the source of all perfections and the ultimate goal of return For the impulse of outgoing to return that constitutes the hierarchy of derived reality is an impulse that comes from and leads hack to the good.

7. The knowledge of this supreme principle is radically different from any other kind of knowledge because the supreme principle is absolutely simple and undetermined: it is not an object (a separate. determined, limited thing) and no predicates can be applied to it. It can be known only if it raises the mind to an immediate contact or union with itself, which cannot be imagined, described or defined.

Origins.—Whether the beginnings of Neoplatonism can be traced back to Plato himself is a question vigorously discussed by modern scholars. As always in the study of Plato, it is difficult to arrive at any sort of certainty. What does seem to be certain is that ideas which can be found in passages of Plato's dialogues (whether interpreted or not as Plato meant them) or in the scanty and obscure accounts of his later oral teaching are the root ideas of Xeoplatonism. The most important are: (1) the basic Platonic doctrine of the two worlds. (*a*) the eternal and intelligible world and (*b*) the sense-world of time and change; (2) the idea that appears in one passage of Plato's *Republic* (509 B) that the principle of the eternal world, of the "forms" or "ideas" (see UNIVERSAL), is "the good . . . beyond being, surpassing it in dignity and power"; (3) the attempt made by Plato in his later teaching (about which very little is known) to derive the ideas by a logical-mathematical process irom ultimate principles, namely "the one" (perhaps identical with "the good") and "the indeterminate dyad"; (4) the doctrine of a supreme divine intelligence, the relation of which to the ideas is not clear, but which forms and rules the sense-world adcording to their eternal order; and (5) the position of soul, human and cosmic, as intermediary between the two worlds, eternal and temporal, belonging to and able to operate in both. It seems to be becoming fairly certain, too, that Plato's immediate pupils and successors, Speusippus and Xenocrates (*qq.v.*), took some steps farther on the road that leads to Neoplatonism. This is particularly true of Speusippus; in the scanty fragments that survive of his teaching we find a "one beyond being."

Yet the beginnings of the continuous development that led immediately to the philosophy of Plotinus cannot be traced back beyond about the 1st century B.C. At that time certain philosophers—notably the stoicizing Platonist Antiochus of Xscalon, who revived dogmatic teaching after a period of skepticism in the Platonic school (see ACADEMY, THE GREEK): and the great Stoic Poseidonius, who was deeply influenced by Plato—inaugurated a type of thought that is found embedded in the vast confused works of Philo (*q.v.*), an Alexandrian Jew of the 1st century A.D., and that was continued and developed into the 2nd century by the philosophers sometimes known as Middle Platonists and Neo-Pythagoreans, for instance Albinus, Atticus (c. 150–zoo), Plutarch of Chaeronea and Numenius of Apamea. The general characteristics of this revived Platonic or Pythagorean philosophy are the recognition of a hierarchy of divine principles and the stressing of the remoteness and transcendence of the supreme principle, which is sometimes called "the one"; the placing of the Platonic ideas in the divine mind; a strongly other-worldly attitude and a stressing of the necessity of the "flight from the body," the ascent of the mind to the divine and eternal; and a preoccupation with the problem of the origin of evil in this lower world, which is sometimes attributed to an evil world-soul (*e.g.*, by Plutarch) and sometimes to matter (by Numenius). Thus it obviously approaches very closely to the fully developed Xeoplatonism of Plotinus, who worked out his own in some ways profoundly original philosophy on the basis of this already existing tradition.

Plotinus.—The history of Neoplatonism must he held to begin with Ammonius Saccas, the master of Plotinus, who was teaching in Alexandria in 232, when Plotinus came to him. But Ammonius wrote nothing and we know next to nothing of his teaching. So it is to the Enneads of his great pupil Plotinus (*q.v.*) that we must turn for our first evidence of authentic Neoplatonism. The Enneads are the primary document of the school, the foundation on which all later developments are built, and at the same time represent the summit of Neoplatonism's philosophical and religious achievement. In them may be seen the great leading ideas mentioned above in their strongest and simplest form.

The hierarchy of reality. in Plotinus, consists of only two great principles below the ineffable source (the One or the Good). The first of these two principles is intellect (*nous*), the divine mind which is identical with the totality of Platonic forms or ideas; it is the level of purely intuitive thought. immediate grasp of reality. which on the principles of Aristotelian psychology is identical with its object and so at once perfect intelligence and true reality. the cause of all less real derived beings. The individual realities in it (and there are forms of individuals as well as universals. and each one of us has his archetype in the world of intellect) are at once forms and living minds which think and so, each in their own way, are the whole as well as parts. The second great principle is soul, which extends from the frontiers of the world of intellect to the last and lowest realities, the forms of material bodies. The chararteristic of the life of soul is discursive reasoning, which proceeds irom premisses to conclusions and does not immediately possess its object but strives to attain it. This restless rational movement of soul is the origin of time; intellect is beyond time in changeless eternity. Yet soul seems able to pass beyond rational-discursive thinking in both directions. On the one hand it can reach up into intellect, be fully illuminated and perfectly conformed to it and then ascend to the One; on the other hand the whole material universe is within the sphere of soul and is not only ruled but formed and animated by it. so that soul has a lower, immanent. unthinking activity that extends beyond even the limits of the organic, down to the forms of the lowest material things, as far as it is possible to go into the darkness of matter. No material thing can exist without a share in soul.

Thus I'lotinus' view of reality. though hierarchic, is not complicated. The great realities. intellect and soul, have different aspects and many (though not infinitely many) members—and different levels on which those members can live. But Plotinus always maintains their essential unity, so as to keep close to the Platonic tradition as he received it and to his own philosophical experience. Moreover, the whole of his universe is open to and filled with the power of its first principle, the One or the Good beyond being. None of the realities that derive from it is cut off or separated from the One; it is immediately present to all of them according to the capacity of each to receive it.

The sole object of the good and wise man, the supreme goal of human endeavour, is to return to the Good and be united to it in the union of love which is beyond and above the contemplation of intellect, by the power coming from the Good. the impulse of return which is constitutive of his very being. First he must detach himself from the worldly desires and concerns of his lower self, the composite being of body and soul, by rigorous intellectual and moral discipline, inspired always by love and helped on his way at first by contemplation of the beauty of the world of the senses—which, rightly contemplated, will lead him back to the intelligible beauty of which it is a reflection. As he becomes perfect in intelligence and virtue (for Plotinus the two kinds of perfection are inseparable), the philosopher will rediscover his true and eternal self, which is intellect, or rather soul perfectly conformed to intellect, and wake to its life. Then he is ready to go on to the One when the One manifests itself and brings him to union.

Plotinus' philosophy. then, is not only theory but practice (a practice admirably exemplified in his own life). It is the union of theory and practice, of powerful metaphysical thinking with the continual stimulation to remember our true nature and return to our source. This accounts for its perennial power and attractiveness.

Porphyry and **Iamblichus.**—Plotinus' pupils were not of the same intellectual stature as their master, and in them can be seen the beginnings of the tendencies that were to become dominant with Iamblichus and that produced a considerable alteration for the worse in Xeoplatonism. Very little is known about Xmelius, the senior member of the school. External religious practice. the observation of feasts and sacrifices, was important to him as it was not to Plotinus, whose religion was entirely interior. In this Amelius points the way to later Keoplatonism; and he seems also to have begun the process of splitting up the levels of reality that was to lead to such fantastic complications later, by dividing the intellect of Plotinus into three. Of Porphyry (*q.v.*), the biographer and editor of Plotinus, a good deal more is known; a number of his writings survive. He kept in most ways very close to the teachings of his master, but he was more interested in the details of practical asceticism, notably vegetarianism, on which he wrote a treatise. He was also a good deal more interested than Plotinus in the *daemones,* spirits intermediate between gods and men in whom Plotinus, as well as all ancient Platonists, believed, but who play no important part in his thought. Porphyry made evil *daemones* responsible for everything that was most repulsive and immoral in the practices of popular paganism, of which he strongly disapproved. He carried on the tradition inaugurated by Plotinus of polemic against the non-Hellenic religions that were steadily gaining influence, Gnosticism and orthodox Christianity. Plotinus himself, and his pupils in his lifetime, had written against Gnosticism, and Porphyry wrote 15 books *Against the Christians.* The work was destroyed by the Christian authorities in the 5th century, but quotations from it in Christian polemical writings allow us to suppose that it was the most powerful and intelligent of all pagan attacks on Christianity. Porphyry's hostility to popular paganism and non-Hellenic religion apparently did not extend, however, to pagan theosophy. He seems to have been the first philosopher to take seriously a theosophical farrago called the *Chaldaean Oracles,* composed late in the 2nd century A.D. by one Julian the Theurgist, which enjoyed unbounded authority among the later Neoplatonists, with most unfortunate results. But on the whole Porphyry remained reasonably close to the teaching of Plotinus, and his chief importance is as the disseminator and popularizer of Plotinian philosophy.

It was Porphyry's pupil Iamblichus (*q.v.*) who more than anyone else was responsible for the type of later Keoplatonism found in the schools of Athens and of Pergamum. Iamblichus, who died *c.* A.D. 330, moved back in later life from Rome, where Plotinus had established his school, to his native Syria; and from his time onward the chief centres of Keoplatonism were in the eastern half of the Roman empire—in Syria and at Athens, at Alexandria and at Pergamum. On the purely philosophical side, a distinctive characteristic of this Xeoplatonism of Iamblichus (which continued to mark its later developments in the Athenian and Pergamene schools) was the tendency to multiply entities and to split up the levels of reality so that the hierarchic chain of being became continually longer and more complicated. Plotinus' hierarchic universe, as we have seen, was relatively simple and close to his own philosophic experience. He was content to allow ideas that might seem, on a superficial or too narrowly logical view, to be inconsistent to coexist in his reticent statements pointing us toward the ineffable source of being, the One or Good; and his great derived realities, intellect and soul, are rich, complex and many-sided. Plotinus, in short, though by no means a muddled thinker, would not seek clarity at the expense of truth. Iamblichus and his successors, while they were certainly anxious not to leave out any of the truth, also pursued perfect clarity and verbal coherence, at the price of no matter how many distinctions, with a fanatical unbalance characteristic of closed philosophical schools engaged in minute comment upon the works of established authorities. The basic assumption underlying their elaborations seems to be that the structure of reality corresponds so exactly to the way in which a late Greek philosopher's mind works that there is a separate real entity corresponding to every distinction that the mind can make.

Another characteristic of Iamblichean Neoplatonism adds considerably to its complications; viz., the apologetic motive, the desire to defend what Neoplatonists regarded as the true Hellenic tradition against its great (and now politically victorious) adversary Christianity. This motive, which had not been absent, as we have seen, from the school of Plotinus, soon became so strong that Iamhlichus and his successors set out to construct a complete pagan theology.. This means that they had to find a place in their system for every supernatural being in whom the pagans of the later Roman empire believed and, in particular, for all those mentioned by that very dubious authority for which Porphyry had opened a way into the school, the *Chaldaean Oracles.* This work, indeed, now became a sort of inspired scripture, along with the dialogues of Plato (into which a remarkable amount of late pagan theology was read by vigorous allegorical interpretation). With this complicated theologizing and under the influence of the *Chaldaean Oracles,* there came into Neoplatonism the practice of theurgy, to which Iamblichus and most of his Athenian and Pergamene successors were enthusiastically addicted. Theurgy was a sort of higher magic aimed at producing an external communion with the gods. This was done sometimes by animating images, filling them with divine power by well-established Greco-Egyptian magical procedures; and sometimes by inducing the gods to possess a medium and even to give visible manifestations of their presence, in ways strikingly reminiscent of modern spiritualism. This kind of thing mas utterly alien to the spirit of Plotinus, who was certainly not a magician or a theurgist, though he was once persuaded to attend a theurgic séance (*see* Porphyry's *Life of Plotinus,* ch. 10); and Porphyry likewise, though he was persuaded by the *Chaldaean Oracles* to admit to some extent the real efficacy of theurgy, yet regarded it as a dangerous and dubious practice, useful at best to purify the lower part of the soul but quite unable to bring the true self to that union with God which he, as a true follower of Plotinus, regarded as the ultimate goal. From Iamblichus onward. however, most of the leading Neoplatonists were practising theurgists.

The Pergamene School.—The Pergamene school of Neoplatonism was founded by Aedesius, a pupil of Iamblichus; and the Pergamenes in general were, if anything, more wholeheartedly devoted to religious magic than the Athenians (though we hear of a strong protest against theurgy from Aedesius' pupil Eusebius of Myndus). Their most spectacular theurgist, Maximus of Smyrna, was the chosen master of the emperor Julian (*q.v.*), who was converted from Christianity to Neoplatonism in its most superstitious and fantastic form and in whose short-lived pagan revival theurgists, Maximus himself and Chrysanthius, played an important part.

The conversion of Julian, in fact, was the great achievement of the Pergamene school; his surviving writings are not of much importance philosophically, but they give a vivid idea of the religious spirit and outlook of Iamblichean Neoplatonism and its devotion to uhat it believed to be the ancient Hellenic tradition. Julian's death in 363 (after a reign of less than two years) and the restoration of Christianity as the state religion brought the Pergamene school to an end.

The Athenian School.—By the beginning of the 5th century the ancient school of Plato in Athens, the Academy, had become Neoplatonist; and there pagan Neoplatonism after the manner of Iamblichus survived nearly two centuries more under the Christian empire. The first outstanding teachers of this Neoplatonist Academy of whom we know were Plutarch of Athens and Syrianus; but far more important, at least for later generations, is Proclus (*q.v.;* 410–485), the great "scholastic" of Neoplatonism, who gathered and preserved in his voluminous works for such of posterity as might have the strength to read them every detail of Iamblichean philosophy as elaborated by his predecessors and by himself. The influence of his writings on Byzantine, Arabic and medieval Latin thinkers was considerable. After him a dim line of Platonic successors leads finally to Damascius (*q.v.*) and to the closing of the school by Justinian in 529.

The School of Alexandria.— Later Neoplatonism, however, was not all Iamblichean elaboration and theurgy. Its exponents did not quite forget the authentic mystical doctrine of Plotinus, and the ideal of union with the One remained at least as a remote aspiration. In Athens, Proclus expounded the "negative theology" very adequately; and Damascius comes, at the beginning at least of his monstrous theological treatise, very close to the spirit of Plotinus. In Alexandria, moreover, a school developed in which little trace can be found of the influence of Iamblichus. The Alexandrian Neoplatonists were not given to metaphysical elaboration or addicted to theurgy. They were, first and foremost, scholars, learned commentators on the great philosophers of the past. and it is interesting to observe that they studied the works of Aristotle quite as much as those of Plato. In this they were following a tendency present in Neoplatonism from the beginning. There was already a very large Aristotelian element in the thought of Plotinus, though his own attitude toward Aristotle was generally critical; he had a low opinion of the philosophical importance of Aristotelian logic, though he admitted that it might have some usefulness as a preliminary study for the philosopher. Porphyry, however, was a good deal more Aristotelian (in this he was following a tradition already well established in the school—just as Plotinus' critical attitude shows the influence of an anti-Aristotelian tendency which appears in some Middle Platonists, notably Atticus) and, in particular, took Aristotle's logic very seriously. The great series of Neoplatonist commentaries on the *Organon* that was continued by the Alexandrian school was inaugurated by Porphyry's commentaries on the logical works and *Introduction to* the *Categories*—which furthermore were to play an important part in the development of medieval logic. It should be noted here that the greatest of the Neoplatonist Aristotelian commentators, Simplicius, though he was a member of the Athenian school, had been a pupil of the Alexandrian Ammonius Hermiae and is closer in spirit to his Alexandrian master than to his Athenian master Damascius.

The scholarly outlook of the Alexandrians and their lack of enthusiasm for the elaborate pagan theology and theurgy of the followers of Iamblichus made them much less hostile to Christianity than the Athenians (in spite of the murder of Hypatia by the Christian mob in 415). In the 6th century the commentator John Philoponus (*q.v.*) was converted to Christianity; and several of his contemporaries in the last generation of Alexandrian commentators, the pupils, like Simplicius, of Ammonius Hermiae, were Christians. Finally, in the 7th century, the last-known Alexandrian scholar, Stephanus, who was a Christian, was called to teach in the University of Constantinople under Heraclius. Stephanus forms one of the most important links in the chain of transmission of Platonism to the Byzantine middle ages.

Neoplatonism and the Christian Tradition.—In the Latin west there was no organized school of philosophy after Porphyry, but such philosophy as there was was Neoplatonist, and Neoplatonist in the manner of Plotinus and Porphyry rather than of Iamblichus. The Latin Neoplatonists included several people who, though not very original or important thinkers, had a considerable influence on western medieval thought. Some were pagans of a mild, scholarly and antiquarian sort; for instance, Macrobius (fl. *c.* 400) and Martianus Capella (early in the 5th century). Others were Christians; for instance, Chalcidius, the 4th-century commentator on Plato's *Timaeus* (he was really more a belated Middle Platonist than a Neoplatonist), and his contemporary the great convert rhetorician, translator and Christian Plotinian theologian Gaius Marius Victorinus (*q.v.*), whose works and example influenced St. Augustine. More important than these was the noble Boethius (*q.v.*), scholar, statesman, philosopher and theologian, who was executed by Theodoric in 524. His logical commentaries on Aristotle and Porphyry transmitted much of the learning of the Alexandrians in this field to the medieval west, and the influence of the book he wrote in prison, *On the Consolation of Philosophy*, was still deeper and wider. It was one of the books most read in the middle ages. King Alfred translated it into Old English.

But the most important achievement of Latin Neoplatonism was to bring the works of Plotinus and Porphyry to the notice of St. Augustine. He has told us himself in his *Confessions* how deeply they influenced him. Augustine had too great and original a mind simply to be labeled a "Christian Neoplatonist"; but it was through his writings more than through any other intermediary that something of the spirit and outlook of Plotinus was transmitted to the Latin middle ages.

In the east the great Cappadocian theologians, St. Basil and St. Gregory of Nyssa, read Plotinus and show some signs of his influence as well as of that of his great Christian contemporary Origen, whose thought sometimes shows striking parallels with that of Plotinus, perhaps due to the teaching of their common master Ammonius Saccas (if it really was the same Ammonius). Like St. Augustine, the Cappadocians are original thinkers and not merely servile copyists, and like him, too, they are Christians first and Platonists very much second; hut through them also something of Plotinus passed into the theological tradition of the eastern and eventually of the western church.

Neoplatonic ideas also came into the Christian Theological tradition through that most successful of pseudonymous writers "Dionysius the Areopagite," who expounded Christian mystical theology in the terminology and using some of the ideas of Proclus c. A.D. 500 and whose writings, with all the authority of their supposed author, St. Paul's Athenian convert, behind them, had an extraordinary influence both in the east and in the west. It was this influence of a diffused, diluted and transformed Neoplatonism in traditional Christian theology that was the most historically important part of the Neoplatonic contribution to European thought and culture.

This Neoplatonic influence can be detected in many places, not only in theology, in metaphysics. in logic and in moral philosophy but also in the early history of European science and of medieval and Renaissance art. From the 12th century onward it was reinforced in the west by the medieval Latin translations of Proclus and of the great Arabic philosophers who owed much to Neoplatonism; and from the 16th century onward the Greek texts of the writings of the Neoplatonist philosophers themselves became available in the west again (they had never been quite forgotten in Byzantium). But though the influence of these, and especially of the works of Plotinus, on those who read them has always been deep and lasting, the number of those who read them, even in translation, has been and probably always will be few; post-Renaissance Neoplatonism based on the original texts has been confined to select individuals and groups, of which one of the most important and attractive was that of the English Neoplatonists of the Cambridge school in the 17th century (*see* CAMBRIDGE PLATONISTS).

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See further the special bibliographies appended to the articles in this encyclopaedia on the individual philosophers cited in the text.

(A. H. AG.)

NEOPTOLEMUS (also called PYRRHUS), in Greek legend, the son of Achilles (*q.v.*) and Deïdameia. He was brought up by his grandfather Lycomedes in the island of Scyros, and taken to Troy in the last year of the war by Odysseus, since Helenus had declared that the city could not be captured without the aid of a descendant of Aeacus. He distinguished himself by his valour and took part in the capture, slaying Priam. He was the ancestor of the Molossian kings, who therefore claimed to be of pure Hellenic stock. He was murdered by Qrestes at Delphi, where he was buried, and a festival held in his honour every 8th year.

NEOPYTHAGOREANISM, a Graeco-Alexandrian school of philosophy, which became prominent in the 1st century A.D. Very little is known about the members of this school, and there has been much discussion as to whether the Pythagorean literature which was widely published at the time in Alexandria was the original work of 1st-century writers or merely reproductions of and commentaries on the older Pythagorean writings. The only well-known members of the school were Apollonius of Tyana and Moderatus of Gades. In the previous century Cicero's learned friend P. Nigidius Figulus (d. 45 B.C.) had made an attempt to revive Pythagorean doctrines, but he cannot be described as a member of the school. Further, it is necessary to distinguish from the Neopythagoreans a number of Eclectic Platonists, who, during the 1st century of our era, maintained views which had a similar tendency (*e.g.* Apuleius of Madaura, Plutarch of Chaeronea and, later, Numenius of Apamea).

Neopythagoreanism was the first product of an age in which abstract philosophy had begun to pall. The Stoics discovered that their "perfect man" was not to be found in the luxurious, often morbid society of the Graeco-Roman world; that something more than dialectic ethics was needed to reawaken a sense of responsibility. A degenerate society cared nothing for syllogisms grown threadbare by repetition. Neopythagoreanism was an attempt to introduce a religious element into pagan philosophy in place of what had come to be regarded as an arid formalism. The founders of the school sought to invest their doctrines with the halo of tradition by ascribing them to Pythagoras and Plato, and there is no reason to accuse them of insincerity. They went back to the later period of Plato's thought, the period when Plato endeavoured to combine his doctrine of Ideas with the Pythagorean number theory, and identified the good with the *one*, the source of the duality of the infinite and the measured (τὸ ἄπειρον and πέρας) with the resultant scale of realities from the *one* down to the objects of the material world. They emphasized the fundamental distinction between the soul and the body. God must be worshipped spiritually by prayer and the mill to be good, not in outward action. The soul must be freed from its material surrounding. the "muddy vesture of decay." by an ascetic habit of life. Bodily pleasures and all sensuous impulses must be abandoned as detrimental to the spiritual purity of the soul. God is the principle of good, matter the groundwork of evil. In this system we distinguish not only the asceticism of Pythagoras and the later mysticism of Plato. hut also the influence of the Orphic mysteries and of oriental philosophy. The Ideas of Plato are no longer self-subsistent entities; they are the elements which constitute the content of spiritual activity. The soul is no longer an appanage of *οὐσία*, it is *οὐσία* itself; the nonmaterial universe is regarded as the sphere of mind or spirit.

Thus Keopythagoreanism is a link in the chain between the old and the new in pagan philosophy. It connects the teaching of Plato with the doctrines of Neoplatonism and brings it into line with the later Stoicism and with the ascetic system of the Essenes. A comparison between the Essenes and the Neopythagoreans shows a parallel so striking as to warrant the theory that the Essenes were profoundly influenced by Neopythagoreanism. Lastly, Neopythagoreanism furnished Neoplatonism with the weapons with which pagan philosophy made its last stand against Christianity. See APOLLONIUS of Tyana; JEWISH SECTS DURING THE SECOND COMMONWEALTH; NEOPLATONISM; PYTHAGORAS AND PYTHAGOREANISM.

See Eduard Zeller, Philosophie der Griechen (1845–52).

NEPAL, an independent state, situated on the northeastern frontier of India, lying between 80° 15' and 88° 10' E. long. and between 26° 20' and 30° 10' N. lat.; area, 54,362 sq.mi. Its extreme length is about 525 mi., and its breadth varies from 90 to 140 mi. It is bounded on the north by Tibet, an autonomous region of China; on the east by Sikkim, an Indian-protected state, and West Bengal, an Indian state; on the south and west by the Indian states of Bihar and Uttar Pradesh, Pop. (1954) 8,256,625.

Physical **Features.**—Nepal consists physically of two distinct territories: (1) the tarai, or strip of level. cultivated and forest land lying along the southern border; and (2) the great mountainous tract stretching northward to Tibet. Along the northern frontier stand many of the highest peaks of the Himalayan range, such as Mount Everest (29,028 ft.), Makalu (27.790 ft.), Kanchenjunga (28,168 ft.), Dhaulagiri (26,790 ft.), Gauri Sankar (23,440 ft.) and peaks varying from 20,000 to 24,000 it. In clear weather this magnificent snowy range may be seen in an almost continuous line from the top of some of the lower ranges near Kathmandu. South of these are numerous parallel lower ranges, varying from 6.000 to 16,000 ft. in height, which are broken up by cross ranges.

These mountain ranges determine the course of the rivers, which are divided by the cross ranges into four groups. The first of these extends from Kumaon eastward as far as Dhaulngiri and consists of the affluents of the Kali (Sarda), Sarju. Kurnali, Eastern Sarju and Rapti, all of which ultimately form the Gogra or Gogari and flow into the Ganges. 'The second group, known to the Nepalese as the Sapt Gandaki, rises from the peaks between Dhaulagiri and Gosain 'Than and unites at Tribeni Ghat to form the Gandak. The third is a group of smaller rivers draining the great valley of Nepal, the valleys of Chitlong, Banepa and Panouti and portions of the *tarai* around the Churiaghati range of hills. These are the various branches of the Bara Gandak, the lesser Rapti, the Baghmati and Kumla. East of this again is the fourth group, known to the Nepalese as the Sapt Kosi. rising irom the peaks between Gosain Than and Kanchenjunga and uniting to form the Sun Kosi, which falls into the Ganges. There is thus a natural division of the country into four portions. The westernmost is the country of the Baisi (22) rajas and contains the towns of Jumla, Doti and Sulliana. The second is the country of the Chaubisi (24) rajas and contains the towns of Malebum, Palpa, Gurkha and Nawakot. The third is the district containing Nepal proper, with the capital and many large towns. The fourth is the eastern portion of Nepal. comprising the country of the Kiratis and many small towns. such as Dhankota, Ilam and Bijapur.

The only portion of Nepal (with the exception of some portions of the tarai country which lies at the foot of the hills) ever visited by Europeans is the valley of Kathmandu. and even this can be entered only by special permission of the Nepal government. A narrow-gauge railway was opened by the Nepal government in Feb. 1927 and runs to Amlekhganj, 25 mi. from the Indian border at Raxaul, a small junction on the Oudh-Tirhut railway in the Champaran district in northern Bihar, due south of Kathmandu; a second railway. opened in 1940, runs a distance of 35 mi. from Jayanagor, on the Oudh-Tirhut railway, to Bijulpura. The road from Raxaul to Kathmandu is 7j mi., the first 50 mi. of which lie across the alluvial plain of the tarai through a sal forest to the foot of the hills, whence the road follows the beds of rivers and across low ridges till the small hamlet of Bhimphedi is 'reached. Up to this point the road is practicable for wheeled traffic. Motor-cars run over it throughout the year except when abnormal rains cause breaches of the road. From Bhimphedi there is only a mountain track, which crosses two ridges (elevation about 8.000 ft.) and reaches the valley of Kathmandu about 9 mi. from the city, whence a fair carriage road is available. A ropeway was constructed from near Bhimphedi to the Kathmandu valley; it is operated by electricity from the power station in the valley, which also supplies electric light to the city.

In and around the Nepal valley the year may be divided into the rainy, cold and hot seasons. The rains begin in June and last till October, the average fa1l being about 60 in. annually. The cold season extends from the middle of October to the middle of April. From April to the beginning of the rains is the hot season, but the thermometer seldom exceeds go° in the shade. The mean temperature is 60°. Violent thunderstorms are common, and occasionally severe earthquakes occur.

Flora *and Fauna.*—The flora and fauna are varied. Nepal may again be divided into three zones: (1) the tarai and lower ranges of hills up to 4.000 ft. in height; (2) the central ranges and high-lying valleys, up to 10,000 ft.; and (3) the alpine region, from 10.000 to 29,000 ft. in height.

The low alluvial land of the tnrai is the granary of Nepal. hut the greater portion consists of swamps, jungles and forests. Considerable stretches of land are, however, being reclaimed from year to year. The crops grown there are those of India—cotton, rice, wheat, pulse, sugar cane, tobacco. opium, indigo and some fruits and vegetables. The forests yield a magnificent supply of sal, sisu and other valuable forest trees and acacias, mimosas, cotton trees (*Bombax*), dak (*Butea* frondosaj, large bamboos, rattans, palms and numerous ferns and orchids. On the Churiaghati range the common *Pinus longifolia* grows freely. Tea can be grown at heights between 2,000 and 4,000 ft. 'The middle zone supplies rice: wheat, maize, barley, oats. ginger, turmeric, chillies, potatoes, Cucurbitaceae, pineapples and many varieties of European fruits,, vegetables and flowers. The forests contain tree rhododendron, *Pinus longifolia*, oak, horse chestnut, walnut, maple, hill bamboo, wild cherry, pear, allies of the tea plant, paper plant (*Daphne*), rose and many other inhabitants of temperate climes, and orchids, ferns and wild flowers. In the alpine zone exist Coniferae of many kinds, juniper, yew, box, holly, birch, dwarf rhododendron and other alpine flora.

The fauna follow a similar distribution. In the lowest zone are found the tiger, leopard. wolf, hyena and jackal, the elephant and rhinoceros, the gaur (*Gavaeus gaurus*), gayal (*Gavaeus frontalis*), wild buffalo or arna and many species of deer and the black bear (*Ursus labiatus*), peafowl, francolins, wild jungle fowl, the smaller vultures, etc. In the middle zone are found the leopard, the Himalayan black bear (*Ursus* tibetanus), the wild dog, cats of many sorts. squirrels, hares, porcupines, the pangolin and some species of deer and antelope, the larger vultures and eagles; pheasants (*Gallophasis*), *chikor*, hill partridges, etc. In the alpine zone are found the true hear (*Ursus isabellinus*, or brown bear), the yak. musk deer, wild goats and sheep, marmots, the eagle-vulture

(Gypaetus), the blood pheasant (*Ithaginis* cruentus), snow pheasant (*Tetraogallus* himalayensis), snow partridge (*Lerwa nivicola*), the homed pheasant (*Ceriornis* saiyra), crested pheasant (Catrens *wallichi*), etc. Geese, ducks, waders of all sorts and other migratory birds abound in the two lower zones.

HISTORY

Nepal and the somewhat similar country of Kashmir are peculiar among the Hindu states of the Indian subcontinent in possessing a historical literature. The Nepalese Vamsavali professes to start from a very early period in the Satya Yuga, when the present valley was still a lake. The earlier portion of it is devoted to the Satya and Treta Yugas and contains mythological tales and traditions having reference to various sacred localities in the country. During these two Yugas and also the Dwapara Yuga, the Vamsavali deals in round numbers of thousands of years.

In the beginning of the Kali Yuga, the Gupta dynasty is said to have been founded by Ne-Muni, from whom the country takes its name of Nepal. Lists are then given of the various dynasties, with the lengths of the reigns of the rajas. The dynasties mentioned are the Gupta, Ahir, Kirati, Somavanshi, Suryavanshi, Thakuri or first Rajput, Vaishya Thakuri, second Rajput and Karnataki dynasties. The country was then invaded by Mukundasena, and after his expulsion various Vaishya Thakuri dynasties are said to have held the throne for a period of 225 years. The chronology of the Vamsavali up to this period is confused and inaccurate; but the records begin to be clearer from the time of the invasion and conquest of the country by Harisinha-deva, raja of Simraun, in 1324. He was driven from Simraun by Tughlak Shah of Delhi, but seems to have found little difficulty in the conquest of Nepal. There were only four rajas of this Ayodhya dynasty, and then the throne was occupied by Jayabhadra-Malla, a descendant of Abhaya-Malla, one of the Rajput dynasty, who reigned in the 13th century. The seventh raja of this dynasty, Jayastithi-Malla, who reigned for 43 years (1386–1429), instituted legal codes and introduced the caste system to the Newars. In the reign of the eighth raja, Yaksha-Malla, the kingdom was divided into four separate states: Banepa, Bhatgaon or Bhaktapur, Kantipur or Kathmandu and Lalitapur or Patan. The Malla dynasty in the other three branches continued in power up to the conquest of the country by the Gurkhas in 1768. (See GURKHA.)

The Gurkhas were driven from their own country by the victorious Moslems and took refuge in the hilly districts about Kumaon, whence they gradually pushed their way eastward to Lamjung, Gurkha, Nayakot and ultimately the valley of Nepal, which under Raja Prithwi Narayana they finally captured. In the struggle which took place at Bhatgaon, Jayaprakasa (the raja of Kathmandu) was killed. Ranjit-Malla, the aged raja of Bhatgaon, retired to Benares, where he died. Tej Narsinha, the raja of Patan, died in confinement. During the latter years of the war Jayaprakasa applied to the British for assistance, and a small force, under Captain Kinloch, was sent into the *tarai* in 1765, but it was repulsed by the Gurkhas.

Prithwi Narayana died in 1774. He left two sons, Pratapasinha Sah and Bahadur Sah. The former succeeded his father but died in 1777, leaving an infant son, Rana Bahadur Sah, and his brother, who had been in exile, returned to Nepal as regent. The mother of the infant king, however, was opposed to him, and he had to flee again to British territory, where he remained till the death of the rani, when he again became regent. In 1790 the Gurkhas invaded Tibet and were at first successful; but they were brought into contact with the Chinese, who in 1791 sent a large force to invade Nepal. In 1792 the Chinese advanced as far as Nayakot and there dictated terms to the Nepalese. In 1791 the Gurkhas had entered into a commercial treaty with the British; William Kirkpatrick was therefore dispatched to Nepal and reached Nayakot in the spring of 1792, after the conclusion of peace. This embassy resulted in the ratification of another commercial treaty on March 1, 1792.

Rana Bahadur removed his uncle, Bahadur Sah, from the regency in 1795 and put him to death two years later. From this time to 1799 the king, who seems to have been insane, perpetrated the most barbarous outrages and his conduct became so intolerable that he was forced to abdicate in favour of his infant son, Girvan-yuddha Vikram Sah. Rana Bahadur recovered the throne in 1804 but was assassinated in 1805.

In Oct. 1801 another treaty was signed by the British and Nepalese authorities. A British resident was then sent to the Nepalese court, but was withdrawn in 1803, from which time the Nepalese carried on a system of encroachment and outrage on the frontier. which led to a declaration of war by the British in Nov. 1814. The fortunes of war were not constant on either side, and fighting was almost continuous.

Nepal Under British Protection.—By the treaty of Sagauli (1815), which was finally ratified in March 1816, the Nepalese relinquished much of their newly acquired territory and agreed to allow a British residency to be established at Kathmandu. In November the raja died and was succeeded by his infant son, Surendra Vikram Sah. Gen. Bhimsena Thapa acting as regent.

In 1839 Bhimsena's enemies succeeded in driving him from power, and he committed suicide, or was murdered, in prison. The Kala Pandry faction then came into power, and there were frequent grave disputes with the British. In 1843 Matabar Singh, the nephe of Bhimsena, returned from exile. gained favour at court and speedily effected the destruction of his old enemies, the Kala Pandrys, who were seized and executed in May. At this time a nephew of Matabar Singh. Jung Bahadur, the eldest of a band of seven brothers, rose rapidly in the army and in favour at the court, especially with one of the ranis. He killed his uncle on May 18, 1845, obtained, with the aid of the rani. a prominent position in the government and soon after destroyed his enemies by what is known as the Kot massacre, on Sept. 1 j. 1846. From that time till the day of his death Jung Bahadur was in reality the ruler of Nepal. His old friend, the rani, was banished, and all posts of any consequence in the state were filled by Jung and his relations. In 1850 Jung Bahadur paid a visit to England and there proved himself to be a stanch friend of the British. On his return in 1851 he devoted himself to reforming the administration of the country, and it must be allowed that he eventually proved himself the greatest benefactor his country ever possessed. A treaty for the extradition of criminals was proposed in 1853 and ratified in Feb. 1855. In 1854 the Nepalese began a war against Tibet. which ended with a peace favourable to Nepal in March 1856.

In June 1857 intelligence of the mutiny of the Indian troops in Hindustan reached Nepal. Jung Bahadur. in spite of great opposition, stood firm as a friend of the British. On June 26, 4,000 troops were dispatched and rendered excellent service. Jung followed on Dec. 10 with a force of 8,000 men, 500 artillerymen and 24 guns, but too late to be of much use. Many of the mutineers and rebels. including Nana Sahib. took refuge in the Nepalese tarai, and it was not till the end of 1859 that they were finally swept out of the country. Jung Bahadur uas knighted and decorated for his services and his troops received pay and handsome donations if wounded. Quantities of arms were presented to the Nepalese government and some territory was restored. This ground contains valuable sal and sisu forests and yields yearly a revenue of several lakhs of rupees.

After termination of the mutiny Nepalese history was uneventful. In spite of friendly relations with the British, many of the early restrictions against entering the country and trading there continued to be rigidly enforced. Jung Bahadur died suddenly in 1877. His brother. Ranadip Singh Bahadur, succeeded him as prime minister. Shortly after his accession to power a plot was formed against him, but nearly 40 of the conspirators were seized and executed. while others escaped into exile. He was, however. murdered in 1885 and was succeeded by his nephew. Shumsher Jung, who died in 1901 and was succeeded by his brother, Deb Shumsher Jung. In June of that year a palace revolution placed another brother, Chandra Shumsher Jung, in power, while Deb Shumsher fled to India. Chandra Shumsher ruled Nepal with much ability. He gave effectiveaid to the British during the Tibet war of 1904, and the relations with the government of India became more cordial after his accession. In 1906 Chandra Shumsher was knighted and in 1908 he visited England as a guest of the government, when he was created major general in the British army and honorary colonel of the 4th Gurkha rifles.

During World War I, Chandra Shumsher Jung placed the entire resources of his country at the disposal of the Allies. From 1915 to 1918 about 10,000 men of the Nepalese army served in India and on the Indian frontier. The 20 Gurkha battalions of the Indian army were increased to 40. In the brief Afghan War (1919), 2,000 Sepalese troops assisted the Indian government. Chandra Shumsher Jung was also responsible for the abolition of slavery in Nepal.

Replacing the old treaty of Sagauli, a new treaty of friendship was signed on Dec. 21, 1923, an important proyision of which was the recognition by the British government of the complete independence of Nepal.

Independent *Nepal.*—From 1846 the king of Nepal was a *roi fainéant* (a "do nothing king"). while the hereditary prime minister was the virtual ruler—both being members of the same Rana family. This system could hardly be continued with India's becoming an independent country. A movement for reforms in the state was receiving support in Delhi. In Feb. 1948 Mohan Shumsher Jung Bahadur became prime minister. while King Tribhuvan Bir Bikram Jung Bahadur (who had come to the throne in 1911) insisted on reforms making him a constitutional king. He failed and sought refuge in the Indian embassy at Kathmandu.

On Nov. 7, 1950, the Rana rulers proclaimed Gyanendra Jung Bahadur, the second son of the crown prince, a boy three years old, as the new king. Four days later Tribhuvan arrived in Delhi. A new government was formed, composed of an equal number of representatives of the Rana family and the Nepali Congress party, and on Jan. 18, 1951, Tribhuvan began to exercise his iunction as a constitutional monarch. In November, however, the five Nepali Congress ministers resigned declaring that the cabinet on a mixed basis with the Rana family was unworkable. A new cabinet. with none of the Ranas, was formed on Nov. 16. This was the end of the oligarchical rule of the Rana family, but not yet the beginning of a smoothly functioning constitutional monarchy.

On Aug. 10, 1952, Matrika Prasad Koirala, the prime minister, criticised in the 61-member advisory assembly by his own brother, Bishewar Prasad. chairman of the Nepali Congress party, resigned, and the king took over the administration. On June 1;, 1953, M. P. Koirala returned to power while B. P. Koirala denounced his cabinet as undemocratic.

On March 2, 195j. I'rince hlahendra Bir Bikram, given provisional power by King Tribhuvan, introduced direct rule; he succeeded his father. who died March 13 at Zurich. Switz. On Jan. 27, 1956, at his request. Tanka Prasad Achariya .formed a coalition government. He resigned on July 9, 1957. A new government headed by Kunvar Inderjih Singh, leader of the left-wing United Democratic party, was appointed. Being boycotted both by the pro-Indian Nepali Congress party as well as by the Praja Parishad party, it was dismissed Nov. 14, 1957. The king assumed direct rule and on Feb. 12, 1959, proclaimed a democratic constitution.

SOCIAL AND ECONOMIC CONDITIONS

Population.— The races occupying Nepal are of mixed Mongolian origin. To the north, in the higher mountains and valleys, dwell the Bhotias or Tibetans, to the west the Gurungs and Magars. The Murmis, Gorkhalis and Newars occupy the central parts, the Kirantis, Limbus and Lepchas the eastern. There are also Brahmans and Chhatris in the hills. There are other lesser tribes in the *tarai* and other malarious districts, known as Kumhas, Tharus, Manjis, etc.. but generally classed together by the Nepalese as Aoulias, or dwellers in the districts where the *aoul*, a special type of malaria, prevails. The Gorkhalis or Gurkhas are descendants of the Brahmans and Rajputs who were driven from India by the hloslems and took reiuge in the western hilly lands. where they ultimately became dominant and intermarried with the other races.

The Bhotias, Newars. Limbus, Kirantis and Lepchas are all Buddhists. but their religion became so mixed with Hinduism as to be hardly recognizable. The Newars entirely abandoned the monastic institutions of Buddhism and in great measure adopted the rules of caste, though these sit but lightly upon them. They burn their dead. eat the flesh of buffaloes, goats, sheep. ducks and fowls and drink beer and spirits. The Gorkhalis, Magars and Gurungs are Hindus, but the last two are by no means strict in the observance of their religion. Where temples are so numerous (there are 2,733 shrines in the valley), priests both Hindu and Buddhist abound. The festivals, too, are many. and holidays incessant. The raj guru, or high priest, is an influential person in the state and a member of council and has a large income from government lands as well as from fines for offenses against caste.

The various races have separate languages, or at least dialects. The Gorkhalis and western tribes use Parbatia (see PAHARI LANGUAGE). which, unlike the other dialects. is of Sanskrit origin. The Newars have a distinct language and alphabets, of which three are known to their pandits, though only one is in use; their language. called Gubhajius, resembles Tibetan but is interspersed with many Sanskrit words. The Bhotias use the Tibetan language and alphabet.

There are three large towns in the Kepal valley: Kathmandu (the capital, said to contain approximately 105,247 inhabitants in 1953), Patan (41,334) and Bhatgaon (32.118). The houses are from two to four stories in height, built of brick and tiled. The windows and balconies are of wood. and many are elaborately carved. There are numerous handsome temples in all the towns, the majority of which are pagoda-shaped and built of brick. with roofs of tiles or copper, which is sometimes gilt. The streets are narrow, many of them paved with brick or stone.

Legal System.— The old savage legal code with its ordeals by fire and water and its punishments by mutilation and torture was abolished by Jung Bahadur after his return from England in 1851. Treason. rebellion and desertion in wartime are punishable by death, and murder and the killing of cows are also capital offenses. Manslaughter and the maiming of cows are punishable by imprisonment for life. other offenses against the person, property or caste by imprisonment or fine. Brahmans and women are exempt from capital punishment.

The marriage laws are peculiar. Among the Gurkhas the laws resemble those of other Hindus as regards the marriage of widows, polygamy, etc., but among the Newars every girl while still an infant is married with much ceremony to a bel fruit. which is then thrown into some sacred stream. As the fate of the fruit is unknown, a Newari is supposed never to become a widow. At the age of puberty a husband is selected, but the woman can at any moment divorce herself by placing a betel nut under her husband's pillow. Slavery was completely abolished throughout the kingdom in 1925 by Chandra Shumsher Jung.

Finance.— The revenue is mainly drawn from the land tax, customs, mines, forests and monopolies. About 10% of the *tarai* lands and 20% of the hill lands are private property. Some lands were assigned by the Gorkhali rajas to Brahmans, soldiers and others, and these are untaxed. Others, which were the gifts of the old Newar kings, pay irom four to eight annas per *bigha*. A considerable revenue in the shape of royalty is obtained from mines of copper. iron. etc. The taxes on merchandise amount to 12%–14% on the value of the goods carried to and irom India and to 5%–6% on goods exported to Tibet. The 1956–57 budget planned a revenue of 45,000,000 Nepalese rupees and expenditure of 60,000,000 Nepalese rupees. The official exchange rate in Aug. 1956 was N.Rs. 145.50 = Indian Rs. 100 = U.S. $21.19.

Army.— The Gorkhalis are a military race. The standing army consists of about 45,000 men; in a fair state of efficiency. There is also a reserve, consisting of men who have served for a few years and taken their discharge but can be called on again to enter the ranks. These would probably raise the strength to between 70,000 and 80,000 men. The regiments are forined on the British system and similarly drilled and officered. Each man carries in addition to a bayonet a kukri or native knife. There is practically no cavalry, the country not being suited for horses. The artillery is on a larger scale and consists nearly entirely of mountain guns. There is a large arsenal well provided with supplies of ammunition and military stores. Rifles and ammunition are for the most part obtained from India.

In addition to its own army, Nepal supplies recruits to 12 Gurkha battalions of the Indian army and 8 Gurkha battalions of the British army.

Education and Health.—In 1957 there were 921 primary schools; 399 vocational and secondary schools; the College of Kathmandu, and other institutions of higher education.

Kathmandu is a storehouse of ancient Sanskrit literature, and some of the oldest manuscripts in that language known to scholars have been found there.

All families of good position have at least one baid, or medical man, in constant attendance, and there are also many general practitioners.

There are two large central hospitals, civil and military, at Kathmandu, and other smaller hospitals are distributed over the country, with free beds and provision for outdoor treatment.

Agriculture.—Military service being the main occupation of the Gorkhalis, the agriculture of the valley is carried on chiefly by the Newars. The soil varies from light micaceous sand to dense ferruginous clay. The whole valley is cultivated and irrigated where practicable, and the slopes of the hills are terraced, so that there is little grazing ground, and few sheep or cattle are kept. There are some milch cows and buffaloes, which are stall-fed or grazed in the jungles at the foot of the hills. Animals for food and sacrifice are all imported and are consumed as fast as they are brought in. In the cold season the Bhotias bring large flocks of sheep and goats laden with bags of borax, salt and saltpetre. The animals are sold for food except for a few that are retained to carry back the bags. Poultry is kept and used by the Newars, especially ducks, the eggs of which are in great demand even among the orthodox Hindus. The crops grown in the valley consist of rice. wheat, pulse, murwah, maize, buckwheat, chillies, radishes, mustard, garlic, onions, ginger, turmeric, sugar cane, potatoes, peanuts. cucumbers and pumpkins, etc. Only foodstuffs may be grown in the valley, hence its suitability for producing tea, cotton and tobacco is unknown. These, however, are grown in other parts of the country, both in the hills and the *tarai*. Large cardamoms are extensively grown in the eastern hills and form an important article of export. The hemp plant (Cannabis indica) grows wild. Many European fruits, flowers and vegetables have been introduced and grow freely. The country is famous for its oranges and pineapples. Garden and wild flowers are sold for use as religious offerings and for wear in the hair. Apples and pears, of English stock, apricots, peaches and plums do well; grapes grow freely but seldom ripen before the rains begin, when they rot.

Minerals.—The lowest zone abounds in fossils. and deposits of lignite and even of true coal are encountered, the latter notably at a place south of Palpa. The middle zone is rich in limestone, marbles and minerals such as iron, copper, zinc, lead and sulfur. Copper is found near the surface in many places, and there are remains of mines both at Markhu and in the great valley of Nepal. Mineral springs, hot and cold, are numerous. Traces of silver and gold have been found in the alpine zone.

Trade and Manufacture.—All the trade and manufactures of the country are in the hands of the Newars and of a few Kashmiris or natives of India. The trade in European goods is chiefly carried on by the latter, while the Newars deal in corn, oil, salt, tobacco and articles of domestic manufacture. The trade with India is carried on at numerous marts along the frontier, at each of which a customs station is established, and the taxes are collected by a *thikadar* or farmer. The Newars also carry on the trade with Tibet. through a colony which has been established at Lhasa for many years.

In July 1953 India agreed to give Nepal Rs. 1,000,000 annually as aid for five years for minor irrigation projects. India also agreed not to levy any excise duty on Indian goods exported to Nepal (*e.g.,* textiles, sugar, salt, matches and tobacco), while Nepal was gaining about Rs. 5,000,000 annually by imposing an import duty on these goods. Estimated exports to India amounted in 1957 to N.Rs. 130,000,000; imports from India to N.Rs. 66,-000.000.

Transport and Communications.—The first motor road from India to Kathmandu, 75 mi. long, was opened on Dec. 11, 1953. It connects Thankot, near Kathmandu, with Bhainse Dhoban, near Amlekganj, the railhead near the Indian frontier. There is an air service from Kathmandu to Calcutta. (H. Wn.; X.)

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NEPENTHES: see Pitcher Plants.

NEPHELINITE is a basic lava, usually completely crystallized, in which the essential minerals are nephelite and pyroxene.

Known only from Tertiary strata, nephelinites are abundant in the Canary Islands. the Azores, the Cape Verde Islands and Fernando Noronha Island off the coast of Brazil. Specimens from the Eifel and Kaiserstuhl regions in Germany are staples in petrographic collections, as are those from central Bohemia and the Odenwald (Katzenbuckel). They are on the whole not common in the Mediterranean area, but leucite-bearing representatives are known from Monte Vulture in Italy and Tripoli in north Africa. Nephelite-rich basic lavas are perhaps most extensively developed in east Africa, in Nigeria, but more especially in Somaliland and Masai-land. In the United States they are best known from the Big Bend region of west Texas, the Bearpaw mountains, Mont., and Cripple Creek, Colo.

The pyroxene in nephelinites may be either titan-augite or aegirine; plagioclase, if present. is commonly labradorite. Varieties rich in leucite and hauyne are well known. Biotite is characteristic in some types; amphibole is scarce. Accessories may include sanidine, melilite. melanite, sodalite, perofskite, pseudo-brookite, apatite and chromite.

The nomenclature of these nephelite-rich basalts is confusing but firmly established. The plagioclase-free varieties are called nephelinite if they also lack olivine. nephelite-basalt if olivine is an essential constituent. The plagioclase-bearing varieties are called nephelite-tephrite if they lack olivine and nephelite-basanite if olivine is an essential constituent. They are otherwise similar in mineralogy, appearance, structure and occurrence. The relative abundance of the plagioclase-free and plagioclase-bearing members of the group is a matter of conjecture, as is the quantitative importance of the group as a whole vis-à-vis more normal (*e.g.,* nonfeldspathoidal) basalts. About all that can be said on this score is that, despite their wide geographic distribution and occasional extensive local development, they are very rare rocks. (F. Cs.)

NEPHELITE, or Nepheline, a rock-forming mineral consisting of sodium, potassium and aluminum silicate, is an essential constituent of certain older alkaline plutonic rocks, such as the nephelite-syenite of southern Norway. Commercial quantities of nephelite-syenite occur in Ontario, Can., and the nephelite, because of its high alumina content, is used in the manufacture of glass and ceramic products as a substitute for feldspar.

Nephelite is commonly associated with feldspar. sodalite, cancrinite, biotite, corundum and zircon; never with primary quartz. Two varieties are distinguished. Nephelite proper is glassy, light coloured and frequently in crystals. It is common in recent eruptive rocks rich in alkalies, such as phonolite, nepheline basalt, leucite basalt, etc.. and also certain dike rocks such as tinguaite. The best crystals occur with mica, sanidine and garnet in the crystal-lined cavities, or vugs, of the ejected blocks of Monte Somma, Vesuvius. The other variety, eleolite, occurs as rough crystals or irregular masses, which have a greasy lustre, and are translucent or nearly opaque, with a red. green, blue or brown colour.

Nephelite has the approximate formula $Na_6K_2Al_8Si_9O_{34}$.

Artificial crystals can be made with the composition $NaAlSiO_4$, but the natural material always contains some potassium and an excess of silica. Nephelite crystals are hexagonal, usually in the form of short six-sided prisms terminated by a basal pinacoid. The specific gravity (2.6), the low index of refraction and the feeble double refraction are nearly the same as in quartz. but it is optically negative, while quartz is positive. and the hardness is only 5.5, in contrast to 7 for quartz. Nephelite is easily decomposed by hydrochloric acid, with separation of gelatinous silica and formation of cubes of salt upon evaporation. A clear crystal of nephelite when immersed in acid becomes cloudy for this reason: hence the name, from the Greek meaning "a cloud." Nephelite alters easily to natrolite, sodalite, cancrinite, kaolin or muscovite. It occurs as a pseudomorph after leucite. (L. S. Rl.)

NEPHELITE-SYENITE or Eleolite-Syenite. a medium- to coarse-grained rock consisting largely of feldspar and nephelite; always considerably poorer in silica and richer in alkalies than granite.

Nephelite-syenite from Canada is used in the place of feldspar in ceramic and glass products (see Nephelite).

Composition. — The feldspar in nephelite-syenite may be cryptoperthite (see Feldspar: *Unmixing at* Low *Temperature*) or a mixture of albite and microcline, the latter combination being on the whole rather rare. The place of nephelite is sometimes wholly or partly taken by sodalite or cancrinite. Quartz and calcic plagioclase feldspar are absent. The amount of dark silicates is generally somewhat greater than in granite, but rarely exceeds 30% by volume. The content of nephelite is also usually less than 30%; perhaps it would be more correct to say that rocks containing more than 30% either of dark silicates or of nephelite usually are not called nephelite-syenite.

The commonest dark silicate is green pyroxene. usually zoned from diopside cores to aegirine mantles. Alkaline amphibole (green, brown or blue) is also abundant, and in some areas pyroxene is virtually absent, its place being taken by a mixture of hornblende and biotite.

The accessory minerals include most of those found in granite, as well as a host of uncommon species. such as melanite, scapolite, pectolite, enigmatite, eudialyte, eucolite, mosandrite. lamprophyllite, perovskite. vesuvianite. Calcite is almost never absent and may be abundant. Minerals rich in zirconium, titanium and rare earths occur frequently and sometimes in great abundance. The extraordinarily varied mineralogy of the nephelite-syenites and their remarkable variation in habit. fabric, appearance and modal composition have attracted much attention; more petrographic research has been devoted to them than to any other plutonic rock.

Occurrence. — Theamount of nephelite-syenite and related volcanic or plutonic rocks in the lithosphere is proportionately very small; the known or reasonably inferred volume of these rocks is probably less, for instance, than the volume of a single large gabbro complex. Yet they occur in great variety on every major land mass, and volcanic representatives are known from a considerable number of oceanic islands. Plutonic nephelite rocks ordinarily occur in small complexes, some quite isolated, but most in close association with effusive rocks of similar composition. The largest known masses are those on the Kola peninsula (Chibina-Lovosero. U.S.S.R.), in Pilansberg (western Transvaal. U. of S. Af.), and near Julianehaab (Ilimausak-Igaliko, Greenland). It is estimated that nephelite rocks underlie about 750 sq.mi. in Kola, about zoo sq.mi. in Pilansberg and about roo sq.mi. near Julianehaab. No other dominantly plutonic complexes of comparable size are known. and most, including some of the most closely studied, are very much smaller.

Mode of Origin. — The magmas which give rise to nephelite rocks must in some way be derivative, either from other. more abundant magmas, or from reaction between one (or more) of these magmas and previously solidified rocks. Lime-rich accessory minerals abound in nephelite-syenite, and many nephelite-syenites are closely associated with limestone. Desilication of basaltic magma by assimilation of limestone was long ago proposed, and has been found to occur. It is extremely limited, however, and where nephelite rocks are genetically associated with other magmatic rocks. the latter are much more often granitic than basaltic. A granite-limestone syntexis, that is, chemical modification by fusion and incorporation of rocks in contact (see Metasomatism), is accordingly favoured by some petrographers, and the field evidence for it is sometimes persuasive. Limestone. however, is a common sediment and is often intruded by granite. the commonest of all plutonic rocks. Why should the products of a reaction between the two be so rare?

The strongest alternative to syntectic explanations is the ingenious pseudoleucite hypothesis of N. L. Bowen, a generalization based on the observed or reasonably imagined consequences of the incongruent melting of orthoclase (see Geochemistry: *The* Reaction Series). It is sometimes argued that the hypothesis requires an extraordinarily delicate co-ordination between crystallization and fractionation, but in view of the scarcity of undersaturated rocks this is not a critical objection. Far more important is the unconformable circumstance that leucite is not known to occur in plutonic rocks. One must thus assume either that the transformation of leucite to a mixture of nephelite and orthoclase always proceeds to completion at depth or that nephelite-syenites form in some other fashion.

In sum, despite the great interest that attaches to the nephelite-syenites and the immense amount of work that has been done upon them, there is little agreement about the way(s) in which these rare rocks have been formed.

For discussion of theories of rock formation see Mineralogy; Petrology. (F. Cs.)

NEPHRITIS: *see* Kidney, Diseases of.

NEPOMUK or **POMUK, JOHN** OF, the national saint of Bohemia. It is necessary to distinguish between the John of Nepomuk of history and the legendary one. A John of Pomuk, son of a German called Wölfel, was vicar-general to the archbishop of Prague: John of Jengenstein, in 1393, and having thn-arted King Wenceslaus IV of Bohemia in a plan to seize the revenues of the abbey of Kladrub, was arrested and tortured, finally being carried to the bridge of Prague and thrown into the Vltava. It is difficult to connect this historical event with the legend of St. John of Nepomuk, who was canonized by Rome in 1729, mainly through the influence of the Jesuits, who hoped that this new cult would obliterate the memory of Hus. The Austrian chronicler Thomas Ebendorffer of Haselbach, who lived two generations later. first states that it was reported that King Wenceslaus had ordered that the coniessor of his queen—an office that John of Pomuk never held—should be thrown into the Vltava because he would not reveal the secret of confession. The story is afterwards told in greater detail by the untrustworthy Bohemian historian Wenceslaus Hajek. It appears certain that the person canonized in 1729 was not the historical John of Pomuk or Nepomuk.

Sep A. H. Wratislaw, *Lift, Legend and Canonization of St. John Nepomuk* (1873), a valuable work founded on the best Bohemian authorities; also A. Frind, *Der geschichtliche Heilige Johann von Nepomuk* (1861); O. Abcl, *Die Legende vom heiligen Johann von Nepomuk* (1855); and particularly vol. iii. of W. W. Tomek's *History of the Town of Prague* (12 vols., 1855–1901).

NEPOS, CORNELIUS (c. 99–24 B.C.), Roman historian, friend of Catullus, Cicero and Atticus, was born in Upper Italy (perhaps at Verona or Ticinum). He wrote: *Chronica,* an epitome of universal history; *Exempla,* a collection of anecdotes; letters to Cicero: lives of Cato the elder and Cicero; and *De viris illustribus,* parallel lives of distinguished Romans and foreigners. in 16 books. One seclion of this work (more commonly known as *Vitae excellentium imperatorum*) and the biographies of Cato and Atticus from another (De *Latinis historicis*), have been preserved. Erotic poems and a geographical treatise are also attributed to him. The *Lives* contain many errors (especially in chronology). but supply information not found elsewhere. 'The language is as a rule simple and correct. The Lives were formerly attributed to Aemilius Probus of the 4th century A.D.; but the view maintained by Lambinus (in his famous edition, 1569)—that they are all the work of Nepos—is now generally accepted. In modern times G. F. Unger *(Der sogenannte C. N.*, 1881) has attempted to prove that the author was Hyginus, but his theory has not been favourably received.

Editions of the *Lives* (especially selections) are extremely numerous; text by E. O. Winstedt (Oxford, 1904), C. L. Roth (1881), C. G. Cobet (1881), C. Halm and A. Fleckeisen (1889), with lexicon for school use; with notes, O. Browning and W. R. Inge (1888), J. C. Rolfe (U.S. 1894), A. Weidner and J. Schmidt (1902), C. Erbe (1892), C. Nipperdey and B. Lupus (ed. maj., 1879, school ed., 1895), J. Siebelis and O. Stange (1897).

NEPOS, JULIUS, emperor of the west (474–475), was the nephew and successor of Marcellinus, count of Dalmatia. Being connected by marriage with Leo I, he was selected by him as emperor after the death of Olybrius. After capturing his rival Glycerius, he was recognized as emperor in Italy, Rome and Gaul. The only event of his reign was the cession of Auvergne to the Visigoths. Nepos was overthrown in 475 by the Patrician Orestes and fled to Salona, where he was assassinated (480 or 481), possibly at the instigation of Glycerius, who had been compelled to enter the church.

NEPTUNE (Latin NEPTUNUS; Etruscan NETHUNS), an Italian god of fresh water and hence not originally a sea-god. In cult he had a female counterpart, Salacia, who was perhaps a goddess of leaping spring water. He is early (at least by 399 B.C.) identified with the Greek Poseidon (*q.v.*) and hence becomes a deity of the sea. Subsequently his cult partner, in literature at least, was equated with the Greek Xmphitrite (*q.v.*).

Neptune's festival (Neptunalia) is listed in the oldest calendars and took place in the heat of the summer (July 23) when water was most wanting. Thus it may be conjectured that its purpose was the propitiation of the fresh-water deity. About the festival little is known save that the intense heat of the season necessitated the construction of shelters from the leaves of trees to keep the sun off the worshipers.

Neptune had a temple in the Circus Flaminius at Rome which was either built or extensively restored by Gnaeus Domitius Ahenobarbus, who was consul in 32 B.C. A coin of Domitius shows it to have been a tetrastyle temple. One of the features of the temple was a sculptured group of marine deities headed by Poseidon and Thetis, executed by Scopas and probably obtained by Domitius in Bithynia.

In art Neptune appears as the Greek Poseidon, whose attributes are the trident and the dolphin.

See W. W. Fowler, *Roman Festivals of the Period of the Republic* (1899); G. Wissowa, *Religion und Kultus der Römer* (1912); Platner-Ashby, *Topographical Dictionary*, s.v. (R. B. LD.)

NEPTUNE, astronomical symbol the trident Ψ, is the eighth planet in order of increasing distance from the sun. The mean distance of Neptune from the sun is 2,796,700,000 mi. or 30.07 times that of the earth. Its period of revolution around the sun is 164.8 years.

Neptune receives so little light from the sun and is so far from the earth that it is invisible to the unaided eye, but is easily visible in a telescope no bigger than a spyglass as a star of about the eighth magnitude. In a large telescope under favourable observing conditions the planet shows a greenish disk 2.5 seconds of arc in diameter. No surface markings have ever been detected upon the disk. From spectrographic observations the period of rotation was found to be 15.8 hours. The direction of rotation is the same as that of the earth.

The mass of Neptune, accurately known from the motion of its larger satellite, is 17.2 times that of the earth. The diameter of the planet is 27,600 mi., according to measures made by G. P. Kuiper in 1949 with the disk-meter at the 82-in. reflector of the McDonald observatory, Ft. Davis, Tex. This measurement makes the mean density of Neptune 2.47 times that of water or 0.45 times the density of the earth. The albedo, or ratio of the light reflected to that falling on it, of Neptune is 0.62 indicating a cloud-covered surface of high reflecting power.

Although Neptune shines by light reflected from the sun, the greenish hue of the disk is due to the absorption of the red, orange and yellow solar rays by the planet's atmosphere. In the infra-red the absorption bands are so strong as nearly to obliterate the spectrum. The origin of the bands remained unknown until 1932 when R. Wildt identified them with methane (CH_4). The amount of methane in the atmosphere has been found to correspond to 25 mi. of the gas under normal atmospheric pressure. The most abundant gases present are believed to be hydrogen and helium, derived originally from the sun and retained by the high velocity of escape from the planet's atmosphere. Unfortunately hydrogen and helium give no observable absorption markings in the spectrum so that their presence can only be inferred. There is a group of bands at λ 7500 found by Kuiper in 1949 in the spectra of Uranus and Neptune which has not been identified.

The temperature at the visible surface of Neptune is low, about −337° F. (−205° C.).

The Satellites of Neptune.——Neptune has two known satellites. The larger was discovered on Oct. 10, 1846 by William Lassell, only 17 days after the discovery of the planet itself. The name of Triton was suggested for the moon by N. C. Flammarion and is often used. Triton revolves around Neptune at a mean distance of 220,000 mi. in a period of 5.876833 days. The direction of revolution is retrograde or opposite to the direction that Neptune rotates on its axis. The mass of Triton found by H. L. Alden (1943) is 0.022 times the mass of the earth or 1.8 times the mass of the earth's moon, in good agreement with earlier determinations. Its diameter has been estimated at 3,000 mi.

From the motion of the plane of the satellite's orbit and the period of Neptune's rotation, the oblateness, or deviation from spherical form, of the planet and the nature of its internal constitution can be inferred. From such deductions it is concluded that internally Xeptune closely resembles Jupiter.

In 1948 a second satellite was discovered by Kuiper, who gave it the name of Nereid. According to G. Van Biesbroeck (1951), Nereid revolves around Neptune in the same direction the planet rotates in a period of 359.4 days. The mean distance or length of the semimajor axis of the satellite's orbit is 3,465,000 mi. But the eccentricity of the orbit is so high (0.76), that Nereid may approach as close as 832,000 mi. to Neptune, and recede as far as 6,100,000 mi. Kuiper estimated that Nereid is 180 mi. in diameter and 1/4000 as massive as Triton.

The Discovery of Neptune.—By far the most interesting thing about Neptune is the story of its discovery. The account which follows was written by Simon Newcomb.

The detection of Neptune through its action upon Uranus before its existence had been made known by observation is a striking example of the precision reached by the theory of the celestial motions. So many agencies were concerned in the final discovery that the whole forms one of the most interesting chapters in the history of astronomy.

The planet Uranus, before its actual discovery by Sir William Herschel in the year 1781, had been observed as a fixed star on at least 17 other occasions, beginning with John Flamsteed in 1690. In 1820 Alexis Bouvard of Paris constructed tables of the motion of Jupiter. Saturn and Cranus. based upon a discussion of observations up to that year. Using the mutual perturbations of these planets as developed by Pierre Laplace in the *Mécanique céleste,* he was enabled satisfactorily to represent the observed positions of Jupiter and Saturn; but the case was entirely different with Uranus. It was found impossible to represent all the observations within admissible limits of error, the outstanding differences between theory and observation exceeding 1′. In these circumstances one of two courses had to he adopted; either to obtain the best general representation of all the observations, which would result in the tables being certainly erroneous, or to reject the older observations which might be affected with errors, and base the tables only on those made since the discovery by Herschel. A few years of observation showed that Uranus was deviating from the new tables to an extent greater than could be attributed to legitimate errors of theory of observation, and the question of the cause thus became of growing interest. Among the investigators of the question was F. W. Bessel, who tried to reconcile the difficulty by an increase of the mass of Saturn. but found that he could do so only by assigning a mass not otherwise admissible. Although the idea that the deviations were probably due to the action of an ultra-Uranian planet was entertained by Bouvard, Bessel and doubtless others, it would seem that the first clear statement of a conviction that such was the case, and that it was advisable to reach some conclusion as to the position of the disturbing body, was expressed by the Rev. T. J. Hussey, an English amateur astronomer. In a letter to Sir George B. Airy in 1834 he asked Airy's views of the subject, and offered to search for the planet with his own equatorial if the required estimate of its position could be supplied. Airy expressed himself as not fully satisfied that the deviation might not arise from errors in the perturbations. He therefore was not certain of any extraneous action; but even if there was, he doubted the possibility of determining the place of a planet which might produce it. In 1837 Bouvard, in conjunction with his nephew Eugène, was again working on the problem; but they appear not to have gone farther than to collect observations and to compare the results with Bouvard's tables.

In 1835 F. B. G. Nicolai, director of the observatory at Mannheim, Ger., in discussing the motion of Halley's comet, considered the possibility that it was acted upon by an ultra-Uranian planet, the existence of which was made probable by the disagreement between the older and more recent observations.

In 1838 Airy showed in a letter to the *Astronomische Nachrichten* that not only the heliocentric longitude but the tabulated radius vector of Uranus was largely in error, but made no suggestions as to the cause. In 1843 the Royal Society of Sciences of Gottingen, Ger., offered a prize of 50 ducats for a satisfactory working up of the whole theory of the motions of Uranus, assigning Sept. 1846 as the time within which competing papers should be presented. It is also recorded that Bessel. during a visit to England in 1842, in a conversation with Sir John Herschel, expressed the conviction that Uranus was disturbed by an unknown planet. He went so far as to set his assistant Fleming at the work of reducing the observations, but died before more was done.

The question had now reached a stage when it needed only a vigorous effort by an able mathematician to solve the problem. Such a man was found in John Couch Adams, then a student of St. John's college, Cambridge, who seriously attacked the problem in 1843, the year in which he took his bachelor's degree. He soon found that the observations of Uranus could be fairly well represented by the action of a planet moving in a radius of twice the mean distance of Uranus, which would closely correspond to Bode's law. During the two following years he investigated the possible eccentricity of the orbit, and in Sept. 1845 communicated his results to James Challis. About Nov. 1. 1845, Adams also sent his completed elements to Airy. stating that according to his calculations the observed irregularities in the motion of Uranus could be accounted for by the action of an exterior planet. of which the motions and orbital elements were given. It is worthy of note that the heliocentric longitude of the unknown body as derived from these elements is only between one and two degrees in error, while the planet was within half a degree of the ecliptic. Two or three evenings assiduously devoted to the search could not therefore have failed to make the planet known. Adams' paper was accompanied by a comparison of his theory with the observations of Uranus from 1780, showing an excellent agreement. Airy in replying to this letter inquired whether the assumed perturbation would also explain the error of the radius vector of Uranus, which he seemed to consider the crucial test of correctness.

The Elements. — At D. F. Arago's suggestion the investigation had been taken up by U. J. J. Leverrier, who had published some excellent work in theoretical'astronomy. Leverrier's first published communication on the subject was made to the French academy on Nov. 10, 1845, a few days after Adams' results were in the hands of Airy and Challis. X second memoir was presented by Leverrier on June 1, 1846. His investigation was more thorough than that of Xdams. He first showed that the observations of Uranus could not be accounted for by the attraction of known bodies. Considering in succession various explanations, he found none admissible except that of a planet exterior to Uranus. Considering the distances to be double that of Uranus he then investigated the other elements of the orbit.

The following are the elements found by Adams and Leverrier: The longitude of the planet was 327" 57′ on Oct. 1. 1846.

	Leverrier	Adams	
		Hypothesis I	Hypothesis II
Semimajor axis	36.154	38.38	37.27
Eccentricity	0.1076	0.16103	0.12062
Long. of perihelion	284° 45'	315° 57'	299° 11′
Mean longitude	318° 47'	32j° 8'	323° 2′
Epoch	1847, Jan. 1	1846, Oct. 1	1846, Oct. 1
True longitude	326° 32′	328°	329°

The close agreement of these elements led Airy to suggest to Challis, on July 9, 1846, a search for the planet with the Northumberland telescope. He proposed an examination of a part of the heavens 30° long in the direction of the ecliptic and 10° broad, and estimated the number of hours' work likely to be employed in this sweep. The proposed sweeps were commenced by Challis on July 29. The plan required each region to be swept through twice, and the positions of all the known stars found to be compared, in order that the position of the planet might be detected by its motion. On Aug. 31 Leverrier's concluding paper was presented to the French academy, and on Sept. 18 he wrote to John G. Galle (1812–1910), then chief assistant at the Berlin observatory, suggesting that he should search for the computed planet, with the hope of detecting it by its disk, which was probably more than 3'' in diameter. This letter, probably received on Sept. 23, was' communicated to J. F. Encke, the director of the observatory, who approved of the search. H. L. d'Arrest, a student living at the observatory, expressed a wish to assist. In the evening the search was commenced. but it was not found possible to detect any planet by its disk.

Star charts were at the time being prepared at the observatory under the auspices of the Berlin Academy of Sciences. It was suggested by D'Arrest that this region might be covered by one of the charts. Referring to the chart, which was lying in a drawer, it was found that such was the case. Comparing the stars on the chart one by one with the heavens it was found that an eighth-magnitude star now visible was not on the chart. This object was observed until after midnight, but no certain motion was detected. On the following evening the object was again looked for, and found to have moved. The existence of the planet was thus established. It was afterward found that Challis had observed the planet on Aug. 4, but had failed to detect it.

The question whether Leverrier should receive the sole credit of the discovery was warmly discussed. Arago took the extreme ground that actual publication alone should be considered. rejecting Adams' communications to Airy and Challis as quite unworthy of consideration. He also suggested that the name of Leverrier should he given to the planet. but this proposal was received with so little favour outside of France that he withdrew it, proposing that of Neptune instead.

The observations at the first opposition showed that the planet was moving in a nearly circular orbit, and was at a mean distance from the sun much less than that set by Leverrier as the smallest possible. The latter had in fact committed the error of determining the limits by considering the variations of the elements one at a time. assuming in the case of each that while it varied the others remained constant. But a simultaneous variation of all the elements would have shown that the representation of the observations of Uranus would be improved by a simultaneous diminution of both the eccentricity and the mean distance, the orbit becoming more nearly circular and the planet being brought nearer to the sun. But this was not at first clearly seen, and Benjamin Peirce of Harvard university went so far as to maintain that there was a discontinuity between the solution of Adams and Leverrier and the solution offered by the planet itself, and that the coincidence in direction of the actual and computed planet was an accident. But this view was not well founded, and the only explanation needed was to be found in Leverrier's faulty method of determining the limits within which the planet must be situated. As a matter of fact the actual motion of the planet during the century preceding, as derived from Leverrier's elements, was much nearer the truth than the elements themselves were. This arose from the fact that his very elliptic orbit, by its large eccentricity, brought the planet near to the sun, and therefore near to its true position, during the period iron: 1780 to 1845, when the action on Uranus was at its greatest.

The observations of the first opposition enabled Sears Cook Walker of the National observatory, Washington, D.C., in Feb. 1847 to compute the past positions of the planet, and identify it with a star observed by J. J. Lalande at Paris in May 1795. This being communicated to the Paris observatory, an examination of Lalande's manuscript showed that he had made two observations of the planet, on May 8 and 10, and finding them discordant had rejected one as probably in error and marked the other as questionable.

A mere re-examination of the region to see which observation was in error would have led him to the discovery of the planet more than half a century before it was actually recognized. The identity of Lalande's star with Neptune was also independently shown by Petersen of Altona, Ger.

Bibliography.—The principal sources for the history of the discovery of Neptune are the *Astronomische Nachrichten*, vol. xxv, xxvi, xxviii, anti Lindenau's paper in the *Ergänzungsheft* to this publication, pp. 1–31 (Altona, 1849). In the *Memoirs of the Royal Astronomical Society*, vol. xvi, Sir George Airy gave a detailed history of the circumstances connected with the discovery, so far as he was cognizant of them. Documents pertaining to the subject arc found in the *Monthly Notices of the Royal Astron. Society*. B. A. Gould, *Report to the Smithsonian Institution on the History of the Discovery of Neptune*, published by the Smithsonian Institution (Washington, D.C., 1850), is the most complete and detailed history of all the circumstances connected with the discovery, anti with the early investigations on the orbit of the planet, that has hcen published. U. J. J. Leverrier's investigation was published *in extenso* as an addition to the *Connaissance des temps*, and J. C. Adams' as an appendix io the [illegible] *Almanac* for 1851. Peirce's discussions, so far as published at all, are found in the *Proceedings of the American Academy of Arts and Sciences*. The first computations of the orbit after the discovery were made by Sears Cook Walker, and published by the Smithsonian Institution (Washington, D.C., 1848–1850).

(S. N.; T. E. R. P.; S. B. N.; R. S. Rn.)

NEPTUNIUM. The synthetic element neptunium has the symbol Np, atomic number 93 arid chemical atomic weight 237.06. It occupies a position in the periodic system of the elements as the fourth member of a rare-earth-like transition series, the actinide series, which includes the heaviest elements, and in which an inner electronic shell (the 5f shell) is being filled. The long-lived isotope Np^{237} can he considered to be the parent of the missing $4n + 1$ radioactive series, and it has been suggested that this radioactive family be given the name "neptunium radioactive series" by analogy with the names for the uraniurn and thorium radioactive series.

An account of the discovery of neptunium is given in the article Transuranium Elements.

Occurrence and Production.— Traces of Np^{239} are to he expectrd in uranium minerals as a result of continual formation by capture in U^{238} of neutrons from various sources, according to the findings of G. T. Seaborg and M. L. Perlman. D. F. Peppard and co-n·orkers established the presence of Np^{237} in Belgian Congo pitchblende in a concentration corresponding to a ratio of Np^{237} to U^{238} of 1.8×10^{-12}, the result of the action of fast neutrons.

At mid-20th century the only practical source of neptunium in weighable amounts was through the production of Np^{237} as a by-product in nuclear chain reactors. In reactors utilizing [?' as fertile material, it results as the decay product of the short-lived, heta-active U^{237} which is formed by the action of neutrons on U^{238}. In such reactors Np^{237} is produced at a rate of about 0.1% of that of the concurrent Pu^{239} production. In high neutron flux reactors with U^{235} as fuel, Np^{237} results from the successive absorption by U^{235} of two neutrons to form U^{236} and then U^{237} which decays to form Np^{237}. The neptuniurn can be isolated by carrying on appropriate precipitates, by solvent extraction procedures or by ion-exchange methods.

Chemical **Properties.**—Metallic neptunium is highly electropositive, much like uranium and other actinide metals: it can he prepared by reducing the trifluoride or tetrafluoride with an active metal such as calcium or barium. The metal has a silvery appearance and melts at 640 ▪ 1° C. The room temperature form of neptunium metal (α–Np) is orthorhombic (calculated density = 20.45 ± 0.03 g. per cubic centimetre). This form has been found to be stable up to 278° C. where it transforms into a tetragonal form (β–Np) with a density at 313" C. of 19.36 g. per cubic centimetre. Above 570° C. the metal seems to be cubic body-centred (γ–Np), and its density at 600° C. is 13.0 g. per cubic centimetre. This phase is presumably stahle up to the melting point. The metal is about as malleable as uranium made under the same conditions. Although the metal is chemically reactive, in common with the other metals of the actinide elements, it does not tarnish rapidly when exposed to laboratory air at room temperature.

Table I.—*Isotopes of Neptunium*

Isotope*	Half Life	Type† and energy of radiation (Mev)
Np^{231}	~50 min.	α6.28
Np^{232}	~13 min.	EC
Np^{233}	35 min.	EC $\alpha(\sim 10^{-8}\%)$ 5.53
Np^{234}	4.40 days	EC (99%) $\alpha(<10^{-2}\%)$ β^+ $(5\times 10^{-2}\%)$
Np^{235}	410 days	EC α $(1.2\times 10^{-3}\%)$ 5.06
Np^{236m}	>5,000 yr.	
Np^{236}	22 hr.	EC (43%) β^- (57%): 0.518
Np^{237}	2.20×10^6 yr	α 4.872 (3.1%); 4.816 (3.5%); 4.787 (53%); 4.767 (29%); 4.713 (1.7%); 4.674 (3.3%); 4.644 (6.0%); 4.589 (0.5%); 4.52 (0.02%)
Np^{238}	2.10 days	β^-1.25 (45%); 0.27 (55%)
Np^{239}	2.33 days	β^-0.715 0.654 0.44 n 33
Np^{240m}	7.3 min.	β^- 2 16 (52%) 1.59 (31%) 1.26 (11%) 0.76 (6%)
Np^{240}	63 min.	β^- 0.89
Np^{241}	~3.4 hr.	β^-

*The symbol m placed after the mass number refers to an isomeric form of isotope
†EC = electron capture; α = alpha particle; β = negative beta particle; 3 = positive beta particle.

Using the isotope Np^{237}, it has been possible to establish the oxidation states and the properties of a large number of the coinpounds of neptunium. These investigations have shown that neptunium has the oxidation states VI, V, IV and III with a general shift in stability toward the lower oxidation states as compared to uranium. The compounds which are formed are very similar to the corresponding compounds of uranium.

The ionic species corresponding to the oxidation states vary with the acidity of the solution: in acid solution of moderate strength the species are Np^{3+}, Np^{4+}, NpO_2^+ and NpO_2^{2+}, similar to the ions of uranium and plutonium. The potential scheme (units of volts relative to hydrogen— hydrogen-ion couple as zero) in one molar perchloric acid is as follows:

$$\begin{tikzcd} Np^0 \arrow[r, "+1.83"] & Np^{3+} \arrow[r, "-0.155"] \arrow[rrr, bend left, "-0.677"] \arrow[rr, bend right, "-0.447"'] & Np^{4+} \arrow[r, "-0.739"] \arrow[rr, bend right=50, "-0.938"'] & NpO_2^+ \arrow[r, "-1.137"] & NpO_2^{2+} \end{tikzcd}$$

The metal is highly electropositive in common with the other actinide elements. The $Np^{3+} \rightarrow Np^{4+}$ couple is reversible and this oxidation can be accomplished by the oxygen of the air. The IV state is stable, not oxidized by air, and only slowly oxidized to NpO_2^+ by nitric acid. The $Np^{4+} \rightarrow NpO_2^+$ couple is not readily reversible while the $NpO_2^+ \rightarrow NpO_2^{2+}$ couple is reversible: this is reasonable on the basis that the former involves breaking the neptunium-oxygen bonds while the latter does not. The oxidation of NpO_2^+ to NpO_2^{2+} requires moderately strong oxidizing agents.

Neptunium ions in aqueous solution possess characteristic colours: pale purple for Np^{3+}, pale yellow-green for Np^{4+}, green-blue for NpO_2^+, while NpO_2^{2+} varies from colourless to pink or yellow-green depending on the acid present. The sharp absorption bands are useful for quantitative and qualitative analysis for neptuniurn with the following the most useful: 5520, 6020. 6610 and 7875 Å for Np^{3+}; 5040, 7430 and 8250 Å for Np^{4+}; 4280 and 6170 Å for Np^{5+}; and 4760 and 53'70 Å for Np^{6+}.

The neptunium V ion NpO_2^+ is in many respects a unique ion, there being few if any elements forming a stable 5^+ oxidation state in solution that at the same time form a simple unpolymerized ion. The NpO_2^+ ion resembles other singly-charged cations such as K^+ in many respects. NpO_2^+, however, is complexed by oxalate ion in aqueous solution; this appeared t~ be the only complex ion of this oxidation state known at mid-20th century. In addition to the well-characterized neptunium V oxalate, a solid incompletely characterized potassium neptunium V carbonate is also known.

The neptunium-oxide system exhibits complexity similar to that found in the uranium-oxide system. Thus the important oxide is NpO_2 and there exists a range of compositions, depending upon the conditions, up to Np_3O_8. The oxide of composition NpO_3 had not been prepared by the early 1960s.

The important halides of neptunium are summarized in the following table.

TABLE 11.—The Halides of Neptunium

Compound	Colour	Crystal structure.	Density* (g./c.c.)	Melting point (° C.)	Boiling point (° C.)
NpF_3	purple	hexagonal	4 12	—	2500†
NpF_4	light green	monoclinic	6.8	—	1750†
NpF_6	white(?)	orthorhombic	—	53	decomposes
$NpCl_3$	white	hexagonal	5.58	800†	1800†
$NpCl_4$	red brown	tetragonal	1.42	—	—
$NpBr_3$	green	hexagonal	7.11		1800†
$NpBr_4$	red brown	UBr_4 type	—	740	decomposes(?)
NpI_3	brown(?)	orthorhombic	6.82	—	—

*Calculated from X-ray diffraction data.
†Estimated values.

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(G. T. SG.)

NERAC, a town of France in the *département* of Lot-et-Garonne, 16 mi. W.S.W. of Agen by road. Pop. (1954) 3,802.

Nérac in the 11th century was a possession of the monks of St. Pierre de Condom. The lords of Albret deprived them of their authority and at the beginning of the 14th century founded a castle on the Baise. Nérac, the inhabitants of which had adopted the Reiormed religion. was seized hy the Catholics in 1562. Conferences held there at the end of 1j78 between the Catholics and I'rotestants ended in the peace of Nérac, 1579. In 1580 the town was used by Henry IV as a base for attacks on the Agenais, Armagnac and Guienne. A Chambre de l'Edit for Guienne and a Chambre des Comptes were established there by Henry IV. In 1621, however, the town took part in the Protestant rising, was taken by the troops of Louis XIII and its fortifications dismantled. Soon after it was deprived both of the Chambre de l'Edit and of the Chambre des Comptes, and its ruin was completed by the revocation of the Edict of Nantes in 1685. The town, once the capital of the dukes of Albret, is divided by the Baise into Grand-Nérac and Petit-Nérac. The river is spanned by the 16th century bridge of Pont Vieux, and by the Pont Neuf, of modern construction. From the left bank a staircase leads to the rue Henri Quatre, where stands a wing of the castle in which Henry IV lived. The former palace of the Chambre des Comptes is now occupied by the tribunal of commerce, the library and the museum. The remains of a Roman villa have been found near the promenade of La Garcnne. A road leads from the south end of La Garenne to the ruins of the feudal castle of Nazareth. The Château du Tasta of the 15th century is within a short distance of Nérac. The industries include brewing and cork-working. It has a large trade in wines, brandy, corks, fruit and vegetables.

NERBUDDA: *see* NARBADA.

NERCHINSK, a town in the Chita *oblast,* Russian S.F.S.R., U.S.S.R., in lat. 52° 10' N., long. 116° 32' E., on the left bank of the Nercha. 25 mi. above its confluence with the Shilka. Pop. (1956 est.) 11.600. It is a centre for the collection of furs, cattle and brick-tea from China and for the distribution of manufactured goods imported from industrial Russia. There are tanneries, candle factories and a fur coat factory. The town is a market for the agricultural products of the fertile river valley.

The fort dates from 1654, and the town was founded in 1658 by Pashkov, who in that year opened direct communication between the Russian settlements in Transbaikalia and those on the Amur which had been founded by Cossacks and fur-traders coming from the Yakutsk region. In 1689 was signed between Russia and China the Treaty of Nerchinsk, which stopped for two centuries the further advance of the Russians into the basin of the Amur. After that Nerchinsk became the chief centre for the trade with China. The opening of the western route through Mongolia, by Urga, and the establishment of a custom-house at Kiakhta in 1728 diverted this trade into a new channel. But Nerchinsk acquired fresh importance from the influx of immigrants into eastern Transbaikalia, the discovery of rich mines and the arrival of great numbers of convicts. In 1812 it mas transferred from the banks of the Shilka to its present site.

NERCHINSK (in full NERCHINSKIY ZAVOD), a town and silver-mine of the East Siberian region in the Russian S.F.S.R.. U.S.S.R.. in lat. 51° 59′ N., long. 116° 39' E., 150 mi. E.S.E. of another Nerchinsk (*q.v.*) (with which it is often confused). on a small affluent of the Argun. Population 3.153. It has a chemical laboratory for mining purposes, and a meteorological and magnetic observatory (51° 18′ N.. 119° 37′ E.. 2,200 ft. above sea-level) founded in 1842. The average yearly temperature is 25.3° F.. with extremes of 97.7° and −52.6°.

NERCHINSK MINING DISTRICT (29,450 sq.m.) includes all the silver, lead and tin mines and eolcl-fields between the Shilka and the Argun, together with a few on the left bank of the Shilka. It is truvcrsed by several parallel chains of mountains which rise to 4,500 ft., and are intersected by a complicated system of deep, narrow valleys, densely wooded, with a few expansions along the larger rivers, where the inhabitants with difficulty raise some rye and wheat. The Nerchinsk mountains, not yet fully surveyed, form the watershed between the streams flowing south-east into the Argun and the Onon, Unda and Shilka on the north-west. They consist of crystalline slates and limestones interspersed with granite, syenite and diorite; they contain rich ores of silver. lead, tin and iron, while the diluvial and alluvial valley formations contain auriferous sands; asbestos is found near the tin.

The Nerchinsk silver mines began to be worked in 1704, but during the first half of the 18th century their yearly production did not exceed 8.400 oz., and the total amount for the first 150 years (1704–1854) amounted to 11,540,000 ounces. Transport and climatic difficulties have prevented the exploitation of the minerals in the region and the silver mines were closed in 1900. If the present scheme of linking the mines to the main railway is carried out. production may redevelop. The more easily reached veins of silver have been exhausted and expensive plant would he needed to work the deeper veins. Gold was first discovered in 1830, and between 1833 and 1855 260,000 oz. of gold dust were obtained. In 1864 a large number of auriferous deposits were discovered.

Until 1863 all the labour was performed by serfs and convicts, numbering usually nearly four thousand.

NEREUS, in Greek mythology, the eldest son of Pontus and Ge. and father of the Nereids. He is represented as a beneficent and sage old man of the sea. The only myth concerning him, related by the Athenian grammarian Apollodorus, is that Hercules compelled him: although, like Proteus, he assumed various forms, to tell him the way to the Hesperides.

The Nereids are mermaids. Amphitrite (consort of Poseidon) and Thetis (*see* PELEUS) are the best known; Galatea is a Sicilian figure. loved by the Cyclops Polyphemus.

NERGAL, the name of a solar deity in Babylonia, the main seat of whose cult was at Kutha or Cuthah, represented by the mound of Tell-Ibrahim. The importance of Kutha as a religious and at one time also as a political centre led to his surviving the tendency to concentrate the various sun-cults of Kahylonia in Shamash (*q.v.*). He becomes, however, the representative of a certain phase only of the sun and not of the sun as a whole. Portrayed in hymns and myths as a god of war and pestilence, Nergal represents the sun of noon-time and of the summer solstice which brings destruction to mankind. Nergal is pictured also as the deity who presides over the nether-world, and stands at the head of the special pantheon assigned to the government of the dead, who are supposed to be gathered in a large subterranean cave known as Arallis or Irkalla. In this capacity there is associated with him a goddess Allatu or Ereshkigal, though there are indications that at one time Allatu was regarded as the sole mistress of Arblu. Ordinarily the consort of Nergal is Laz. Nergal was pictured as a lion and his symbol is a griffin with panther's head, sometimes supporting his other symbol, a weapon with two panther heads.

As in the case of Nin-urta, Nergal appears to have absorbed a number of minor solar deities, which accounts for the various names or designations under which he appears, such as Lugalgira, Sharrapu ("the burner," perhaps a mere epithet), Ira or Gira, Gibil (though this name more properly belongs to Nusku, *q.v.*). A certain confusion exists in cuneiform literature between Kin-urta and Nergal, perhaps due to the traces of two different conceptions regarding these two solar deities. Nergal is called the "raging king," the "furious one," and the original Sumerian name consists of three elements, Ne-urugal, "might of the great dwelling" and thus at the head of the nether-world a pantheon is indicated. In the astral-theological system he is the planet Mars, while in ecclesiastical art the great lion-headed colossi serving as guardians to the temples and palaces seem to be a symbol of Nergal, just as the bull-headed colossi probably typify Nin-urta.

The name of his chief temple at Kutha was E-shid-lam, from which the god receives the designation of Shidlamtäea, "the one that rises up from Shidlam." The cult of Nergal does not appear to have been as widespread as that of Nin-urta. He is frequently invoked in hymns and in votive and other inscriptions of Babylonian and Assyrian rulers, but we do not learn of many temples to him outside of Kutha. Sennacherib speaks of one at Tarbisu to the north of Nineveh, but although Nebuchadrezzar II. (606–586 B.C.), the great temple-builder of the neo-Babylonian monarchy, alludes to his operations at E-shid-lam in Kutha, he makes no mention of a sanctuary to Nergal in Babylon. Local associations with his original seat—Kutha—and the conception formed of him as a god of the dead acted in making him feared rather than actively worshipped. He is often spoken of as a god who passed judgment on the souls of the dead, and in the late period arose the theory of compensation at his hands in Arallu for the righteous, and thus arose the late Hebrew belief in rewards after death to explain the problem of providence.

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NERI, SAINT PHILIP (FILIPPO SERI) (*1j15–159j*), one of the outstanding figures of the Counter Reformation. known as the second "apostle of Rome," was the founder of the Congregation of the Oratory (*q.v.*). St. Ignatius Loyola and St. Charles Borromeo were his friends. the church historian Caesar Baronius was his disciple. and Palestrina came within his circle. Born in Florence on July *21.* 151*j*. Philip left the city at about the age of *18* for the home of a relative near Monte Cassino. After what might be termed a conversion (though his life was innocent). he went to Rome where he spent his remaining *60* years. Hz tutored the sons of a Florentine in return for an attic and a pittance. He attended lectures on philosophy and theology, though not intending to receive holy orders but rather to pursue a lay apostolate. Cheerful and open by temperament. he conversed with the young men of the city in order to lead to some serious question: "Well. and when shall we begin to do good?" He served in the hospitals and frequently spent whole nights in prayer in the catacombs of St. Sebastian.

In 1548 he founded the confraternity of the Holy Trinity to give hospitality to poor pilgrims and convalescents discharged from hospitals.

In *1551*, prevailed on by his spiritual adviser, he was ordained priest and went to reside with the chaplains at San Girolamo della Carita, in the via di Monserrato. There he gathered in his room the young men he had already grouped around him and others whom he won by an assiduous ministry in the confessional. These meetings had some resemblance to modern discussion groups with the addition of prayers and hymns. When numbers increased he transferred these meetings to the church attics. They called this locality "the Oratory," a name that came to be applied also to those who met there and to the devotional, charitable and recreational activities that Philip devised for them (among these music, whence ultimately. "oratorio"). For a time (*1564–75*) Philip was rector of the Florentines' church of San Giovanni; in this period Baronius and other disciples were ordained, thus forming the germ of a new community.

In *1*575, a bull of Gregory XIII granted Philip the ancient church of Sta. Maria in Vallicella and established there in perpetuity "a Congregation of secular priests and clerics known as the Oratory." The old church was pulled down and a new one built—still called the Chiesa Nuova—and a house for the priests, though it was not until 1583 that Philip went there to reside. In 1577 he was formally elected provost of the congregation.

Apart from the pressure he exerted on Pope Clement VIII to obtain the absolution from excommunication of King Henry IV of France, Philip played no part in the political events of the time. His work was essentially one of personal influence: he attracted men not merely by his joyfulness and humour but. even more. by the supernatural gifts he manifested. His fervour of spirit was accompanied by a sensation of physical heat and a violent palpitation of the heart; distrustful of all ecstatics he was frequently carried away by ecstasies himself. Many miracles were attributed to him. notably the raising to liie of Paolo dei Massimi. Up until the end of his life he continued to hear confessions and receive all who sought his help.

Philip died on May *26. 159j*, and was buried in the church he had built. He was canonized in *1622;* his feast day is May *26.*

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(V. J. M.M.)

NERNST, WALTHER HERMANN (1864–1941), German chemist. was one of the founders of modern physical chemistry, making fundamental contributions in the fields of electrochemistry, theory of solutions, thermodynamics, the solid state and photochemistry. He was born June 25, 1864, in Briesen. West Prussia. and was educated at the universities of Zurich. Graz and Würzburg. In *1887* he became assistant to Wilhelm Ostwald (*q.v.*) at Leipzig university. Ostwald, along with J. van't Hoff and Svante Arrhenius, was then establishing physical chemistry as an independent branch of chemistry, and Nernst, in the midst of such a stimulating group, at once began his own important researches.

His academic career commenced with his appointment to the physics department of the University of Gottingen in 1890. In 1905 he moved to the Physicochemical laboratory of the Cniversity of Berlin and in 1924 he became director of the Institute for Experimental Physics there. He remained in this position until his retirement in 1933. His electrochemical studies were begun under the inspiration of the then new dissociation theory of Arrhenius which first recognized the importance of ions in solution.

In 1889 Nernst worked out the theory of galvanic cells by assuming a solution pressure which forced ions from the electrode into solution and which was opposed by an osmotic pressure of the dissolved ions. In the same year, still thinking in terms of ions, Nernst derived the equations for the solubility product which defined the conditions under which solids precipitate from saturated solutions. In 1906 he announced his heat theorem, or third law of thermodynamics, which showed that the maximum work obtainable from a process could be calculated from the heat evolved at temperatures near absolute zero. This made precise the older ideas which had neglected the effects of temperature and permitted calculation of conditions of equilibrium in many chemical reactions. Besides its great theoretical importance, the theorem had many industrial applications, including calculations for the synthesis of ammonia. Nernst received the Nobel prize in chemistry for the heat theorem in 1920. Nernst and his students made many important physicochemical measurements, especially the determination of vapour densities at high temperatures and of the specific heats of solids at very low temperatures. These he considered from the point of view of the quantum theory. In 1918 his photochemical studies led him to the atom chain reaction theory. This assumed that once the energy of a quantum has initiated a reaction in which free atoms are formed, these atoms can in turn decompose other molecules with the liberation of more free atoms, and so the reaction can continue for long periods without further illumination. This mechanism explained many reactions which had puzzled photochemists.

Nernst was mechanically minded and was much interested in the application of science to industry. Besides his theoretical contributions he invented an improved electric light and a piano with electronic amplification of its sounds. His inventions never received wide acceptance, however. His textbook on theoretical chemistry, first published in 1893. was influential for many years. He also published a number of monographs in his special fields. In his later years he concerned himself chiefly with astrophysical theories, a field in which the heat theorem also had important applications. He died Nov. 18, 1941, in Muskau. (H. M. L.)

NERO (NERO CLAUDIUS CAESAK AUGUSTUS GERMANICUS) (A.D. 37–68): Roman emperor 54–68, was born at Antium on Dec. 1j, 37. He was the son of Gnaeus Domitius Ahenobarbus and Agrippina the younger, and his name was originally L. Domitius Ahenobarbus. His father died when Nero was scarcely three years old. In the previous year (39) his mother had been banished by order of her brother Caligula (Gaius), and Nero found shelter in the house of his aunt Domitia. The emperor Claudius recalled Agrippina, who spent the next 13 years in a struggle to obtain the succession of the throne for Nero. She married Claudius in 49, and in 50 he adopted Kero as his son. Seneca was recalled from exile to be his tutor.

On his 14th birthday Nero assumed the toga *virilis,* and was introduced to the senate by Claudius with the title of *princeps inventutis*. This made his succession almost certain, and Agrippina subsequently got rid of the partisans of Britannicus and installed Burrus as praefect of the praetorian guard.

Succession. — In 52, in Claudius' absence. Nero was praefect of the city. He married Claudius' daughter Octavia. On Oct. 13, 54, Claudius died, poisoned by Agrippina's orders and Nero was presented to the soldiers on guard as their new sovereign. From the palace steps he proceeded to the praetorian camp, and thence to the senate house, where he was made emperor.

Agrippina's bold stroke had been completely successful. Only a few voices were raised for Britannicus; nor is there any doubt that Rome was prepared to welcome the new emperor with genuine enthusiasm. His prestige and his good qualities, carefully fostered by Seneca, made him popular, while his darker passions were as yet unsuspected. His first acts confirmed this favourable impression. He modestly declined the title of *pater patriae;* the memory of Claudius, and that of his own father Domitius were duly honoured. He promised to follow the principles of Augustus, and his clemency, liberality and affability were the talk of Rome.

Much of the credit of all this is due to Seneca and Burrus. Seneca had seen from the first that the real danger with Nero lay in the savage vehemence of his passions, and he made it his chief aim to stave off by every means in his power the dreaded outbreak. The policy of indulging his tastes and helping him to enjoy.the sweets of popularity without the actual burdens of government succeeded for the time.

During the first five years of his reign, little occurred to damp the popular enthusiasm. Nero's promises were fulfilled. and the senate found itself free to discuss and even to decide important administrative questions. Abuses were remedied, the provincials protected from oppression, and the burdens of taxation lightened. On the frontiers no serious disaster occurred, and even the murder of Britannicus was accepted as a necessary measure of self-defense. But an essential part of Seneca's policy was to remove Nero from the influence of his mother.

Agrippina's Eclipse. — In 55. Seneca found a powerful ally in Nero's passion for the beautiful freedwoman Acte, a passion which he deliberately encouraged. Agrippina's angry remonstrances served only to irritate Nero, and caresses equally failed. She then threatened to espouse the cause of Britannicus. Nero retaliated by poisoning Britannicus. Agrippina then tried to win over Nero's neglected aife Octavia, and to form a party of her own. Nero dismissed her guards. and placed her in a sort of honourable confinement (Tac. *Ann*. xiii. 12–20). During nearly three years she disappears from the history, and with her retirement things again for the time went smoothly.

In 58 Nero was enslaved by Poppaea Sabina, a woman of a very different stamp from her predecessor. She was resolved to be Nero's wife. and her first object was the removal of Agrippina. By rousing Nero's jealousy and fear she induced him to seek Agrippina's death, with the aid of a freedman Anicetus praefect of the fleet of Misenum. Agrippina was invited to Baiae, and after an affectionate reception, was conducted on board a vessel so constructed as, at a given signal, to fall to pieces. But Agrippina saved herself by snimming, and wrote to her son, announcing her escape, and affecting entire ignorance of the plot. A body of soldiers under Anicetus then surrounded her villa, and murdered her in her own chamber. Nero mas horror-struck at the enormity of the crime and terrified at its possible consequences But a six months' residence in Campania, and the congratulations which poured in upon him from the neighbouring towns, where the report had been officially spread that Agrippina had fallen a victim to her treacherous designs upon the emperor, gradually restored his courage. In Sept 59 he re-entered Rome amid universal rejoicing. Races, exhibitions and games in the Greek fashion rapidly succeeded each other.

Poppaea.—The result of the death of Agrippina was the growing influence over Nero of Poppaea and her friends In 62 Burrus died, it was said by poison, and Seneca retired from his post. Their place was filled by Poppaea. and the infamous Tigellinus, whose sympathy with Nero's sensual tastes had gained him the command of the praetorian guards in succession to Burrus. The fear of conspiracy mas skillfully used by them to direct Nero's suspicions against possible opponents. Cornelius Sulla, who had been banished to Massilia in 58, was put to death on the ground that his residence in Gaul was likely to arouse disaffection in that province, and a similar charge proved fatal to Rubellius Plautus, who had for two years been living in retirement in Asia. Nero's taste for blood thus whetted, Octavia was divorced, banished to the island of Pandateria and murdered. Poppaea's triumph was now complete She was married to Nero; her head appeared on the coins uith his; and her statues were erected in the public places of Rome.

In the course of 61 occurred the rebellion of Boudicca (Boadicea) and the Iceni in Britain, resulting in the sack of Colchester and the destruction of the 9th legion before it was suppressed by Suetonius Paulinus. Further disasters were the destruction of Pompeii and the evacuation of Armenia in 63.

The Burning of Rome. —A far deeper and more lasting impression was produced by the great fire in Rome. The fire broke out on the night of July 18, 64, among the wooden booths at the southeast end of the Circus Maximus. Then in one direction it rapidly spread over the Palatine and Velia up to the low cliffs of the Esquiline, and in another it laid waste the Aventine, the Forum Boarium and Velabrum until it reached the Tiber and the solid barrier of the Servian wall. After burning fiercely for six days it started afresh and desolated the regions of the Circus Flaminius and the Via Lata. and after it was finally quenched only four of the 14 *regiones* remained untouched; three had been utterly destroyed and seven reduced to ruins.

The conflagration is said by all authorities later than Tacitus to have been deliberately caused by Nero himself. But Tacitus, though he mentions the rumours, declares that its origin was uncertain. and in spite of such works as Profumo's *Le fonti* ed *i tempi dello incendio Neroniano* (1905), there is no proof of his 'guilt. By Nero's orders, the open spaces in the Campus Martius were utilized to give shelter to the homeless crowds. provisions were brought from Ostia and the price of corn lowered. In rebuilding the city every precaution was taken against the recurrence of such a calamity. Broad regular streets replaced the narrow winding alleys. The new houses were limited in height, built partly of hard stone and protected by open spaces.

This disaster undoubtedly told against Nero. being widely regarded as evidence of the wrath of the gods. The work of rebuilding included the erection of Nero's famous palace, the "Golden House." and the laying-out of its wonderful grounds.

To defray the enormous cost, Italy and the provinces, says Tacitus. were ransacked, and in Asia and Achaia especially the rapacity of the imperial commissioners recalled the days of Mummius and of Sulla. It was the first occasion on which the provincials had suffered frorn Nero's rule. and the discontent it caused helped to weaken his hold over them at the very moment when the growing dissatisfaction in Rome was gathering to a head. Early in 65 Sero was panic-stricken by the discovery of a conspiracy involving such men as Faenius Rufus, Tigellinus' colleague in the prefecture of the praetorian guards. Plautius Lateranus, one of the consuls elect. the poet Lucan, and. lastly, not a few of the tribunes and centurions of the praetorian guard itself. Their chosen leader, whom they destined to succeed Nero, rr-as C. Calpurnius Piso. a handsome. n-ealthy and popular noble, and a boon companion of Xero. The plan to murder Xero was betrayed by a freedman Milichus. Piso, Faenius Rufus: Lucan and Seneca himself were executed.

In the nest few months many more fell victims to his fear and resentment. Conspicuous among them was Paetus Thrasea. whose unbending virtue had long made him distasteful to Sero. and who was now suspected! possibly with reason. of sympathy with the conspirators. Poppaea died in the autumn of 65. and the general gloom was increased by a pestilence which followed the fire.

Early in the summer of 66 the Parthian prince Tiridates came to Italy to receive the crown of Armenia at Nero's hands. It represented the final triumph of the arms and policy of Corbulo in the East, and at least a temporary solution of the Parthian problem.

Greece.—Toward the end of 66 Nero visited Greece with a retinue of soldiers. courtiers, musicians and dancers. The spectacle presented by Sero's visit was unique. He went professedly as an enthusiastic worshipper of Greek art and a humble candidate for the suffrages of Greek judges. At each of the great festivals: which to please him were for once crowded into a single year, he entered in regular form for the various competitions, scrupulously conformed to the tradition and rules of the arena, and awaited in nervous suspense the verdict of the umpires. The dexterous Greeks humoured him to the top of his bent. He planned and commenced the cutting of a canal through the Isthmus of Corinth.

Meanwhile the general dissatisfaction was coming to a head. as may be inferred from the urgency with which the imperial freedman Helius insisted upon Nero's return to Italy. Revolt started in Gaul with the insurrection of Julius Vindex, governor of Gallia Lugdunensis. It is probable that the aims of Vindex included the liberation of northern Gaul, which would explain both the enthusiasm of the Gallic chiefs. and the opposition of the legions of the Rhine. This force defeated Vindex at Vesontio (Besançon) and offered the throne to their own commander Virginius Rufus. who refused it. Meanwhile governors Galba of Tarraconensis and Otho of Lusitania had rebelled, and Galba had claimed the throne. Nero returned from Greece to Saples for further revels.

Suicide.—The revolts in Spain and Germany terrified him too late into something like energy. The senate almost openly intrigued against hirn, and the populace were silent or hostile. The fidelity of the praetorian sentinels even was more than doubtful. When finally the palace guards forsook their posts. Xero despairingly stole out of Rome to seek shelter in a freedman's villa some four miles off. There he heard of the senate's proclamation of Galba as emperor. and of the sentence of death passed on himself. On the approach of the horsemen sent to drag him to execution. he collected sufficient courage to save himself by suicide. Nero died on June 9. 68, in the 31st year of his age and the 14th of his reign, and his remains were deposited by the faithful Acte in the family tomb of the Domitii on the Pincian hill. With his death ended the line of the Caesars, and Roman imperialism entered a new phase. His statues were broken, his name everywhere erased. and his "Golden House" demoiished.

'The Roman populace for a long time reverenced his memory as that of an open-handed patron, and in Greece the recollections of his magnificence. and his enthusiasm for art. were still fresh when the traveler Pausanias visited the country a century later. The belief that he had not really died, but would return again to confound his foes, was long prevalent. not only in the remoter provinces, but even in Rome itself; and more than one pretender was able to collect a following by assuming the name of the last of the race of Augustus.

More lasting still was the implacable hatred of those who had suffered from his cruelties. Roman literature, faithfully reflecting the sentiments of the aristocratic salons of the capital. while it almost canonized those who had been his victims, fully avenged their wrongs by painting Nero as a monster of wickedness. In Christian tradition he even appears as the mystic Antichrist, who was destined to come once again to trouble the saints. Even in the middle ages. Xero was still the very incarnation of splendid iniquity. while the belief lingered that he had only disappeared for a time. and as late as the 11th century his restless spirit was supposed to haunt the slopes of the Pincian hill.

The chici ancient authorities for Nero's life and reign are Tacitus (*Annals*, xiii–svi, edit. *by* Furneaux). Suetonius. Dio Cassius (*Epit.* Ixi, lxii, lxiii) and Zonaras (*Ann.* xi). The most important modern work is that of B. W. Henderson, *The Life and Principate of the Emperor Nero* (1903; *see* an important notice in *Class.* REV., vol. xviii, p. 57), which contains full bibliography of ancient and modern writers: *see* also H. Schiller's Xero, and *Geschichte d. Kaiserzeit;* Lehmann, *Claudius und Nero;* Desider Kostolanyi, *Nero* (1928).

NERVA, MARCUS COGCEIUS (A.D. ?35–98), Roman emperor from Sept. 18. 96, to Jan. 2j.98, was born at Narnia in Umbria on Nov. 8, probably in the year 3j. He came of a senatorial family, his father and grandfather having been jurists.

He was praetor (66) and twice consul. in 71 with the emperor Vespasian for colleague and again in 90 with Domitian. Toward the close of the latter's reign (93) he is said to have been banished to Tarentum on a charge of conspiracy. On the murder of Domitian in Sept. 96 Nerva was declared emperor by the people and the soldiers.

He is described as a quiet, kindly, dignified man. honest of purpose, but unfitted by his advanced age to bear the weight of empire. Nevertheless, his selection, in spite of occasional exhibitions of weakness, justified the choice. The new emperor recalled those who had been exiled by Domitian; what remained of their confiscated property was restored to them. and a stop was put to the vexatious prosecutions which Domitian had encouraged. But the popular feeling demanded more than this. The reaction against the informers became as dangerous as the previous system. It was checked by Nerva, who was actuated by the taunt of Titus Catius Caesius Fronto that. "bad as it was to have an emperor who allowed no one to do anything. it was worse to have one who allowed everyone to do everything."

Nerva seems to have followed the custom of announcing the general lines of his future policy. He showed himself anxious to respect the traditional privileges 'of the senate, and such maxims of constitutional government as still survived. He pledged himself to put no senator to death. His councillors in all affairs of state were senators, and the hearing of claims against the *fiscus* was entrusted to a praetor and a court of *indices.*

The economical condition of Italy evidently excited his alarm and sympathy. The last mention of a *lex agraria* in Roman history is connected with his name. Under the provisions of this *lex,* large tracts of land were bought up and allotted to poor citizens. The cost was defrayed partly from the imperial treasury, but partly also from Nerva's private resources, and the execution of the scheme was entrusted to commissioners. He also founded or restored colonies at Verulae, Scyllacium and Sitifis in Mauretania.

An entirely new departure was the maintenance at the public cost of the children of poor parents in the towns of Italy, which was combined ingeniously with the provision of loans for farmers. The treasury found the money, which was lent on the security of farms, and the farmers paid the interest to their municipality for the maintenance of poor children.

Private individuals were also encouraged to follow the imperial example. In the hands of Trajan, Hadrian and the Antonines, Nerva's example bore fruit in the institution of the *alimentationes,* the most genuinely charitable institution of the pagan world. These measures Nerva supplemented by others which aimed at lightening the financial burdens on the declining industry of Italy. The cost of maintaining the imperial postal system (*vehiculatio*) was transferred to the *fiscus;* from the same source apparently money was found for repairing the public roads and aqueducts; and lastly, the lucrative but unpopular tax of 5% on all legacies or inheritances *(vicesima hereditatum*), was so readjusted as to remove the grosser abuses connected with it. At the same time Nerva did his best to reduce the overgrown expenditure of the state.

A commission was appointed to consider the best modes of retrenchment, and the outlay on shows and games was cut down to the lowest possible point. Early, apparently, in 97 Nerva detected a conspiracy against his life headed by L. (or C.) Calpurnius Crassus, but he contented himself with a hint to the conspirators that their designs were known, and with banishing Crassus to Tarentum. The praetorian guards, at the instigation of one of their two prefects, Casperius Aelianus, whom Nerva had retained in office, imperiously demanded the execution of Domitian's murderers, the chamberlain Parthenius and Petronius Secundus, Aelianus's colleague. Nerva vainly strove to save, even at the risk of his own life: the men who had raised him to power, but the soldiers brutally murdered the unfortunate men, and forced him to propose a vote of thanks for the deed. This humiliation convinced Nerva of the necessity of placing the government in stronger hands than his own. He resolved to adopt as his colleague and destined successor: M. Ulpius Trajanus, a distinguished soldier, at the time in command of the legions on the Rhine. In Oct. 97. in the temple of Jupiter on the Capitol, Trajan was formally adopted as his son and declared his colleague in the government of the empire.

For three months Nerva ruled jointly with Trajan, but on Jan. 25, 98, he died somewhat suddenly. He was buried in the sepulchre of Augustus, and divine honours were paid him by his successor. The verdict of history upon his reign is best expressed in his own words—"I have done nothing which should prevent me from laying down my power, and living in safety as a private man." The memory of Nerva is still preserved by the ruined temple in the Via Alessandrina (il Colonacce) which marks the site of the Forum begun by Domitian, but which Nerva completed and dedicated.

Bibliography.—Dio Cass. lxviii, 1–4; Aurelius Victor 12, and *Epit.* 24; Zonaras xi, 20; compare also Pliny, *Epistolae* and *Panegyricus;* Tillemont, *Histoire des empereurs romains,* ii; C. Merivale, *History of the Romans Under the Empire,* ch. 63; H. Schiller, *Geschichte der römischen Kaiserzeit,* i, pt. 2, p. 538 (1883); J. Asbach, *Römisches Kaiserthum und Verfassung bis auf Trajan* (1896); A. Stein in Pauly-Wissowa's *Real-Encyclopadie der classischen Altertumswissenschaft* (*s.v.* Cocceius, 16); J. B. Bury, *The Student's Roman Empire,* ch. 23 (1893); M. I. Rostovtsev, *Social and Economic History of the Roman Empire* (1926); B. W. Henderson, *Five Roman Emperors* (1927).

(H. F. P.; X.)

NERVAL, GERARD DE (1808–1855), the adopted name of Gérard Labrunie, French man of letters, born in Paris on May 22, 1808. His father was an army doctor, and the child was left with an uncle in the country, while Mme. Labrunie accompanied her husband in his campaigns. She died in Silesia. In 1811 his father returned, and besides Greek and Latin taught the boy modern languages and the elements of Arabic and Persian. Gérard found his favourite reading in old books on mysticism and the occult sciences. His first work, *La France guerrière, élégies nationales,* was published while he was still a schoolboy at the Collège Charlemagne. In 1828 he published a translation of Goethe's *Faust,* the choruses of which were afterward used by Berlioz for his legend symphony, *The Damnation of Faust.* A number of poetical pieces and three comedies combined to acquire for him, at the age of 21, a considerable reputation, and led to his association with Théophile Gautier in the preparation of the dramatic *feuilleton* for the *Presse.* He conceived a violent passion for the actress Jennie Colon, in whom he thought he recognized a certain Adrienne, who had fired his childish imagination. Her marriage and her death in 1842 were blows from which his nervous temperament never really recovered. He traveled in Germany with Alexandre Dumas, and alone in various parts of Europe, leading a very irregular and eccentric life. In 1843 he visited Constantinople and Syria, where, among other adventures, he nearly married the daughter of a Druse sheikh. He contributed accounts of his travels to the *Revue des Deux Mondes* and other periodicals. After his return to Paris in 1844 he resumed for a short time his *feuilleton* for the *Presse,* but his eccentricities increased and he committed suicide by hanging, on Jan. 25, 1855. The literary style of Gérard is simple and unaffected, and he has a peculiar faculty of giving to his imaginative creations an air of naturalness and reality. In a series of novelettes, afterward published under the name of *Les Illuminés, ou les précurseurs du socialisme* (1852), containing studies on Rétif de la Bretonne, Cagliostro and others, he gave a sort of analysis of the feelings which followed his third attack of insanity. Among his other works the principal are *Les Filles du feu* (1854), which contains his masterpiece, the semi-autobiographical romance of *Sylvia; Scènes de la vie orientale* (1848–50); *Contes et face'ties* (1852); *La Bohême galante* (1856); and *L'Alchimiste,* a drama in five acts, the joint composition of Gérard and Alexandre Dumas. His *Poésies complètes* were published in 1877.

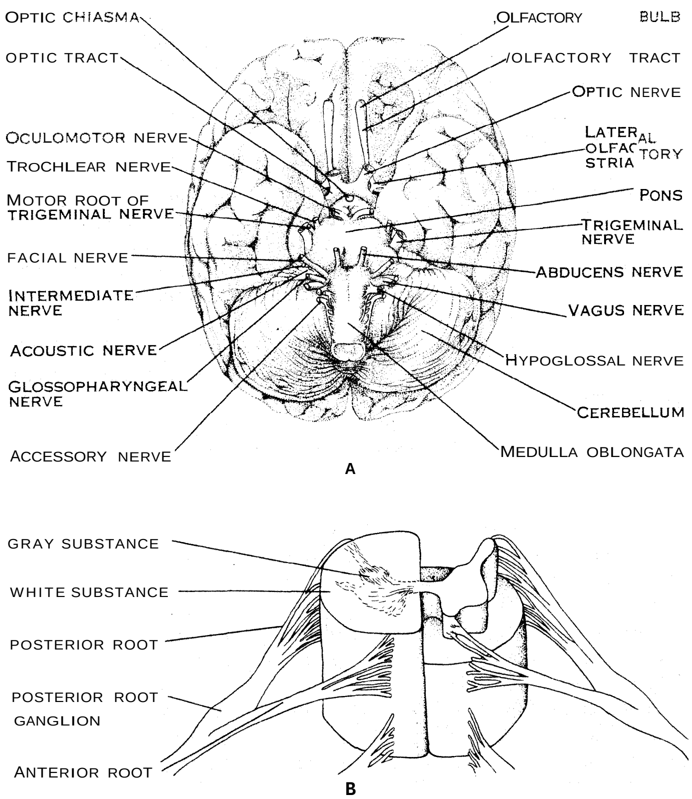
See the notices by Théophile Gautier and Arsène Houssaye, prefixed to the posthumous *Le Rêve et la vie* (1855); Maurice Tourneux's sketch in his *Âge du romantisme* (1887); and a sympathetic study of temperament in the *Névrosés* (1898) of Mme. Arvède Barine. *See* also G. Ferrières, *Gérard de Nerval* (1906).

NERVE, in anatomy, is a glistening white cordlike bundle of fibres, surrounded by a sheath, that connects the nervous system with other parts of the body (*see* Nervous System). The nerves conduct impulses toward or away from the central nervous mechanism. In man 12 pairs, the cranial nerves, are attached to the brain and 31 pairs, as a rule, of spinal nerves attach to the spinal cord. The fibres constituting the individual nerves are very numerous; and all, save those arising in the sympathetic ganglia, extend from the brain or cord to the peripheral structures which they innervate.

With respect to function, nerve fibres are divided into two categories, namely, sensory or afferent and motor or efferent. The fibres of these categories and their subdivisions constitute the functional components of the nerves. The combinations of such components vary in the individual cranial nerves; in the spinal nerves they are more uniform.

The afferent (sensory) fibres are subdivided into somatic and visceral groups. The somatic afferents conduct impulses received from outside the body or produced by movements of the muscles and joints, those from the muscles and joints also being known as proprioceptive fibres. The visceral afferents conduct messages from the organs serving the internal economy of the body; such impulses result in reflex control of these organs (*e.g.,* the rate of the heart beat, activities of the digestive system and others).

The motor fibres are divided into somatic and visceral motor or efferent groups. Somatic efferent fibres innervate voluntary muscles that derive from the myotomes of the embryo (*see* Mus-



(TOP) MODIFIED FROM O. LARSELL, IN MORRIS' "HUMAN ANATOMY," 11TH ED. (1953); REPRODUCED BY PERMISSION OF BLAKISTON DIVISION McGRAW-HILL BOOK COMPANY, INC. (BOTTOM) FROM O. LARSELL, "ANATOMY OF THE NERVOUS SYSTEM," 2ND ED. (1951); REPRODUCED BY PERMISSION OF APPLETON-CENTURY-CROFTS, INC.

FIG. 1.—(A) INFERIOR SURFACE OF THE BRAIN SHOWING ROOTS OF THE CRANIAL NERVES; (B) SEGMENT OF THE SPINAL CORD SHOWING ONE PAIR OF SPINAL NERVE ROOTS

CLE AND MUSCULAR SYSTEM). Visceral motor fibres are subdivided into special visceral efferents, which innervate striped muscles of branchial origin; and general visceral efferents, which innervate involuntary muscle and secreting glands. The general visceral efferent fibres constitute the autonomic system, of which there is a sympathetic division and a parasympathetic division, based on differences in anatomical arrangement and physiological characteristics. The term sympathetic also is frequently used to include both divisions as well as the ganglia and afferent fibres associated with them.

The autonomic pathway involves a chain of two fibres, one arising in the brain or spinal cord and ending in a sympathetic ganglion (hence called the preganglionic fibre), the second (the postganglionic fibre) arising in the ganglion and passing to the organ innervated.

CRANIAL NERVES

The cranial nerves (fig. 1[A]) are designated by name and also by number. Roman numerals being conventionally used as a rule. They emerge through openings (foramina) of the skull (see SKULL). Some of the cranial nerves are purely sensory, some entirely motor and others are mixed. The afferent fibres, save those of the olfactory and optic nerves, arise in the cranial sensory ganglia, situated in the course of sensory nerves near the brain. Central processes (in this context the word process means a projecting part, an extension) terminate in sensory nuclei of the brain. The motor fibres arise within the brain from motor nuclei. In some instances the central nuclei. sensory or motor, are distinct for each nerve; in others the functional components of the same category from several nerves may enter or arise from a nucleus shared in common.

In addition to the 12 pairs described below, a small pair, the nervus terminalis. whose significance is obscure, is found in close relation with the olfactory nerve.

Olfactory Nerve.—The first cranial nerve is entirely afferent, serving the sense of smell. It comprises about 20 small filaments formed by convergence of numerous fibres that arise from cells in the olfactory mucous membrane. These cells also are the olfactory receptors and are unique in combining a sensory percipient function with giving origin to long nerve fibres. The filaments enter the brain cavity through small openings in the anterior part of its floor and terminate in the olfactory bulb of the forebrain (fig. 1[A]). (*See* also OLFACTORY SYSTEM.)

Optic Nerve.—The second cranial nerve serves the sense of sight and is entirely afferent. Its cells of origin lie in the retina of the eye. The nerve fibres emerge from the back of each eyeball as a bundle called the optic nerve. The two nerves converge and form the optic chiasma, from which the optic tract continues to the lateral geniculate body of the thalamus and the superior colliculus and pretectal area of the midbrain (figs. 1[A] and 2). The nerve fibres: however, pass without interruption from the retina to the centres named.

Those from the medial (toward the nose) half of each retina cross in the chiasma and enter the opposite optic tract; those from the lateral (toward the temples) side of the retina enter the optic tract of the same side. The optic centres of either half of the brain. accordingly, receive fibres from both eyes. (See also EYE, HUMAN.)

Oculomotor Nerve.—The third cranial nerve has its origin in the oculomotor nucleus of the midbrain (fig. 3). This nucleus comprises (1) a group of cells, the principal nucleus. which sends fibres to the extrinsic eye muscles; and (2) the nucleus of Edinger-Westphal, which gives rise to preganglionic parasympathetic fibres.

The nerve emerges from the underside of the midbrain and divides into a superior branch and an inferior branch. The superior branch supplies one of the muscles of the eyeball and the muscle of the upper eyelid. The inferior branch supplies three of the muscles of the eyeball: from the branch to one of these muscles the preganglionic parasympathetic fibres pass by a short connection to the ciliary ganglion. This ganglion gives rise to postganglionic fibres that enter the eyeball and end in the constrictor muscle of the iris and the ciliary muscle. The oculomotor nerve also includes proprioceptive fibres to the extrinsic eye muscles.

Trochlear Nerve.—The fourth cranial nerve has its origin in the trochlear nucleus (figs. 1[A] and 3). The fibres cross to the opposite side and emerge dorsally, continuing as a long slender

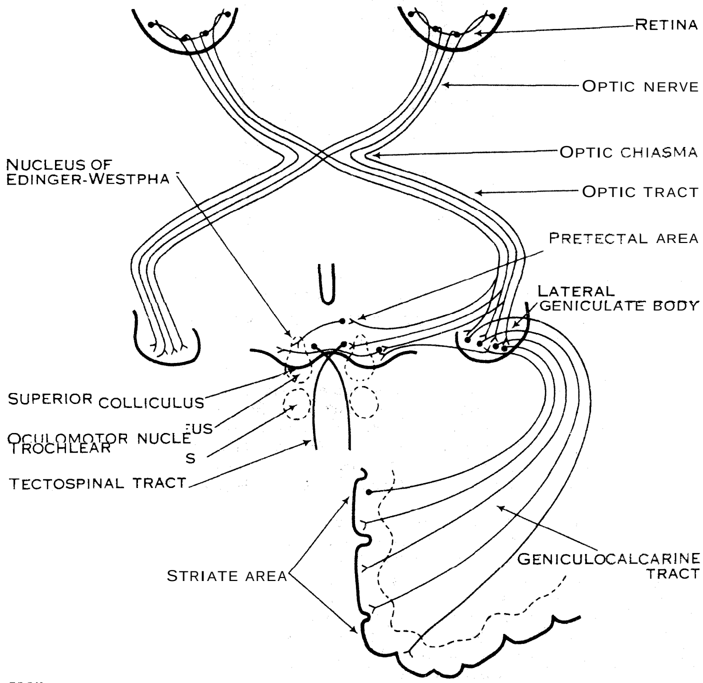


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FIG. 2.— DIAGRAM OF THE OPTIC NERVE. OPTIC TRACT AND CENTRAL CONNECTIONS

strand to the superior oblique muscle of the eyeball. Proprioceptive fibres probably are included with the predominant motor component.

Trigeminal Nerve.—The fifth cranial nerve (figs. 1[A] and 3) is the largest of this group. It has sensory and motor roots, both attached at the anterior lateral surface of the pons. The sensory fibres arise from the semilunar ganglion, their central processes terminating in the superior and spinal trigeminal nuclei. The peripheral fibres are gathered into three divisions, (1) the first or ophthalmic, (2) the second or maxillary and (3) the third or mandibular.

Ophthalmic Nerve.—This supplies a branch to the dura mater of the brain and then divides into lacrimal, nasociliary and frontal nerves, the last subdividing into supraorbital and supratrochlear branches. These nerves supply the skin of the upper part of the face and the front of the scalp (fig. 4). The lacrimal nerve also sends twigs to the conjunctiva of the eye, and the supratrochlear nerve supplies part of the conjunctiva of the upper eyelid.

Maxillary Nerve.—Numerous branches are given off by the maxillary. These are (1) a small meningeal nerve; (2) two connections with the sphenopalatine ganglion that continue as pharyngeal, palatine and nasopalatine nerves to the mucous membrane of the pharynx, palate and nasal cavity; (3) the posterior superior alveolar nerve to the upper teeth; (4) the zygomatic nerve to the skin of the prominence of the cheek and the temple; (5) the infraorbital nerve to the upper gums and teeth, mucosa of the nasal floor, the skin below the eye, on part of the nose and the upper lip.

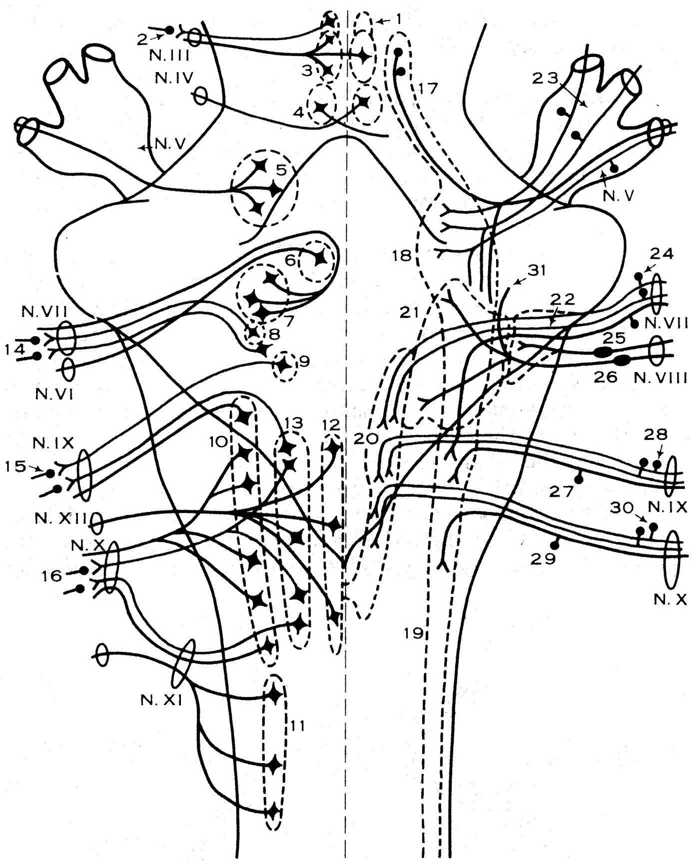

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FIG. 3—DIAGRAM OF ROOTS OF CRANIAL NERVES III TO XII, THEIR CENTRAL NUCLEI AND FUNCTIONAL COMPONENTS

Right side: **Sensory components and nuclei;** ***left side:*** **motor components and nuclei. Cranial autonomic ganglia, situated at a distance from the brain, are indicated in connection with the appropriate nerve roots**
Nerves: **(N. III) oculomotor; (N. IV) trochlear; (N. V) trigeminal; (N. VI) abducens; (N. VII) facial; (N. VIII) acoustic, including cochlear and vestibular divisions; (N. IX) glossopharyngeal; (N. X) vagus; (N. XI) spinal accessory; (N. XII) hypoglossal**
Nuclei and Ganglia: **(1) nucleus of Edinger-Westphal; (2) ciliary ganglion; (3) oculomotor nucleus; (4) trochlear nucleus; (5) motor trigeminal nucleus; (6) abducens nucleus: (7) motor facial nucleus; (8) superior salivatory nucleus; (9) inferior salivatory nucleus; (10) vagus and glossopharyngeal dorsal motor nucleus; (11) spinal accessory nucleus; (12) hypoglossal nucleus; (13) nucleus ambiguus; (14) submaxillary and sphenopalatine ganglia; (15) otic ganglion; (16) vagus visceral ganglia; (17) mesencephalic trigeminal nucleus; (18) superior sensory trigeminal nucleus; (19) spinal trigeminal nucleus; (20) solitary tract nucleus; (21) vestibular nuclei; (22) cochlear nuclei; (23) semilunar ganglion; (24) geniculate ganglion; (25) spiral ganglion; (26) vestibular ganglion; (27) superior glossopharyngeal ganglion; (28) glossopharyngeal petrous ganglion; (29) vagus jugular ganglion; (30) vagus nodose ganglion; (31) direct vestibular fibres to cerebellum**

Mandibular Nerve.—The mandibular includes motor and proprioceptive fibres, in addition to sensory fibres. The latter are distributed (1) to the skin and inner mucous lining of the cheek by the buccinator nerve; (2) to the mucous membrane of the tongue by the lingual nerve; (3) to the lower teeth, lower lip and chin by the inferior alveolar nerve; and (4) to the skin of the auditory canal, eardrum and much of the external ear by the auriculotemporal nerve.

The motor fibres of the mandibular nerve arise in the motor trigeminal nucleus and emerge as the motor root, passing beneath the semilunar ganglion. They are distributed by branches of the nerve to the muscles of mastication, the temporal muscle and the tensors of the palate and eardrum.

The proprioceptive fibres arise from cells of the mesencephalic trigeminal nucleus, in the midbrain, and are distributed to the muscles of mastication with the motor root and its branches. Components related to proprioceptive fibres reach the teeth and gums through the alveolar branches of the mandibular and maxillary nerves.

Abducens Nerve.—The sixth cranial nerve takes origin from the abducens nucleus (figs. 1[A] and 3) and emerges from the forward surface of the medulla oblongata. Passing into the orbit it ends on the lateral rectus muscle. Save for possible proprioceptive fibres the abducens nerve is entirely motor.

Facial Nerve.—The seventh cranial nerve leaves the medulla oblongata by the principal or motor root and the smaller root called the intermediate nerve of Wrisberg (figs. 1[A] and 3). The two roots unite to form a common nerve trunk which enters the facial canal of the petrous bone. Within the canal it gives off a small branch to the stapedius muscle of the ear and one that joins the auricular branch of the vagus nerve, described below. On leaving the canal the facial nerve gives off branches to two muscles beneath the angle of the jaw and also branches to the muscles of facial expression.

The motor fibres derive from the facial nucleus. The intermediate nerve includes both motor and sensory fibres. The motor component consists of parasympathetic fibres from the superior salivatory nucleus and adjacent region. Those from the nucleus are preganglionic fibres that unite with the sensory fibres to form the chorda tympani. This nerve leaves the trunk of the facial nerve before the latter emerges from the facial canal, loops upward into the tympanic cavity and then downward and forward, joining the lingual branch of the trigeminus. The sensory fibres reach the taste buds on the anterior two-thirds of the tongue. The preganglionic fibres turn to the submaxillary and sublingual ganglia, from which postganglionic fibres lead to the glands similarly named.

Another contingent of preganglionic parasympathetic fibres leaves the trunk of the facial nerve just before it enters the facial canal and passes to the sphenopalatine ganglion by way of the great superficial petrosal nerve; postganglionic fibres distribute to the lacrimal gland and the mucous glands of the posterior nasal cavity. The sensory fibres of the intermediate nerve have their origin in the geniculate ganglion; their central processes form part of the solitary tract and end in the nucleus of this tract.

Acoustic Nerve.—The eighth cranial nerve includes two divisions, (1) the vestibular, serving equilibrium; and (2) the cochlear, which serves hearing (figs. 1[A] and 3). They are closely related in much of their course, but have separate central connections and peripheral distribution.

The fibres of the vestibular nerve arise in the vestibular ganglion, the central processes terminating in the vestibular nuclei. The peripheral branches of the nerve pass to the utricle, saccule

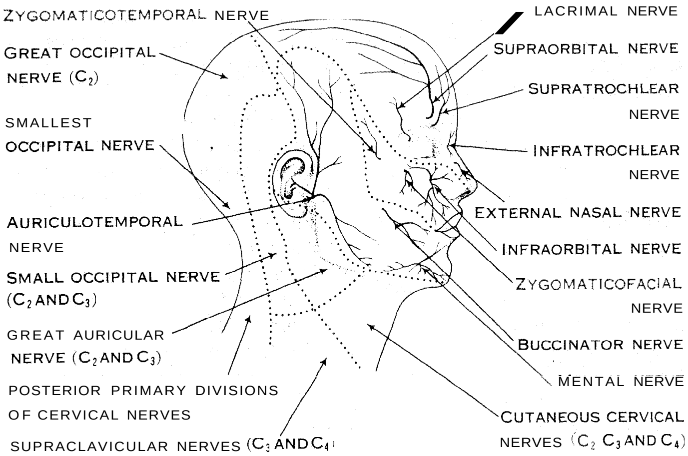

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FIG. 4.— CUTANEOUSNERVE AREAS OF THE HEAD AND NECK

and ampullae of the semicircular canals, the nerve fibres ending in relation to sensory hair cells (see EAR, ANATOMY OF).

The cochlear fibres arise in the spiral ganglion of the cochlea. The centrally directed processes terminate in the cochlear nuclei and the peripheral processes end in relation to hair cells of the organ of Corti. which are stimulated by sound waves.

Glossopharyngeal Nerve.—The ninth cranial nerve is attached to the side of the medulla oblongata by five to six linear rootlets (fig. 1[A]). It includes both motor and sensory fibres, the latter having their origin in the superior and inferior ganglia of the nerve. The central processes of those of the inierior ganglion pass into the solitary tract and end in its nucleus (fig. 3). The peripheral branches of the nerve distribute to the mucous membranes of the pharynx and middle ear and the posterior third of the tongue and to taste buds on this part of the tongue. The motor fibres include special visceral efferents from the nucleus ambiguus to muscles of the pharynx, soft palate and the stylopharyngeus muscle. Preganglionic parasympathetic fibres arise in the inferior salivatory nucleus and relay in the otic ganglion to the parotid gland.

Vagus Nerve.—The tenth cranial nerve is attached to the side of the medulla oblongata by eight to ten linear rootlets that converge to form the nerve trunk (figs. 1[A], 3 and 5). It has two ganglia, the superior and the inferior of the vagus. The superior ganglion gives off meningeal and auricular branches: the auricular distributes to the skin of part of the ear and external auditory canal. The inferior ganglion gives rise to the pharyngeal and superior laryngeal nerves. The former joins the pharyngeal branch of the glossopharyngeus as sensory supply to the mucous membrane of the pharynx. The superior laryngeal nerve is sensory to the mucous membrane of the larynx and base of the tongue; it includes motor fibres to one muscle of the larynx and one of the pharynx.

The recurrent laryngeal nerve branches from the vagus in the neck and supplies the remaining muscles of the larynx and the inierior constrictor of the pharynx; it also provides sensory fibres to the mucous membrane of the larynx below the vocal cords.

Parasympathetic fibres irom the dorsal motor nucleus of the vagus pass through cardiac branches of the nerve, through the cardiac plexus in the chest, to the heart, in which their ganglia are situated. Branches also contribute to the esophageal and pulmonary plexuses. relaying in ganglionic clusters in the plexuses and in the esophagus. trachea. bronchi and lungs to reach the involuntary muscle and glands of these organs.

The vagus continues into the abdomen, supplying the parasympathetic innervation of the greater part of the digestive tract and other abdominal viscera through the gastric. celiac and other plexuses. which also include sympathetic fibres,

The right and left vagus nerves differ somewhat in course and specific distribution. Visceral afferent fibres irom the thoracic and abdominal organs, with cells in the inferior ganglion, enter the solitary tract and its nucleus. The somatic afferents from the skin end in the spinal trigeminal nucleus.

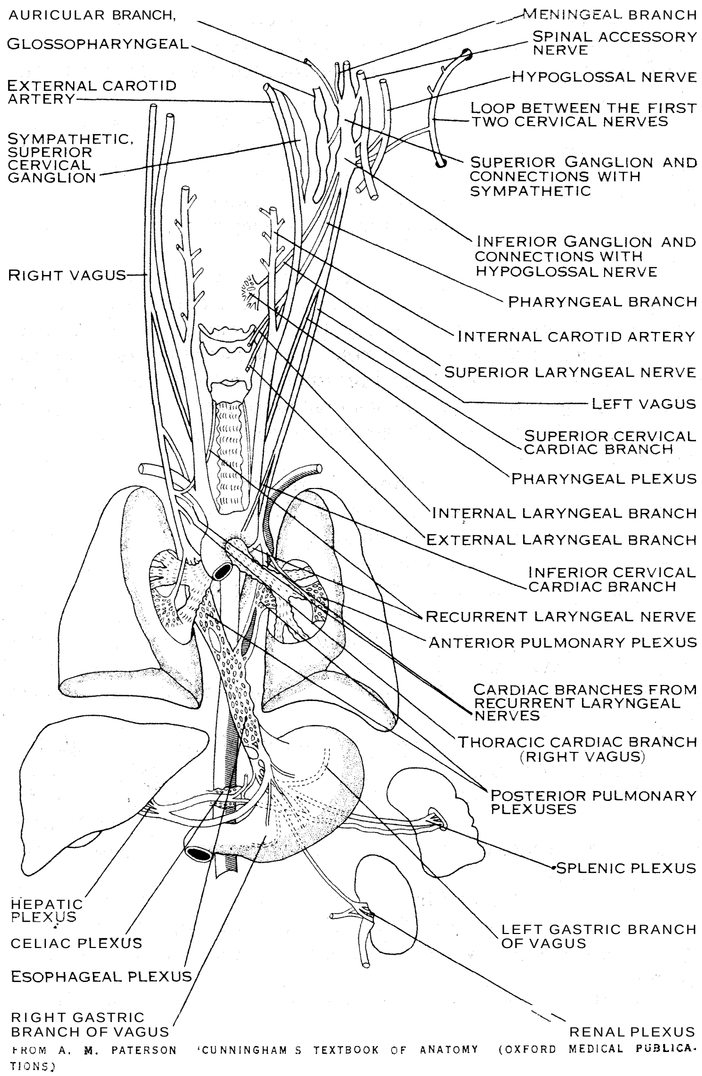
Spinal Accessory Nerve.—The 11th cranial nerve comprises a spinal part and an accessory part (figs. 1[A] and 3), both motor. The accessory part arises chiefly from the nucleus ambiguus and the spinal part from the motor column of the upper five or six segments of the spinal cord. The accessory part joins the vagus and accompanies its branches to the pharynx. The spinal part contributes to the innervation of two muscles of the neck which are of branchial origin.

Hypoglossal Nerve.—The 12th cranial nerve arises from the hypoglossal nucleus. its fibres emerging by numerous rootlets that converge into one trunk (figs. 1[A] and 3). This gives off branches to the musculature of the tongue. which in origin is related to myotomic muscles, Proprioceptive fibres have been described in the hypoglossal nerve. (*See* also TONGUE.)

SPINAL NERVES

The spinal nerves are named and numbered according to the region of the spinal cord to which they attach (*See* SPINAL CORD) There are 8 cervical (abbreviated C) 12 thoracic (T), 5 lumbar (L) 5 sacral (S) and usually 1 coccygeal (Co)

Each spinal nerve has two roots. a dorsal or posterior (meaning "toward the back) and a ventral or anterior (meaning 'toward the front) (fig 1[B]). The dorsal root is sensory and the ventral root motor (the lau of the roots"), the first cervical nerve may lack the dorsal root Oval swellings the spinal ganglia, characterize the dorsal roots, they are formed of nerve cells that give rise to the sensory nerve fibres The fibres of the ventral



FROM A. M. PATERSON 'CUNNINGHAM'S TEXTBOOK OF ANATOMY (OXFORD MEDICAL PUBLICATIONS)

FIG. 5.— DISTRIBUTION OF THE VAGUS NERVE

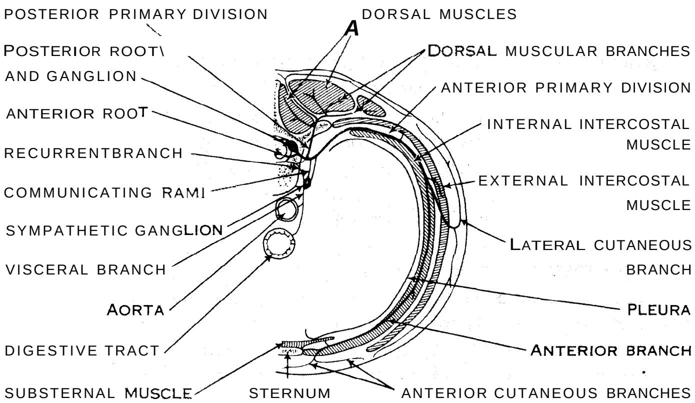


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FIG. 6.— DIAGRAM SHOWING DISTRIBUTION OF A TYPICAL SPINAL NERVE

roots derive from cells in the anterior gray column (ventral horn) of the cord.

Central processes of the dorsal root fibres end in the posterior gray column (dorsal horn) of the cord or ascend to nuclei in the lower part of the brain. Immediately lateral to the spinal ganglia the two roots unite into a common nerve trunk which includes both sensory and motor fibres; the branches of this trunk distribute both types of fibres.

Thoracic Nerves.—The thoracic nerves are the simplest in pattern and distribution. A typical one of these, such as the fifth thoracic, may first be described in greater detail (fig. 6) The common nerve trunk, as is true of all other spinal nerves, soon branches into a posterior primary and an anterior primary division, but first gives off a slender recurrent (or meningeal) branch to the spinal canal.

The posterior primary division subdivides into lateral and medial branches, each sending muscular and cutaneous branches to the back. The anterior primary division gives off a slender strand, the white communicating ramus, which connects with a sympathetic chain ganglion; it also receives a slender gray communicating ramus from such a ganglion.

Passing lateralward between the ribs as the intercostal nerve, on reaching the lateral part of the body wall it gives off the lateral cutaneous nerve, which innervates the skin and fascia of the side of the chest. The nerve then continues forward, as the anterior branch, to the border of the breastbone where it turns outward and forms the anterior cutaneous branch to the front of the chest. Throughout its course the intercostal nerve sends twigs to the intercostal muscles.

The functional types of fibres in the fifth and other thoracic nerves include (1) somatic afferents and efferents to the body wall; (2) autonomic fibres of the sympathetic division; and (3) visceral afferents from the internal organs.

The preganglionic sympathetic fibres take origin in the lateral part of the ventral horn of the cord; all pass through the anterior roots, common nerve trunk and white communicating rami to the sympathetic chain ganglia. Some end in these ganglia, while others continue through splanchnic nerves to the celiac and mesenteric ganglia of the abdomen.

Postganglionic fibres from the chain ganglia pass through the gray rami to the common nerve trunk and are distributed by its branches to sweat glands, erector muscles of the hairs and blood vessels. Those arising in the celiac and mesenteric ganglia pass through the celiac, mesenteric and subsidiary plexuses to the internal organs.

The visceral afferent fibres from the internal organs reach the spinal cord without interruption by way of the splanchnic nerves, sympathetic ganglia, white rami, common nerve trunk and the dorsal roots.

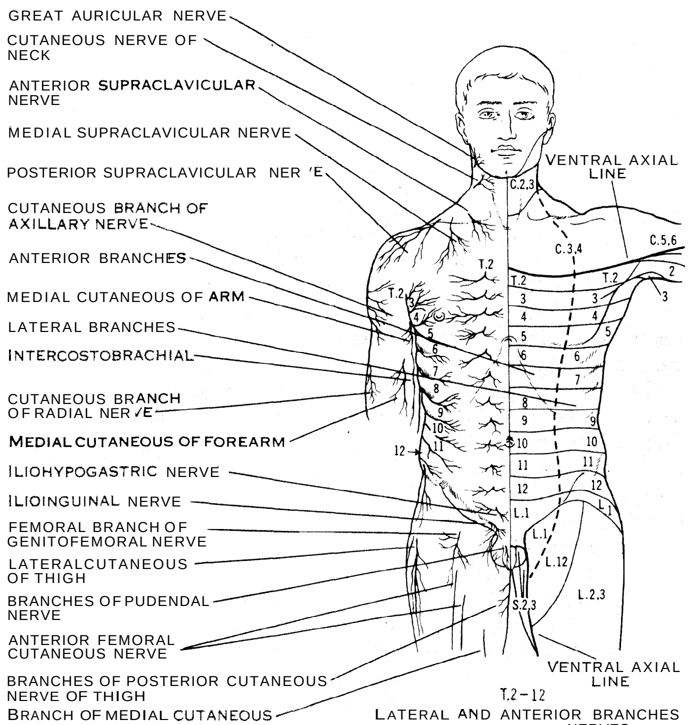
Other thoracic nerves show various departures from the pattern of the fifth. The first thoracic nerve enters also into the formation of the brachial plexus. described below. The second thoracic nerve gives off the intercostobrachial nerve to the skin of the armpit and medial side of the arm (fig. 7). The third thoracic nerve sends a lateral cutaneous branch to the skin of the medial side of the base of the arm, which usually joins the intercostobrachial nerve. The 7th to 12th thoracic nerves continue obliquely into the wall of the abdomen, providing branches to its muscles, and to the skin and fascia as far down as the crest of the hipbone and onto the buttock. The 12th nerve frequently sends a connection to the lumbar plexus, described below. The cutaneous branches of a given thoracic nerve supply not only its own body segment but overlap onto adjacent segments above and below it. Each segment, accordingly, is innervated by cutaneous branches of three spinal nerves (fig. 7). The intercostal nerves also send numerous tuigs to the linings of the thorax and abdomen.

The innervation of the skin of the shoulder, upper extremity, lower part of the body and lower extremity overlaps as in the trunk but in a less regular pattern. Tests after injury to individual sensory nerve roots have revealed longitudinal zones of reduced sensibility, some extending from the lower neck or upper trunk to the hand, or from the lower back or the buttock to the foot. These indicate the areas primarily supplied by individual spinal nerves.

Spinal Nerve Plexuses.—The cervical, lumbar, sacral and coccygeal nerves all receive gray rami from the sympathetic chain ganglia. but only the upper lumbar. in addition to the thoracics, have white communicating rami. The posterior primary divisions of all, according to their regions of origin, pass to the muscles of the back that are associated with the axial skeleton, and to the skin and fascia of the back of the head and neck, the back, medial part of the buttock, and that overlying the coccyx or tail bone.

The anterior primary divisions of all these nerves are arranged in a series of plexuses, namely, the cervical, brachial, lumbar, sacral and coccygeal, in nhich fibres from the individual spinal nerves are regrouped before entering the nerves of distribution.

Cervical Plexus.—The cervical plexus is formed from the first four cervical nerves as a series of loops whose branches include fibres of two or more upper cervical nerves. These branches supply the skin of the head, neck and shoulder and the muscles of the neck and diaphragm, with the result that the skin areas, especially,



FROM A. M. PATERSON, "CUNNINGHAM'S TEXTBOOK OF ANATOMY," (OXFORD MEDICAL PUBLICATIONS)

FIG. 7.— DISTRIBUTION OF CUTANEOUS NERVES ON ANTERIOR SURFACE OF THE TRUNK. THE POSITION AND COURSE OF THE NERVES ARE SHOWN ON THE LEFT; THE DISTRIBUTION OF EACH AS NUMBERED, ON THE RIGHT

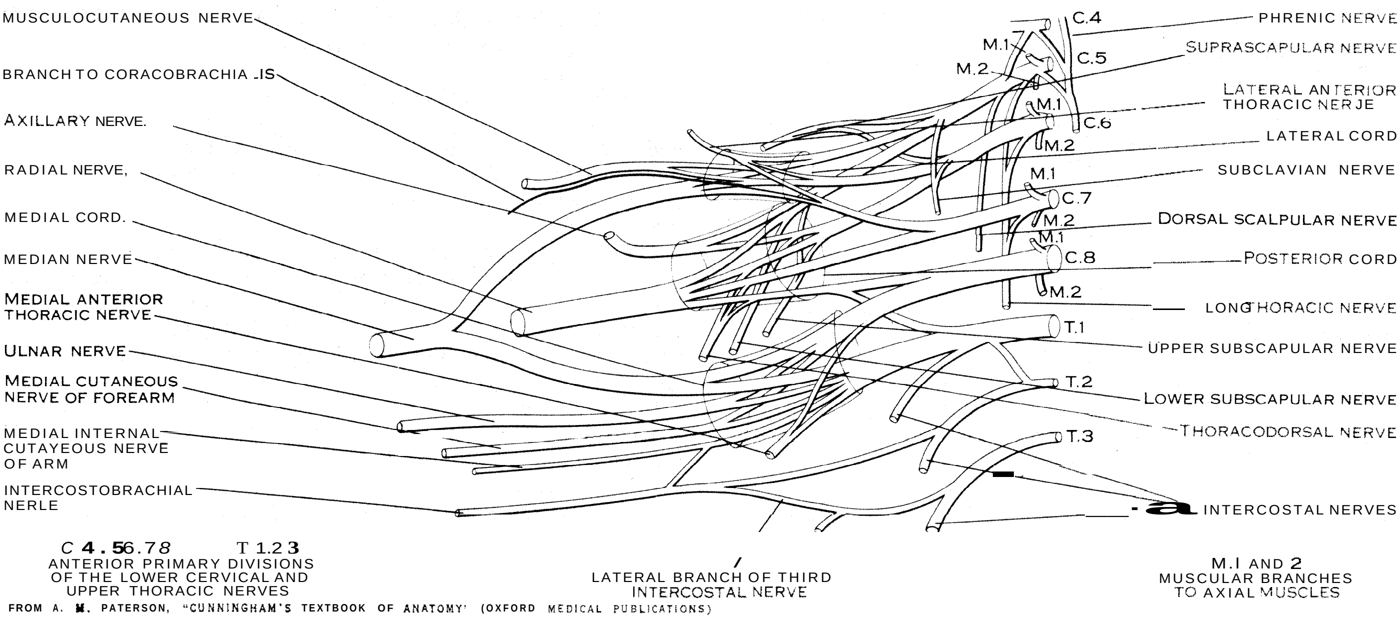


FIG. 8.— THEBRACHIAL PLEXUS AND ITS NERVES

have multiple innervation. The nerves to the muscles, as a rule, do not form loops but are arranged as medial and lateral groups.

Brachial *Plexus*.—This plexus (fig. 8) is derived from the fifth to the eighth cervical nerves and the greater part of the first thoracic. These first form three trunks — the superior, medial and inferior — and then recombine through anterior and posterior divisions of each trunk into three cords.

The plexus is divided into supraclavicular and infraclavicular parts. Before the cords are reached the supraclavicular part gives off the long thoracic (C. j, 6, 7), dorsal scapular *(C.* j). subclavian (C. 4, 5, 6) and suprascapular (C. 4, S, 6) nerves. These supply muscles of the shoulder girdle, the suprascapular also innervating the joint between the collar bone and the acromion process.

The infraclavicular part comprises the three cords — lateral, medial and posterior — from which are derived the nerves of distribution to the shoulder and upper extremity. Each cord is composed of fibres from several of the lower cervical nerves. Some include both sensory and motor fibres, while others have only cutaneous or muscular fibres. The segmental source of the muscular supply does not necessarily correspond to that of the overlying skin.

The lateral cord gives off (1) the lateral anterior thoracic nerve (C. 5, 6. 7), to the breast muscles; (2) the musculocutaneous nerve *(C* 4, 5, 6), to the muscles of the front of the arm and to the skin of the side of the forearm; and (3) the median nerve (C. j. 6, 7, 8; T. 1), to certain muscles of the forearm, thumb and fingers, to the skin of the palm, hand and fingers and to the elbow. wrist and hand joints.

The medial cord branches into (1) the ulnar nerve (C. 8; T. 1), to flexor muscles of the wrist and fingers, most of the muscles of the hand, to the skin of the medial part of the hand and to the joints of the elbow, wrist and long bones of the hand; (2) the medial brachial cutaneous nerve (C. 8; T. 1), to the skin of the medial side of the arm and forearm; and (3) the medial anterior thoracic nerve (C. 8; T. 1), to the breast muscles.

The posterior cord divides into (1) the axillary nerve (C. 5, 6), to shoulder muscles and joint and to the skin of the lateral part of the shoulder and arm; and (2) the radial nerve (C. 5, 6, 7, 8). to muscles of the arm and forearm and to the skin of the back of the arm and hand, also to elbow. wrist and hand joints and, through its (a) subscapular (C. 5. 6) and (b) thoracodorsal (C 6, 7. 8) branches, to muscles related with the humerus and shoulder girdle.

Lumbosacral Plexus. — The lumbar. sacral and coccygeal nerves form the lumbosacral plexus, subdivided into lumbar and sacral plexuses.

The lumbar plexus (fig. 9) usually involves the first three and part of the fourth lumbar nerves. Most of the first lumbar, however, is distributed much like a thoracic nerve.

The plexus first gives off the iliohypogastric (L. 1) and ilioinguinal (L. 1) nerves. which pass around the abdominal wall in its muscles; into which they send twigs. The iliohypogastric also supplies the skin and fascia of the upper and lateral parts of the buttock and above the pubis. The ilioinguinal supplies the skin of the upper part of the thigh and part of the external genitals.

The remaining branches of the plexus are: (1) the obturator nerve (L. 2, 3, 4), to the muscles and skin of the inner side of the thigh and to the hip and knee joints; (2) the genitofemoral nerve (L. 1. 2). to the skin of the upper part of the thigh and of the scrotum or major labium: (3) the lateral femoral cutaneous nerve (L. 2, 3), to the skin of the lateral part of the thigh: (4) the femoral nerve *(L.* 2, 3. 4) to the iliac muscle and muscles on the front of the thigh, to the hip and knee joints, to the skin on the front and inner side of the thigh and, through the saphenous nerve, to the leg and foot.

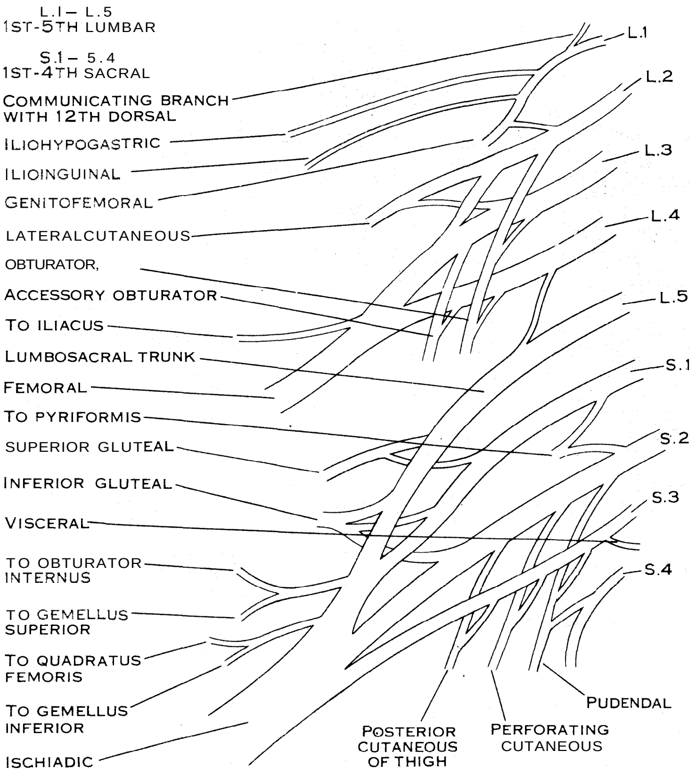
The sacral plexus (fig. 9) is formed from the fourth and fifth lumbar and the first four sacral nerves. the lumbosacral trunk connecting the first two with the first sacral.

The divisions of the fourth and fifth lumbar and the first three sacral nerves are gathered into the sciatic or ischiadic nerve. which runs down the back of the thigh. It includes the common peroneal and tibial nerves as far as the space behind the knee joint.

The common peroneal nerve *(L.* 4. 5; S. 1, 2) supplies a muscle that flexes the knee joint and fibres to this joint. The deep peroneal nerve passes to muscles of the lower leg and the foot. to toe muscles, to skin between the first and second toes and to the joints of the ankle and foot. The superficial peroneal nerve supplies muscles of the foot, the skin of the lower lateral part of the leg and upper surface of the foot. The tibial nerve (L. 4, 5; S. 1, 2, 3) innervates muscles of the back of the leg and the foot, the skin of the back of the leg and the knee and ankle joints.

Branches from the sacral plexus pass to the muscles of the hip and buttock and to the skin of the buttock. The pudendal nerve (S. 2, 3. 4) contributes to supply the skin and muscles of the perineum (the region of the outlet of the pelvis) and the genital organs. The posterior cutaneous nerve of the thigh (S. 2, 3, 4) innervates the skin of the posterior part of the buttock, thigh and perineum. Variable perforating cutaneous branches (S. 2, 3) pass to the skin of the buttock.

Sacral parasympathetic fibres emerge with the second and third or third and fourth sacral nerves, pass through the pelvic plexus



FROM "GRAY'S ANATOMY' (LONGMANS, GREEN & CO)

FIG. 9.— PLAN OF THE LUMBAR AND SACRAL PLEXUSES AND NERVES

and terminate in ganglionic clusters in the plexus or in the walls of the organs supplied. Postganglionic fibres reach the lower part of the colon, the rectum: bladder and lower ureter and the genital organs.

Coccygeal Plexus.—The coccygeal plexus is formed from the fourth and fifth sacral and the coccygeal nerves. It sends small branches to muscles of the floor of the pelvis and to the skin over the coccyx.

See also EQUILIBRIUM. ANIMAL; MUSCLE AND MUSCULAR SYSTEM; SERVE CONDUCTION ; NERVOUS SYSTEM; SPINAL CORD.

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(O.LL.)

NERVE CONDUCTION, the process by which the nerve fibres carry messages throughout the bodies of multicellular animals. In the higher animals, information about the outside world or the state of the animal's body is conveyed along sensory nerves to the central nervous system. which sorts out the information and issues appropriate orders to the muscles or glands. The outgoing information travels in motor nerves and reaches the muscles after crossing a special region between nerve and muscle. In vertebrates, the nerve cell bodies, from which nerve fibres arise, are situated in or near the spinal cord. The cell bodies are essential for the growth and maintenance of nerve fibres. but not for the conduction of impulses. Fibres which have been separated from their cell bodies are able to conduct impulses for several hours or days but do not survive indefinitely! either inside or outside the animal.

On the basis of their appearance under the microscope, nerve fibres may be divided into two distinct classes. .In myelinated fibres. which form the bulk of our own nerves, the protoplasmic core of the fibre is surrounded by a sheath of a fatty substance known as myelin. The sheath is interrupted at intervals of about one millimetre by a short gap called the node of Ranvier. In unmyelinated fibres there is no fatty sheath and the fibre consists of a cylinder of protoplasm separated from the external medium by a membrane whose thickness is probably of the order of one-millionth of a centimetre. A similar membrane is almost certainly present at the node of Ranvier.

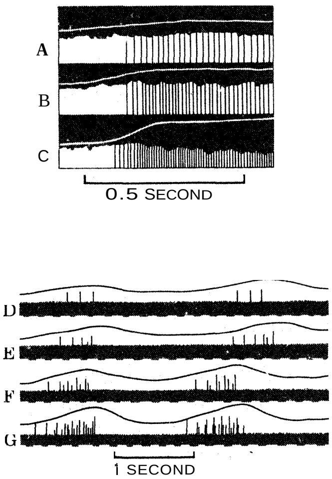
The diameter of most nerve fibres is usually 0.001 to 0.02 mm., but certain invertebrates possess very large unmyelinated fibres and in the extreme case of the squid these may be as much as one millimetre in diameter. The length of nerve fibres varies from a fraction of a millimetre in a small insect to many melres in the largest mammals.

The protoplasmic core of the fibre is an aqueous solution and a reasonably good conductor of electricity. It contains a high concentration of potassium ions and a low concentration of sodium and chloride ions. This is the reverse of the animal's blood. in which sodium and chloride are the dominant ions and potassium ions are reiatively dilute.

In contrast to the protoplasm, the membrane at the surface of the fibre is a moderately good insulator, and this helps to prevent the contents of the fibre from mixing rapidly with the external solution. In addition, much of the cells' metabolism is probably directed toward maintaining a state of unequal ionic concentration across the surface membrane.

Nervous messages are invariably accompanied by brief electrical changes, known as action potentials. When a sense organ is stimulated, or when the central nervous system issues an order to a muscle, electrical impulses can be recorded from the nerves which would be expected to be carrying information. Fig. 1 illustrates trains of action potential traveling to and from the central nervous system in two of the nerves that control the respiration of a cat.

The action potentials which carry information along the nerve fibres last about $\frac{1}{1,000}$ sec. and travel at speeds of 1–100 m. per second (100 m. per second is equal to 224 m.p.h.). The velocity of conduction is greater in large fibres than in small, and myelinated nerve fibres conduct faster than unmyelinated fibres of comparable size. However, in any one fibre, the size and velocity of the action potential is constant and cannot be altered by changing the strength or quality of the stimulus. In other words, provided that a stimulus is strong enough to evoke an impulse. the size of the action potential in a single fibre is independent of the strength of the stimulus. This invariance of the action potential arises because the energy used in propagation does not come from the stimulus but is released by the nerve along its length. In this respect. nervous conduction resembles the burning of a fuse of gunpowder and is unlike the propagation of an electric signal along a cable or telephone wire.



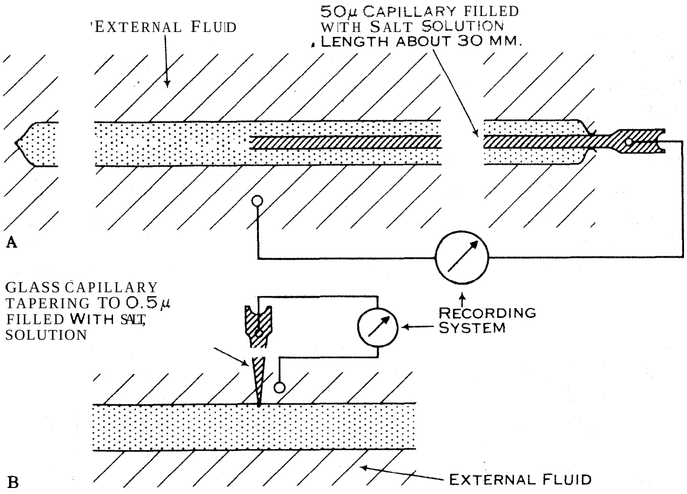
(A–C) FROM E D ADRIAN IN "THE JOURNAL OF PHYSIOLOGY" (1933); (D–G) FROM BARRON IN J. F. FULTON, "TEXTBOOK OF PHYSIOLOGY," 17TH ED., W B. SAUNDERS COMPANY, PHILADELPHIA (1955)

FIG. 1.—ELECTRICAL IMPULSES IN THE RESPIRATORY NERVES OF A CAT

(A–C) Sensory impulses traveling from the lungs to the brain in the vagus nerve. White lines indicate the degree of inflation of the lungs. The impulses, recorded with external electrodes from a strand of the nerve trunk, appear as black vertical lines. The deflections produced by the impulses are shown downward and the frequency of the impulses rises as the distension of the lungs is increased

(D–G) Motor impulses traveling to the diaphragm in the phrenic nerve. Upper tracing indicates the respiratory movement; impulses are shown below as upward deflections. One fibre carries the impulses in (D), t in (E) and (F), and three in (G)

For many years physiologists suspected that the electrical changes in nerve arose at the surface membrane. This idea was verified by experiments in which the electrical potential difference across the surface of the fibre was measured directly with an internal electrode (figs. 2 and 3). In such experiments it is found that the inside of the fibre is usually about 0.07 v. negative to the external solution; this difference in electrical potential is known as the resting potential. When an impulse travels along



FROM 'BIOLOGICAL REVIEWS," VOL. 26 (1951)

FIG. 2.— METHODS OF RECORDING ELECTRICAL CHANGES ACROSS THE SURFACE MEMBRANE OF A NERVE FIBRE

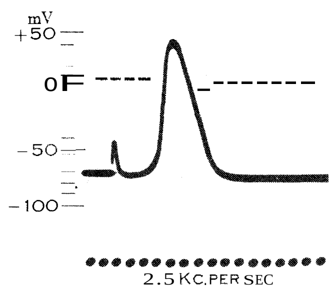
(A) Longitudinal insertion of internal electrode, used with giant nerve fibre. (B) Transverse insertion of internal electrode used with nerve or muscle fibres and other cells. The electrical recording system consists of a vacuum tube amplifier and cathode ray osciliograph. ($1\mu = \frac{1}{1,000}$ mm.)

the fibre, the inside swings momentarily positive. giving a transient action potential of amplitude 0.1–0.12 v. At the crest of the action potential the inside of the fibre is about 0.04 v. positive to the outside.

When a hrief electric current is applied to a nerve it is found that the impulse always arises at the cathode. This means that the event which starts the impulse is a decrease of the electrical potential difference across the membrane. The amount by which the potential difference must be reduced is naturally somewhat variable but under most conditions is about 0.02 v.

Shortly after a stimulus has evoked a response, the nerve enters an absolute refractory period, during which no stimulus. however strong, can evoke a second response. The absolute refractory period lasts for about $\frac{1}{1,000}$ sec. and is follon-ed by the relative refractor). period during which a second impulse can be evoked, but only by a stimulus which is stronger than normal.

Although nerve fibres normally conduct impulses in one particular direction (toward the central nervous system in sensory fibres. away from it in motor fibres), all nerves can conduct impulses in both directions, and the velocity at which the impulse propagates is independent of the direction in which it is traveling.



FROM "PROCEEDINGS OF THE ROYAL SOCIETY" B , 148, I

FIG. 3.—ACTION POTENTIAL, TRAVELING TOWARD MUSCLES, IN THE GIANT NERVE FIBRE OF THE SQUID, RECORDED FROM A NERVE FIBRE IN ITS NATURAL POSITION IN THE WHOLE ANIMAL

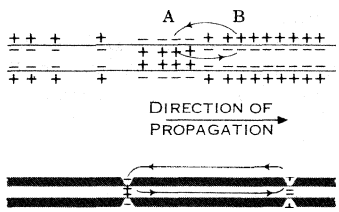
The record shows the electrical potential difference between the inside of the fibre and the external fluid (1 mV = $\frac{1}{1,000}$ volt). Dots below the record correspond to a frequency of 2,500 per second. The brief excursion at the beginning of the record occurred at the moment when the electric shock, which started the action potential was applied to the nerve. The temperature was 8.5' C.

The conductivity of the surface membrane increases greatly during an impulse. and sodium and potassium ions cross the membrane more easily than in the resting state. The net efiect of an impulse is that a small quantity of sodium ions enters the fibre and a corresponding amount of potassium ions leaves it. These movements. which are both down concentration gradients, are thought to provide the immediate source of energy for propagation and must be reversed by a metabolic process operating during the period of recovery which follows a burst of electrical activity.

Mechanism of Nervous Conduction.—Many of the facts described in this article are explained by a hypothesis which is essentially a modification of the membrane theory. proposed early in this century by Bernstein, Overton and Lillie. According to this hypothesis, the resting membrane i impermeable to aodiurn ions hut is moderately permeable to potassium ions. Since potassium ions are more concentrated inside the fibre, they tend to move outward. and this makes the inside of the fibre negative with respect to the external solution. Evidence for this idra is provided by the observation that. the resting potential disappears if the concentration of potassium in the external solution is made equal to that inside the fibre.

When the potential difference across the resting membrane is reduced by an external electric current, or by the approach of the active region. the properties of the membrane change in a remarkable way. The molecular nature of this change is entirely unknown. but it always involves an increase in the conductivity of the membrane and its effect appears to be that the membrane undergoes a large but transient increase in the permeability to sodium ions. Since sodium ions are more concentrated outside the fihre. they enter it and make the inside of the membrane positive. The change in permeability generates the action potential and the movement of sodium ions provides the inward current on which conduction of impulses depends.

The way in which the impulse propagates in an unmyelinated fibre is illustrated in the upper part of fig. 4. Suppose that point A is active and that B is resting. A is sodium permeable so the inside of the fibre is positive; B is potassium permeable so the inside is negative. Electric current therefore flows in a local circuit between resting and active nerve and this reduces the potential difference just ahead of the active region. When the potential difference at B is reduced by about 0.02 v. the pertneabilityto sodium rises and the inside of the fibre becomes positive. Point B is now active and can stimulate the next region in precisely the same manner. In this way a wave of increasrd sodium permeability spreads along the fibre.



FROM 'PROCEEDINGS OF THE ROYAL SOCIETY" 6 , 148, I

FIG. 4.— DIAGRAMS ILLUSTRATING PROPAGATION OF THE NERVE IMPULSE IN (TOP) AN UNMYELINATED FIBRE AND (BOTTOM) A MYELINATED FIBRE. THE APROWS SHOW THE DIRECTION OF THE ELECTRIC CUR-RENT

Since the increase in sodium permeability is transient. the membrane does not remain in the active state hut returns to its original condition after about $\frac{1}{1,000}$ sec. The restoration of the normal votential difference is brounht about bv an outward movement of potassium ions and is accelerated by a rise in potassium permeability. which takes place later than the initial rise in sodiurn permeability.

Like most other theories of nervous conduction. the one just outlined assumes that the causal agent in propagation is the elcctric current which flows between resting and active nerve. This assumption is supported by extremely strong evidence and is accepted by those who have reservations about the part played by the sodium and potassium ions in generating the action potentials.

Unmyelinated fibres are continuous structures and the impulse propagates smoothly from one point to the next. In myelinated nerve fibres. which are present in all vertebrates and in shrimps and prawns, a difierent type of conduction has been evolved. Here most of the fibre is covered with an insulating layer and the excitable membrane is exposed only at the nodes of Ranvier. When one node becomes active. current flows through the next node in the manner shown in fig. 4.

In this system only the nodes generate the action potential, and the function of the myelin is to make the local electric current act at some distance ahead of the active point. The effect of this type of propagation. which is known as saltatory conduction, is that the impulse is conducted at a higher velocity and with greater economy than in an unmyelinated fibre of comparable size.

See also NERVE; NERVOUS SYSTEM; SYNAPSE; SPINAL CORD; COMPARATIVE SEUROLOGY. (A. L. Hs.)

NERVI, PIER LUIGI (1891–), internationally known Italian structural engineer, was born in Sondrio, Italy, June 21, 1891, and graduated from the University of Bologna in 1913. He later joined the staff of the School of Architecture of Rome, teaching technology and construction technique. His most important works are several large-span structures built in Italy—the municipal stadium in Florence (1929); aircraft hangars with geodesic structure at Orvieto. Orbetello and Torre del Lago (1936–41), all destroyed during World War II; a complex for the Turin exhibition (1948–50); the permanent headquarters of the United Nations Educational, Scientific and Cultural organization at Paris. in collaboration with Rlarcel Breuer and B. Zehrfuss, architects; and the Olympic sport palace and the Flaminio stadium, both built in Rome, and the stadium of Taormina, in Sicily.

In 1956 Nervi went to the United States to lecture on his work at the invitation of several universities. He is an honorary member of the American Academy Institute of Arts and Letters (1957) and of the American Institute of Architects. and a member of the National .Association of Italian Engineers and Architects and of the International Congress of Contemporary Xrchitecture.

(E. F. C.)

NERVI, formerly a roast town of Liguria, Italy. province of Genoa, incorporated into greater Genoa after World War II, 82 ft. above sea level. Pop. (1936). 4.002 (town), 8,769 (commune). It is a winter resort area and is surrounded with groves of olives, oranges and lemons. Its villas have beautiful gardens.

At Quarto. 2½ mi. N.W., 1,000 Garibaldians embarked for Marsala in 1 Yho.

NERVO, AMADO (1870–1919), recognized as Mexico's best modernist poet. was horn in Tepic, Mex., on Aug. 27, 1870, and was originally named Amado Ruiz de Nervo. He studied at the Colegio de Jacona and at the seminary of Zamora from 1886 to 1888.

Nervo's literary career mas begun in Mazatlán as a newspaperman. From there he went to Mexico City in 1894, where he published his short novel *El Bachiller* (1895), his first volume of poems *Perlas Negras* (1898) and also wrote for the *Revista azul.* With J. E. Valenzuela he founded the modernist periodical *Revista moderna* (1898–1903).

From 1905 to 1918 he lived in Madrid, Sp., as secretary to the Mexican legation; and there he wrote most of his innumerable poems. essays and short stories. After a short visit to Mexico in 1918 he was appointed minister to Argentina and Uruguay. He died in Montevideo on Rlay 24, 1919.

His best poems. found in the volumes *Elevación* (1914–16) and *Plenitud* (1917) are characterized by a deep religious feeling and a simple but perfect form.

BIBLIOGRAPHY.—Genaro Estrada, *Bibliografía de Amado Nervo* (1925); Alfonso Reyes (ed.), *Obras completas,* 29 vol. (1920–28); Esther T. Wellman, *Amado Nervo, Mexico's Religious Poet (1936)*; Luis Leal (ed.), *Amado Nervo, sus mejores cuentos* (1951).

(L. LL.)

NERVOUS SYSTEM. The nervous system may be divided into (1) the central nervous system, consisting of the brain and spinal cord and (2) the peripheral nervous system, consisting of the cranial, spinal and peripheral nerves with their motor and sensory endings.

The anatomy and physiology of many parts of the nervous system are treated in separate articles (.see BRAIN; CIRCULATION OF BLOOD; DIGESTION; EAR, ANATOMY OF; EYE. HUMAN; MUSCLE AND MUSCULAR SYSTEM; NERVE; NERVE CONDUCTION; NEUROLOGY, COMPARATIVE; OLFACTORY SYSTEM; SMELL AND TASTE; SPINAL CORD; TOUCH, SENSE OF).

HISTOLOGY

The organs and organ systems of the body are composed of tissues, and these in turn are composed of microscopic units termed cells. Cells are specialized to perform a particular function, such as secretion (gland cell), contraction (muscle cell) or conduction (nerve cell). The nervous system is composed of billions of individual cells. The most noted investigator of the histology (microscopic anatomyj of these cells was the Spanish scientist Santiago Ramón y Cajal.

Nerve Cells.—Nerve cells or neurons are distinguished by processes (projections) that conduct nerve impulses to and from the body of the cell. Nerve impulses are physicochemical reactions that sweep along the surfaces of neurons and their processes (see NERVE CONDUCTION). Similar reactions occur in many other types of cells, but are most notable in neurons. the structural features of which are designed to transmit impulses over long distances to many parts of the body.

The bodies of neurons vary in diameter from $4–5\mu$ (microns) up to $50–100\mu$ (a micron is about $\frac{1}{25,000}$ in.). The largest neurons are almost visible to the naked eye. The nuclei of cells contain a material called chromatin; chromatin in the nuclei of neurons is sparse in amount, although the nucleolus is very prominent. The cytoplasm of neurons contains a chromatinlike material called Nissl substance (named after Franz Nissl) (fig. 1[A]). The cytoplasm also contains special particles called mitochondria, and a complex, lipoid structure. the Golgi apparatus (after Camillo Golgi). Both are important in metabolic processes and both are present in other types of cells. Thin fibrils termed neurofibrils are also present in the cytoplasm and processes of nerve cells; their significance is unknown.

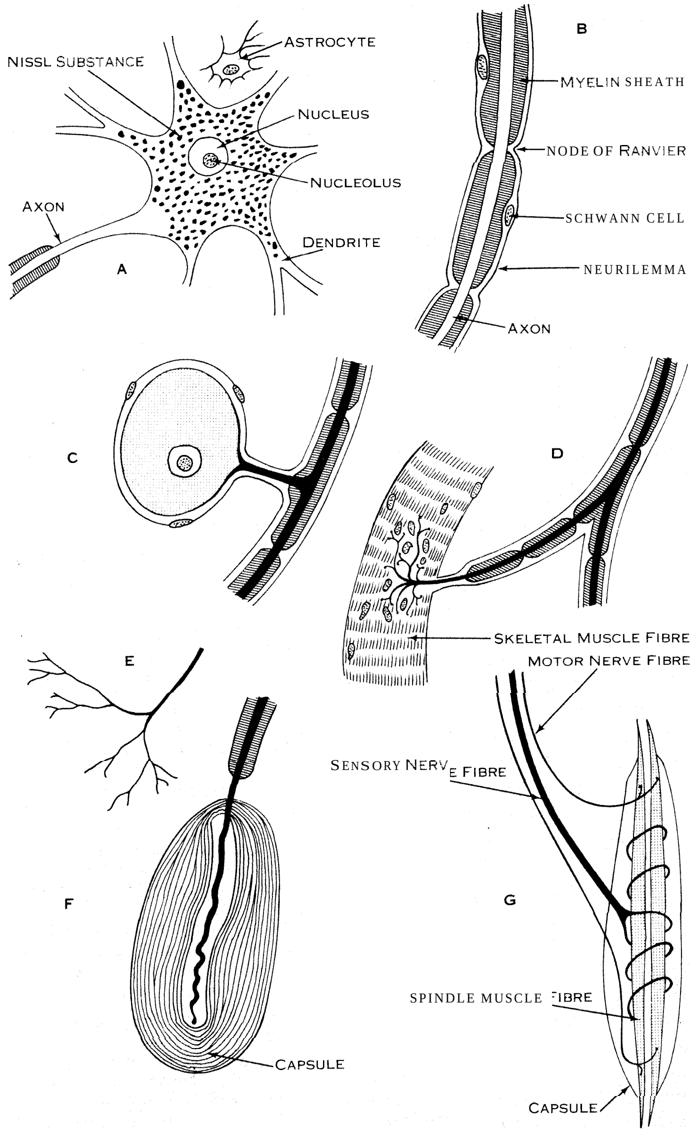


FIG. 1.—DIAGRAMS OF NERVE CELLS AND ENDINGS AT HIGH MAGNIFICATIONS

(A) Multipolar cell of spinal cord; (B) part of a myelinated nerve fibre; (C) unipolar cell; (D) motor endplate; (E) nonmyelinated fibre forming a free ending; (F) pacinian corpuscle; (G) neuromuscular spindle, present in muscles near the junction of muscle and tendon

The processes of neurons may be only a few microns in length, or they may extend several feet. Processes that conduct impulses away from the cell body are termed axons. A neuron generally has only one axon. Processes that conduct toward the cell body are called dendrites. Most neurons have many dendrites and are classified as multipolar cells (fig. 1[A]). The neurons of the brain. spinal cord and autonomic ganglia are multipolar. The neurons of spinal ganglia and of the ganglia of certain cranial nerves arc unipolar: that is, they have only one process (fig. 1[C]). This process divides into two branches, one of which conveys impulses from sensory endings toward the cell body, while the other conveys these impulses to the brain or spinal cord. Certain neurons in ganglia of the inner ear. in one of the layers of the retina of the eye and in the olfactory mucous membrane have two processes and are classified as bipolar. One process conducts toward, and the other away from, the cell body. The processes of unipolar and bipolar cells are structurally similar to the axons of multipolar cells.

The dendrites of multipolar cells are short branching processes that contain Nissl substance and mitochondria. The branching increases the surface area of the cell. Axons (and the processes of unipolar and bipolar cells) lack Nissl substance but contain mitochondria. They often extend for long distances. and have few branches until near their terminations. If an axon is more than about one micron in diameter, it is surrounded by a whitish. lipoid sheath, the myelin or medullary sheath (fig. 1[B]). This sheath is interrupted at regular intervals to form nodes of Ranvier (after Louis Ranvier). which are of fundamental importance in nerve conduction. The largest axons. with their myelin sheaths, are no more than about 20μ in diameter. All axons of the peripheral nervous system. whether they have a myelin sheath or not, are surrounded by a thin, protoplasmic sheath, the neurilemma. This sheath is a cellular tube formed by cells of Schwann (after Theodor Schwann). It is of fundamental importance in the formation of myelin and in nerve regeneration. There are no neurilemmal cells in the central nervous system.

The term nerve fibre is often used to specify an axon and its various sheaths; hence the terms myelinated fibre and nonmyelinated fibre. The gray matter of the central nervous system is composed mainly of cell bodies and fibres that, for the most part, are nonmyelinated. By contrast. white matter contains large numbers of myelinated fibres and relatively few cells. A nerve is a collection of nerve fibres that is visible to the naked eye; the constituent fibres are bound together by connective tissue. Each fibre is microscopic in size, hence hundreds or thousands of fibres are present in each nerve. Thus. according to the number of constituent fibres. a nerve may be barely visible or it may be quite thick.

Nerve Endings.—Nerve fibres carry impulses to and from nonnervous structures (such as muscle'). and they end in a special way in relation to these structures. They also transmit impulses to other nerve cells and have special endings at the points of transmission.

Sensory Endings (Receptors). — When skin is stimulated so that the sensation of touch is aroused, the stimulus activates certain special structures in the skin. These structures are receptors, composed of nerve fibres and nonnervou tissue, so arranged that when mechanically deformed by the stimulus. they discharge nerve impulses to the brain or to the spinal cord. Receptors are further specialized according to the type of stimulus to which they are most sensitive: *e.g.*, the retina of the eye is activated by radiant energy, taste buds of the tongue by chemical reactions.

Receptors for the special senses (vision. hearing, balance, taste and smell) are described in other articles. Receptors for the general senses (touch, pain, temperature, pressure. position and movement) are of several varieties that differ mainly in the way in which the nonnervous tissue is arranged. The simplest are those in which a nerve fibre breaks up into fine branches that end in connective tissue or in epithelium; these are free nerve endings (fig. 1[E]).

In other receptors. the nerve fibres end in a complicated branching, surrounded by a specialized connective tissue capsule. Such endings are often called corpuscles: they are most sensitive to mechanical deformation. The nerve fibres to corpuscles are usually myelinated, but the myelin is lost before the fibre enters the corpuscle.

The sensations of touch. pain and temperature can be aroused from skin. The only receptors in hairy skin are free endings and complicated plexuses around hair follicles. In skin without hair, such as on the finger tips, there are also oval. encapsulated endings known as Meissner's corpuscles (after George Meissner) and believed to be touch receptors. Other types of corpuscles may also be present. Some receptors in skin are sensitive to mechanical deformation (touch). others to injury (pain) and others to radiant energy (temperature). Further correlation between structure and function is quite speculative.

The Pacinian corpuscle (aiter Filippo Pacini) has a capsule

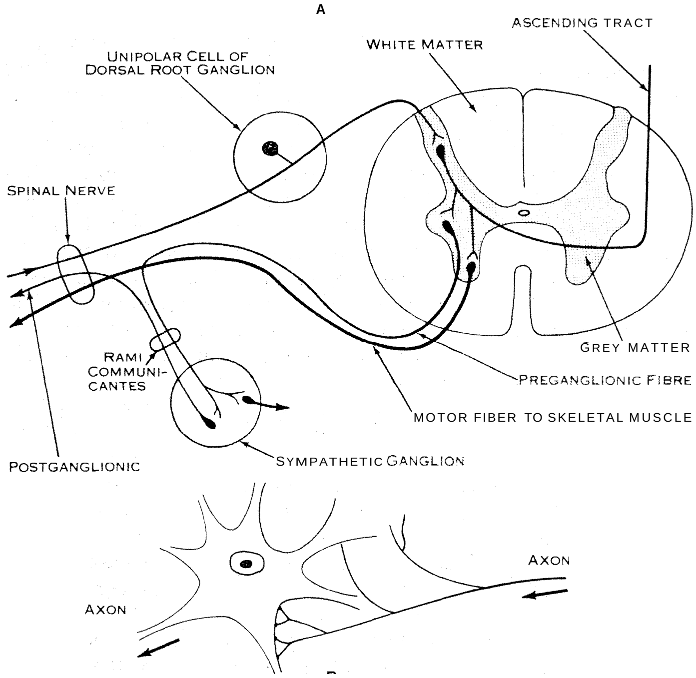


FIG. 2.—(A) DIAGRAM OF REFLEX PATHS AND CROSS-SECTION OF THORACIC SPINAL CORD

A sensory fibre enters the cord over a dorsal root and synapses with a cell, the axon of which synapses with motor cells, then ascends to the brain. Motor fibres leave by way of a ventral root. Preganglionic sympathetic fibre leaves the spinal nerve to synapse in a ganglion of the sympathetic trunk. Postganglionic fibres go to adjacent viscera or back to the spinal nerve. Preganglionic parasympathetic fibres also have a peripheral synapse, but are carried in certain cranial nerves (mainly the 10th pair, the vagus nerves) and in the 2nd–4th sacral ventral roots

(B) DIAGRAM OF A MULTIPOLAR CELL SHOWING AXON OF ANOTHER CELL SYNAPSING ON ITS SURFACE
(Arrows indicate direction of conduction)

arranged in layers like an onion (fig. 1[F]). This corpuscle is often large enough to be visible to the naked eye. It is present in the deeper parts of skin and in the subcutaneous tissues. and in these locations is believed to be concerned with the sensation of pressure (deep touch). Pacinian corpuscles are present in and around muscles. joints. ligaments and tendons. Other complex receptors are also found in these structures. One is the neuromuscular spindle (fig. 1[G]). which is so constructed that it is deformed if the muscle is stretched. Hence it is sensitive to a change in muscle length and on that account is oiten called a stretch receptor. Neurotendinous spindles are stretch receptors in tendons. A Ruffini ending (after Angelo Ruffini) is a stretch receptor in ligaments and joints; it lacks a definite capsule. The various receptors in muscles, joints. ligaments and tendons are concerned with the sensations of position and movement. Free endings are also present in these structures and are believed to be associated with pain.

Viscera also contain receptors. Some are concerned with pain and others with sensations, but most are involved in the reflex control of visceral activity. For example, some viscera contain Pacinian corpuscles, the positions of which near blood vessels suggest that they are sensitive to changes in vessel diameter due to pulsation. Many viscera and blood vessels contain endings that resemble stretch receptors. Those in blood vessels are activated when the vessel walls are stretched during dilatation of the vessels. and the resulting impulses are transmitted to neurons in the brain that are concerned with the reflex control of blood pressure.

Motor Endings.—Motor impulses to the heart. glands and smooth muscle are carried by small nerve fibres of the autonomic system. The way in which they end is still obscure. Presumably they form simple, free endings in these structures.

Skeletal muscle fibres are supplied by large motor nerve fibres that are axons of cells in the brain and the spinal cord. When such an axon enters a muscle (hundreds or thousands usually enter each muscle) it divides into many smaller branches. Each branch ends on a muscle fibre as a ramification that is surrounded by muscle fibre nuclei and is termed a motor end plate or myoneural junction (fig. 1[D]). The myelin sheath ends before the muscle fibre is reached, and the neurilemma becomes continuous with the cell membrane of the muscle fibre. The arrival of a nerve impulse at a motor ending is followed by the contraction of the muscle fibre.

Neuronal Junctions *(Synapses)*.—When an axon approaches a neuron to which it is conveying an impulse, it decreases in diameter and divides repeatedly. Each branch ends by making contact with the surface of a dendrite or of the cell body (fig. 2[B]), generally as a small swelling that may have a ringlike appearance. The branch may make several contacts before it ends. These contacts or junctional regions are called synapses. The axon and the cell with which it is synapsing are not fused. This "contiguity without continuity" has been demonstrated by electron microscopy. It is the basis of the neuron theory, that neurons are cellular units.

Some of the terminal branches of an axon may synapse with one neuron. others with another, so that one axon may make contact with hundreds of neurons. Conversely, any one neuron may have hundreds or thousands of synaptic contacts on its surface. derived from many axons. Nerve impulses usually cross synaptic junctions in only one direction, namely from the axon of one neuron to a dendrite or the cell body of the next neuron.

Neuroglia.—The central nervous system contains blood vessels and a small amount of connective tissue around the vessels. Otherwise the nonnervous elements consist of cells known collectively as neuroglia. Glial cells differ in size and shape; nearly all have processes that weave around cells and fibres, and are frequently attached to the walls of blood vessels. Some glial cells have many processes and. because of their shape, are known as astrocytes (fig. 1[A]). Others? with fewer and shorter processes, are termed oligodendroglia. Both types develop embryologically from cells of the neural tube. Another type of glial cell is derived embryologically from connective tissue cells carried in with blood vessels. These cells are small and have few processes; they are called microglia. The lining of the cavities of the brain and the spinal cord is called ependyma; its cells constitute a special type of neuroglia. Most glial cells can act as phagocytes; that is, they can ingest and remove dead or injured nervous tissue. There is evidence that glial cells are also concerned with the formation of myelin. Glial cells are clinically important because all tumours that begin in the brain and spinal cord are composed of glial cells.

Degeneration **and Regeneration.**—Adult neurons cannot divide and form new cells. Hence. a neuron that is lost cannot be replaced. If an axon is destroyed, however, the cell body may survive, although it undergoes certain changes. For example, if the axon of a spinal cord neuron is severed by cutting a peripheral nerve, the Nissl substance in that cell disappears (chromatolysis). but may reappear after several weeks or months; however. neurons confined entirely to the central nervous system generally do not survive axonal section. That part of the axon separated from the cell body degenerates; the myelin sheath and the axon swell and disintegrate. The fragments are removed by scavenger cells, most of which are proliferating neurilemmal cells. These cells remain as a cellular cord. The tip of that part of the axon still connected with the cell body begins to grow through the neurilemmal cord (at the rate of about one to two millimetres a day in man) and eventually re-establishes contact with whatever structure it had previously innervated. Function is often restored more or less completely. The myelin sheath is reformed, probably by neurilemmal cells.

There is no significant regeneration in the brain and spinal cord of warm-blooded animals; it may occur to a striking degree in many cold-blooded animals, however.

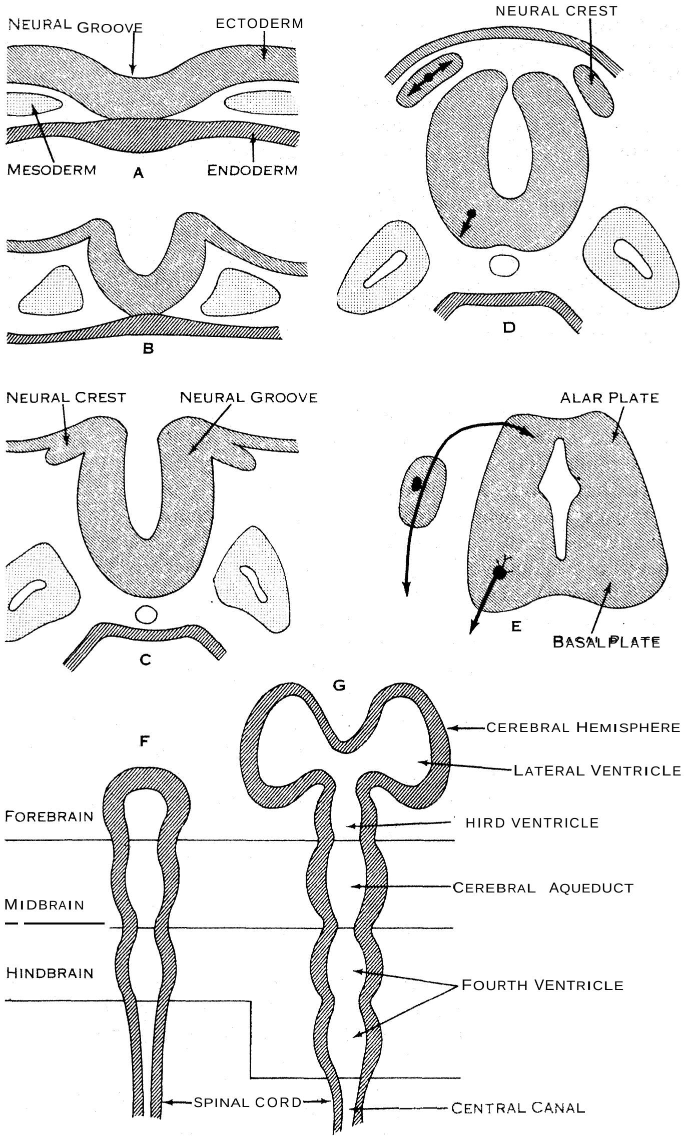


FIG. 3.—DIAGRAMMATIC REPRESENTATION OF CERTAIN FEATURES OF THE EMBRYOLOGY OF THE NERVOUS SYSTEM

(A–E) Cross-sections of parts of embryos. The ectoderm is a sheet of cells (individual cells not shown) that grows to form a longitudinal groove. The groove deepens and closes off to form a neural tube, from which the neural crest detaches. A single neuroblast is shown in the neural crest of D, and in E this has become a unipolar cell with processes growing centrally and peripherally. A neuroblast of the basal plate in D develops an axon that in E is growing out of the spinal cord. (F–G) Longitudinal views of the front end of the neural tube showing enlargements and cavities from which the adult brain develops

EMBRYOLOGY

Early in embryonic development, a neural tube is formed in the manner illustrated in fig. 3. This figure also shows that the head end of the neural tube early in development has three and then five enlargements from which the adult brain is derived The rest of the tube forms the spinal cord. In spite of complex changes during growth and maturation, the central nervous system retains the cavity of the neural tube. The ventricles of the adult brain develop from this cavity.

Some cells in the neural tube are called spongioblasts; glial cells develop from these. Others, known as neuroblasts. give rise to adult neurons. Some cells in the neural crest develop into the unipolar cells of the spinal ganglia. others into neurilemmal cells, and still others, together with neuroblasts from the basal plate, migrate to positions alongside the vertebral column and to viscera. Most of these migrating cells develop into multipolar neurons of the autonomic ganglia. Some, however. give rise to the medullary cells of the suprarenal glands. Cell division in the nervous system stops at or shortly after birth. Individual cells and processes. however, continue to grow and enlarge until after adolescence.

COMPARATIVE ANATOMY

The nervous systems of vertebrates have certain features in common and show certain evolutionary changes that are summarized very briefly here.

The vertebrates include fishes. amphibians, reptiles, birds and mammal:: and are the largest suhdivisinn (subphylumi of the phylum Chordata. All chordates have a single nerve trunk situated along the back, above the notochord or the vertebrae. This cord is a hollow, nonganglionated structure with a central, fluid-filled cavity. Its embryonic development is similar in all chordates. The anterior (front) end of this tube has evolved, in vertebrates. into a hollow brain with characteristic subdivisions. There are also characteristic sense organs (eyes, ears, etc.) that develop in the head region of vertebrates. The rest of the tube becomes the spinal cord.

The spinal cord has nerve roots attached to it. In *Amphioxus* (the lancelet; not a vertebrate. but a primitive chordate) the dorsal and ventral roots alternate; a dorsal root on one side is opposite a ventral root on the other. The dorsal roots are both sensory and motor; the ventral roots are purely motor. In fishes and higher vertebrates, dorsal and ventral roots unite to form spinal nerves. and there is an increasing tendency for dorsal roots to be entirely sensory. Ventral roots are motor in all chordates.

The cranial nerves of chordates are special nerves associated with the brain. They are named from studies in man, but the human arrangement of 12 pairs does not hold throughout the phylum Chordata. In *Amphioxus,* for example, there are two pairs of cranial nerves. The 12th pair of cranial nerves (hypoglossal) is absent in fishes. The 11th pair (accessory) is not separate in lower vertebrates: but is part of the 10th pair (vagus). The first pair in most vertebrates is the "terminal nerve"; it is absent or rudimentary in man.

The fibres in cranial nerves are of several types. Some cranial nerves are composed of but one type, others of several. There are fibres for the special senses, general sensory fibres from the head and face, special sensory and motor fibres for the branchial or gill region (primarily pharynx, larynx, facial muscles, muscles of mastication), parasympathetic fibres and motor fibres to eye muscles and tongue.

The major evolutionary changes of the nervous system are found in the brain. The hind end of the brain stem (the brain stem connects the cerebral hemispheres with the spinal cord) contains motor and sensory nerve cells like those of the spinal cord. It also contains groups of nerve cells concerned with certain special sensations. such as hearing, balance and taste, and with certain vital functions, such as respiration and circulation. This part of the brain stem changes relatively little in ascending the vertebrate scale.

'The cerebellum is a part of the brain that is concerned with automatic regulation of posture and movement. Certain groups of cerebellar neurons regulate trunk muscles, others limb muscles, and still others are connected with the cerebral cortex. Hence the anatomical arrangement of the cerebellum varies greatly from species to species. depending on mode of locomotion. The cerebellum is relatively best developed in primates, especially in man.

In lower vertebrates, the main nervous centres are in the front end of the brain stem. which receives impulses of the special and general sensations. It acts as a co-ordinating centre. Parts of it are highly developed in birds, in which those portions devoted to vision are relatively large.

The primitive cerebral hemispheres are centres for smell, but in higher vertebrates they carry out many of the iunctions of the brain stem. Furthermore, by virtue of a complex, surface layer of nerve cells. the cerebral cortex. the hemispheres in higher vertebrates are important association centres. The increasing importance and complexity of the cerebral hemispheres are associated with two main evolutionary trends. One involves the cerebral cortex, which is first present in reptiles and is most highly developed in man (important regions of the human cerebral cortex are concerned with speech mechanisms). The other trend involves the basal ganglia.

Basal ganglia are masses of nerve cells in the interior of the cerebral hemispheres: and are concerned with many stereotyped or automatic aspects of movement. sensation, visceral activity and einotional behaviour. Basal ganglia are first present in amphibians and are most specialized and advanced in birds, in which they are the highest level of nervous function. Basal ganglia are present and important in mammals. but they are overshadowed by the increasing development and complexity of the cerebral cortex.

AUTONOMIC NERVOUS SYSTEM

The term autonomic nervous system refers to those parts of the central and peripheral nervous systems that. regulate the activity of the viscera. By a very broad definition the term viscera means the heart with its special type of muscle. and any organ or structure, such as stomach or skin, that contains sniooth (involuntary) muscle and glands. The term autonomic implies an autonomy that does not actually exist. For example, skin exposed to cold air becomes blanched or pale because of a reflex constriction of blood vessels in the skin. The cold air stimulates temperature receptors in the skin. and the spinal reflex, by way of autonomic fibres to blood vessels, acts to conserve heat. At the same time impulses are sent to the brain for the sensation of cold. This is an example of co-ordination of somatic arid autonomic activities.

The autonomic nervous system can be considered as a series of levels that differ in function in that the higher the level the more widespread and general its functions; the lower the level the more restricted and specific the functions. The highest level is the cerebral cortex, certain areas of which control or regulate all visceral functions. These areas send nerve fibres to the next level, the hypothalamus, at the base of the brain. The hypothalamus is a co-ordinating centre for the motor control of visceral activity. One of its many functions: for example, is regulation of body temperature. The hypothalamus has nervous and vascular connections with the pituitary gland. by virtue of which it influences the pituitary and through it the entire endocrine system. The hypothalamus also sends nerve fibres to lower centres in the brain stem that are concerned with still more specific functions; *e.g.*, the reflex regulation of respiration, heart rate and circulation. These centres function by virtue of their connections with still lower centres, which are collections of nerve cells that send their axons into certain cranial and spinal nerves. It is characteristic of these axons that. unlike motor fibres to skeletal muscle, they synapse with multipolar cells outside the central nervous system before they reach the viscus to be supplied. These cells are collected into ganglia; hence the ganglionic level is the lowest one. The axons from the central nervous system to ganglion cells are termed preganglionic fibres. The axons of ganglion cells are called postganglionic fibres. and all such fibres from a particular ganglion supply a specific organ or region of the body.

The preganglionic fibres that issue from the thoracic and upper lumbar levels of the spinal cord comprise the sympathetic or thoracolumbar part of the autonomic system. These fibres reach spinal nerves by may of ventral roots, then leave the spinal nerves to enter adjacent ganglia (fig. 2[A]). These ganglia are contained in long nerve trunks (sympathetic trunks), one on each side of the vertebral column, extending from the base of the skull to the coccyx. Some preganglionic fibres continue to medullary cells of ihe suprarenal glands. bur most synapse in the ganglia. The postganglionic fibres either go directly to adjacent viscera and blood vessels, or else return to spinal nerves and thus reach blood vessels, smooth muscle and glands of the limbs and body wall.

The preganglionic fibres that issue from the brain stem and sacral part of the spinal cord comprise the parasympathetic or craniosacral part of the autonomic system. The ganglion cells with which these fibres synapse are in or near the organs innervated. The postganglionic fibres are very short; apparently none go to the blood vessels. smooth muscle and glands of the limbs and body wall. Most viscera, however, have a double motor supply, sympathetic and parasympathetic, generally with opposing functions.

There is also a physiological classification. Certain chemicals that are liberated at the terminals of postganglionic autonomic fibres act as transmitters; *i.e.*, they are released when nerve impulses arrive, and in turn they initiate activity in the viscus or alter its existing activity. Acetylcholine is liberated at postganglionic parasympathetic terminals; such fibres are called cholinergic. Noradrenaline is released at most postganglionic sympathetic terminals, and such fibres are called adrenergic. The sympathetic fibres to smooth muscle and sweat glands of the skin, however, are cholinergic. Adrenaline, formed by the medullary cells of the suprarenal glands and released into the blood stream, has actions similar to those of noradrenaline. Hence the sympathetic system, by virtue of stimulating the release of adrenaline, can enhance its own actions.

The autonomic system is an important part of the mechanism by which the body keeps its internal environment constant; *i.e.*, maintains temperature, fluid balance, ionic composition of the blood, etc. This maintenance is generally known as homeostasis. The parasympathetic system regulates many specific functions, such as digestion, intermediary metabolism and excretion. The sympathetic system is an important part of the mechanism by which a person reacts to stress. This system tends to act as a whole, especially when stress is of sudden onset. For example, a situation that results in fear or rage may also result in increased blood pressure, pulse rate, cardiac output and blood sugar, measures designed for "fight or flight." These acute responses to stress are widespread because the sympathetic system has many connections and also because adrenaline is secondarily released into the blood stream.

Stress may also be followed by more slowly developing changes in metabolic activities and defense mechanisms, brought about by activation of the hypothalamic–pituitary system, leading to changes in the functions of the endocrine organs.

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(E. D. G.)

NERVOUS SYSTEM, SURGERY OF. This article discusses the surgery of the human nervous system, taking up the major subdivisions of the subject in the following order: brain, spinal cord and sympathetic and peripheral nerves. For information about the anatomy of these structures, see BRAIN; SPINAL CORD; NERVE.

Brain. — Evidences of surgical operations on the skull have been found in the skeletons of prehistoric man and of peoples of many later eras. Such procedures cannot be considered brain surgery since they rarely, if ever, were carried deeper than the cranial bones, for experience taught the ancient physicians that penetration of the tough sheath (dura mater) covering the brain was usually fatal because of infection by bacteria — a phenomenon not understood until a century ago. Only when operations were carried out under conditions that minimized the likelihood of bacterial invasion could brain surgery develop.

The early success of this type of surgery was hampered by a lack of knowledge of the localization of function within the brain and spinal cord. In order to know where to make an opening through the skull to expose diseased tissue, the surgeon had to be able to interpret properly the symptoms and signs of disease of the nervous system. In the first place, the fact that one side of the brain controlled the movements and sensation of the opposite side of the body had to be firmly established. Then, the principle that certain parts of the brain had to do with movement, others with common cutaneous sensation and still others with vision and audition had to be proved. Later the location of these areas in the cortex of the big brain, or cerebrum, was demonstrated. When the neurologist knew that a blindness in the right half of the visual field in both eyes was associated with derangement of the left occipital (back part of the brain) lobe, he could then decide if the condition might be relieved by an operation and could indicate precisely where the surgeon should make a hole in the skull to find the trouble.

Techniques for Detecting Abnormalities. — Other means soon became available, however, for detecting abnormal conditions in the brain. With these techniques the surgeon is able to locate the diseased places within the head and to plan his operation accurately.

Soon after the discovery of X-rays, photographs were made of the head with those rays. In these pictures the structure of the skull bones is seen and brain conditions that involve the cranium can be recognized. But since this technique shows changes in bone only, methods by which the brain itself could be visualized had to be devised. Within the cerebrum are cavities, or ventricles, containing a watery fluid (ventricular fluid); this fluid passes about the base of the brain and is absorbed by the veins on the surface of the hemispheres. Normally these cavities are symmetrical on the two sides and have a fairly constant shape. But in the presence of a tumour or other disease of the brain they may be distorted. If the fluid is removed from the cavities with a needle and is replaced by air, an X-ray photograph of the head will show the ventricles, for the X-rays pass more readily through air than brain and hence more rays reach the film through the ventricles and therefore fog their outline. This technique is termed ventriculography (or if the air is injected through the spinal canal, pneumoencephalography).

Another method of showing the contour of the brain utilizes an injection of a radiopaque dye (one that stops X-rays) in the neck (carotid) artery at the time that an X-ray photograph is made of the head. This outlines the arteries of the brain, which usually have a constant position, and will show any displacement of the vessels or any collection of abnormal blood channels within the brain. This technique is called cerebral angiography.

When it was found that normal brain activity is accompanied by changes of electrical potential that can be detected by leading wires from different places on the scalp, another means of demonstrating the location of brain disease became available. The changes in potential normally occur at constant and identical frequencies (8 to 11 per second) on the two sides of the head. Unusually slow, fast or sharp waves often indicate abnormalities in the brain; a disturbance in electrical activity localized in one area usually means that that part of the brain is diseased. This technique, called electroencephalography (*q.v.*), is particularly useful in studying the epilepsies. (See EPILEPSY.)

When radioactive isotopes were produced for use in medicine, another tool for determining the location of disease within the brain became available. Diagnostic use of the isotopes is based on the fact that tumours of the brain take up or accumulate greater amounts of certain radioactive substances than does normal brain tissue. Several hours after the irradiating isotopes of these substances (*e.g.*, iodine) are given to the patient, a detecting tube is passed over the head to determine the areas of maximum discharge of gamma rays from the isotope. The findings from this process, known as brain scanning, can be recorded on paper or photographic film over an outline of the head.

Exposing *the* Brain. — The purely mechanical procedure of uncovering the brain taxed the ingenuity of the first brain surgeons,

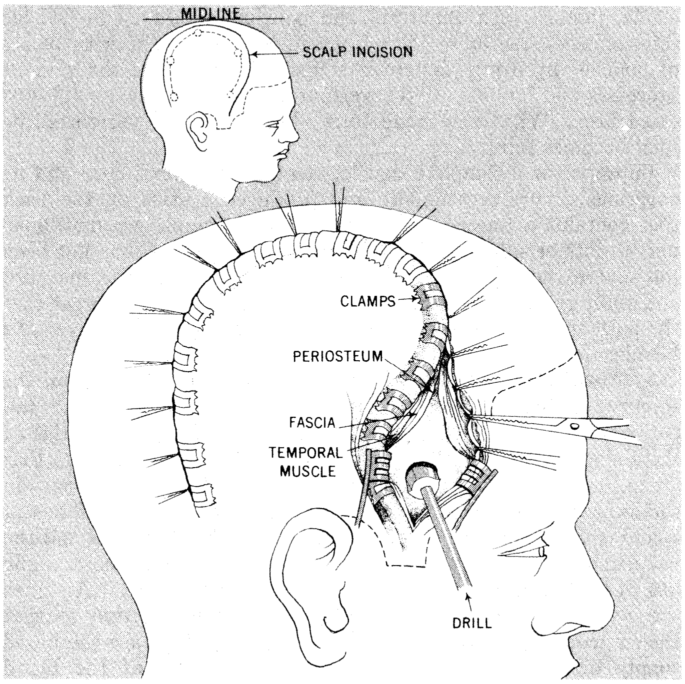

FIG. 1.—SURGICAL PROCEDURE USED TO EXPOSE BRAIN (*see* TEXT)

for the control of bleeding from scalp arteries. which retracted when cut, and from skull bones was a serious matter. The early surgeons attempted to stop the bleeding from the scalp vessels by tying a tight band around the head just above the ears. Later. clamps were applied to the layer of fibrous tissue just beneath the blood vessels and turned back over the scalp to choke off the bleeding vessels, or clips were applied to squeeze the vessels between the scalp and fibrous layer. This fibrous layer is loosely attached to the underlying outer covering of the skull bone: it was in this plane that the American Indians scalped their victims.

To expose the hard coverings of the brain. the skull was periorated by a trephine—a tool similar to a carpenter's brace and bit—and the hole enlarged by rongeurs, an instrument similar to a pair of pliers but with cutting edges on the jaws so that the bone can be bitten away. However, this left a hole in the skull after recovery that sometimes caused headache and alarmed the patient for fear a fall or blow might damage the brain.

The hole technique has been replaced in recent years by a trap door in the skull (technically called a bone flap) that is made by boring holes about 4 cm. apart around the area to be exposed f g . 1). Usually the base of the flap is at the margin of one of the muscles attached to the lower part of the skull. The bone between the holes away from this base is cut with a wire saw so that a horseshoe-shaped piece of bone is free except beneath the muscle. By prying up on the bone, the base of the flap is broken and the entire piece attached to muscle is then lifted up and turned away from the dura mater of the brain. using the muscle as a hinge. The edges of the cut bones are plugged with wax to stop their bleeding. Thus a large area of dura mater is uncovered, and the underlying brain can be easily exposed by cutting the dura mater with a scissors around most of the margin of the bony opening. The cortex. which is covered by the transparent pia arachnoid. or soft membrane, is thus brought into view (fig. 2).

After the operative procedures on the brain have been completed, the dura mater is usually sewed together to cover the brain (fig. 3). The bone flap is replaced and held by a wire suture that is passed through the adjacent outer and inner margins of skull bone. The cut margins of the muscle at the base of the flap are sewed together. Then the deep layer of fibrous tissue of the flap is stitched to the same layer of the scalp, usually with silk thread. Finally the superficial margins of the incision are brought together by sutures tied on the surface. Thus the scalp edges are held together in apposition so that they can heal. The cutaneous stitches may be removed in three to seven days.

Occasionally if a tumour cannot be taken out completely, pressure inside the head is relieved by (1) removing the lower portion of the bone flap under the muscle and the temple bone adjacent to the flap, and (2) incising the hard coverings of the brain in a radiating manner so as to leave a defect through which the brain can protrude and press against the temporal muscle. The remainder of the bone flap is then replaced and wired in place, and the muscles and scalp are closed as described above. The decompression left beneath the muscle will prevent too great an increase in pressure inside the head, and yet the muscle will tend to keep the protrusion on the side of the head from becoming too large and unsightly.

In certain operations when only a small hole in the skull is necessary and when the proposed opening is covered by muscle, the bone is perforated by a trephine and the opening enlarged to the desired size by a rongeur. Such holes are usually made beneath the temporal muscle or the heavy neck muscles; consequently, when the muscles are sewed together they cover (and protect) the defect so that it is barely, if at all, visible.

Excision *Procedure*.—The surgical procedures thus far discussed allow the surgeon to expose and inspect the brain. Depending upon the disease condition—a tumour, abscess, scar or other abnormal state—the surgeon then proceeds to explore the brain or excise the diseased area. First, the many extremely small vessels in the soft covering of the brain are usually shrunken and cut with a high-frequency electric current. The underlying brain tissue, which has the consistency of a soft cheese, may be cut through with a blunt instrument and a large piece of diseased tissue removed.

Usually it is not desirable to cut into the motor cortex, the area of the cortex that controls movements, because doing so may leave the patient paralyzed on one side and speechless.

The extent and type of the surgical procedure depends on the abnormality present in the brain. Some tumours do not invade the brain and may be removed completely. Some are invasive and only a portion of them can be excised to relieve the pressure within the skull. .Abscesses usually may be removed without difficulty. Scars that cause epilepsy can often be removed completely; the abnormal tissue at the scar margins. which is responsible for the convulsions, can be mapped accurately by applying electrodes to the surface of the cortex and making a record of the brain activity during the operation (fig. 2).

Many other types of brain operations may be done; for example, the outpouchings (aneurysms) of blood vessels that sometimes

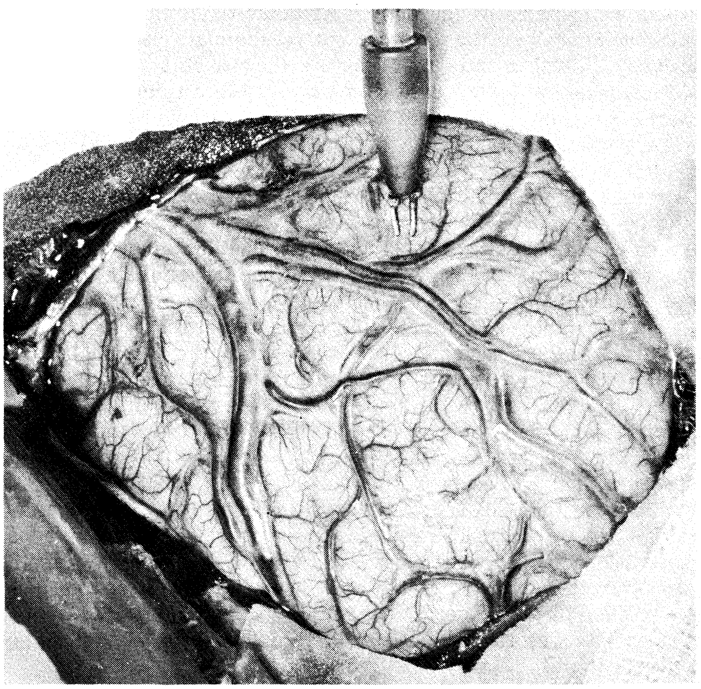

FIG. 2.— BRAIN AFTER OPENING OF DURA MATER

rupture and cause serious hemorrhages into the brain may be clipped at their base, leaving the flow of blood in the parent vessel intact. Nerves at the base of the brain may be cut to relieve excruciating pain or bouts of dizziness. Needles can be inserted under X-ray control to destroy the deeper nuclei of the brain and thereby abolish the tremor or relieve the stiffness of a shaking palsy. Finally, the normal contour of the head may be restored by filling holes in the skull bones with pieces of bone from the patient's hip or rib or with sheets of tantalum or plates of molded plastic.

Spinal Cord.—As soon as aseptic techniques and anesthesia were developed, the surgeon cut through the bony coverings of the spinal cord—the spinous processes and laminae of the vertebrae—and removed them with the rongeurs to expose the hard membrane. A longitudinal incision in the spinal dura mater brings into view the transparent soft coverings and the cord. Tumours that do not invade the spinal cord usually are removed easily. Invasive tumours may be partially removed and the dura mater left unsutured

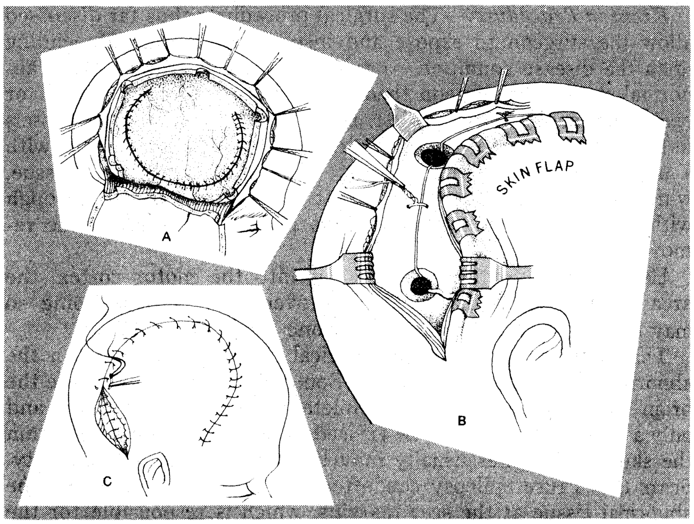

FIG. 3.— CLOSURE OF BONE FLAP AND SCALP INCISION (A) DURAL FLAP SUTURED: (B) BONE FLAP IN PLACE AND FASTENED WITH STAINLESS STEEL WIRE; (C) SUTURING OF SKIN FLAP

to relieve pressure on the nerve tracts in the cord. At times, the surgeon cuts a part of the spinal cord (cordotomy) to relieve pain in the lower parts of the body. At other times the nerve roots entering or leaving the cord are cut to eliminate pain or muscle spasms. Spinal injuries that fracture the vertebrae may or may not damage the spinal cord and may cause varying degrees of paralysis. In most instances conservative measures such as a cast and the posturing extension of the spine are the only forms of treatment required. A decompressive laminectomy (excision of a lamina) is occasionally indicated if the spinal cord is compressed by blood clots or by bone fragments. Paraplegia that results from severe injuries requires a long period of rehabilitation and training but some patients make a remarkable adjustment to their disability and become economically self-supporting.

An important phase of neurosurgery is the treatment of sciatica and arm pain by the removal of the protruding cartilaginous material (disc) that normally acts as a cushion between each vertebral bone. When this disc is broken as result of injury or degeneration from chronic wear and tear, it may stick out at the side of the vertebra and press against a nerve root, causing pain in the leg if the protrusion is of a disc of the lower back or in the arm if it is of the neck. Such protrusions are easily exposed surgically by separating the muscles from one side of the spinous processes and laminae at the involved site. The removal of a small portion of the adjacent laminae allows the surgeon to see the compressed and displaced nerve root so that it may be retracted to one side and the protruding disc material underneath may then be removed.

At times the disc material degenerates and leaves the back unstable. that is, with unnatural and painful mobility. To relieve this condition the loose joint is fused by plugging it with pieces of bone or by firmly fastening strips of bone along the spinous processes and laminae of the vertebrae on either side of the diseased disc. When new bone forms between these vertebrae the joint becomes solid.

Improper or incomplete development of the spinal cord and its coverings occurs occasionally and produces a mass on the back that contains a watery fluid surrounding incompletely developed nerve roots or spinal cord. If the failure of growth has not been too severe the surgeon may make a new covering for the cord and nerve roots. Often, unfortunately, the defect is so great that the patient is paralyzed in the legs and has no control over the bladder or bowel. In such cases operation is futile.

Sympathetic and Peripheral Nerves.—A further part of the surgery of the nervous system concerns the sympathetic and peripheral nerves. The former control many of the activities of the abdominal organs, the blood vessels and skin—activities that are automatically modified by the brain in response to changes in the internal or external environment of the individual. Thus in a cold environment the blood vessels of the skin constrict and the hairs stand up to form "goose pimples"; both actions decrease the loss of heat from the skin and conserve it for the body. At times the sympathetic nerves may become excessively active so that the surgeon must remove a portion, of them to increase the blood supply of an arm or leg or to prevent spasms of the blood vessels.

The peripheral nerves—those that supply muscles and skin—are subject to the same injuries and diseases as are other tissues of the arms and legs. They must be sutured together after being cut so that their nerve fibres can regenerate and innervate the muscles and skin.

Such operations are relatively simple compared with those of the brain and spinal cord but require a technical skill to obtain apposition of the nerve ends. Even with perfect suturing, severed nerve fibres rarely regenerate so completely that normal muscle function and skin sensation are regained.

See also MENINGES AND CEREBROSPINAL FLUID; NERVOUS SYSTEM; SPINE, DISEASES AND DISABILITIES OF.

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NESSELRODE, KARL ROBERT, COUNT (1780–1862), Russian diplomat. served under three tsars. Born on Dec. 14, 1780, at Lisbon. Port., where his father was Russian ambassador. he was educated in Berlin. Entering the Russian navy at the age of 16, he became naval aide-de-camp to Paul I. then he went into the army, received another court appointment. and finally entered the diplomatic service.

He served at embassies in Berlin and The Hague; in 1806 he traveled in southern Germany to report on French troops to the new emperor, Alexander I, who was turning away from Napoleon. Nesselrode served as diplomatic secretary to Generals Mikhail Kamenski. Friedrich von Buxhowden and Levin August Bennigsen in the war that followed. Nesselrode was present at the battle of Eylau in Jan. 1807. He assisted at the peace of Tilsit, and then went to the embassy at Paris, where he acted as intermediary between Talleyrand and Alexander. After the breach of diplomatic relations in 1811, Nesselrode tried to persuade Alexander to open negotiations with Napoleon. In the war that followed, Nesselrode served at the tsar's headquarters at Vilna, and though Nikolai Rumiantzev was foreign minister, directed foreign policy, as he did in fact for the rest of his life. He was present at the battle of Leipzig. Accompanying the invading army to Paris, he signed the treaty of Chaumont, March 1, 1814. He influenced Alexander to favour the Bourbon restoration and to oppose a ruinous war indemnity on France.

After the congress of Vienna, Nesselrode supplanted Count Capo d'Istria, foreign secretary, in the tsar's favour and in 1822 replaced Capo d'Istria. Nesselrode advocated the tsar's "universal union."

Alter Alexander's death, Nesselrode retained office under Nicholas I, and was responsible for the change in policy after 1829 that abandoned the traditional goal of conquering Constantinople in favour of keeping Turkey a weak power dependent on Russia. The treaty of Unkiar Skelessi (1833), realized this change; he conducted the negotiations that led to the shelving of that treaty anti to the alliance between Russia and Great Britain resulting in the Straits convention of 1841. In 1849 he suggested the intervention of Russia in Hungary on the side of Austria, although he restrained Nicholas from making an active intervention in France, as he had in 1830. During the crisis of 1853, Nesselrode prolonged negotiations as long as he could in the hope of avoiding the Crimean War. The last of his important political acts, the signing of the treaty of Paris in 1856, at the end of that war, undid the results of his patient efforts to establish Russian preponderance in the Balkan peninsula. Retiring from the foreign office, he retained the chancellorship, which he had held since 1844.

He died at St. Petersburg on March 23, 1862.

NEST. The practice of nest building (nidification), as the term is used in zoology, includes all preparations for the reception of eggs or newborn young and for their care. Common conceptions of nest making are derived from observations of birds: but mammals, reptiles amphibia and fishes, as well as invertebrates include species which make more or less elaborate preparation in advance for the reception of their young. The first stage in this sequence is the selection of a definite site for the nest, in or on which the eggs or young are to be deposited. Two chief factors governing this preparation are the conditions of the environment and the state of the young on emergence.

BIRDS

Not all birds make nests; some waterfowl and a few land birds lay eggs on hare rock or ground. For example, auks and murres deposit single eggs on bare Ledges of rock projecting from the face of a cliit rising steeply from the sea. Species which haunt sandy wastes make little or no preparation by way of a nest. This receptacle seems originally to have been an adaptation for the purpose of keeping the incubating bird and the eggs from contact with cold, damp earth.

Much more elaborate are the nests of the smaller species. These, placed in hedgerows or bushes or even on the ground, are bowl-shaped structures made of fine grass interwoven with horsehair and cunningly masked by moss or lichen, as in the case of the European long-tailed titmouse. Some, like the thrush, use a foundation of clay and line the interior of the nest with a mixture of decayed wood and cow dung. Certain African weaverbirds and American Baltimore orioles or hangnests, suspend the nest (made of long grass stems and vegetable fibres) by a long fibrous strand or rope attached to the bough of a tree. Toward the end this rope is enlarged to iorm a spherical chamber, with an entrance at the top or side in the hangnests; and at the end of a further extension of the rope beneath the nest in the weavers. Some of the flowerpeckers of Australia build a nest of felted cotton-down. A few species make a more or less extensive use of saliva as a cement for mud-built nests, as the swallow tribe, the South American ovenbird and the flarningo. The use of salivary glands in nest building reaches its maximum with the swifts which glue small twigs to the inside of a chimney to form a tiny basket or, as in the case of the Asiatic edible swifts, use saliva alone. Such nests are harvested early in the nest-building season and used by the Chinese in making bird's nest soup.

Hollows in trees are used by many birds, such as the parrots and the woodpeckers, the eggs being deposited on the rotten wood at the bottom of the hole. Others, like the sand martin and the kingfisher, drive long tunnels into the face of a sandbank, enlarging the end of the tunnel to form a nest chamber. The greatness of this achievement is commonly overlooked, for it mould be difficult to find birds so unsuited for such a task. The sand martin has very feeble feet and an extremely short beak, while the short legs, partly united toes and long pointed beak of the kingfisher seem less fitted for burrowing.

While there is general conformity of type characteristic of the nests of the different groups of birds, there are striking exceptions to the rule. The stork trihe, generally, is content with a simple platform of sticks; but the hammerhead stork (*Scopus umbretta*) builds a huge nest of mud and sticks, covered over by a roof which may be as much as 6 ft. across and so substantial as to bear easily the weight of a man. The flamingos build a steep pedestal of mud, the top of which is scooped out to receive the eggs. Parrots nest in hollow trees, but the quaker-parrot (*Myopsittacus*) of South America builds a large domed nest of sticks.

The chickenlike or gallinaceous birds make little more than an apology for a nest, fashioned in a depression in the ground. The fowllike megapodes of Celebes, New Guinea and Australia, however, build a huge mound of decaying vegetable matter, lay their eggs deep down in the fermenting mass and leave them to hatch by the heat generated by decay.

One of the most remarkable cases of nest building among birds is furnished by the hornbills whose eggs are laid at the bottom of a cavity in a tree. As soon as the female has started incubation, the male closes the entrance hole with clay; he leaves open a space wide enough for his mate to push her beak through to receive food from him.

See also BIRD.

OTHER NEST BUILDERS

Mammals. — Few other animals are as skillful as birds in weaving nests. The harvest mouse among the mammals is, however, the rival of most birds, and many squirrels build bulky structures in treetops or vines. The rabbit builds a nest in her burrow and lines it with the underfur plucked from her body, in the same manner as ducks, geese and swans line the nest with down plucked from the breast. The only nest-building mammals which produce eggs are the *echidna* or spiny anteater *Tachyglossus* and the duck-billed platypus *Ornithorhynchus*. The nest is of the simplest character, a chamber lined with leaves and grass at the end of a long tunnel dug by the animal.

Reptiles. — Among the reptiles nest building, if practiced, goes little, further than digging a hole in the ground and depositing the eggs within it, leaving them to their fate. The European pond tortoise, however, takes a little more trouble. She prepares the ground by watering it from the bladder and from special anal water sacs. Then, boring a hole with the tail, as one would use a stick, the tortoise enlarges it with her feet. When the hole is about 5 in. deep the eggs are laid at the bottom, the soil is replaced and beaten down flat. The crocodile digs a hole in the sand about 2 ft. deep, lays her eggs in it and covers them. She returns periodically to sleep above the incubating eggs and is thus at hand to assist the young to escape at the time of hatching. She is warned of this by the noise they make in endeavouring to break through the shell, just as young birds announce their advent by cheeping before the shell is actually broken. When the baby crocodiles have all emerged the mother escorts them to the water. The alligator, on the other hand! builds a great mound of decaying vegetation in a marsh to a height of about 3 ft. and as much as 8 ft. in diameter. The white and hard-shelled eggs, 20 to 30 of them, are laid about 8 in. from the surface.

The python, among the snakes, like *Ichthyophis* among the Amphibia, coils her body around the eggs until they hatch and guards her young for some time after.

Amphibia.—Among Amphibia, frogs of the genus *Phyllomedusa* build nests resembling those of the tailorbird. *Phyllomedusa hypochondria*, the *Wollenkukk* of the Paraguayan Chaco is a good example. The female carries the male upon her back while searching for a suitable leaf which must be on a tree overhanging the water. This found, both seize it and hold the edges together with their hindfeet; the female pours her eggs into the funnel thus formed while the male fertilizes them as they pass in. The gelatinous envelope of the eggs suffices to hold the leaf edges in position as they are brought together in the filling process which goes on until about 100 eggs are laid.

Fishes. — Among the fishes the fresh-water sticklebacks (*Gasterosteus*) and the marine 15-spine stickleback (*Spinachia*) build nests of weeds, the task being undertaken by the male, who uses a secretion produced by the kidneys as a binding material. He has sole charge of the eggs and young. The gourami (*Osphronemus*) of the Malay archipelago fashions a nest of air bubbles toughened by a kind of saliva, and mounts guard over both eggs and young. The perchlike fishes of the family Cichlidae, both of America and the old world, as well as some of the catfishes and their relatives (Siluroid fishes), carry the young in the mouth; in some species both sexes do this, in others the male alone. The male pipefish and seahorse carries the eggs and young either in a pouch running along the belly or attached to his body. The Aspredo, a catfish of the Guianas carries her eggs attached to the under surface of the head, belly and paired fins. The skin assumes a spongy condition for their accommodation so that each lies within a deep depression, recalling the egg pits of the Surinam toad; in the case of Aspredo, however, the pits are shallow and the larvae are not retained there.

Invertebrates. — Among the insects the elaborate care for the eggs and young displayed by the ants, bees and wasps is well known (see SOCIAL INSECTS). The scorpions and the wolf spiders carry their young on their backs until they can fend for themselves; some of the scorpions, again, like the wolf spiders, carry their eggs closely packed within a spherical silken bag.

Among the marine invertebrates, viz., the echinoderms, an antarctic sea slug (*Cucumaria* crocea) carries the young on its back. One of the sea urchins (*Hemiaster philippi*) and a starfish (*Asterias spirabilis*) carry the young in brood pouches — on the back in the case of the sea urchin and around the mouth in the starfish. It would seem that only arctic and antarctic species behave in this manner. In all other cases the young leave the parent as minute, free-swimming larvae and undergo a complicated metamorphosis before they become fully grown.

In the invertebrates the care of the young must be regarded as an entirely impersonal, unconscious act, determined by the physical peculiarities of the external environment. This should be borne in mind in considering the origin and evolution of nest building in animals of all levels. (W. P. P.; X.)

NESTOR (c. 1056–*c.* 1114), the reputed author of the earliest Russian chronicle, was a monk of the Pecherskiy cloister of Kiev from 1073. The only other known fact of his life is that he was commissioned with two other monks to find the relics of St. Theodosius, a mission which he succeeded in fulfilling. The chronicle begins nith the deluge, as those of most chroniclers of the time did. The compiler appears to have been acquainted nith the Byzantine historians; he makes use especially of John Malalas and George Hamartolus. He also had in all probability other Slavonic chronicles to compile from, which are now lost. Many legends are mixed up with Nestor's *Chronicle;* the style is occasionally so poetical that perhaps he incorporated *byliny* which are now lost. The early part is rich in these stories, among which are the arrival of the three Varangian brothers, the founding of Kiev, the murder of Askold and Dir, the death of Oleg, who was killed by a serpent concealed in the skekton of his horse, and the vengeance taken by Olga, the wife of Igor, on the Drevlians, who had murdered her husband. The account of the labours of Cyril and Methodius among the Slavs is also very interesting, and to Nestor we owe the tale of the summary way in which Vladimir suppressed the worship of Perun and other idols at Kiev. As an eyewitness he could only describe the reigns of Vsevolod and Sviatopolk (1078–1112), but he gathered many interesting details from the lips of old men, two of whom were Giurata Rogovich of Novgorod, who gave him information concerning the north of Russia, Petchora, and other places, and Jan, a man ninety years of age, who died in 1106, and was son of Vishata the voivode of Yaroslavl and grandson of Ostromir the Posadnik, for whom the *Codex* was written. Many of the details given by Nestor of the various races of the Slavs arc of the highest value. *The Chronicle* has come down in several manuscripts; the oldest (1377), the so-called Lavrentievski, has been translated into Polish, Bohemian, German and French. The work is of primary importance for early Russian history.

See L. Leger, *Chronique dite de Nestor* (1884). (W. R. Mo.)

NESTOR, in Greek legend, son of Neleus and Chloris, king of Pylos (Navarino) in Elis. When all his brothers were slain by Heracles. in consequence of the refusal of Neleus to purify him for the murder of Iphitus, Nestor alone escaped. In the *Iliad* he is about 70 years old, having seen two generations of men flower and die. Sage and pious, his role is largely to incite the warriors to battle and to tell stories of his early exploits, by contrast with which his auditors' warlike experiences are shown to be soft and easy. After the war Nestor returned easily to Greece, avoiding the troubles and wanderings which afflicted Agamemnon, Menelaus and Odysseus (*qq.v.*). In the Odyssey, whose dramatic date is ten years later than that of the Iliad, Nestor is still ruling in Pylos, where he is visited by Telemachus. Ovid parodied his antique garrulity, making him zoo years old and putting into his mouth a long and gruesome account of the famous battle between the Lapiths and the Centaurs (*Metamorphoses,* 12). (T. V. B.)

NESTORIANS. The present article deals not with the life and doctrine of Nestorius (*q.v.*) but with the Eastern Churches called by his name.

A christology of the kind usually called Nestorian was eagerly and successfully propagated in Syria and Persia by Ibas, bishop of Edessa (435) and Barsumas, bishop of Nisibis. In Persia the old churches were stimulated into vigour and new ones founded. Their centre was at Ctesiphon on the Tigris, a busy trading city. The church traced its doctrines to Theodore of Mopsuestia rather than to Nestorius, whose name at first they repudiated, not regarding themselves as having been proselytized to any new teaching. After the Mohammedan invasion of Persia early in the 7th century the Nestorians were able to come to terms with the invaders; and for five centuries the Nestorians were a recognized institution within the territory of Islam, though their treatment varied from kindly to harsh. But the barbaric invasions of the 13th and 14th centuries fell with crushing force on the Nestorians. In 1258 Hulagu Khan took Baghdad, and about 1400 Timur again seized and sacked the city. Though the Nestorians were numerous, their moral influence and their church life had greatly deteriorated. Those who escaped capture by Timur fled to the mountains of Kurdistan, and the community that had played so large a part in Mesopotamian history for a thousand years was thus shattered. Various attempts during the 16th century to promote union between the Nestorians and Rome proved fruitless, but the Roman Church has never ceased in its efforts to absorb this ancient community.

The Nestorians showed a zeal for evangelization which resulted in the establishment of their influence throughout Asia, as is seen from the bishoprics founded not only in Syria, Armenia, Arabia and Persia, but at Halavan in Media, Merv in Khurasan, Herat, Tashkent, Samarkand, Baluk, Kashgar, and even at Kambaluk (I'ekin) and Singan fu (Hsi'en fu) in China, and Kaljana and Kranganore in India. Mongolian invasions and Mohammedan tyranny have, of course, long since swept away all traces of many of these. The 400,000 Syrian Christians ("Christians of St. Thomas," *see* THOMAS, ST.) who lived in Malabar no doubt owed their origin to Nestorian missionaries. the stories of the evangelization of India by the Apostles Thomas and Bartholomew having no real historical foundation, and the Indian activity of Pantaenus of Alexandria having proved fruitless, in whatever part of India it may have been exercised. The theology of the Indian Syrian Christians is of a Nestorian type, and Cosmas Indicopleustes (6th century) puts us on the right track when he says that the Christians whom he found in Ceylon and Malabar had come from Persia (probably as refugees from persecution, like the Huguenots in England and the Pilgrim Fathers in America). Pehlevi inscriptions found on crosses at St. Thomas's Mount near Madras and at Kottayam in Travancore, are evidence both of the antiquity of Christianity in these places (7th or 8th century), and for the semi-patri-passianism (the apparent identification of all three persons of the Trinity in the sufferer on the cross) which marked the Nestorian teaching In 74j Thomas of Kana brought a new band of emigrants from Baghdad and Nineveh, and possibly the name "Christians of St. Thomas" arose from confusion between this man and the apostle. Other reinforcements came from Persia in 822, but the Malabar church never developed any intellectual vigour or missionary zeal They had their own kings, lived as a close caste, and even imitated the Hindus in caste regulations of food and avoidance of pollution In 1330 Pope John XXII issued a bull appointing Jordanus, a French Dominican, bishop of Quilon, and inviting the Nestorians to enter "the Christian Church." The

Chestnut bittern (*Ixobrychus cinnamomeus*) nest among the reeds overgrowing a rice field. Indonesia

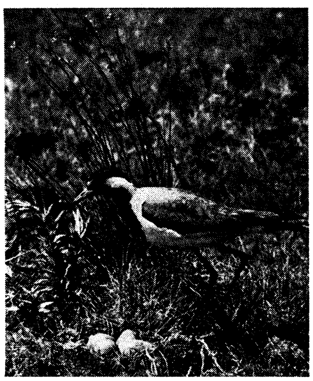
Nest and eggs of a robin (*Turdus migratorius*). North America

Nest of a chimney swift (*Chaetura pelagica*) in a well. Mucus is used to hold sticks together. North America

Common sparrow hawk (*Accipiter nisus*) guarding its young in a nest of twigs and branches. Europe

Gentoo penguin (*Pygoscelis papua*) on her nest, a hollow among the rocks. Islands south of Australia

Nest of a paradise flycatcher (*Tchitrea paradisi* lencogaster) on the side of a sapling. India



Ground nest of the red-wattled lapwing (*Lobivanellus pluvius*). India

Rookery of nests of the great blue heron (Ardea *herodias*). North America

Bank swallow (*Riparia riparia riparia*) nests in a sandy bank. North America

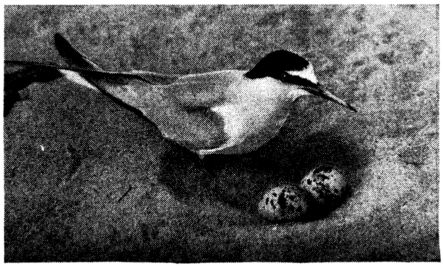
BIRDS' NESTS

PHOTOGRAPHS (TOP LEFT, THIRD ROW LEFT, THIRD ROW CENTRE) CAMERA PRESS—PIX FROM PUBLIX (TOP CENTRE) JACK E SHADE FROM BLACK STAR, (TOP RIGHT BOTTOM LEFT, BOTTOM RIGHT) JOHN H. GERARD, (SECOND ROW LEFT JOHN MARKHAM (SECOND ROW RIGHT) E. AUBERT DE LA RUE

American flamingo (*Phoenicopterus ruber*) nests made of mud and clay. Bahama islands

Nest of the tailor bird (*Orthotomus sutorius*), an Asian thrush, constructed by sewing leaves together, using the bill as a needle. Malaya

Ibis nests of sticks and leaves in a marsh. Australia



A depression in the sand serves as a nest for the little tern (*Sterna albifrons*). Europe

Platform nest of the mourning dove (*Zenaidura macroura*) on the branch of a tree. North America

Nest made of reeds by the Florida gallinule (*Gallinula chloropus cachinnans*)

Nest of a sandhill crane (*Grus canadensis*) in a marsh. North America

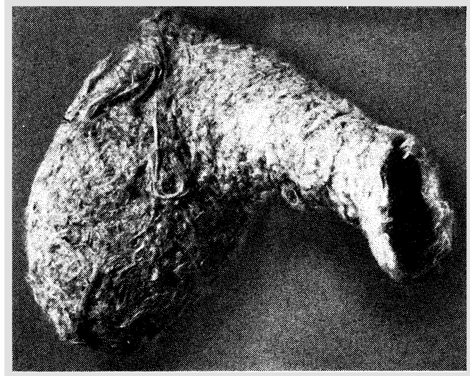
Treetop nest of the northern bald eagle (*Haliaeetus leucocephalus washingtoniensis*). North America

BIRDS' NESTS

BY COURTESY OF (TOP LEFT BOTTOM LEFT) THE AMERICAN MUSEUM OF NATURAL HISTORY; PHOTOGRAPHS, (TOP RIGHT, CENTRE LEFT) CAMERA PRESS—PIX FROM PUBLIX (CENTRE ABOVE) JOHN MARKHAM, (CENTRE BELOW CENTRE RIGHT, BOTTOM RIGHT) JOHN H. GERARD

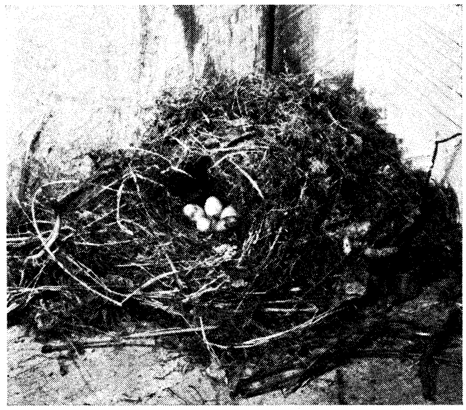
Shelflike nests made of saliva by the East Indian cave swiftlets (*Collocalia*). The edible nest is used by the Chinese in making bird's nest soup

Tree trunk sectioned to show the hollowed-out nest of a downy woodpecker (*Dendrocopus pubescens*)



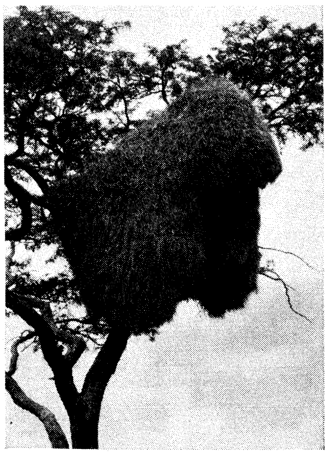
Hanging nest of the Turkistan Remara (*Remiza caspia*) formed of dried grasses and feathers

Nest of a golden eagle (*Aquila chrysaëtos canadensis*) on a mountain ledge



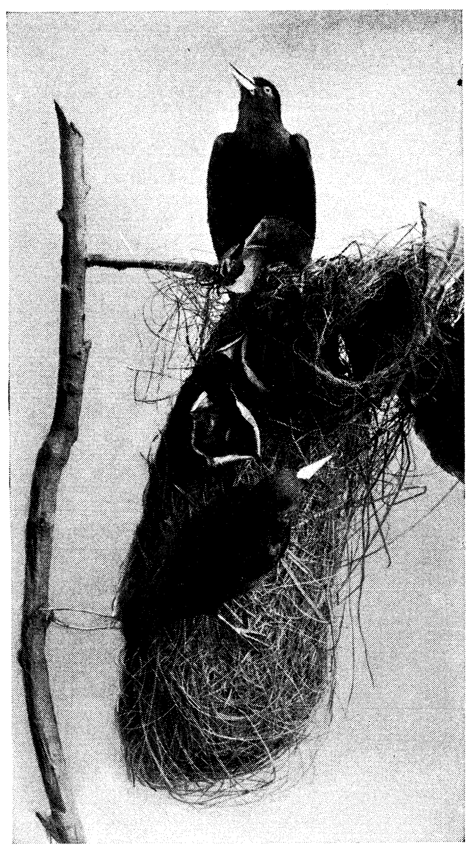
Large nest of the Carolina wren (*Thryothorus ludovicianus*) in a barn

Stork nest of sticks and reeds on a chimney top in France. A permanent nest, it is enlarged annually



Grass nest of the social weaver bird (*Philetaerus socius*), Africa. Interior contains feather-lined cavities

Clay nest of the ovenbird (*Seiurus aurocapillus*), opened to show interior and protected entrance passage



Suspended nest woven of grass by Amazonian caciaues (*Cacicus cela*)

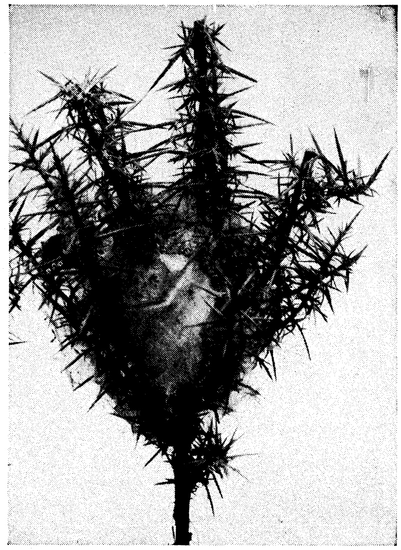
BIRDS' NESTS

BY COURTESY OF (TOP LEFT, TOP RIGHT, BOTTOM RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM, (CENTRE LEFT, BOTTOM CENTRE ABOVE) THE AMERICAN MUSEUM OF NATURAL HISTORY; PHOTOGRAPHS, (TOP CENTRE, CENTRE RIGHT) JOHN H. GERARD, (BOTTOM LEFT) EWING GALLOWAY, (BOTTOM CENTRE BELOW) KURT SEVERIN FROM BLACK STAR

NEST

Nest of tent caterpillars in the branches of a tree

Nest of the red-eared turtle. The hole is plugged with soil after the eggs are laid



Nest of the funnel-web or grass spider in a thistle branch

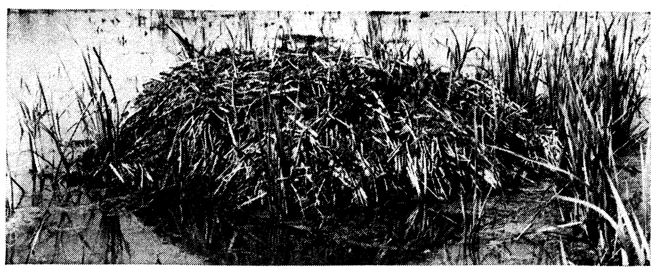
Entrance to a nest of Florida harvesting ants

Bald-faced hornets' nest cut away to show arrangement of brood cells

Red-backed salamander guarding its eggs in a cave nest

Prairie meadow mouse nursing its young in nest made of grass

Cutaway view of the underground grass-lined nest of a mole



Muskrat house in a shallow marsh

EXAMPLES OF NON-AVIAN NEST BUILDING

BY COURTESY OF (TOP RIGHT, BOTTOM RIGHT ABOVE) THE TRUSTEES OF THE BRITISH MUSEUM, (CENTRE RIGHT) THE AMERICAN MUSEUM OF NATURAL HISTORY; PHOTOGRAPHS (TOP LEFT. TOP CENTRE, CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT BELOW) JOHN H. GERARD. (CENTRE) A. C. PARSONS FROM BLACK STAR

invitation was declined. but in the 16th century the Syrian Christians sought the help of the Portuguese settlers against Mohammedan oppression, only to find that before long they were subjected to the fiercer perils of Jesuit. antagonism and the inquisition. 'l'he Syrians submitted to Rome at the synod of Diamper in 1599, but it was 3 forced submission. and in 1653 when the Portuguese arrested the Syrian bishop just sent out hy the cntholicus of Babylon. the rebellion broke out. The renunciation was not quite thorough. one party adhering to the Roman Church as Romo-Syrians: the others reverting wholly to Syrian usages and forming! in modern times, about three-fourths of the whole community.

WIDESPREAD MISSIONS

Early evidence of Nestorian missions in China is extant in the tablet found in 1625 at Sian in the province of Shensi. It commemorates "the introduction and propagation of the noble law of Ta t'sin in the Middle Kingdom," and beneath an incised cross sets out in Chinese and Syriac an abstract of Christian doctrine and the course of a Syrian mission in China beginning nith the favourable reception of Olopan. who came from Judsea in 636. For tn-o generations the little cause prospered. and again after persecutions in 699 and 813. Later on a second mission arrived. many churches were built, and several emperors patronized the faith.

In the 10th century the Nestorians introduced Christianity into Tartary proper; in 1274 Marco Polo saw two of their churches. The legend of Prester John is based on the idea of the conversion of a Mongol tribe, the Karith, whose chieftain Ung Khan at baptism received the title Malek Juchana (King John). Their activity may well be said to have covered the continent. Their campaign was one of deliberate conquest, one of the greatest ever planned by Christian niissionaries. Marco Polo is nitness that there were Nestorian churches all along the trade routes from Baghdad to Peking.

The Modern **Nestorians.**—The Nestorians or East Syrians (*Surayi*) of Turkey and Iran inhabit a district bounded by Lake Urmia, or Urumia, on the east. stretching westward into Kurdistan. to Mosul on the south. and nearly as far as Van on the north. It is only recently, under the influence of the different missions, that education, ruined by centuries of persecution, revived among the Nestorians; and the mountaineers, cut off from the outer world, are as a rule destitute of learning, and greatly resemble their neighbours, the wild and uncivilized Kurds. They are, however. extraordinarily tenacious of their ancient customs, and, almost totally isolated from the rest of Christendom since the 5th century. they afford an interesting study to the ecclesiastical student. Their churches are rude buildings, dimly lighted and destitute of pictures or images, save that of the cross. which is treated with the deepest veneration. There are three liturgies—of the Holy Apostles. of Theodore and of Sestorius. The first is quite free from Sestorian influence, dates from some remote period, perhaps prior to 431, and is certainly the most ancient of those in use in Christendom; the other two, though early, are undoubtedly of later date. The Nestorian canon of Scripture seems never to have been fully determined. nor is the sacramental system rigidly defined. Nestorian writers. however. generally reckon as sacraments the Priesthood. the Oil of Pnction. the Offering of the Body and Blood of Christ. Absolution. the Holy Leaven and the Signation of the life-giving Cross. 'The Holy Leaven is reputed to be a part of the original bread of the first Eucharist, brought by Xddai and Mari and maintained ever since in the church; it is used in the confection of the Eucharistic wafers, nhich are rather thicker than those used in the western church. Communion is given in both kinds. as throughout the east; like\\ise. confirmation is administered directly after baptism. Sacramental confession is enjoined but has recently become obsolete; prayers for the departed and invocation of saints form part of the services. The bishops are always celibates and are chosen from episcopal families. The service-books were wholly in manuscripts until the press of the archhishop of Canterhury's mission at Urmia issued the *Takhsa* (containing the liturgies, baptismal office. etc.) and several other liturgical tests.

The Nestorinns cornmemorate Nestorius a a saint and invoke his aid and that of his companions. 'They reject the Third Oecumenical council. and though showing the greatest devotion to the Blessed Virgin, deny her the title of *Theotokos; i.e.*, the mother or bearer of God. Their theological teaching is misty arid perplexing; but systematic or even consistent theological thinking is not their primary interest (*see* J. F. Bethune-Baker. *Nestorius and His Teaching*). The peculiar circumstances, both ecclesiastical and temporal, of the Nestorians have attracted much attention in western Christendom, and various missionary enterprises among them have resulted (*see* authorities named below).

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NESTORIUS (d. c. 451), Syrian ecclesiastic. patriarch of Constantinople from 428 to 431, was a native of Germanicia at the foot of Mount Taurus, in Syria. 'The year of his birth is unknown. He received his education at Antioch, probably under Theodore of Mopsuestia. As monk in the neighbouring monastery of Euprepius, and afterward as presbyter, lie became famous in the diocese for his asceticism. his orthodoxy and his eloquence. By Theodosius II he was nominated patriarch of Constantinople and was consecrated on April 10, 428. He immediately set to work to extirpate heresy in his diocese. beginning by the suppression of the assemblies of the Arians. These. by a bold stroke of policy. anticipated his action by themselves setting fire to their meeting house. Nestorius being forthwith nicknamed "the incendiary." His repression of the Novatians and the Quartodecimans led to serious disturbances at Sardis and Miletus.

The toleration the followers of Macedonius had long enjoyed was also broken. the recently settled Pelagians alone finding any respite. One of the practices assailed by Nestorius was the custom. which had become almost universal in Constantinople, of bestowing the epithet Θεοτόκος "mother of God." upon Mary the mother of Jesus. From Xntioch Nestorius had brought along n-ith him to Constantinople a copresbyter named Anastasius. who erijoyed his confidence and is called by Theophanes his "syncellus." This Anastasius, in a pulpit oration which the patriarch himself is said to have prepared for him. caused great scandal to the partisans of the cult of Mary by saying. "Let no one call Mary the mother oi God. for Mary was a human being; and that God should be born of a human being is impossible."

Cyril (*q.v.*) of Alexandria seized his opportunity. He stirred up his own clergy. he encouraged the dissidents at Constantinople. he addressed himself to the sister and wife of the emperor. and he bribed the officials of the court. He also sent to Rome a careful selection of Nestorius's sayings and sermons. Nestorius himself. on the other hand. having occasion to write to Pope Celestine I about the Pelagians (whom he n-as not inclined to regard as heretical). gave from his own point of view an account of the disputes which had recently arisen within his patriarchate. Celestine naturally resented any questioning of the Roman decision concerning the Pelagians and was jealous of the growing power of the Constantinople see.

In a synod which met in 430, he decided in favour of the title Θεοτόκος, bade Nestorius retract his erroneous teaching on pain of instant excommunication and entrusted the execution of this decision to the patriarch of Alexandria.

In this situation the demand for a general council became irresistible, and accordingly Theodosius and Valentinian 111 issued letters summoning the metropolitans of the Catholic church to meet at Ephesus at Whitsuntide in the year 431. each bringing with him some able suffragans. Nestorius with 16 bishops and an armed following. Cyril with 50 bishops. Juvenal of Jerusalem, and Flavian of Thessalonica arrived. John of Antioch was delayed on his journey and wrote requesting that the opening of the synod should not be delayed on his account. Cyril and his friends assembled in the church of the Theotokos on June 22, and summoned Nestorius to give an account of his doctrines. He replied that he would appear when all the bishops were assembled; and the imperial commissioner, Candidian, formally protested against the opening of the synod. Cyril and the 159 bishops who were with him nevertheless proceeded to read the imperial letter of convocation, and afterwards the letters which had passed between Nestorius and Cyril. The entire assembly then cried anathema on Nestorius and his doctrines, and the decree of his exclusion from the episcopate and from all priestly communion was solemnly read and sigced by all present. The accused and his friends never had a hearing.

The populace accompanied the members with torches and censers to their lodgings, and there was a general illumination of the city. A few days afterwards (June 26th or 27th) John of Antioch arrived; whether inclined or not to the cause of his former co-presbyter, he disapproved the precipitancy with which Cyril had acted, and at a *conciliabulum* of forty-three bishops held in his lodgings he was induced by Candidian, the friend of Nestorius, to depose the bishops of Alexandria and Ephesus on the spot. The Ephesians intervened to prevent the execution of this decision on the next Sunday. Meanwhile a letter from the emperor declared invalid the session at which Nestorius had been deposed unheard; numerous sessions and counter-sessions were afterwards held, the conflicting parties both seeking the imperial support. In the end Theodosius decided to confirm the depositions which had been pronounced on both sides, and Cyril and Memnon as well as Nestorius were by his orders laid under arrest. Representatives from each side were now summoned before him to Chalcedon, and at last, yielding to the sense of the evident majority, he gave a decision in favour of the "orthodox," and the council of Ephesus was dissolved. Maximian, one of the Constantinopolitan clergy, a native of Rome, was promoted to the vacant see, and Nestorius was henceforward represented in the capital only by one congregation, which presently became extinct.

But the Antiochenes maintained for some time an attitude of antagonism towards Cyril and his creed, and were not pacified until an untlerstanding was reached in 433 on the basis of a new formula involving some concessions by him. The union even then was opposed by certain bishops, who were deposed from their sees. Their school at Edessa was closed by Zeno in 489. Immediately after his deposition Nestorius withdrew into private life in his old monastery of Euprepius, Antioch, until 435, when the emperor ordered his banishment to Petra in Arabia A second decree, it would seem, sent him to Oasis, probably the city of the Great Oasis, in Upper Egypt, where he was still living in 439, at the time when Socrates wrote his *Church History*. He was taken prisoner by the Blemmyes, a nomad tribe that gave much trouble to the empire in Africa, and when they set him free in the Thebaid near Panopolis (Akhmim) *c.* 450, they exposed him to further persecution from Schenute, the hero of the Egyptian monks. There is some evidence that he was summoned to the Council of Chalcedon, though he could not attend it, and in the concluding portion of his book known as *The Bazaar of Heraclides* he not only gives a full account of the "Rohher Synod" of Ephesus 449, but knows that Theodosius is dead (July 450) and seems aware of the proceedings of Chalcedon and the flight of Dioscurus, the unscrupulous successor of Cyril at Alexandria Nestorius was already old and ailing and must have died very soon after There are still Nestorians in Kurdistan, and the Syriac Church is Nestorian in theology, as are the churches in Asia founded by Nestorian missionaries in the middle ages.

Modern View.—Only recently has an attempt been made to judge Nestorius from some other evidence than that afforded by the accusations of Cyril and the inferences drawn therefrom. This other evidence consists partly of letters from Nestorius, preserved among the works of those to whom they were written, some sermons collected in a Latin translation by Marius Mercator, an African merchant who was doing business in Constantinople at the time of the dispute, and other material gathered from Syriac manuscripts Since the helpful collection of *Nestoriana* published by Dr. F. Loofs in 1905 there has also come to our knowledge the most valuable evidence of all, Nestorius's own account of the whole difficulty, viz., *The Bazaar*[1] *of Heraclides of Damascus*. This pseudonym served to protect the book against the fate that overtook the writings of heretics, and in a Syriac version it was preserved in the Euphrates valley where the followers of Nestorius settled. Ebed Jesu in the 14th century mentions it together with *Letters* and *Homilies*, as well as the *Tragedy*, or a *Letter to Cosmas*, the *Theopaschites* (of which some fragments are still extant) and the *Liturgy*, which is still used by the Nestorian Church. The discovery of *The Bazaar*, which is the *Apologia* of Nestorius, was made public by Dr. H. Goussen (though members of the Archbishop of Canterbury's Mission to the Assyrian Christians had previously been acquainted with the book). The text has been edited by P. Paul Bedjan (Leipzig, 1910) and a French translation has been made by M. l'abbé F. Nau. A representative selection of extracts has been given to English readers in J. F. Bethune-Baker's *Nestorius and his Teaching* (Cambridge, 1908), chapter ii. of which describes the ms. and its accounts.

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NET. A fabric of thread, cord or wire, the intersections of which are knotted so as to form a mesh. The art of netting is intimately related to weaving, knitting, plaiting and lace-making, from all of which, however, it is distinguished by the knotting of the intersections of the cord. It is one of the most ancient and universal of arts, having been practised among the most primitive tribes, to whom the net is of great importance in hunting and fishing. Net is a common Teut. word, of which the origin is unknown: it is not to be connected with "knit" or "knot." The term "net," *i.e.*, remaining after all deductions, charges, etc., have been made, as in "net profit," is a variant of "neat," tidy, clean, Lat. *nitidus*, shining. Net-making, as a modern industry, is principally concerned with the manufacture of the numerous forms of net used in fisheries, but netting is also largely employed for many other purposes, as for the temporary division of fields, for protecting fruit in gardens, for screens and other furniture purposes, for bags, appliances used in various games, etc. Since the early part of the 19th century numerous machines have been invented for netting, and several of these have attained commercial success. Fishing nets were formerly made principally from hemp fibre — technically called "twine."

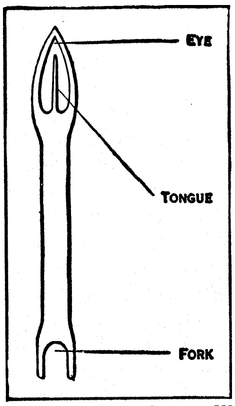

FIG. 1.—NEEDLE USED IN NET-MAKING

The forms of fishing nets vary according to the manner in which they are intended to act. This is either by entangling the fish in their complicated folds, as in the trammel; receiving them into pockets, as in the trawl; suspending them by the body in the meshes, as in the mackerel-net; imprisoning them within their labyrinth-like chambers, as in the stake-net; or drawing them to shore, as in the seine. The parts of a net are the head or upper margin, along which the corks are strung upon a rope called the head-rope; the foot is the opposite or lower margin, which carries the foot-rope, on which in many cases leaden plummets are made fast. The meshes are the squares composing the net. The width of a net is expressed by the term "over"; *e.g.*, a day-net is three fathoms long and one over or wide. The lever is the first row of a net. There are also accrues, false meshes or quarterings, which are loops inserted in any given row, by which the number of meshes is increased. To bread or breathe a net is to make a net.

[1]Syriac, *tĕgūrtā*, lit. "merchandise." The Greek word may have been ἐμποριόν. Nothing is certainly known of any such Heraclides.

Hand Netting — Thetools used in hand netting are the needle, an instrument for holding and netting the material: it is made with an eye *E*, a tongue *T* and a fork *F* (fig. 1). The twine is wound on it by being passed alternately between the fork and round the toiigue. so that the turns of the string lie parallel to the length of the needle, and are kept on by the tongue and fork. A spool. or mesh pin. is a piece of round or flat wood on which the loops are formed. the perimeter of the spool determining the size of the loops. Each loop contains two sides of the square mesh; therefore, supposing that it be required to make a mesh one inch square—

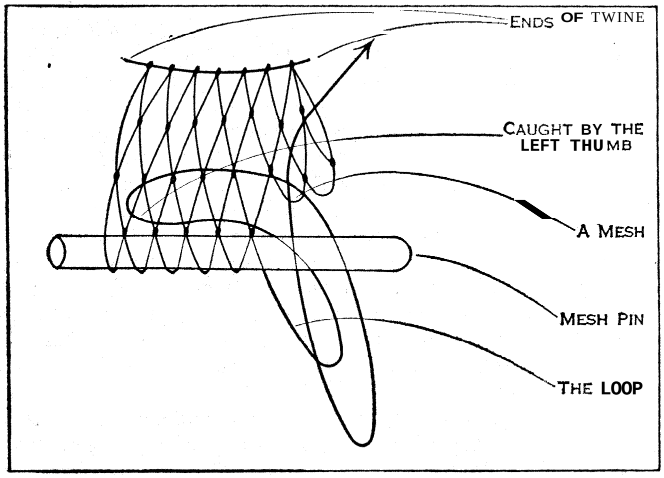

FIG. 2.— –DIAGRAM SHOWING COURSE OF TWINE IN FORMING A FISHERMAN'S KNOT IN NETMAKING

that is. measuring one inch from knot to knot—a spool two inches in circumference must be used. Large meshes may he formed by giving the twine two or more turns round the spool, as occasion may require; or the spool may he made flat and of a sufficient width. The method of making the hand knot. known as the fisherman's knot, is more easily acquired by example than described in writing. Fig. 2 shows the course of the twine in forming a single knot. From the last-formed knot the twine passes over the front of the mesh pin and is caught behind by the little finger of the left hand, forming the loop, thence it passes to the front and is caught by the leit thumb, then through the loop and mesh as sketch indicates. after which the twine is released by the thumb and the knot is drawn taut. Fig. 3 is a bend knot used for uniting two ends of twine.

Machine Netting. — In 1778 a netting machine was patented by William Horton. William Ross, Thomas Davies and John Golby. In 1802 the French government offered a reward of 10,000 fr. to the person who would invent an automatic machine for netmaking. Joseph Jacquard submitted a model of a machine which was brought under the notice of Napoleon I and Lazare Carnot. and he was summoned to Paris by the emperor, who asked—"Are you the man who pretends to do what God Almighty cannot — tie a knot in a stretched string?" Jacquard's model. which is incomplete. was depoiited in the Conservatoire des Arts et Métiers; it was awarded a prize, and he himself received an appointment in the conservatoire, where he perfected his famous attachment to the common loom. In the Cnited Kingdom, the first to succeed in inventing an efficient machine and in establishing the industry of machine netmaking was James Paterson of Musselburgh. Paterson, originally a cooper, served in the army through the Peninsular War, and was discharged after the battle of Waterloo. He established a net factory in Musselburgh about 1820; but the early form of machine was imperfect, the knots it formed slipped readily and, there being much prejudice against machine nets. t'he demand was small. Walter Ritchie, native of Musselburgh, devised a method for forming the ordinary hand knot on the machine nets. and the machine, patented in July 1835, became the foundation of an extensive and flourishing industry. The Paterson machine is very complex. It consists of an arrangement of hooks. needles and sinkers, one of each being required for every mesh in the breadth being made. The needles hold the meshes, while the hooks seize the lower part of each arid twist it into a loop. Through the series of loops so iormed a steel wire is shot. carrying with it twine for the next range of loops. This twine the sinkers successively catch and depress sufficiently to form the two sides and loop of the next mesh to be formed. The knot formed by threading the loops is now tightened up, the last-formed mesh is freed from the sinkers and transferred to the hooks and the process of looping, threading and knotting thus continues.

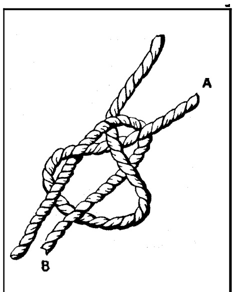

FIG. 3.—A BEND KNOT USED TO JOIN TWO ENDS, A AND B

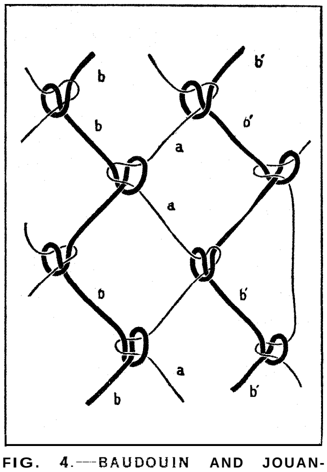

FIG. 4.—BAUDOUIN AND JOUANNIN'S NET LOOM, WHERE THE A SERIES IS DRAWN INTO LOOPS, OVER AND THROUGH WHICH THE B SERIES PASSES

Another form of net loom. working on a principle distinct from that of Paterson, was invented and patented in France by Onésiphore Pecqueur in 1840, and again in France and in Great Britain in 1849. This was improved by many subsequent inventors: especially by Baudouin and Jouannin.

Net Manufacture in the United States. — The manufacture of nets for the fisheries in the United States dates back to about 1844, being initiated by a rrranufacturer of cotton yarns at Canton. Mass. The popularity with which the first experimental cotton twines were received led the manufacturer to devote his n-hole time to their manufacture and improvement. In 1858 the first netting machine in the United States was seen. The limitations of this machine led to the development of new inventions, particularly those designed for handling heavy twines.

In view of the wholly inadequate supply of domestic flax and since but little of it is suitable for the manufacture oi netting, domestic manufacturers are dependent upon imports for their raw materials. The use of cotton in the making of nets increased until the quantities used exceeded those for linen. Manilla is used by the domestic nianufacturers in the making of trawls or other bag nets.

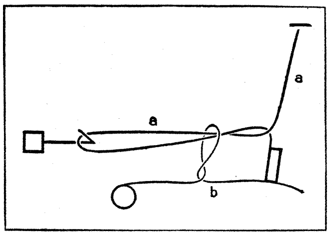

FIG. 5.---DIAGRAM SHOWING THE CONTINUATION OF THE PROCESS

Fishery apparatus employed in the fisheries of the United States and Alaska represents a large portion of the capital investment. a large part of which includes nets. nettings and lines. chiefly cotton, flax and hemp. Much of this material lasts hut two years at best, so that the annual investment in new netting each year is an important factor in the fisheries.

NETBALL, a popular game in English girls' schools, is similar to girls' basketball in the U.S. (*see* BASKETBALL: *Women's Basketball*). It is played on a rectangular outdoor court of asphalt or grass measuring 100 ft. by 50 ft. with half circles 16 ft. in radius marked at either end for shooting. The goal posts stand 10 ft. high with circular rings, or baskets, and nets at the top for the ball to pass through. The hall is usually of leather, about 27 in. in circumference and weighs 14 to 16 oz.

'The game is played between two teams of seven players each—three centre players: two attacks and two defenses. The ball must be passed hand to hand from player to player and nu one may run with it. The centre players try to pass the ball up the court into the circle for the attackers to shoot, The defenders. by guarding their opponents and by intercepting, try to prevent goals from being scored.

The game is played for 15 or 20 min. each way with a 5-min. break at half-time. (C. T. E.)

The game called netball in the United States is similar to volleyball (*q.v.*) except that the ball is thrown and caught instead of being batted. The player may not walk with the ball, which must be thrown from the place where it is caught. The penalty is loss of serve if the foul is committed by the serving side or one point to the serving side if committed by the receiving side. As in volleyball, a game may be played on a time instead of a point basis. (M. D. HA.)

NETHERLANDIC LANGUAGE. Netherlandic is the national language of Holland (kingdom of the Netherlands) and one of the two national languages (besides French) of Belgium. Popular English usage applies the term "Dutch" to the Netherlandic of Holland and "Flemish" to the Netherlandic of Belgium, but in actual fact they are the same language. In its various forms, standard and dialectal, Netherlandic is the indigenous language of most of Holland (all but the Frisian-speaking province of Friesland), of northern Belgium and of a small part of France immediately to the west of Belgium. Netherlandic is also used as the language of administration in the colonies of Holland, and a derivative of it (with slightly different sounds, simplified grammar, but similar vocabulary) is the Afrikaans spoken besides English in the Union of South Africa.

As a written language, Netherlandic is quite uniform; it differs in Holland and Belgium no more than written English does in the United States and the British empire. As a spoken language, however, it exists in far more varieties than does the English of North America. At one extreme is Standard Netherlandic (*Algemeen Beschaafd Nederlands* "General Cultured Netherlandic"), which is used for public and official purposes and is the language of instruction in schools and universities. It is everywhere quite uniform, except that speakers usually show by their accent the general area from which they come. At the other extreme are the local dialects, used among family and friends and with others from the same village. Some dialects are very similar to the standard language. while others are markedly different from it.

Sounds and **Spelling.**—Netherlandic has three classes of vowels and diphthongs: (1) six checked vowels, which are short and occur only before consonants; (2) thirteen free vowels, most of them long, which can occur in all positions (though three are found only in foreign words); and (3) a vowel that occurs only in unstressed position.

Usual spelling

			ie	uu	oe
ɪ	u	o	ee	eu	oo
			ij,ei	ui	ou
e		o			
			(e	eu	o)
	a			aa	

Unstressed: e

Phonetic value

			ɪ	y	u
e	ϕ	o	e:	ϕ:	o:
			ɛi	œy	ɔu
ɛ		3			
			(ɛ:	œ:	3:)
	α			a:	

Unstressed: a

Examples of the checked vowels: *bit* "bit," *put* "well," *bot* [bot] "flounder," *bed* "bed," *bod* [bɔt] "offer," *bad* "bath." Many speakers have no contrast between [o] and [ɔ], but generally use [o] before nasals (*bom* "bomb"), [ɔ] elsewhere *(bot, bod)*. The free vowels spelled *ie, uu, oe* are long only before *r: bier* "beer," *buur* "neighbour," *boer* "farmer"; short otherwise: *biet* "beet," *buut* "goal," *boet* "mends." The other free vowels and diphthongs are long: *beet* "bite," *beuk* "birch," *boot* "boat," *bijt* "bites," *buit* "booty," *bout* "bolt," *baat* "benefit"; and, in foreign words, *scène* "scene," *freule* "young lady of noble birth," *zone* "zone." When the free vowels *uu, ee, oo, aa* occur in an open syllable (before a single consonant plus another vowel), they are written singly: *buur, beet, boot, baat* (as above), but plural *buren, beten, boten, baten.* When the checked vowels occur in an open syllable, the following consonant letter is doubled: *bit, put, bot* (as above), but plural *bitten, putten, botten.*

Standard Netherlandic has the following system of consonants:

stops	p	b	t	d		k			*other:*	l	r
spirants	f	v	s	z	ch		g	h		w	j
nasals	m		n			ng					

p, t, k are unaspirated; *ch,* g, *ng* are phonetically [x], [ɣ], [ŋ]; *r* is uvular with some speakers, apical with others. After vowels w is a bilabial semivowel, but initially or after consonants it is a fully voiced labiodental spirant; it contrasts with the weakly voiced labiodental *v*. *j* is like English y.

Of the stops and spirants, *p, t, f, s, ch* are fortis and voiceless, while *b, d, v, z, g* are lenis and weakly voiced. *k* is usually fortis and *h* usually lenis; but *see* below. The contrast between lenis and fortis is suspended before pause, where only fortis stops and spirants occur. The spelling shows this in the case of *v* and *z: geven, lezen* "give, read," but *ik geef, ik lees* "I give, I read"; it does not show it in the case of *b, d, g: hebben, redden, leggen* "have, save, lay," but *ik keb, ik red, ik leg* "I have, I save, I lay," pronounced *hep, ret, lech.* In normal transition, fortis stops and spirants become lenis before a following b or d: *dat boek* "that book," pronounced *dad boek; vijf dagen* "five days," pronounced *vijv dagen; poetsdock* "polishing cloth," pronounced *poedzdoek;* and similarly, *ik ben* "I am," with lenis *k*. On the other hand, lenis spirants become fortis after any preceding fortis stop or spirant: *het vuur* "the fire," pronounced *het fuur; op zee* "at sea," pronounced *op see; vijf ganzen* "five geese," pronounced *vijf chanzen;* and similarly, *vijf honden* "five dogs," with fortis *h*. When these assimilations would give long consonants, they are simplified: *dat ding* "that thing," pronounced *dading; vijf vingers* "five fingers," pronounced *vijfingers; zes zakken* "six sacks," pronounced *zesakken.*

History. — Together with English, Frisian and German, Netherlandic belongs to the West Germanic group of languages. *(See* GERMANIC LANGUAGES.) It is descended primarily from the speech of the Franks who entered this area in the 4th and 5th centuries; in historical studies it is therefore often called Low Frankish. At the same time, it shows a few non-Frankish features ("Inguaeonisms"), which were probably borrowed from the former Germanic inhabitants of the coast. Documents written in Netherlandic do not begin to appear until the end of the 12th century. From the immediately preceding period there are only a few glosses, the names and occasional words that appear in Latin documents, and the single sentence *hebban olla uogala nestas bigunnan hinase hi[c] enda thu* "all birds have begun [their] nests save I and thou."

The development of Standard Netherlandic is closely tied to the political and economic history of the area. During the 13th and 14th centuries Flanders (in western Belgium) was culturally predominant, and Bruges the leading city. Toward the end of the 14th century the cultural centre began to shift eastward to Brabant, with Antwerp as the leading city. By the middle of the 16th century the speech of this region was well on its way to becoming standard for the whole area. Then came the revolt against Spain, in which the northern province of Holland played the leading role. Holland's cultural importance was greatly increased by the fact that many of the most influential southern families fled to the north, above all to Amsterdam, especially after the fall of Antwerp (1585).

The political split between the United Netherlands in the north and the Spanish Netherlands in the south had far-reaching linguistic effects. In the prosperous and vigorous north a standard language rapidly developed, based on the speech of the big cities of the province of Holland (especially Amsterdam) but also showing the influence of the culturally important refugees from Brabant. This has continued to develop as the standard language, down to the present. In the south, French came more and more to prevail among the upper classes. The less privileged classes continued to use dialectal Netherlandic, but no supradialectal standard was developed.

The cultural predominance of French increased during the period of French rule (1795–1814), abated somewhat during the years when Belgium and Holland were united independently (1815–30), but rose again after the founding of the kingdom of Belgium in 1830. At this time French was the only official language, used exclusively in government, courts and schools. Then there began a long struggle to give Netherlandic equal status with French, ending with the Language act of 1938, which made it the only official language of the northern part of Belgium. During these years of .struggle there were attempts to set up a standard Flemish. different from that of the north; but in the end the standard Fetherlandic that had become established in Holland was accepted for northern Belgium as well.

The close relationship of Netherlandic with English is most obvious in the consonants of the two languages: *plug* "plug," *tong* "tongue." *kan* "can." *bloed* "blood." *doen* "do," *gras* "grass," *hand* "hand," *man* "man." *naam* "name." *lip* "lip," *recht* "right." *winter* "winter," *jaar* "year." Former *f-* and s- are now *v-* and *z-*: *vinger* "finger." *zingen* "sing": former *th* and *d* have coalesced as *d*: *dief* "thief." *diep* "deep": former *al, ol* before *d, t* have changed to *ou*: *koud* "cold." *bout* "bolt"; former *ft* has changed to *cht*: *zacht* "soft." Former sk (English *sh*) gives *sch* initially: *schip* "ship," but *ss* or *s* elsewhere: *vis* "fish." plural *vissen;* former *hs* (English *x*) has also given *ss* or *s*: *vos* "fox." plural *vossen.*

Dialects.— At the border separating Holland or Belgium from Germany, the use of the standard language changes abruptly: Netherlandic is used to the west.. German to the east. In the local speech, however. there is no such change: from the point of view of village dialects, the entire Netherlandic-German territory from the Sorth sea to the Alps is a single dialect area with only gradual transitions from one village to the next.

In an area bounded roughly by Amsterdam, The Hague and Rotterdam. the local dialects are relatively uniform and do not differ greatly from the standard language. But north, east or south of this area. the local dialects diverge more and more from the standard language, until finally the two become mutually unintelligible. By tradition. dialects are named after the provinces in which they are spoken: Gronings in Groningen. Limburgs in Limburg, etc. In actual fact there are no sharp boundaries between dialects! hut only more or less gradual transitions; and the relatively sharp transitions do not necessarily occur at provincial borders.

The use of dialect varies markedly. In the area Amsterdam-The Hague-Rotterdam, most rural inhabitants are puzzled at the suggestion that they speak a "dialect." Their speech is so similar to the standard language that they arc not aware of any real diiferences. Even a few miles from this area. however, the differences become so great that everyone is fully aware of them. The result is that, throughout most of Holland, the vast majority of people in effect speak two closely related hut distinct languages: Standard Setherlandic and local dialect, in varying degrees of proficiency.

In Setherlandic Belgium the use of Standard Setherlandic is much more limited. and that of local dialect is much more extensive. Some of the better educated speak the standard language fluently and u'se it regularly. while others prefer French. The less well educated use dialect almost exclusively, and are often able to handle the standard language only with difficulty.

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NETHERLANDISH LANGUAGE: *see* NETHERLANDIC LANGUAGE.

NETHERLANDS. The Netherlands first became known to the Romans through the campaigns of Julius Caesiir. He found tlie country peopled partly by tribes of Celtic (Gallic) stock. partly by tribes of Germanic, the river Rhine forming roughly the line of demarcation between the races. The Gallic tribes bore the general appellation of Belgae, and among these the Nervii, inhabiting the district between the Scheldt and the Sambre, were at the date of Caesar's invasion, 57 B.C.. the most warlike and important. To the north of the Meuse and. more particularly. in rhe low-lying ground enclosed between the Waal and the Rhine (*insula Batavorum*) lived the Batavi. Beyond these were found the Frisians (*q.v.*), who gave their name to the territory between the Rhine and the Ems.

Julius Caesar, after a severe struggle with the Nervii and their confederates, was successful in bringing the Belgic tribes into subjection to Rome. Under Augustus (15 B.C.), the conquered territory was formed into an imperial province. Gallia Belgica, and the frontier mas strongly fortified. The Batavi were first brought under Roman rule in the governorship of Drusus (13 B.C.). They were not incorporated in the empire. but were ranked as allies. In 69 they revolted under a native leader, known only under his Roman name of Julius Civilis. After the rising, they returned to their position of *socii*. Their land became a recruiting ground for the Roman armies and they were henceforth faithful in their steady allegiance to Rome.

When at the end of the 3rd century the Franks (*q.v.*) began to swarm over the Rhine into the Roman lands, the names of the old tribes had disappeared. The branch of the Franks—who were a confederacy, not a people—that gradually overspread Gallia Belgica bore the name of Salii, from their position on the river Saale. In the days of their great king Clovis (481–511) they were in possession of the whole of the southern and central Netherlands.

The conversion of the Franks tended to facilitate fusion between them and the Gallo-Roman population and to accentuate the enmity between the Franks and their heathen neighbours, the Frisians in the northern and western strip of the coastal region and the Saxons in the eastern part of the country. In the south of the Netherlands bishoprics were set up at Cambrai, Tournai. Arras, Thérouanne and Liège. In the north, however, progress was much slower and success was the result as much of the arms oi the Carolingian mayors of the palace and kings. as it was of the efforts of the missionaries Willibrord and Boniface. In 695 the bishopric of Utrecht was founded by Pippin II, and the Anglo-Saxon missionary Willibrord became the first a chbishop among the Frisians. In the two following centuries the Frisians and Saxons, after an often severe struggle, finally surrendered to the authority of the Frankish empire and embraced Christianity.

The Duchy of Lower Lorraine.— The Verdun treaty (843) assigned the central part of the empire to the emperor Lothair, separating the kingdom of East Francia (the later Germany) from West Francia (the later France). This middle kingdom included the whole of the later Netherlands with the exception of the portion on the left bank of the Scheldt. which river was made the boundary of West Francia. On the death of the emperor in 855 his second son Lothair (82j–869) received the northern part of his father's domain, known as Lotharii Regnum, corrupted later into Lotharingia and Lorraine. Lothair had no heir, arid in 870 by the treaty of Merssen his territory was divided between the kings of East and West Francia. . In 880 East Francia acquired the whole; from 912 to 924 it formed part of West Francia. In 92j Lorraine passed in the reign of Henry the Fowler under German overlordship. Henry's son, Otto the Great. placed it in 954 in the hands of his able brother. Bruno, archbishop of Cologne, for pacification. Bruno. who kept for himself the title of archduke, divided the territory into the two duchies of Upper and Lower Lorraine. Godfrey of Verdun was invested by him with the government of Lower Lorraine. The history of the Netherlands from that time forward—with the exception of Flanders. which continued to be a fief of the French kings—is the history of the various feudal states into which the duchy of Lower Lorraine was gradually broken up. (*See* BRABANT; FLANDERS; GELDERLAND; HOLLAND; LIÈGE; LIMBURG; LORRAINE; UTRECHT.)

The development of feudalism in the Setherlands was largely caused by the necessity of protecting the land against the Scandinavian attacks of the 9th and 10th centuries. For a time near the middle of the 9th century the Sorthmen were masters of all Holland and Friesland, though they never established permanent settlements there. The remoteness of the Netherlands iroin the centres of either French or imperial power threw the burden of defense upon local magnates, and a great increase in their authority was the inevitable consequence. Long before the end of the 11th century the system of feudal states had been firmly established in the Netherlands.

The Rise of the Cities.— Little is known about the Netherlands towns before the 11th century. The earliest charters date from that period. The charters were of the nature of a treaty between the city and its feudal lord, and they difiered much in character according to the importance of the place and the pressure that the citizens were able to put upon their lord. The extent of the rights which the charter conceded determined whether the town was a free town or a commune. In the case of a commune the concessions included generally the right of inheritance, justice, taxation, use of wood, water, etc. The lord's representative, entitled justiciary (*schout*) or bailiff (*baljuw*), presided over the administration of justice and took command of the town levies in war. The *gemeente*—consisting only of those bound by the communal oath for mutual help and defense—elected their own magistrates. These electors were often a small proportion of the whole body of inhabitants; sometimes a few influential families alone had the right, and it became hereditary. The magistrates bore the name of scabini, and at their head was the seigneurial official—the *schout* or *baljuw*.

The most powerful and flourishing of all were those of Flanders —Ghent, Bruges and Ypres. In the 13th century those towns had become the seat of large industrial populations employed in the weaving of cloth with its dependent industries and closely bound up by trade interests with England, whence they obtained the wool for their looms. Bruges, at that time connected with the sea by the river Zwijn, was the central mart and exchange of the world's commerce. In those Flemish cities the early oligarchic form of municipal government in the long run gave way. to a more democratic one. The great mass of the townsmen, organized in trade guilds.—weavers, fullers, dyers, smiths. leather-workers, brewers, butchers, bakers and others, of which by far the most powerful was that of the weavers—as soon as they became conscious of their strength rebelled against the exclusive privileges of the patricians and succeeded in ousting them from power. The patricians relied upon the support of the French crown, but the battle of Courtrai (battle of the Golden Spurs. 1302), in which the handicraftsmen laid low the chivalry of France, secured the triumph of the democracy. The power of the Flemish cities rose to its height during the ascendancy of Jacob van Artevelde (*c.* 1290–1345), the famous citizen-statesman of Ghent, but after his downfall the mutual jealousies of the cities undermined their strength, and with the crushing defeat of Roosebeke (1382), in which Jacob's son Philip van Artevelde perished, the political greatness of the municipalities entered upon its decline.

In Brabant—Antwerp, Louvain, Brussels. Malines (Mechelen) —and in the episcopal territory of Liège—Liège, Huy, Dinant—there was a more feeble repetition of the Flemish conditions. Flourishing communities were likewise to be found in Hainaut, Namur. Cambrai and the other southern districts of the Netherlands. but nowhere else the vigorous independence of Ghent, Bruges and Ypres, nor the splendour of their civic life. In the north also the 13th century was rich in municipal charters. Dordrecht, Leyden, Haarlem, Delft, Vlaardigen. Rotterdam in Holland and Middelburg and Zierikzee in Zeeland repeated with modifications the characteristics of the communes of Flanders and Brabant. But the growth and development of the northern communal movement., though strong and instinct with life, was slower and less tempestuous than the Flemish. In the bishopric of Utrecht, in Gelderland and in Friesland the privileges accorded to Utrecht, Groningen, Zutphen, Stavoren, Leeuwarden, followed on the model rather of those of the Rhenish "free cities" than of the Franco-Flemish commune.

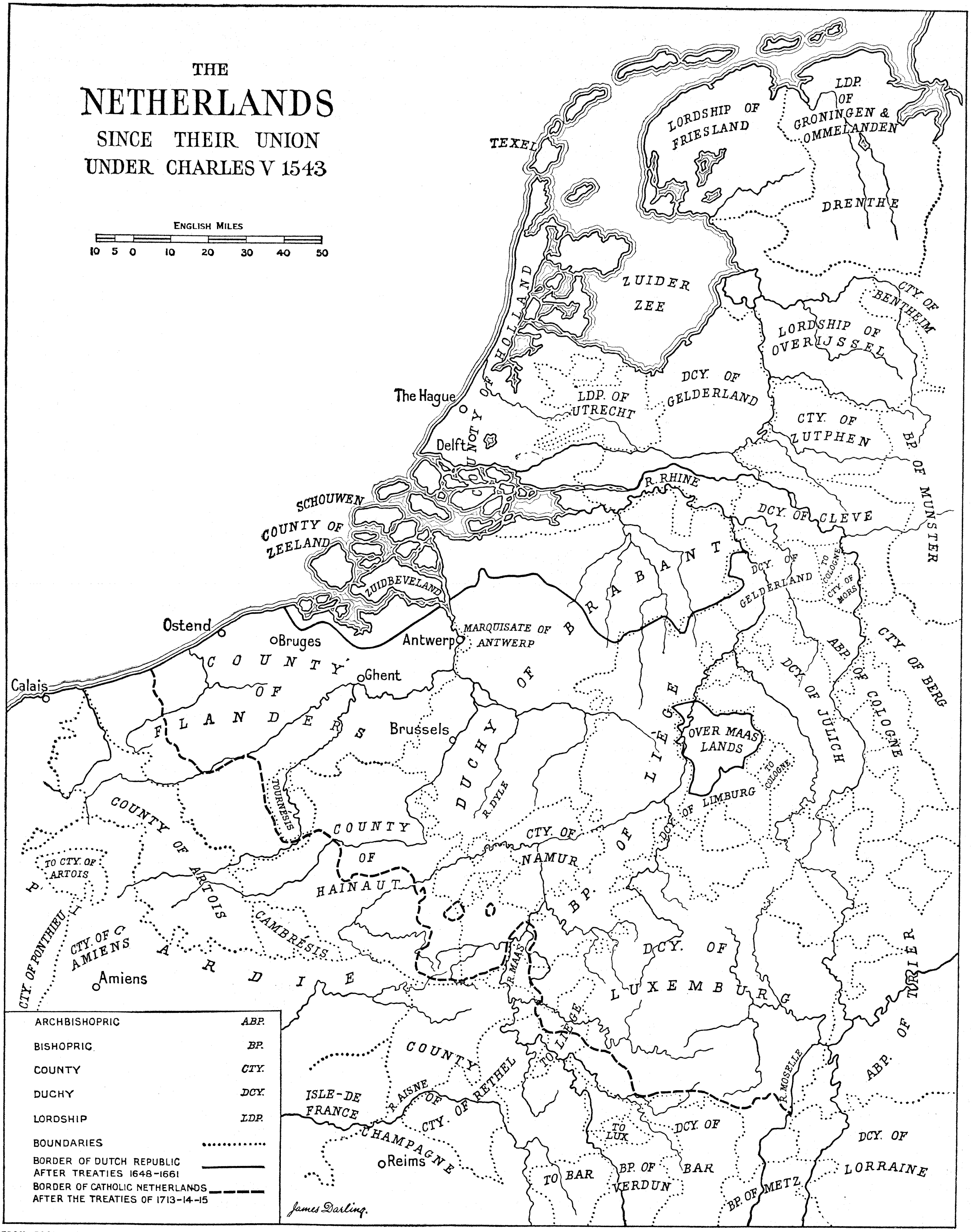
The Dukes of Burgundy.—It was at that time that Flanders and gradually the other feudal states of the Netherlands, by marriage, purchase or force. fell under the dominion of the house of Burgundy. The foundation of the Burgundian rule in the Netherlands was-laid by the succession of Philip the Bold to the counties of Flanders and Artois in 1384 in right of his wife, Margaret of Mâle. In 1406 Antony. Philip's second son (killed at Agincourt, 1415), became duke of Brahant by bequest of his maternal great-aunt. Joan. The consolidation of the Burgundian power was effected by Philip the Good, grandson of Philip the Bold, in his long ahd successful reign of 48 years (1419–67). He inherited Flanders and Artois. purchased the county of Namur (1421) and compelled his cousin Jacqueline. the heiress of Holland. Zeeland. Hainaut and Friesland, to surrender her possessions to him in 1433, after his having become in 1428, by the Reconciliation of Delft, regent of Jacqueline's counties. On the death, in 1430. of his cousin Philip. duke of Brabant (Antony's younger son), he took possession of Brabant and Limburg; the duchy of Luxembourg he acquired by purchase in 1443. He made his bastard son David bishop of Utrecht, and from 1456 onward that see continued under Burgundian influence. The duchy of Gelderland too came temporarily under the Burgundian power during the reign of Charles the Bold.

This extension of the Burgundian dominion implied the establishment of a strong monarchical authority. The dukes had united under their sway a number of provinces with different histories, institutions and languages, and their aim was to centralize their government. The nobility and clergy were on the side of the ducal authority; its opponents were the municipalities, especially those of Flanders. Their strength had been seriously weakened by the overthrow of Roosebeke, but Philip the Good on his accession found them once more advancing rapidly in power and prosperity. He was quite aware that the industrial wealth of the great Flemish communes was financially the mainstay of his power, but their very prosperity made them the chief obstacle of his schemes of unifying into a solid dominion the loose aggregate of states over which he was the ruler. On this matter Philip would brook no opposition: Bruges was forced after strenuous resistance to submit to the loss of its most cherished privileges in 1438, and the revolt of Ghent was quenched in the "red sea" of Gavre in 1453. The splendour and luxury of the court of Philip surpassed that of any contemporary sovereign. A permanent memorial of it remains in the famous Order of the Golden Fleece, which was instituted by the duke at Bruges in 1430 on the occasion of his marriage with Isabella, daughter of John I of Portugal.

(C. D. J. B.; X.)

Before the accession in 1467 of Charles the Bold, Philip the Good's only son, two important steps had been taken toward unification. The first was the appointment of a grand council with supreme judicial and financial functions, whose seat was finally fixed at Malines in 1473; the other, the summoning of deputies of all the provincial "estates" of the Netherlands to a states-general at Brussels in 1465. At first all went well with Charles. By his ruthless suppression of revolts at Dinant and Liège he made his authority undisputed throughout the Netherlands. His campaigns against the French king Louis XI were conducted with success. His creation of a formidable standing army, the first of its kind in that age of transition from feudal conditions, gave to the Burgundian power all the outward semblance of stability and permanence. But Charles, though a brave soldier and good military organizer. was neither a capable statesman nor a skilful general. At the very height of his power all his schemes of aggrandisement came to sudden ruin through a succession of disastrous defeats at the hands of the Swiss. At Nancy, on Jan. 5, 1477, Charles was himself among the slain, leaving his only daughter, Mary (*q.v.*) of Burgundy, then in her 20th year, sole heiress to his possessions.

Mary of Burgundy.— The catastrophe of Nancy threatened the loosely knit Burgundian dominion with dissolution. Louis XI claimed the reversion of the French fiefs and seized Burgundy, Franche Comté and Artois. But the Netherland provinces, though not loving the Burgundian dynasty, had no desire to have a French master. Deputies representing Flanders. Brabant, Hainaut and Holland met at Ghent, where Mary was detained almost as a prisoner, and compelled her (Feb. 10, 1477) to sign the "Great Privilege." This charter provided that no war could be declared nor marriage concluded nor taxes raised by the sovereign without the assent of the estates, that natives were alone eligible for high office and that the national language should be used in public documents. The central court of justice at Malines was abolished, but the grand council was reorganized and made thoroughly representative. The Great Privilege was supplemented by provincial



FROM POOLE, "HISTORICAL ATLAS" (CLARENDON PRESS, OXFORD) charters, the Flemish Privilege (Feb. 10), the Great Privilege of Holland and Zeeland (Feb. 17), the Great Privilege of Namur and the *Joyeuse Entrée* of Brabant, both in May, thus curtailing the sovereign's power of interference with local liberties. On these conditions Mary obtained the hearty support of the estates against France. Her marriage four months later to Maximilian of Austria was the beginning of the long domination of the house of Habsburg.

The Archduke Philip.—When Mary died from the effects of a fall from her horse (March 1482), Rlaximilian became regent (*mambourg*) for their son, Philip. The peace of Arras with France (March 1483) freed him to deal with the discords in the Netherland provinces, and more especially with the turbulent opposition in the Flemish cities. With the submission of Ghent (June 1485) the contest was decided in favour of Maximilian, who in 1494, on his election as emperor, was able to hand over the country to his son, Philip, in a comparatively tranquil and secure state. Philip was 15 years of age, and his accession was welcomed by the Netherlanders, with whom Maximilian had never been popular. Gelderland, however, which had revolted after Nancy, had Charles of Egmont for its duke, and the two bishoprics of Liège and Utrecht were no longer subject to Burgundian authority. In 1496 Philip married Joan of Aragon, who in 1500 became heiress apparent to Castile and Aragon. She gave birth at Ghent to a son, afterward the emperor Charles V. On the death of Queen Isabella, Philip and Joan succeeded to the crown of Castile and took up their residence in their new kingdom (Jan. 1506). A few months later Philip unexpectedly died at Burgos (Sept. 25). His Burgundian lands passed without opposition to his son Charles, then six years of age. (X.)

Charles V.—The emperor Maximilian, who was regent during the minority of his grandson, appointed his daughter, Margaret, widow of Philibert, duke of Savoy, as governor general, an office which she held with varying success for eight years. In 1515, at the instance of the states-general, the 15-year-old Charles was suddenly declared of age. Born and brought up in the Netherlands, he was personally popular there. The country was prosperous. The period of Burgundian rule had given it not only common constitutional organs but the unifying sentiment of a common loyalty. Unfortunately, however, the accession of Charles brought the Netherlands into the huge and incongruous collection of states which the wars and marriages of the Habsburgs had heaped together. By the time he was 20 Charles was king of Aragon and Castile. with their Italian and American possessions, head of the house of Austria and emperor. This meant first that he had to spend most of his life in his other dominions, leaving the Netherlands again to his aunt, Margaret, and aiter her death (Nov. 27, 1530) to his sister Mary, the widow of Louis II of Hungary. It meant also that he had to make large financial demands on these rich provinces for the purposes of his many wars. Opposition to the taxes led at last to one serious collision: the great city of Ghent resisted, and on Feb. 14, 1540, Charles entered it as a conqueror and humbled it by annulling its liberties and exacting a heavy fine. Another difficulty was the rapid growth of Protestantism. A series of severe edicts against heresy was issued and enforced; but though many heretics were executed, every form of Protestant belief continued to make converts. None of these dangers, however, came as yet to a head. The rule of Charles and the "governesses" was on the whole moderate and successful. He rounded off the dominions by the purchase and subjugation of Friesland (1524), the annexation of the lands of the bishops of Utrecht (1528) and the defeat of an opponent who tried to establish himself in the duchy of Gelderland (1538). By 1543 he ruled over the 17 provinces which are usually tneant by the name Netherlands, though oddly enough there are several different ways of enumerating them. It is due not to any geographical or racial factors but simply to the subsequent course of political history that there was no further expansion of the frontiers to the east or south. In the task of welding these provinces together by constitutional links Charles made some headway, but not much. He made the rules of hereditary succession the same for all of them, so that they should never be divided among different heirs. He carried out a nominal, but in the result quite ineffective, incorporation of the provinces in the Holy Roman empire. He governed the provinces by executive councils of the type usual in the monarchies of the period and, in addition to the provincial estates, he liked to summon, when he needed grants of money, states-general such as his predecessors had sometimes used. These stood, however feebly, for the principle of the unity of the Netherlands.

Philip II.—Conflict was precipitated in the Netherlands under Philip II, who succeeded his father in his Spanish dominions on his abdication in 1555. In the first 12 years of his reign all the latent quarrels burst out. In 1559 the peace of Cateau-Cambrésis removed the pressure of war with France, and so cleared the way for the Dutch revolt and for the French wars of religion. Since Philip was not emperor and ceased to be king of England on the death of his wife, Queen Mary, in 1558, the Netheriands now belonged to a combination of states, in which no other part was infected with Protestantism: the religious struggle there was consequently more uncompromising than in Germany. Philip was determined to 'crush heresy. His policy was in a sense no more harsh than that of Charles; but, as Protestantism grew, its repression caused greater discontent. Philip began, but never completed. the carrying-out of a scheme which had been for some time in contemplation for rectifying the anomalies of the boundaries of the episcopal sees and for making smaller dioceses with a more efficient episcopate. This not only intensified the fear of persecution but alienated the greater nobles.

Religious questions would not alone have led to revolution. The most powerful class in the Netherlands was the great nobles, from whom the stadholders, or lieutenants of the provinces, were chosen. Among these there was widespread feeling against Spanish rule and a desire to subordinate the power of the king's. ministers to their own and that of the estates. The period from 1559 (when Philip departed to Spain) to 1567, during which the governor-general was the king's illegitimate half-sister Margaret, duchess of Parma, constitutes the prelude to the revolt. Its first stage lasted till 1564. By this time the magnates, led by William the Silent, prince of Orange, and the counts of Egmont and Horn (*qq.v.*) had succeeded in two things. They had brought about the withdrawal of the Spanish troops and they had got rid of the minister Cardinal Granvella, archbishop of the new see of Malines, whom they somewhat mistakenly blamed for most of their grievances. Margaret's decision to rely on co-operation with the magnates did not, however, promote real harmony. The religious troubles increased and led to a conflict between the government and the chartered privileges of the towns and estates, in the course of which the magnates formulated demands for the summoning of the states-general'and for government by councils of aristocratic composition. In the summer of 1565 a new element came forward. More than 300 of the lesser nobles or gentry signed the Compromise, by which they undertook to help and protect one another against persecution and to put an end to the inquisition. They were actuated by religious conviction, not, like the magnates, by the tolerance of the man of the world, and there were many among the rich burghers who were prepared to back up this determined party. On April 5, 1566, the signatories presented to Margaret a petition called the Request. On this occasion a nobleman contemptuously referred to them as beggars (gueux). They adopted this nickname and wore as badges the curious medals with a beggar's wallet which may still be seen in museums. Margaret made an ambiguous concession to their demands; but the result was only to precipitate the conflict (*see* GUEUX, LES). Extreme Calvinists and religious fanatics of all sects redoubled their activity. Field-preaching spread like wildfire and became something very little different from rebellion. In August many places, especially Antwerp, were alarmed by formidable riots for the smashing of the images, altars, pictures and painted windows of the churches. The Calvinist burghers and gentry were forming armies and preparing to defend the towns where they were most influential. The general confusion, however, caused many of their adherents to fall away and most of the magnates to rally to the government. William of Orange, by attempting to mediate, lost the confidence of both sides. Margaret raised a considerable force o i German mercenary troops, which took posses-ion of Valenciennes and Tournai and destroyed the ill-organized rabble of Calvinists in West Flanders and before Antwerp.

The troubles had reached a stage in which there was to be no more mercy or hesitation on the side of the government; but the only one of the discontented magnates who grasped this was William of Orange, who departed to his German estates in April 1567. The veteran Spanish general the duke of Alva was already on the march from Italy with a model force of about 10,000 men.

Alva.—Alva's rule, from 1568 to 1573, is a great example of military despotism. Margaret resigned soon after his arrival; Egmont and Horn had already been arrested. An illegal tribunal, the Council of Troubles, nicknamed the Council of Blood, was set up to try those who had taken part in the disturbances. There were wholesale executions. Crowds of refugees fled by sea and land. Orange was outlawed (Jan. 24, 1568) and his estates confiscated; his eldest son and heir, a student at Louvain, was kidnapped and carried away to Spain. The father meanwhile, acting in his capacity as a sovereign prince and making war nominally only on Alva, not on his master Philip, had raised an army in Germany. which was led by his brother Louis of Nassau into Friesland. There it won a fight at Heiligerlee (May 23); hut at Jemgum (or Jemmingen) it was completely defeated on July 21 by Alva in person. Before setting out from Brussels he had struck a characteristic blow. Egmont and Horn and 20 other nobles had been beheaded. In September Orange appeared with another army; but Alva, avoiding battle. starved him back into Germany. He was now undisputed master in the Netherlands and settled down to the military, ecclesiastical, judicial and other measures which were needed to consolidate his success. These measures caused subterranean discontent and growing opposition.

In 1572, however, affairs in the Netherlands took a new turn. William had been in the habit of granting to some of his followers commissions to act as privateers. These fierce sea rovers. the Sea Beggars (*gueux* de *mer*), had committed many depredations on commerce and had not abstained froni cruelties: especially against priests, but they had had to operate from foreign parts, such as England or East Friesland. Now, on April 1, 1572. they seized the port of Brill, at the mouth of the Maas. Soon after this they took Flushing, which commands the other great waterway, the Scheltit. Henceforth the rebels had a foothold of their own in the Netherlands. In comparison with this great iact it was of minor importance, though few saw it at the time, that an almost simultaneous movement of rebellion in the southern provinces n-as overpowered. William's brother Louis met with disaster in his seizure oi Mons, from which the promised help of the French Huguenots was cut off by the massacre of St. Bartholomew's day. The co-operating army of William failed as his other armies had failed. Within three months of the capture of Brill Amsterdam was the only town still remaining to the Spaniards in the province of Holland. The estates of Holland assembled and put the finances and administration of the rebels on a sound footing. When the south fell away after his and Louis's failure, William took up his residence at Delft. He had been converted to Lutheranism at an earlier stage, but was soon to throw in his lot with the Calvinists of Holland. Alva moved northward to stamp out the rebellion. At Malines there were three days of butchery. The duke's son Don Frederick of Toledo sacked Zutphen and massacred the whole population of Naarden. Rut a new element was making its appearance in history; the burghers began to show a heroism with which the Spaniards could not cope. Haarlem held out all through tlie winter. On July 12. 1573, it surrendered; the townsfolk nere spared, but the garrison, except the German mercenaries, was killed to a man. At Xlkmaar victory began; the dikes were cut and Don Frederick withdrew his army before the advancing inundations. In October Alva's fleet was defeated on the Zuider Zee and the admiral captured; on land his troops were unpaid and mutinous. He had lost the confidence of the king, and on Dec. 1S he left Brussels, having served the master as badly as he had served the subjects.

Requesens.—His successor. Don Luis de Requesens, grand commander of Castile. arrived in Nov. 1573. Both sides were now ready for compromise. The south was suffering from the maritime war; but the north insisted on freedom of religious belief, and the negotiations that were begun broke down in July 1574. Meanwhile, the war had gone on. with serious reverses for the rebels hut on the whole in their favour. In Feb. 1574 the fall of Middelburg ended the hold of the Spaniards on Zeeland; but on March 14 Louis of Nassau was defeated and killed at. Mook heath near Nijmegen. The siege of Leyden was a turning point. After enduring every extremity the town was at last relieved on Oct. 3 by ships which crossed the flooded countryside. This triumph was commemorated by the foundation of the university which soon made Leyden one of the famous places of the world. During the summer support had been falling away from the inefficient Requesens; only Hainaut, Artois and Namur appeared at a meeting of the states-general. On the other hand the north set about strengthening its organization. Holland and Zeeland made an agreement for union and entrusted William of Orange, their stadholder, with the command of the naval and military forces and the final appointment to all political and judicial offices and to vacant city magistracies.

The fighting was still not uniformly favourable to the north. In October the Spaniards Cristobal de Mondragon and Osorio de Ulloa began the reconquest of the islands of Duiveland and Schouwen in Zeeland. But this availed little. On March 5, 1576, Requesens died and the council of state took over the government. The fighting in Zeeland had used up all the money, so in July the troops there mutinied and marched into Brahant. where they established themselves at Alost. I'opular opinion turned against the council of state. The estates of Brabant had troops in their service. and on Sept. 5 these arrested the members of the council in the name of the estates, though not by their order.

The Pacification *of Ghent* and *Don John.*—William of Orange saw the chances of the moment and. with a picked body of troops, advanced into Flanders, occupied Ghent and entered into negotiations with the states-general. His overtures were favourably received, the council at Brussels was dissolved and a conference was opened at Ghent on Oct. 19. While it mas at work, the news came of the Spanish Fury at Antwerp; on Oct. 3 the mutinous troops had marched thither from Alost, overpowered the garrison and sacked the greatest city of the Netherlands with barbarous ferocity. This news silenced all differences among the Netherlanders and on Nov. 8 there was signed the Pacification of Ghent.

This marked in a sense the zenith of the revolt; but the nobles of Brabant and Hainaut were not under William's leadership, and the religious articles left the way open for a later split. The first problem was that of Don John of Austria. This famous man, bastard brother of the king and victor of Lepanto. had been appointed governor and had arrived at Luxembourg on the day of the Spanish Fury. Orange opposed his recognition as governor and persuaded the states-general to recognize him only on condition that he should accept the Pacification. Negotiations led to a declcllock. At this crisis the hands of Orange and the patriotic party were greatly strengthened by a new cornpact. the Union of Brussels (Jan. 1577), which was signed by all the provinces represented in the states-general. This engaged its signatories to unite in ejecting the foreign soldiery, in carrying out the Pacification, in recognizing Philip's sovereignty and at the same time in maintaining the charters and constitutions which the king on his accession had sworn to observe. It added tlie northeast to the area which had accepted the Pacification; many signatories were Catholics. Luxembourg was left outside it. Faced by this opposition, Don John had to yield and on Feb. 12 signed the Perpetual Edict (ratified soon after by Philip), in which he accepted the program of William of Orange, except that Catholicism was to be maintained.

On May 1 Don John made his state entry into Brussels, but only to find that he had no real authority. He wrote to Philip: "The prince of Orange has bewitched the minds of all men. They keep him informed of everything and take no resolution without consulting him." In July. with some Walloon troops. Don John suddenly left Brussels for Namur. This was practically a renewal of civil war. It alienated the states-general and the southern aristocrats, and on Sept. 23 William of Orange triumphantly returned to Brussels after an absence of ten years.

The unanimity on which this triumph was based did not last long; in October the states-general repudiated him as their leader. The prospect of success ended unity. The growth of Calvinism alarmed the Catholics. At the secret invitation of the Catholic nobles of the south, headed by Philippe de Croy, duke of Aerschot. there arrived in Brussels the 20-year-old archduke Matthias, brother of the emperor Rudolph II and afterward emperor himself. On Jan. 18, 1578, he assumed the title of governor, which he nominally held till 1581.

Philip, now thoroughly alarmed, sent Alexander Farnese, son of Margaret of Parma, with a veteran force of 20,000. With these Don John at Gemblours near Namur routed the rebel army. He became master of Louvain, Judoigne, Tirlemont, Aerschot, Bouvignes. Sichem, Nivelles. Roeux. Soignies, Binch, Beaumont. Walcourt, Maubeuge and Chimay. The malcontent Catholics now turned from Matthias to Francis, duke of Anjou (formerly Alencon), who had invaded the Netherlands with a French force and seized Mons. At the same time John Casimir, brother of the elector Palatine, at the invitation of the Calvinist party and with the secret financial aid of Elizabeth of England, entered the country at the head of a body of German mercenaries from the east. In Ghent under his protection there were Calvinist excesses which alienated the southern Catholic nobles, the states-general and the town patriciates. Orange prevailed on Anjou to accept the title of "defender of the liberties of the Netherlands," and Anjou promised, if the provinces would raise an army of 10.000 foot and 2.000 horse, to come to their aid with a like force. John Casimir and Anjou both left the Netherlands in the winter of 1578–79, the latter to return at a later stage of events. Meanwhile. Don John had aroused the distrust of Philip by his dreams of invading England and marrying Mary, queen of Scots, and Philip cut off supplies. Don John died on Oct. 1, 1578.

North and South Divided.—On Jan. j, 1579, the deputies of Hainaut, Artois. Douai, formed themselves into a league for the defense of the Catholic religion and, subject to his observance of the political stipulations of the Union of Brussels. professed loyal allegiance to the king. This league of Arras called forth the answering Protestant Union of Utrecht, the work of John of Nassau. Both were nominally under the Pacification of Ghent, but the signatories were cleanly divided by religion. At this point it is convenient to end the narrative of the history of the Netherlands. treating henceforth as separate political units the obedient provinces of the south and the seven northern provinces which had already as good as won their independence and were to maintain it as a republic. *(See* BELGIUM: *History,* and HOLLAND: *History.)*

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NETHERLANDS ANTILLES (NEDERLANDSE ANTILLEN), two widely separated groups of Caribbean islands in the Lesser Antilles. The southern group, comprising Curaçao (*q.v.*), Aruba and Bonaire. lies less than 60 mi. off the Venezuelan coast. The northern group includes St. Eustatius (*q.v.*), Saba and the southern part of St. hlartin (Sint Maarten); geographically this group lies within the Leeward Islands.

Area, Population and Principal Towns

Island	Area (sq.mi.)	Population 1955 est.	Population 1960 prelim. census	Principal town
Curaçao	173	118,858	124,500	Willemstad
Aruba	69	55,483	53,199	Oranjestad
Bonaire	95	5,661	5,800	Kralendijk
St Martin (Dutch part)	17	1,607		Philipsburg
Saha	5	1,131	4,700	Bottom
St. Eustatius	12	1,055		Oranjestad
Total	371	183,795	188,199	

The Southern Islands.—These islands are generally low, though hills rise to 1.230 ft. in Curaçao, 787 ft. in Bonaire and 617 ft. in Aruba. They consist mainly of igneous rocks and are fringed with coral reefs. Temperature varies little from an annual average of 81° F. and the heat is tempered by the easterly trade winds. The islands lie west of the hurricane zone. Rainfall is low and variable, often less than 20 in. a year. and the vegetation. much overgrazed by animals, is sparse. Cacti and other drought-resistant plants abound.

This group was discovered in 1499 by Alonso de Ojeda and settled in 1527 by the Spanish. The native Carib Indians were exterminate~except on Aruba, where their descendants form nearly two-thirds of the population. The Dutch, attracted by salt deposits, occupied the islands in 1634 and, except for brief British occupation in 1800 and 1807–16, they have remained Dutch possessions. The population is racially mixed and speaks Dutch (the official language), English, Spanish and Papiamento, a local patois composed of European and African words.

Through much of the 17th and 18th centuries the islands prospered from Dutch trade in slaves, plantation products and contraband, but they declined from 1816 until 1914, when the opening up of the Venezuelan oil fields turned the economic tide. A large oil refinery was opened in 1918 on Curaçao. Another began operating in Aruba in 1930, and in 1959 was the largest in the world with an annual capacity of 23,500,000 metric tons. The industry is now the economic mainstay of the islands, employing over one-third of the working population and providing over 98% by value of all exports. The tourist industry and the entrepôt trade of the free ports of Curaçao and Aruba also contribute their quota.

The Northern Islands.—These islands consist of volcanic rocks rising to 1,266 ft. on St. Martin, 1,968 ft. on St. Eustatius and 2,821 ft. on Saba. The climate is similar but rainfall is higher and hurricanes occur. They were first settled by Europeans between 1625 and 1640. Plantations of sugar and cotton were established on St. Martin and on St. Eustatius, which later became an entrepôt comparable to Curaçao. Saba, with precipitous slopes and no harbour, had no commercial value. Most of the population now engages in small-scale agriculture, hut many men leave to work in the oil refineries. English is the principal language.

Administration.—The Netherlands Antilles are an integral part of the kingdom of the Netherlands. Executive authority is vested in the governor. appointed by the crown, and in a council of ministers of 7 members. They are responsible to the legislature (*staten*) of 22 members (12 from Curaçao, 8 from Aruba. 1 from Bonaire and 1 from the northern islands) elected by universal suffrage.

See P. H. Hiss, *Netherlands America* (1943), *A Selective Guide to the English Literature on the Netherlands West Indies* (1943); W. N. van de Poll, *Netherlands West Indies,* Eng. trans. by J. Dolman (1951). (D. R. H.)

NETLEY, a village in Hampshire, Eng., about 3 mi. S.E. of Southampton and on Southampton water. A Cistercian abbey was founded in 1237 by Henry III; its ruins include a great part of the cruciform church, abbot's house, chapter house and domestic buildings. The style is Early English and Decorated. The gatehouse was transformed into a fort in the time of Henry VIII. Netley hospital for wounded soldiers, huilt after the Crimean War. is one of the principal military hospitals in Great Britain. Pop. (1951) 2.327.

NETSCHER, CASPAR (1639–1684), painter of the Dutch school. was born at Heidelberg in Germany. His father died soon afterward and his mother moved to Arnhem. where his first master was Hendrick Coster. Later he was a pupil of Gerard Terborch. and a copy. dated 1655. of Terborch's "Paternal Advice" already displays full technical mastery. In 1658 or 1659 he set out by sea for Rome. but went no farther than Bordeaux. where he was married in 1659. By 1662 he had returned to the Setherlands and settled in The Hague, where he spent the rest of his life. after establishing a fashionable practice as a portrait painter. He died on Jan. 1;. 1684.

His most satisfying works are the earlier genre pieces. which maintain a high standard within the traditions of Terborch, from whom he acquired great skill in rendering textures. and of Gabriel Metsu. The "Lace Maker" in the Wallace collection. London, is a fine example. Though superficially elegant. the later biblical and mythological subjects and the small, glossy portraits that made his reputation in his lifetime are mostly deficient in true feeling or perception.

Netscher's sons THEODOR (1661–1732) and CONSTANTIJN (1668–1723) were among his many pupils and imitators.

(R. E. W. J.)

NETTLE, any plant with stinging hairs belonging to the genus *Urtica*, which gives its name to the family Urticaceae (nettle family) and to a few related genera. *Urtica* contains about 35 species of wide distribution. Three are found in the eastern United States, mostly as weedy plants introduced from Eurasia. The commonest is *U. dioica*, a cosmopolitan weed, often troublesome. Equally stinging is the native wood nettle (*Laportea canadensis*), found in rich woods throughout eastern North America. As in all nettles the stinging quality (which is not lasting, except in some tropical relatives) is caused by minute quantities of formic acid secreted in the extremely sharp-pointed hairs, which upon entry into the skin set up instant irritation. In an Australian relative (*Laportea*), the effect may last for months and has been credited (perhaps falsely) with the ability to kill a horse.

In southern and western United States there are other nettles. among them *U. chamaedryoides* of the southeastern states. *U. holosericea* of the western states and the closely allied western nettle (*Hesperocnide tenella*) of California.

Three species of nettle are wild in Great Britain; the common, bigsting or great nettle (*U. dioica*). a hairy perennial with male and female flowers on separate plants; the small nettle (*U. urens*), which is annual. has male and female flowers on the same plant and is also often a naturalized weed in North America: and the Roman nettle (*U. pilulifera*), also an annual and the most virulent of British species. It is widely distributed. but mostly near the eastern coast. The small nettle (*U. urens*) once had some use as a fibre.

The eradication of the annual species of nettle is easy—cutting off the tops before flowering prevents the setting of seed. The perennials are more difficult to eradicate; spraying with 2,4-D in bright weather or with chlordane provides the most effective control. (N. TR.)

NETTLE TREE, the name sometimes applied to certain trees of the genus *Celtis*, belonging to the elm family (Ulmaceae). The best-known species have usually obliquely ovate or lanceolate leaves, serrate at the edge and marked by three prominent nerves. The flowers are inconspicuous, with a four- or five-parted perianth, as many stamens, a hairy disk and a one-celled ovary with a two-parted style. The fruit is succulent. drupelike. a character which serves to separate the genus from the allied nettles and the elms. C. *australis* is a common tree. both wild and planted, throughout the Mediterranean region extending to Afghanistan and the Himalayas: it is also cultivated in Great Britain. It is a rapidly growing tree. from 30 to 40 ft. high, with a remarkably sweet .fruit. recalling a small black cherry. and was one of the plants to which the term lotus was applied by Dioscorides and the older authors. The wood, compact and hard. is used for many purposes. *C. occidentalis*, a North American species, is the hackberry (*q.v.*).

NETWORK THEORY is a branch of engineering theory concerned with the evaluation of the properties of interconnections (networks) of basic components and with the synthesis of such interconnections for prescribed system characteristics. Network theory has been developed primarily by electrical engineers; particularly for the design of the systems for electrical power distribution and telephone transmission. hut has subsequently been applied to the design or understanding of systems for water and gar- distribution. industrial automation. missile and vehicle guidance and control. and automobile or aircraft traffic control. Other applications include such systems as those involved in the spread of communicable diseases and in various human functions such as seeing and hearing. The three elements of network theory are analysis. synthesis and identification.

1. Analysis is the evaluation of the properties of a given system: *e.g.*, the determination of the behaviour of an electrical power distribution system involving thousands of individual components including local loads, distribution lines, generators and protective devices. A typical analysis problem is the determination of the performance of the system when a short circuit occurs at one point.

2. Synthesis is the design of a system for specified performance. A classical problem in network synthesis is the design of electric circuits to separate 480 telephone conversations carried simultaneously on a single cable. At the sending end, the signals are combined by shifting each to a different portion of the frequency spectrum. With normal speech involving frequency components from 100--4.000 cycles per second (c.p.s.), one signal is transmitted from 0–4.000 c.p.s., one from 4.000–8.000 c.p.s.. one from 8.000–12.000 c.p.s., and so on. At the receiving end. the signals must he separated by electrical networks, each of which transmits only one of the incoming messages.

3. Identification is the determination of a mathematical or analytical model from measurements of an actual system. For example, the dynamic characteristics of an airplane are measured by firing a bullet from the craft and observing the oscillation which results from the reaction force; or the characteristics of an industrial process can be evaluated by feeding into it a small randomly varying signal: or an automobile driver can measure road conditions and vehicle dynamics by continual small perturbations of the .teering-wheel position.

Historically, network theory has developed from the work in classical mechanics by I. Newton, J. L. Lagrange and W. R. Hamilton, and the original studies of electric circuits by G. R. Kirchhoff. Until the advent of transcontinental telephone systems at the beginning of the 20th century. network theory emphasized the dynamic properties of vibrating mechanical systems. The field is now a central element of electrical engineering, with fundamental contributions in synthesis aspects from Ronald Foster, Wilhelm Cauer, O. Brune and S. Darlington. The rapid technological development during and following World War II included an expansion of network theory to encompass nonlinear networks (with analysis based on the work in nonlinear mechanics by L. Poincaré in France and by P. P. Lyapunov, A. N. Krylov and N. Bogoliuboff in Russia), feedback networks (with work developing from the pioneering efforts of H. S. Black, H. Nyquist and H. W. Bode at the Bell Telephone laboratories during the 1920s and 1930s), and such diverse areas as switching circuits and finite automata.

The basic analytic techniques of network theory are concerned with the evaluation of mathematical models (*e.g.*, sets of differential equations or the response of the system to a specified input signal) for the interconnection of the basic electrical components: resistors. capacitors. inductors. transformers, and voltage and current sources. Analysis is based on Kirchhoff's two laws which state that (1) the instantaneous sum of the currents entering any node of the network must be zero. and (2) the instantaneous sum of the drops in voltage around any closed loop must he zero. When these two laws are combined with the voltage-current relation for each element. differential equations can be written for the system without the direct utilization of the principle of the conservation of energy. The number of equations which must be written to describe network behaviour and the particular equations which can be used are determined from considerations of mathematical topology. Network theory also includes a large number of theorems which permit simplification of the analysis in many special cases of importance.

In the basic synthesis problem, with the input and output signals given, a network is to be realized by a suitable interconnection of the available components. In 1931 Brune showed that any specified driving-point impedance function (the ratio voltage to current at a single pair of terminals) can be realized if the impedance is a positive real function of the complex frequency s. In subsequent work, the necessary and sufficient conditions were established for the realization of a wide variety of different network functions (*e.g.*, the ratio of output voltage to input voltage, and the ratio of output current to input voltage).

Network theory has been extended to the study of feedback configurations, systems in which a portion of the output signal is compared with the input, with the difference used to control the output. Such systems are fundamental in automation (*q.v.*) and automatic control since the accuracy of the over-all transmission (the ratio of output to input) can be made insensitive to changes in the characteristics of the motor element. As a result of this insensitivity, engineering systems can operate properly even when the environment varies radically (*e.g.*, as the weather around an aircraft changes, as a space vehicle passes from outer space into the relatively dense atmosphere or as the road conditions for an automobile vary from dry to icy).

The analysis and synthesis of feedback systems is complicated by the stability problem, which is fundamental in network theory. Physical systems may oscillate out of control either because of the feedback of energy from the output to a preceding point in the system (as in the case of ataxia observed in a man when he is an element of a feedback loop), or because of excitation of thr system at its natural resonant frequency. (As a motor is brought up to speed, uncontrolled vibrations occur if the motor resonates at a frequency lower than the normal operating frequency.) Mathematical tests for stability in linear time-invariant systems (systems described by linear differential equations) were formulated hy E. J. Routh in 1883 and for feedback systems by Nyquist in 1928. Fundamental contributions to the much more difficult problem of the stability of nonlinear systems have been made by Poincaré and Lyapunov, but the general problem of stability analysis and associated design techniques to insure stability still provide fundamental research problems in network theory.

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NEUBER, (FRIEDERIKE) CAROLINE (née WEISSENBORN) (1697–1760), one of the earliest and best-known German actress-managers. was born in Feichenbach, Saxony. March 9. 1697. She and her husband Johanr served their theatrical apprenticeship in various companies of strolling players until, in 1727, they acquired a royal patent enabling them to form their own acting company with headquarters first in Leipzig, later in Hamhurg. Johann Christoph Gottsched, the Leipzig literary critic and advocate of pseudoclassic drama, persuaded the Neubers to include German translations and imitations of French classic plays into their repertory. Frau Neuber crusaded for Gottsched's program until 1739 when she broke with him. Their association is generally regarded as the turning point in German theatre history and the start of modern German acting.

After an ill-fated visit to St. Petersburg in 1740, Frau Neuber failed to regain the patronage of German audiences. The long struggle to reassert herself as a producer and actress came to an end when the outbreak of the third Silesian war forced her to quit the stage. She died in poverty at Laubegast near Dresden on Nov. 30, 1760. (A. M. N.)

NEUBRANDENBURG, a town of Germany, in the district of the same name. on the Tollense See at the mouth of the Tollense, 58 mi. W.N.W. of Szczecin (Stettin) by rail. Pop. (1959 est.) 32.018. Neubrandenburg, founded in 1248. has belonged to Mecklenburg since 1292. It is partly surrounded with walls, and has four old Gothic gates. dating from about 1300. The principal buildings are the Marienkirche. a 13th-century Gothic building, the former grand ducal palace and Belvedere palace.

NEUCHÂTEL (Ger. NEUENBURG), one of the cantons of western Switzerland, on the frontier toward France. It is the only Swiss canton that is situated entirely in the Jura, of which it occupies the central portion (its loftiest summit is Mont Racine, 4,731 ft.. in the Tête de Rang range). The canton has a total area of 308 sq.mi., of which more than three-quarters is reckoned productive. It consists, for the most part, of the longitudinal ridges and valleys characteristic of the Jura, while its drainage is unequally divided between the Thièle (Zihl) and the Doubs. which forms part of the northwest boundary of the canton, and receives only the streams flowing from the Le Locle and La Chaux de Fonds valley.

Three regions make up the territory. That stretching along the shore of the lake is called Le Vignoble (from its vineyards) and extends from about 1,500 ft. to 2,300 ft. above sea level. An intermediate region is named Les Vallées, for it consists of the two principal valleys of the canton (the Val de Ruz, watered by the Seyon, and the Val de Travers, watered by the Xreuse), which lie at a height of about 2,300 ft. to 3,000 ft. above sea level. The highest region is known as Les Montagnes, and is mainly composed of the long valley in which stand the industrial centres of La Chaux de Fonds (*q.v.*) and Le Locle, to which must be added those of La Sagne. Les Ponts and Les Verrikres, the elevation of these upland valleys varying from 3,000 it. to 3.445 ft.

The canton is well supplied with railways, the direct line from Berne past Kerzers (Chiètres), Neuchâtel, the Val de Travers and Les Verrikres to Pontarlier for Paris passing through it. while La Chaux de Fonds is connected by a line past Le Locle with Morteau in France. Other lines join the capital. Neuchâtel, to La Chaux de Fonds. as well as to Yverdon at the southwest extremity of the lake. and to St. Blaise at its northeast end.

The population in the 20th century was (1920) 131.349; (1930) 123,324; (1941) 117,994; (1950) 128,152; (1960) 147.633. In 1950, 105.311 were French-speaking, 14,428 German-speaking and 1.303 Italian-speaking; 100,158 were Protestants. 24.829 Roman Catholics and 506 Jews. There are three established and state-endowed churches. the National Evangelical. the Roman Catholic and the Old Catholic (this sect in La Chaux de Fonds only), while the pastors of the Free Evangelical Church and of the Jews (mostly in La Chaux de Fonds) receive special privileges.

Besides the capital. Neuchâtel (*q.v.*), the chief towns are La Chaux de Fonds, Le Locle and Fleurier, the latter the principal village in the Val de Travers.

The most valuable mineral product is asphalt, of which there is a large and rich deposit in the Val de Travers. 'The wine of the Vignoble region is plentiful. Absinthe is manufactured in the Val de Travers.

The most characteristic industry is that of watchmaking. which is chiefly carried on (since the early 18th century) in the highland valleys of La Chaux de Fonds and of Le Locle, as well as at Fleurier in the Val de Travers.

The canton is divided into 6 administrative districts. which comprise 63 communes. The legislature or *grand conseil* consists of members elected in the proportion of population and holds office for three years. The canton in 1941 sent six representatives (elected for a term of four years) to the *nationalrat,* lower chamber of the national parliament. It sends two members to the upper chamber.

History. — The *novum castellum* (Neuchâtel) is first mentioned in the will (1011) of Rudolf III, the last king of Burgundy. on whose death (1032) that kingdom reverted to the empire. About 1034 the emperor Conrad II gave this castle to the lord of several neighbouring fiefs. his successors establishing themselves permanently there in the 12th century and taking the title of count.

In 1288 the reigning count resigned his domains to the emperor Rudolf. who gave them to the lord of Châlon-sur-Saône, by whom they were restored to the count of Neuchâtel on his doing homage for them. This act decided the future history of Neuchâtel. for in 1393 the house of Châlon succeeiled to the principality of Orange by virtue of a marriage contracted in 1388. The counts gradually increased their dominions. so that by 1373 they held practically all the present canton, with the exception of the lordship of Valangin which was held by a cadet line of the house until bought in 1592. In 1532 the title of prince was taken by the reigning count, while by the treaty of Westphalia (1648) the principality became sovereign and independent of the empire. In 1707 the Longueville house of Neuchâtel also became extinct, and a great struggle arose as to the succession.

Finally the parliament (states) of Neuchâtel decided in favour of Frederic I, the first king of Prussia. The nominal rule of the Prussian king (for the country enjoyed practical independence) lasted until 1857, with a brief interval from 1806 to 1814, when the principality was held by Marshal P. A. Berthier, by virtue of a grant from Napoleon. In 1814 its admission into the Swiss confederation was proposed and was effected in 1815, the new canton being the only nonrepublican member, just as the hereditary rulers of Neuchâtel were the last to maintain their position in Switzerland. This anomaly led in 1848 to the establishment (attempted in 1831) of a republican form of government, brought about by a peaceful revolution led by A. M. Piaget.

A royalist attempt to regain power in 1856 was defeated, and finally, after long negotiations, the king of Prussia renounced his claims to sovereignty, though retaining the right to bear the title of "prince of Neuchâtel." Thus in 1857 Neuchâtel became a full republican member of the Swiss confederation.

NEUCHÂTEL, capital of the Swiss canton Neuchâtel, situated near the northeast corner of Neuchâtel lake. In 1960 it had 33,430 inhabitants, the greater portion of whom were French-speaking and Protestant, with a minority of German-speaking inhabitants and Roman Catholics, and a small number of Jews. It is the meeting point of several important railway lines. The older portion of the town is built on the steep slope of the Chaumont (3,871 ft.) and originally the waters of the lake bathed the foot of the slope. But the gradual growth of alluvial deposits, and later the artificial embankment of the shore of the lake, added much dry ground, and on that site the finest modern buildings were erected.

The 16th-century castle and the 13th-century collegiate church of Notre Dame (now Protestant) stand close together, and were founded in the 12th century when the counts took up their permanent residence in the town, to which they granted a charter of liberties in 1214. Among the buildings on the quays are the Musée des Beaux Arts (modern Swiss paintings and various historical collections, including that of Desor relating to the lake dwellings), the Gymnase (in which are also the museum of natural history, with the fine collections of Agassiz, and the town library), the university and the École de Commerce. The town owes much to the gifts of citizens.

NEUCHÂTEL, LAKE OF. The lakes of Neuchâtel, Bienne and Morat, connected by canals, are survivors of a former great lake of the lower Aar valley. It is the largest lake wholly in Switzerland. Its total area of 83 sq.mi. is shared by the cantons of Neuchâtel, Vaud, Fribourg and Berne. It is about $23\frac{1}{2}$ mi. long, from $3\frac{3}{4}$ to 5 mi. wide, its greatest depth is 502 ft., while its surface is 1,407 ft. above sea level. The Thièle (Zihl) river enters at its southwestern end and issues from it at its northeastern end, but it also receives the Areuse (N.W.), Seyon (N.W.) and the Broye (N.E.).

On the southeastern shore the picturesque and historic little town of Estavayer is the chief place. At the southwestern extremity of the lake is Yverdon (the *Eburodunum* of the Romans and the residence of Pestalozzi, 1806–25). Far more populated is the northwestern shore, where from southwest to northeast, is found Grandson, Cortaillod, Serrières and Neuchâtel itself. On the north shore is La Tène.

NEUHOF, THEODORE STEPHEN, Baron von (*c.* 1690–1756), German adventurer and for a short time nominal king of Corsica, was the son of a Westphalian nobleman. Born at Cologne, he was educated at the court of France; he served first in the French army and then in that of Sweden. Baron de Goertz, minister to Charles XII, realizing Neuhof's capacity for intrigue, sent him to England and Spain to negotiate with Cardinal Alberoni. He returned to Sweden and then went to Spain, where he was made colonel and married one of the queen's ladies-in-waiting. Deserting his wife soon afterward he repaired to France and became mixed up in Law's financial affairs. He then wandered about Portugal, Holland and Italy.

At Genoa he made the acquaintance of some Corsican prisoners and exiles, whom he persuaded that he could free their country from Genoese tyranny if they made him king of the island. With their help and that of the bey of Tunis he landed in Corsica in March 1736, where the islanders, believing that he had the support of several of the powers, proclaimed him king. He assumed the style of Theodore I, issued edicts, instituted an order of knighthood and waged war on the Genoese, at first with some success. But he was eventually defeated, and civil broils soon broke out in the island. The Genoese put a price on his head and published an account of his antecedents, so he left Corsica in Nov. 1736, ostensibly for foreign assistance. He returned to the island in 1738, 1739 and 1743, but the combined Genoese and French forces drove him out.

Arrested for debt in London he regained his freedom by mortgaging his "kingdom" of Corsica and subsisted on the charity of Horace Walpole and other friends until his death in London on Dec. 11, 1756.

See *Mémoires pour servir à l'histoire de la Corse,* by his son Frederick, also an English trans. (1768). In 1795 he published a new edition on *Description of Corsica with an account of its union to the crown of Great Britain. See* also Fitzgerald, *King Theodore of Corsica* (1890) and Le Glay, *Théodore de Corse* (1907).

NEUILLY, TREATY OF. The Bulgarian treaty following World War I was signed at Neuilly on Nov. 27, 1919, and went into force on Aug. 9, 1920. In the main it was the same as the Austrian treaty. But there were important differences in the military and naval clauses, and also in reference to reparation and finance.

The only serious territorial changes were to the west and south. The Serb-Croat-Slovene kingdom obtained several strategic ratifications. The two most important were that the Strumitsa salient in the extreme southwest was flattened out, the western half being ceded to the Serbs; also, and more important, in the Nish-Pirot area the town of Tsaribrod was taken from Bulgaria and a line drawn whereby an advance on Nish would be rendered more difficult. The frontier, however, conferred no offensive advantage on the Serbs.

A loss more serious in another sense was that to Greece of the district of western Thrace, lying between Xanthi and the Maritsa river. This was ceded to Greece on its obtaining eastern Thrace and Adrianople. Bulgaria, for ethnic reasons, received a slight extension of territory west of Adrianople. The expulsion of Greeks from Adrianople and east Thrace by the Turks did not, however, cause the Allies to change their minds about western Thrace, which remained annexed to Greece and was denied to Bulgaria.

Bulgaria had always asserted claims to that part of Macedonia in Serbian hands, and also to eastern and western Thrace. In the former area its ethnic pretensions are better founded than in the latter. But Serbian Macedonia was in the hands of a formidably armed and militarily strong nation. Greek Macedonia and Thrace were populated by hundreds of thousands of Greek refugees from Asia, and contain over 80% of a purely Greek population. In population Bulgaria lost about 300,000 persons, of whom some were not Bulgars.

The military, naval and air clauses had some special points. Bulgaria was allowed 20,000 regulars, 10,000 gendarmes and 3,000 frontier guards or 33,000 in all. This number was insufficient to maintain order in a turbulent Balkan state, and the subsequent serious disturbances in Bulgaria were caused directly by this fact. It was increased by the difficulty of applying the voluntary long-service system of 12 consecutive years to a nation of peasants. In an agricultural country it was practically impossible to get men to leave their farms for 12 years, and the army was always likely to be dangerously below strength, and the less regular formations dangerously above it. The naval clauses did not differ from those of the German or Austrian treaties. All Bulgaria's navy had been destroyed. and it was left with four torpedo boats, of which three were damaged, and six motorboats, of which four were damaged.

The clauses pertaining to prisoners of war and graves (pt. v) and penalties (pt. vi) were the same as in the Austrian treaty (see ST. GERMAIN, TREATY OF).

The reparation clause (pt. vii) contained the most novel and interesting feature of the treaty, and was the only serious attempt to get reparation on to a business basis. It contained three features of great interest. (*a*) Contrary to the practice in the German, Austrian and Hungarian treaties, there was no attempt made to seize or distribute the Bulgarian commercial fleet on the ton-for-ton or class-for-class principle. (b) It fixed the amount to be paid at the lump sum of £90,000,000. (*c*) It created a reparation commission consisting of French. British and Italian representatives with power to reduce this amount by a simple majority vote (not by unanimity as is the systematic rule), on the suggestion of the interallied commission.

The general scope and powers of the reparation commission were drawn in such a manner as to control the finances of the country sufiiciently to obtain reparation, without offensive interference. In the end. the reparation commission, after examining the question on the spot. practically remitted three-quarters of the total of £90,-000,000. The annual sum required to meet the charges on the 550,000,000 gold francs of the debt was well within the capacity of the new Bulgarian state, and was punctually paid. None of the remaining clauses of the Bulgarian treaty had any special features of interest or importance.

See BULGARIA; PARIS, CONFERENCE OF; REPARATION, etc.

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NEUILLY-SUR-SEINE, a suburb of Paris about 12 mi. northwest from Notre Dame. in the Seine *département*. It is situated between the fortifications and the Seine. Pop. (1954) 65.406. A castle at Neuilly, built by the count of Argenson in the 18th century, ultimately became the property and favourite residence of the duke of Orléans (Louis Philippe), the birthplace of nearly all his children and the scene of the offer of the crown in 1830. The buildings were pillaged and burned by the mob in 1848.

The park, extending from the fortifications to the river, as well as the neighbouring park of Villiers (also belonging to the princes of Orleans), was broken up into building lots, and occupied by many small middle-class houses and a few fine villas. The fine bridge, designed in the 18th century by Perronet, is noteworthy as the first level bridge constructed in France. The Galignani institution, founded by the brothers Galignani for aged booksellers, printers and others, has accommodations for 100 residents.

Manufactures include perfumery, chocolate, colours, varnish, automobiles and carpets. Neuilly is an engineering centre.

NEUMANN, (JOHANN) BALTHASAR (1687–1753), German architect of diverse talents, a master of the late baroque style, mas born in Eger, Bohemia. in 1687. In 1709 he emigrated to Wiirzburg, where he learned his profession. Neumann had an astonishing combination of talents. He designed palaces, housing. public buildings, bridges, a water system, fireworks and more than 100 churches. He ran a glass factory, became a colonel of engineers and was a professor of architecture. A stolid and conventional man, he produced works brilliant in design and elegant in engineering.

Neumann the dreamer would conceive the most intricate and original interiors; Neumann the builder realized them. achieving a maximum of security from a minimum of material. He directed squadrons of painters, sculptors, woodcarvers, iron founders and landscape gardeners in creating the sumptuously harmonious decoration of his masterpieces. The Residenz palace in Würzburg (1719–46), designed by Neumann and Germain Boffrand, is one of the great palaces of the baroque period. Neumann's church of Vierzehnheiligen (1743–71), decorated in pink, gold and white, is a triumph in rococo styling. Among his other works are the episcopal palaces of Bruchsal (1728–49) and Werneck (1733–45) and the pilgrimage churches of Neresheim (1745–92) and Kappele near R'urzburg (1747–50).

See Max H von Freeden, *Balthasar Neumann* (1953). (J. P. C)

NEUMANN, FRANZ ERNST (1798–1895), German mineralogist, physicist and mathematician who formulated the law (known by his name) that the molecular heat of a compound is equal to the sum of the atomic heats of its constituents, was born at Joachimsthal on Sept. 11, 1798. Neumann's earlier papers on crystallography led to his appointment as *Privatdozent* at Königsberg, where in 1828 he became extraordinary, and in 1829 ordinary professor of mineralogy and physics. In 1831, from a study of the specific heats of compounds. he formulated Neumann's law.

Devoting himself next to optics, he produced memoirs which entitle him to a high place among the early searchers after a dynamical theory of light. In 1832, by the aid of a particular hypothesis as to the constitution of the ether, he reached results agreeing with those obtained by A. L. Cauchy, and succeeded in deducing laws of double refraction resembling those of A. J. Fresnel. He made contributions to the mathematical theory of electrodynamics. and in papers published in 1845 and 1847 established mathematically the laws of the induction of electric currents. His last publication was on spherical harmonics (*Beiträge zur Theorie* der *Kugelfunktionen*, 1878).

Neumann died at Konigsberg on May 23, 1895. His works were published in three volumes (1906–28).

See Luise Neumann, *Franz Neumann* (1929); A. Wangerin, *Franz Neumann* (1907).

NEUMANN, JOHN NEPOMUCENE (1811–1860), Bohemian-C.S. Roman Catholic bishop of Philadelphia. the first American Catholic prelate proposed for canonization (1886), was born in Prachatitz. Bohemia, on March 28, 1811. He studied at the *Gymnasium* at Budweis. the diocesan seminary of Budweis and the University of Prague. emerging with a reputation for a clear, penetrating. analyzing mind and for solid piety. His zeal for the American missions took him to New York, where he was ordained priest in June 1836. Neumann joined the Redemptorist congregation in 1830. his holiness of life and administrative abilities winning for him the post of superior of St. Philomena's parish in Pittsburgh, Pa., and later command of all Redemptorists in the United States. He became rector of St. Alphonsus' parish. Baltimore. Md., in 1851, and was named by Pope Pius IX in March 1852 to rule the see of Philadelphia. For eight years Neumann worked to build churches, schools and asylums, legislating for his priests and people and visiting every corner of his spiritual domain. He combated trusteeism; was the first prelate to organize a diocesan school system; and introduced the diocesan-wide celebration of the devotion called the Forty Hours.

A deep personal love of God and a resolve to lead others to Him were the goals of Neumann's life. He died on Jan. 5, 1860, and in 1921 Pope Benedict XV declared his virtues heroic.

See Michael J. Curley, C.SS.R., *Venerable John Neumann, C.SS.R.* (1952), with bibliography; Johann Rerger, C.SS.R., *Leben und Wirken des hochseligen Johannes Nep. Neumann* (1883), Eng. trans. by Eugene Grimm, C.SS.R., *Life of the Right Reverend John N. Neumann* (1884). (M. J. C.)

NEUMANN, JOHN (JANOS) VON (1903–1957), was one of the outstanding mathematicians of the 20th century and a scientist of extraordinary breadth. Born in Budapest. Hung., Dec. 28, 1903, he was a general scientific prodigy and took a doctorate in mathematics in 1926 in Budapest. By 1933 (three years after coming to the U.S.), when he assumed the position he held for the rest of his life as professor at the Institute for Advanced Study (Princeton, N.J.), he had already an international reputation, based on contributions to operator, quantum, set and game theories. He may well be remembered longest for his work in pure mathematics during 1933–43, and notably for founding the theory of operator rings, a high point of the axiomatic and integrative tendencies characteristic of 20th-century mathematics, the direction of which von Neumann probably as much as anyone helped to determine. This work, of remarkable originality and boldness, showed that analysis was subject to these trends and that it had interesting and unsuspected connections with algebra and geometry. During and after World War II he engaged mainly in applied scientific research and related administrative work. He led in the development of large high-speed digital computers and such applications as the design of the hydrogen bomb and long-range weather forecasting, as well as doing important work on a variety of military problems, including the atomic bomb. From 1955 to the time of his death on Feb. 8, 1957, he was a member of the U.S. Atomic Energy commission, which, in recognition of his relevant basic scientific contributions, gave him the $50,000 Enrico Fermi award in 1956. (I. E. S.)

NEUMES, the signs employed in western musical notation before the introduction of the staff (Gr. *neuma*, "a sign"). They were, in the first instance, merely rough expression marks placed over the words, to guide the singers of the plain-song melodies, the melodies themselves being learned by ear, and hence they gave no indication as to the pitch or time-relations of the notes. Gradually, however, they became more and more elahorate and precise, then their positions on the paper were varied to indicate pitch, though at first without the employment of lines: subsequently lines were introduced, and so, step by step, the whole present-day system was evolved. *See* MUSICAL NOTATION.

NEUMÜNSTER, a city in the *Land* of Schleswig-Holstein, Germany, lies on the Schwale, 40 mi. N. of Altona-Hamburg by rail, and at the junction of lines to Kiel, Vamdrup (Denmark) and Tönning. Pop. (1959 est.) 73,062. The name, which was originally Wipendorp, is derived from an Augustine monastery, founded in 1130. Its industrial importance began in the 17th century, when clothworkers migrated to it. It became a town in 1870.

NEUNKIRCHEN or OBER-NEUNKIRCHEN, a city in Saarland, Germany, on the Blies, 12 mi. N.E. of Saarbrücken. Pop. (1959 est.) 45,303. The town is first mentioned in 1280, and became important industrially during the 18th century. The industries include iron and steelworks. Around the town are important coal mines. The castle built in 1570 was destroyed in 1797.

NEUQUÉN, an inland province of Argentina on the Chilean frontier, between the Colorado and Limay rivers. Pop. (1960) 111,008; area 36,324 sq.mi. The greater part of the territory is mountainous, with fertile, well-watered valleys and valuable forests. The eastern part, however, contains large plains shoving only stunted vegetation and having numerous saline deposits. The long droughts that prevail in this region have deterred agricultural settlement. Nevertheless, agriculture and stock raising provide the chief sources of wealth. The temperature of the Andean region is cold even in summer, hut on the lower plains the summer is hot. The Neuquén, which unites with the Lirnny near the 68th meridian to form the Río Negro, is the principal river of the province. The largest of a group of beautiful lakes in the higher Andean valleys is the celebrated Nahuel Huapí (lion grass), which lies partly in the southwestern angle of the province, partly in Río Negro and Chile. It is the source of the Río Limay and receives the overflow from two smaller neighbouring lakes.

The territory of Neuquén, officially created in 1884, was promoted to the status of a province in 195j. The population is concentrated in a few small towns on the rivers and in some colonies in the fertile districts of the Andes. The provincial capital, Neuquén (pop. [1956 est.] 9,892), was founded on Sept. 12, 1903. Near the capital is the Rio Negro dam, source of irrigation for a large area. The province is reached hy a light-drait river steamer which ascends the Rio Negro to the capital, at the confluence of the Limay and Neuquén, and by railway from Bahia Blanca to Zapala, via Neuquén. (GE. P.)

NEURALGIA. A symptom, not a disease, neuralgia is manifested by pain along the course of a nerve. Various forrns are distinguished according to the nerve affected: suboccipital neuralgia when the pain is in the back of the head and neck, intercostal neuralgia when it is between the ribs, etc. Strictly speaking, the term is restricted to those nerve pains for which no specific cause and no evidence of impaired function of the nerve can be found. Actually the word is often employed for pain caused by local nerve damage when pain is the prominent symptom. Most sciatic neuralgia, for example, is attributable to mechanical compression and stretching of a sensory root of the sciatic nerve from displacement of an intervertebral disc within the spinal canal. Neuralgic pain is frequently the iorerunner of hidden organic disease, and the first consideration in treatment is the search for a definitive cause.

Characteristically the pain of neuralgia is sharp, acute, darting and paroxysmal. The attacks, commonly brief in themselves, may succeed each other without respite for hours or days, robbing the victim of appetite and sleep and reducing him to a state of exhaustion and mental depression. Neuralgia of a nonspecific kind tends to occur during states of debility and malnutrition from any cause and in association with iniections. Exposure, chilling and fatigue are sometimes precipitating causes.

Treatment for relief of symptoms is sometimes of little use, many cases proving refractory to all measures. Pain is controlled, as well as can be, by ordinary analgesics, together with hypnotics if required for sleep, avoiding narcotics if at all possible. Hot or cold applications, diathermy or repeated local anesthesia with novocaine may be beneficial. For extremely severe or prolonged attacks palliative operations on sensory nerves, roots or their central connections have been resorted to with differing success.

Trigeminal Neuralgia.— In this condition, also called *tic douloureux*, the pain is strictly confined to one or all of the three divisions of the main sensory nerve of the face. Pain appears in the lower jaw, cheek, tongue and temple, in the upper jaw, cheek and side of the nose or in the forehead, depending on the division affected. The flashing, stabbing, boring pains, usually lasting less than a minute, are excruciating, and the suiferer commonly recoils from his agony with a spasmodic facial contorticin. Characteristically, stimulation of circumscribed areas of the face or mouth, eating, talking or even the lightest touch may provoke an explosion of neuralgic pain. There is little, if any, discomfort during the intervals between paroxysms. The contiition, for which no cause can usually he found, afflicts the elderly by preference and may have spontaneous remissions. Medical therapy is undependable, but surgical treatment is effective. Injection of the affected branch with alcohol gives prompt relief but rarely for more than a year or two. Cutting of the sensory roots within the skull affords almost certain permanent freedom from pain.

Atypical Facial Neuralgia.— This differs from trigeminal neuralgia in that the pain, although felt in the face, tends to be more diffuse, is duller in quality, persists for minutes or hours ant1 is not ordinarily provoked by sensory stimulation. The nature of the condition is obscure hut it seems probable that it is a disorder of the sympathetic nervous system and may he a variant of migraine (*q.v.*). Some cases respond to a regimen of treatment for migraine, but most are more intractable. All do poorly with surgical treatment. A variety of paroxysmal, unilateral nocturnal neuralgic pain involving the eye and temple, often called histamine headache in the United States, is a closely related condition.

Postherpetic Neuralgia.— This is merely the continuation for weeks, months or sometimes years of the nerve-root pain which is always present in the region of the skin eruption during the acute stage of an attack of shingles (*q.v.*). This distressing sequel of the disease affects mostly elderly persons. X-ray therapy appears to benefit some patients. Otherwise, once established, the pain stuhhornly resists treatment. (R. B. R.)

NEURITIS (NEUROPATHY) denotes a disease of nerves. Characteristic of neuritis are pain and tenderness; impaired sensation, strength and areflexia; and abnormal circulation and sweating in the distribution of the diseased nerve or nerves. Neuritis of the special sense organs and viscera has other, but equally specific, charactefistics.

A unique feature of the nerve cell is its extraordinary length. In its course a nerve may lie next to skin or bone; it may pass through muscles or tunnels; proximally its roots lie in relation to the spinal column and distally its fibres diminish in calibre. All these anatomic vicissitudes represent hazards. Nerve fibres are sites of elaborate enzymatic systems that can be blocked by toxins or can fail through lack of specific vitamins. Nerve fibres are richly supplied with blood vessels, and disease of these vessels may have devastating effects. Nerve fibres are housed in connective tissue that may become infected, scarred, edematous or invaded by tumours, events that may cause injury to nerve fibres. (*See* also NERVE.)

There are many causes of neuritis, but in general it may be said that when neuritis affects one nerve (mononeuritis) or a plexus of nerves (plexitis) the cause commonly is a mechanical one; that when several single nerves are affected simultaneously (mononeuritis multiplex) the cause often is a vascular or allergic one; and that when nerves are affected diffusely (multiple neuritis) the cause often is toxic, metabolic, viral or allergic. Electromyography, a procedure by which changes in the electric potential of muscle may be recorded through stimulation of its nerve, is of decisive help in the diagnosis of neuritis.

Mononeuritis and **Plexitis.**—Bell's palsy (neuropathy of the facial nerve) often follows exposure to a draft. The facial nerve passes through a bony canal that can accommodate little more than the nerve and its attendant blood vessels, and in about two-thirds of the cases of Bell's palsy the nerve is injured here. If continuity of the fibres is interrupted. they must grow anew. Growing fibres and their branches often arrive at a wrong destination, and this results in extraneous movements that ever after betray an old Bell's palsy.

One of the nerves most commonly afflicted is the ulnar, which serves the hand and arm. In about two-thirds of the cases this nerve is injured at the elbow, where it lies between skin and bone, or where it enters the antecubital tunnel in the forearm. The nerve again becomes vulnerable at the wrist, and ulnar neuropathy therefore is conspicuous among the occupational neuropathies.

The median nerve, serving muscles of hand and forearm, carries large complements of sensory and vasomotor fibres and is especially intolerant of injury. The commonest cause of median neuritis is compression of the nerve in the carpal (wrist) tunnel. This is convincingly demonstrated by electromyography. Slight injury to the nerve at higher levels may result in a prolonged and distressing affliction of the hand known as causalgia.

The radial nerve spirals the humerus (the bone of the upper arm) immediately under the skin and here is subject to compression. The wrist and finger drop that results is sometimes called Saturday night paralysis. A small cutaneous branch of the radial nerve may be compressed at the wrist by the band of a wrist watch. with resulting cheiralgia paraesthetica.

In at least half of 400 cases of neuropathy of the brachial plexus that were reviewed, the brachial plexus (the great nerve plexus of the neck and armpit, where meet all the nerves supplying shoulder, arm and hand) was injured by traction or compression. In a fifth of the cases, cancer of the breast or lung had invaded the plexus.

Involvement of the sciatic nerve (the great nerve supplying the thigh and leg) or its roots accounts for about 40% of cases of neuritis. Among the causes are protrusion of intervertebral disks, arthritis of the spine and trauma of the nerve itself.

Crossed leg palsy is caused by wedging of the common peroneal nerve (serving the anterior muscles of the leg) between the head of the fibula and the opposite knee. When prolonged squatting compresses the nerve between the head of the fibula and the tendon of the biceps femoris muscle, a foot drop results! sometimes called gardener's paralysis.

Numbness of the lateral aspect of the thigh because of neuritis of the lateral femoral cutaneous nerve is known as meralgia pamesthetica. The nerve usually is injured where it traverses or passes under the inguinal ligament.

Mononeuritis **Multiplex.**—When several isolated and even widely separated nerves are involved simultaneously, it is usually found that trouble .has started within the nerve itself. This may occur in leprosy (*q.v.*), in serum paralysis, in periarteritis nodosa and in porphyria (*q.v.*).

Multiple Peripheral Neuritis. — This term (also polyneuritis or polyneuropathy) denotes diffuse and symmetrical involvement of nerves. Symptoms usually begin in the feet, then in the hands, then progress upward. The usual causes are bacterial. viral, chemical and metabolic poisons, allergy or the lack of substances that are needed to support the function of nerves. Associated with multiple neuritis may be the Guillain-Barre syndrome, in which the content of protein of the spinal fluid is elevated without increase in the number of cells.

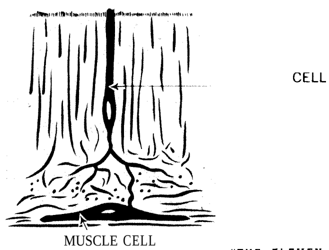
Treatment of Neuritis. — The general principles of treatment include management of the underlying cause, care of the afflicted limbs, application of heat. adequate nutrition and physical therapy. Specific forms of therapy include the administration of BAL (2.3-dimercaptopropanol) in the treatment of arsenical polyneuritis: of EDTA (ethylenediaminetetraacetic acid) in the treatment of lead poisoning; of cortisone in the treatment of serum paralysis and the neuritides of collagen diseases: and of vitamins of the B complex in the treatment of neuropathies associated with poor nutrition. (H. W. Wn.)

NEUROLOGY is the area of science that deals with the nervous system. See NERVE; NERVE CONDUCTION; NERVOUS SYSTEM; NERVOUS SYSTEM, SURGERY OF.

NEUROLOGY, COMPARATIVE. The field of comparative neurology comprises the nervous mechanism and activities of all animal types, from the most primitive to man. Nearly all living organisms are sensitive to sudden changes in environmental conditions. This property of sensitivity is one of the fundamental characteristics of living matter and is termed irritability. Changes in environment, which may be of many kinds, act as stimuli; because of the irritability of living matter, a stimulus results in some form of response that usually is advantageous to the organism.

Introduction. — Stimuli as a rule are localized as to point of impact, and all animals, except the lowest forms. possess special cells or aggregations of cells for the reception of different types of stimuli. Such specialized cells are called receptors: in their most elaborate form. such as the eye and the organ of hearing. of higher animals. they constitute the special sense organs. Both in man and in lower animals there are many types of more simply organized receptors that are activated by a variety of external and internal stimuli such as touch. temperature changes. chemical substances. pain-producing contacts. contraction of muscle and many others. The stimulus typically produces a change in the part of the cell to which it is applied or in the receptor and is followed by a wave of change that progresses to points distant from that of impact.

The power of transfer of an impulse initiated by a stimulus is called conductivity and represents another characteristic of living matter. All living cells probably possess it in some degree, but nervous tissue is especially adapted for the reception and conduction of stimuli. The response may be accomplished by another part of the same cell. which may or may not he modified for that purpose. or by specialized cells connected with the receptors by conducting fibres. The structure that has the capacity for response is called the effector.



ADAPTED FROM G H PARKER, "THE ELEMENTARY NERVOUS SYSTEM," J. B. LIPPINCOTT COMPANY, PHILADELPHIA, 1919

FIG. 1. — SIMPLE RECEPTOR-EFFECTOR SYSTEM

INVERTEBRATES

Protozoans. — The simplest animals (the protozoans) consist as a rule of a single cell. Some of the protozoans possess a system of delicate threads or fibrils that interconnect the bases of whiplike locomotory cilia. These fibrils centre in a small body, the motorium, which is situated near the gullet. Co-ordinated movements of the cilia adapted to propel the animal forward or backward indicate the presence of a special conducting mechanism: this is provided by the fibrils, which constitute a primitive neuromotor system.

Sponges. — In sponges. which consist of many cells, no nervous structures have been identified. These animals have a system of channels with inlet and outlet pores through which a current of water may pass through their bodies. Minute organisms that serve for food are extracted from the water by cells lining the channels. The chief movements of sponges consist of opening and closing the pores that govern the circulating stream. These movements are accomplished by very simple contractile cells that appear to he activated by direct stimulation without the intervention of nervous elements. Such musclelike elements have been designated independent effectors. Another example of an independent effector is afforded by the minute stinging organs of jellyfishes and related animals. These organs also react directly to stimuli and serve to paralyze or ensnare the prey. In the larger jellyfishes the threadlike lances that the stinging organs discharge can penetrate the human skin and inflict,painful injuries. In the higher animals more specialized effectors in the form of muscles. glands and electric organs are activated by impulses transmitted to them by nervous tissue.

Coelenterates. — The coelenterates, jellyfishes and related animals, also possess effectors in the form of well-differentiated muscles, whose cells can change their shape rapidly. Certain of these muscles may respond directly to stimuli but as a rule muscle responds to a nervous impulse. In the tentacles of sea anemones and related animals a simple receptor-effector apparatus is found that consists of a sensory cell and muscle.

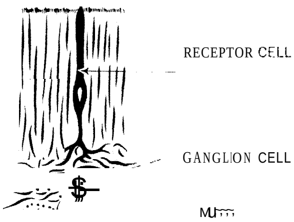


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FIG. 2.—COMPLEX RECEPTOR-EFFECTOR SYSTEM OF SEA ANEMONE

The sensory cell reaches the external surface and constitutes a receptor. The receptor is stimulated by mechanical impact or by dissolved substances. such as ~neatjuices, in the water. h e deep part of the receptor cell gives rise to a fibrous process that serves as a conductor. This process has numerous branches that form a plexus in the layers beneath the surface and end in relation to the muscles in the deep layers. The plexus spreads the stimulus so that a widespread response of muscle is produced from a localized stimulus. This response results in movements of the tentacles to carry food to the mouth. The combination of specialized receptor cells and muscle makes possible relatively quick movements in response to slight stimuli.

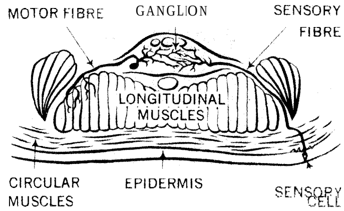
A further elaboration of the receptor-conductor-effector apparatus. found in hydroid polyps, sea anemones and jellyfishes. includes primitive nerve cells and their processes which are interposed between the receptors and effectors. Each of these primitive nerve cells has numerous branching fibres that form an intricate plexus beneath the surface of the animal and penetrate to internal structures. There is good histological evidence that the processes of the nerve cells do not fuse but only interlace or run parallel with each other. They have points of contact at which the nerve impulse is transmitted from one fibre to another. Such a point of contact between individual nerve cells or their processes is known as a synapse.

Synaptic junctions are characteristic features of the nervous systems of higher animals, and in these animals they serve as one-way valves that transmit impulses in only one direction. In the jellyfishes, however, transmission may be in either direction. An impulse initiated at any point. accordinqly, may spread through the entire nerve plexus to all parts of the body. in contrast with the manner of its spread in the greater part of the nervous system of higher animals in which the one-way synaptic connections direct the impulses into specific channels.

Higher Invertebrates. — The nervous system of animals above the jellyfishes assumes such a variety of forms that only a few examples can be given. In all of the bilaterally symmetrical animals. however, it is made up of specific nerve cells. which, with their processes. long and short. are known as neurons. Typically the cell bodies are grouped into masses called nerve centres. whereas the longer processes are collected into bundles in a central nervous axis that connects the nerve centres with each other and into peripheral bundles known as nerves The nerve centres and connecting bundles form a central nervous system The nerves connect the neripherally or internallv situated receptor and effector organs with the central nervous apparatus

As represented in segmented invertebrates such as the earthworm and the Insects, the central nervous systcnt comprises an anterior collection of nerve cells and fibres. usually called the brain arid two elongated strands of nerve fibres and groups of cells extending throughout most of the length of the body.

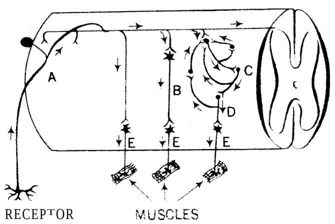
The groups of nerve cells, called ganglia, constitute nerve centres that occur in pairs, one pair for each body segment. Each pair is interconnected by short transverse bundles of nerve fibres so that a ladderlike pattern of the central nervous system results. The brain is situated in the head region. above the digestive tube, but is connected to an enlarged nerve centre at the anterior end of the nerve cord by a strand of nerve fibres that passes downward on either side of the forward part of the alimentarv canal. In the invertebrates the nerve cord lies beneath the digestive tract.



ADAPTED FROM G. RETZIUS, "BIOLOGISCHES UNTERSUCHUNGEN"

FIG. 3.—TRANSVERSE SECTION THROUGH VENTRAL BODY WALL AND A GANGLION OF CENTRAL NERVOUS SYSTEM OF THE EARTHWORM

Earthworm.—In the earthworm a pair of ganglia occurs in each of the 100 or more segments of the body. From these ganglia, and from the brain. nerves pass to the adjacent body parts to the muscles and to the skin. The earthworm has sensory cells in the skin especially in the anterior part of the body. The outer ends of these cells reach the external surface and are modified as receptors. Their inner ends are elongated as small nerve fibres that collect together to form nerves which reach the nerve centres Within the latter these fibres m tke synaptic connectrons nith the cell bodies. or their processes of a second set of neurons whose long fibres become included in the nerves and are distributed to muscle. A stimulus applied to the skin may produce a muscular movement. the nervous mechanism involved consisting of receptor or sensorv neuron. connections ın the nerve centre and an effector or motor neuron Such a chain of neurons from receptor to effector constitutes a reflex arc. the simplest comprising two elements and their synaptic connection in the nerve centre



ADAPTED FROM O LARSELL ANATOMY OF THE NERVOUS SYSTEM 2ND EDITION APPLETON CENTURY CROFTS INC NEW YORK 1951

FIG 4 —REFLEX ARCS IN HIGHER VERTEBRATES

A. afferent fibre, one of whose collaterals synapses with an efferent neutron E, forming a two-neuron reflex arc. B, intercalated neuron in a three-neuron arc. C, closed self-exciting circuit. D, final intercalated neuron from self-exciting circuit

A third type of neuron situated between the sensorv and the motor neurons is also found in the earthworm. It is known as the internuncial neuron and serves as an adjustor Such neurons occur only within the brain and the nerve cord and its centres extending lengthwise from one nerve centre to another and conducting impulses that influence the activities of segments of the body remote from the point of stimulation

Ex-en in the worms there is some degree of control by the anterior nerve centres over other parts of the nervous system After the brain of an earthworm ıs removed the animal can eat and crawl right itself and perform other functions normally. It is restless and active. however, its anterior segments are lifted upward and it requires a much longer time to burrow than the normal worm.

Marine Sandworm. — The sandworm. *Nereis*, whose nervous system is built on the same general plan. has few sensory cells in the skin but possesses several pairs of eyes and feelers and tentacies that are stimulated by chemical substances. These all are attached to the head region and their nerves are connected

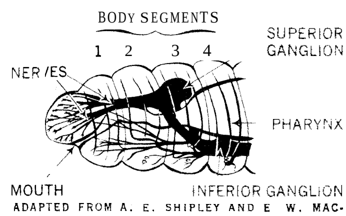


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FIG. 5.—SIDE VIEW OF BRAIN AND ANTERIOR NERVES OF THE EARTHWORM

with the brain. When the brain is removed. the animal loses light and chemical sensitivity, it ceases to feed and to burrow and it becomes overactive.

Much more definitely than in the earthworm the brain of the sandworm is a sensory centre that normally exercises a restraining control over the chief motor centres These centres. situated in a nerve centre beneath the gullet, have connections with the segmental nerve centres.

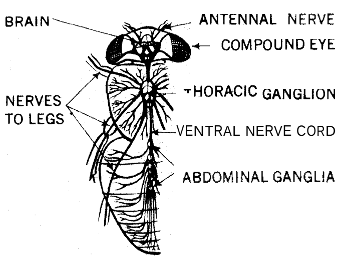

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FIG. 6 —NERVOUS SYSTEM OF HORSEFLY

Insects. — Some of the activities of many animals are instinctive. Much of the behaviour of insects is of this type. Such animals have no basis of learning but rest on a structural pattern of the nervous system which is preformed in each individual. Instinctive acts require only an appropriate stimulus to start them but are much more complicated than reflexes

Bees. for example, build their combs and do other things instinctively and without training. but their nervous system also is adaptable to some degree so that they can learn to find their way and are helped by their fellows Even higher animals perform many instinctive acts, such as the suckling of young mammals or the crying of a newborn infant.

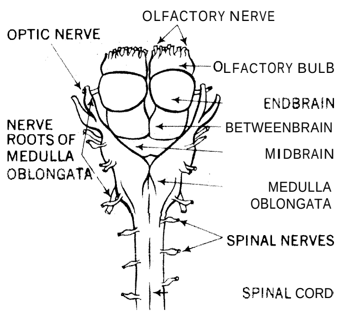

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FIG 7. — BRAINOF HAGFISH

VERTEBRATES

The central nervous system of the vertebrates (animals with spinal axis of cartilaginous or bony segments) consists of a spinal cord surrounded by the vertebrae and a brain situated in the head.

Spinal Cord.—The spinal cord is largely a reflex organ but is influenced hy impulses from the brain centres It also relays to the brain sensory impulses brought by the spinal nerves. In mammals the motor activities of the cord are more strongly influenced by the brain than in lower vertebrates. In addition there is a voluntary motor pathway, originating in the cerebral cortex. the impulses of which result from integrations at the highest levels of the nervous system rather than at reflex levels.

'The relative functional importance of the sensory and some of the motor systems of the brain varies in different species. Also many water vertebrates. such as fishes, have a special system of sensory organs and nerve centres, the lateral line system, that is lacking in air-breathing animals. The relative size of the nerve centres of the brain corresponds with the importance of such centres to the different groups of animals; for example, in birds, which have extremely good visual powers, the optic centres are large, whereas the lateral line centres are absent.

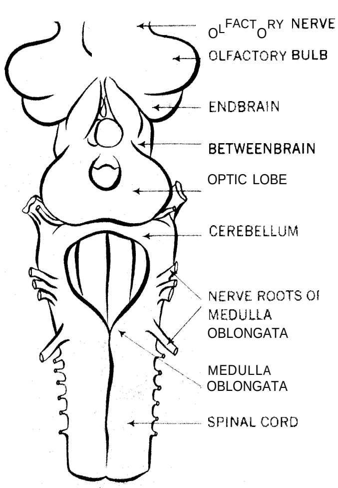

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FIG. 8. — BRAIN OF LAMPREY

Through observation and experimental studies most of the functional regions and related fibre bundles of the vertebrate brain have been determined and their activities investigated.

Brain. — In all animals from the worms and insects to the highest forms the brain is an important and characteristic part of the nervous system. It is always situated at the anterior end of the animal and with it are connected the principal sense organs of the body. In man and other higher animals the brain is thus associated with the organs of sight, hearing, smell and taste. The development of these special receptors and of the brain has progressed hand in hand in the evolutionary process. This process has involved transformation of several of the sense organs of the head from surface receptors, which require contact of the stimulus with the body surface, to distance receptors, the stimuli of which come from more or less remote points although they must impinge on the specialized structures. such as the eye or the ear, to be effective.

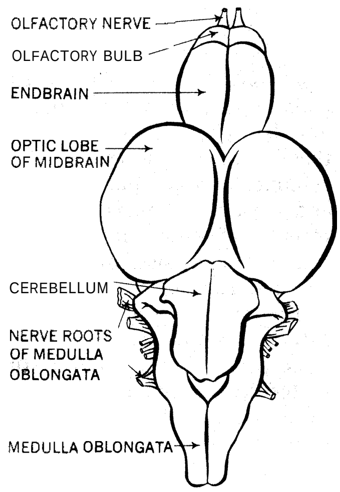

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FIG. 9.—BRAIN OF YOUNG SALMON

There is reason to believe that the distance receptors have evolved from the contact receptor type and with this transformation the brain has also undergone a far-reaching development. As the distance receptors become increasingly important the brain becomes a more complex switchboard to meet the needs of increased sensory reception. With the development within it of more and more internuncial neurons the brain becomes in the higher animals the centre for increasingly complex nervous activities.

The brain comprises five divisions (see below) whose relative size varies with the sensory equipment and other variables of the different groups of vertebrates. Paired nerves are attached both to the brain and the spinal cord. The spinal nerves include both sensory and motor fibres and are similar in all vertebrates but vary in number. The nerves connected with the brain are made up of diverse combinations of sensory and motor fibres and some are entirely sensory or entirely motor.

Each of the five divisions of the brain, termed the endbrain (telencephalon), betweenbrain (diencephalon), midbrain (mesencephalon), cerebellum (metencephalon) and medulla oblongata (myclcncephalon), has characteristic structural patterns and functions. Part of the endbrain and all of the betweenbrain. midbrain and medulla oblongata constitute the basis of the entire organ; collectively these subdivisions are termed the brain stem (see

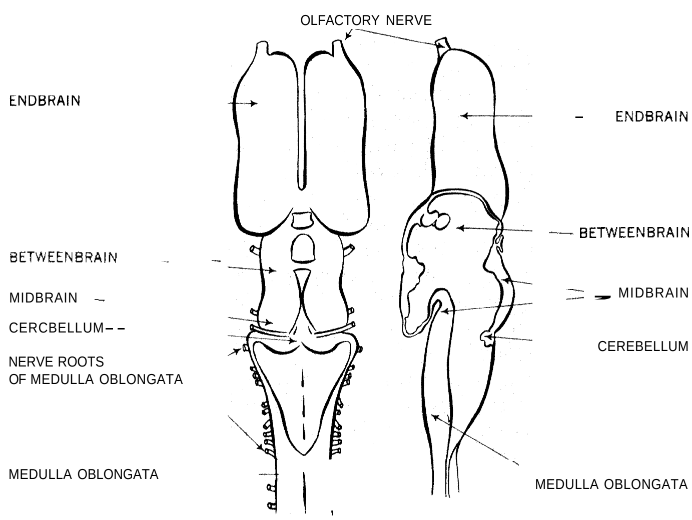

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FIG. 10. — BRAIN OF SALAMANDER

BRAIN).

Lower Vertebrates.—In all but the lowest vertebrates a covering layer. the mantle or pallium, is superposed on the deep part of the endbrain, and a cerebellum is found above the anterior part of the medulla oblongata. From the pallium the cerebral cortex is differentiated. This is lacking in fishes and lower urodeles but beginning with the frog and upward through the animal series it assumes increasing size and importance; in man it is so extensive as to hide the remainder of the brain when viewed from above. The cortex consists entirely of internuncial neurons and constitutes the adjustor apparatus, which is at the saine time the most complex and also of the highest order in the nervous system. The brain stem consists of complex reflex centres and their connecting fibre bundles, many of the centres having connections with the cerebral cortex as well as with the lower centres.

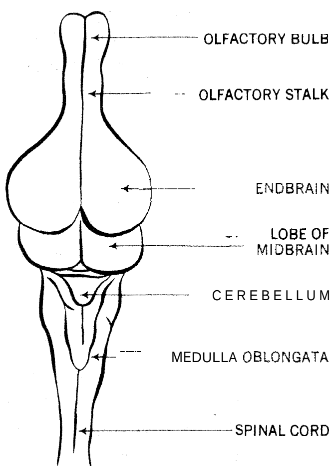

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FIG. 11.—BRAIN OF LIZARD

Mammals, Including Man.—The cortex of mammals is divided into sensory. motor and association areas. The sensory areas receive relayed impulses; such as visual and auditory, from centres in a subdivision of the betweenbrain called the thalamus. The motor areas give rise to fibres that reach lower centres related to motor activity. The association areas are small in lower mammals, but in man they constitute the greater part of the cortex. In these areas more complex patterns of integration are formed from impulses supplied bv other centres. cortical' and thalamic.

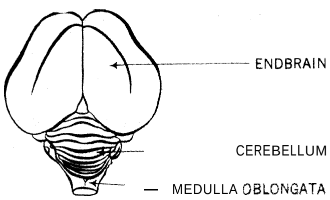

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FIG. 12.—BRAIN OF GOLDEN EAGLE

The frontal lobe of the cerebrum. in which the most complex integrations occur, is very small in lower mammals but increases in size until in the higher apes it forms a large subdivision **of** the brain. In man it is especially prominent and includes the cortex involved in the highest activities of the human mind. Other lobes of the cerebral cortex also increase in size and complexity from the lower to the higher mammals.

In the ascending scale, from the lowest to the highest animals and man, the nervous system becomes increasingly complex in structure. The impulses that reach it provide an increasing amount of information regarding environmental conditions. and the brain exercises an increasing dominance over the activities of lower nerve centres.

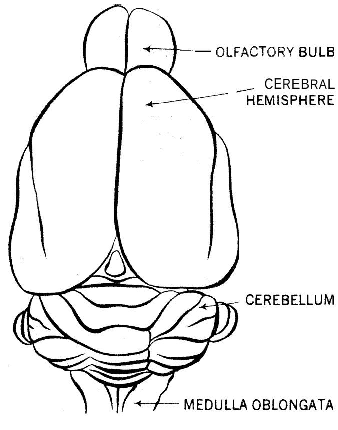

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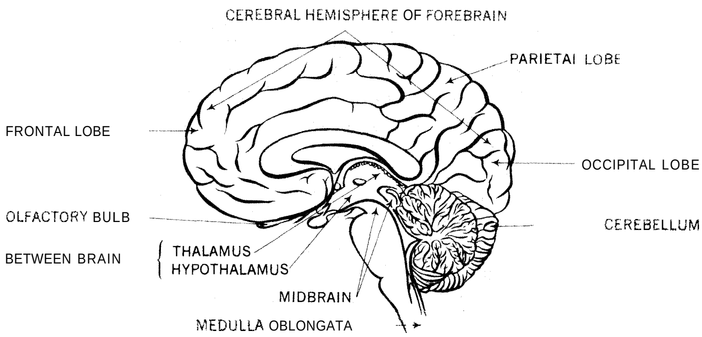
FIG. 13.— BRAINOF RAT

In mammals as well as man the dominance over lower centres may express itself in inhibitions or modifications of behaviour that result from integrations of impulses from the most important sense organs or from memory of past experiences. Such integrations may overcome or modify responses organized at lower levels: for example, an individual with social training may suppress so purely a reflex act as a sneeze. which in the untrained person may take explosive force. Some acquired functions such as speech, recognition of spoken or written words and various skills, furthermore, are localized in



O. LARSELL

FIG. 14.— MEDIAL VIEW OF HUMAN BRAIN

one or the other hemispheres of the cerebrum. In right-handed persons the so-called dominant hemisphere is the left; in left-handed persons it is the right.

Trends in the Nervous System.—Comparative studies of the nervous system hy anatomical and physiological methods have revealed the following trends: increasing speed of conduction of stimuli and the impulses resulting from them. for example. the rate of conduction in the nerve plexus of the jellyfish attains a maximum speed of 120 cm. (48 in.) per second, whereas in a human nerve it may be more than 100 times as fast: integration of impulses so that a given stimulus may result in increased response or in failure to respond; the pattern of response may be modified; dominance by the brain as a result of connection with it of the most important sensory organs; and control of motor centres by the brain through the action of its adjustor mechanism.

The human brain is the most intricate mechanism in nature. It comprises pathways of many degrees of complexity, from a relatively simple reflex arc. illustrated by the pathway involved in constriction of the pupil in response to light (sensory impulses emanating from receptor cells in the retina of the eye travel along the optic nerve to a specific centre in the midbrain. which in turn relays these impulses to a motor centre from where new impulses are dispatched to the muscles of the iris to cause constriction'), to extremely complex integrations that affect behaviour.

These latter integrations may involve not only present experience and the individual's memories of his own past, but also "racial memories" of man as stored in folklore and books. The mind, of which the brain is the organ, can analyze. synthesize and project to the future: it is capable of imagination and other qualities that give man predominance by reason of the complexity of the cerebral cortex and its connections.

See also BRAIN; NERVE; NERVE CONDUCTION; NERVOUS SYSTEM; SPINAL CORD.

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NEUROPHARMACOLOGY AND PSYCHOPHARMACOLOGY, the general names of the sciences concerned with the action of drugs on the nervous system. A number of drugs that influence the higher brain centres have been known for centuries. The general anesthetics the pain-relieving opiates, alcohol and the sleep-producing hypnotics have been known and classified as central nervous system depressants for many years.

Certain other drugs such as strychnine, caffeine and amphetamine have a stimulant effect upon the nervous system. These drugs generally do not produce in man behaviour changes useful in psychiatric therapy. Not until the middle of the 20th century were there discovered therapeutic agents that are useful in mental illness. With the discovery of the neuropharmacologic drugs reserpine and chlorpromazine, some of the major forms of mental illness involving thinking disturbances, especially the schizophrenias; showed definite improvement with drug therapy. These were the first modern drugs used as tranquilizers in mental patients. There are many tranquilizing or ataraxic drugs available, with many others undergoing clinical trials. Indeed. in most mental institutions the use of these drugs has revolutionized the handling of mentally disturbed patients. The ataraxic drugs differ from the hypnotic barbiturates in that their primary action is not on the cerebral cortex but on the lower levels of the brain. Their principal effect is to make emotional stress less disturbing while at the same time the patient remains alert. Patients receiving such medication are not depressed and lethargic as they would be after barbiturates; rather they seem willing to exercise and care for their personal needs. In addition, some types of neuropharmacologic agents are useful in overactive states such as epilepsy and paralysis agitans. The anticonvulsant drugs diphenylhydantoin sodium (Dilantinj, trimethadione (Tridione) and the antiparkinsonian drug trihexyphenidyl (Artane) are examples.

Concomitant with the introduction of tranquilizing drugs into psychiatric practice was the discovery of the remarkable substance lysergic acid diethylamide (LSD) by the Swiss chemist Albert Hofmann in 1947. This compound when ingested in minute amounts produces hallucinations, depersonalization and thinking disturbances, which have features in common with those of schizophrenia and paranoia. Other less potent hallucinating agents formerly were known, including bufotenine from *Piptadenia peregrina,* harmine from *Peganum harmala,* and mescaline from *Lophophora williamsi.* It is apparent that with the possession of drugs that can either cause or suppress hallucinations the experimental pharmacologist, the animal behaviour psychologist and the psychiatrist can combine their skills to study brain functions in health (normal behaviour patterns) and in mental disease (abnormal behaviour patterns).

Extensive investigations in neuropharmacology were undertaken, involving study of the chemical constituents of different areas of the brain (neurochemistry) as these may be influenced by psychopharmacologic drugs. These behavioural drugs influence the electrical activity of the brain as recorded in the electroencephalogram normally and in mental illness. Thus the neuropharmacologic agents have provided tools for the study of normal nervous functions at the chemical, electrical and behavioural levels.

Perhaps the most significant aspect of the discovery of these neuropharmacologic agents was the demonstration that it is possible to modify by drug therapy some of the baffling behaviour changes of mental disease. This was a major medical milestone, and it lent new impetus to the organic concept of mental illness. *See* also TRANQUILIZING DRUGS.

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NEUROPTERA, the term used in zoological classification for that order of insects which includes the alder flies, snake flies, ant lion flies, lacewings and their allies. They comprise small to rather large soft-'bodied insects with usually elongate antennae and two pairs of similar, net-veined, membranous wings; the wings are closed roof-like over the body when at rest and the hind pair is usually without a plicated posterior lobe. The mouth parts are for biting. the tarsi are five-segmented, and there are no cerci or tail filaments. All Neuroptera undergo complete metamorphosis, and the larvae are active and predatory with well-developed antennae, sense organs and legs; they are mostly terrestrial, but some are aquatic. The pupae have the appendages free and are generally enclosed in silken cocoons.

About 4,500 species of Neuroptera were known by the early 1960s—about 60 occur in Great Britain and 300 in the U.S.

Neuroptera are all insects of weak flight, they are rarely abundant in individuals and, in the adult stage, they feed mostly upon soft-bodied insects or liquid matter such as honey dew. Most of the species have beautiful net-veined wings that often exhibit a complex reticulation formed by numerous accessory veins. There are numerous veinlets arising from the costal vein. In the larval stages they are exclusively predaceous. The order is divided into two suborders, Megaloptera and Planipennia.

SUBORDER I, MEGALOPTERA

This suborder is characterized by veins with little or no tendency to fork at the margins of the wings, the third vein in the wing (radial sector) with few branches; larvae with biting mouth parts; pupae not enclosed in a true cocoon.

This group includes a small number of archaic insects separable into two superfamilies comprising about 200 species throughout the world.

1. Superfamily Sialoidea, all with aquatic larvae, include the alder flies (*q.v.;* family Sialidae), so called because in England the adults often frequent alders along the banks of streams. Their larvae respire by means of seven or eight pairs of slender, jointed, abdominal gills. The genus *Sialis* is widely distributed with two British and many North American species. Also included are the large dobsonflies (*q.v.*), belonging to the family Corydalidae and found in North and South America and in parts of the old world. Smaller members of the same family are often known in America as fish flies (*q.v.*).

2. Superfamily Raphidiodea or snake flies (*q.v.*) is distinguished by the elongate prothorax and by the very long ovipositor in the female. They are terrestrial insects whose larvae are found under the bark of trees and feed on scale insects and aphides. There are 20 species found in North America (1945) and 4 in Britain.

SUBORDER II, PLANIPENNIA

This suborder is characterized by veins with evident forking at the margins of the wings, third vein (radial sector) usually with numerous branches; larvae with piercing mouth parts; pupae enclosed in a cocoon.

Included here are most of the Neuroptera. They are nearly all terrestrial insects, only a small number being partially or truly aquatic in their larval stages. Planipennia are divided into 16 families of which only the most important are mentioned.

1. Ithonidae or moth lacewings are confined to Australia; they are large, stoutly built, mothlike insects with primitive venation. Their larvae live in the soil where they prey upon those of chafer beetles, to which they bear a close general resemblance.

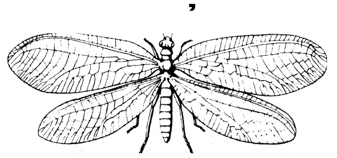

FIG. 1.— GREEN LACEWING (CHRYSOPIDAE)

2. Hemerobiidae or brown lacewings are widely distributed and fairly numerous in species. Their larvae along with those of the Chrysopidae or green lacewings (fig. 1) roam about vegetation preying upon mites, aphides, thrips and other soft-bodied insects (*see* LACEWING FLY).

3. Osmylidae have aquatic larvae. They are medium to large sized species which differ from the lacewings in certain venational characters. They are widespread in the tropics but are represented in Europe by only one species and are absent from North America.

4. Sisyridae, which also have aquatic larvae, differ from the Osmylidae in having very few cross veins to the wings, besides being much smaller in size. They are brown or fuscous insects found along the borders of rivers which contain the fresh-water sponge upon which their larvae feed and live. Three species of *Sisyra* occur in Great Britain, and this genus, along with *Climacia,* is found in the United States.

5. Mantispidae or mantis flies (*q.v.*) are easily distinguished by the elongate thorax arid the prehensile forelegs which resemble in form those of the common mantis (*q.v.*) and are likewise used for seizing other insects that serve as their prey. The larvae of the European *Mantispa styriaca* are predacious upon young *Lycosa* spiders and during development they undergo striking changes of form constituting hypermetamorphosis. The family is mainly tropical but occurs in southern Europe and in much of the United States.

6. Psychopsidae have very broad. rounded wings supportrd by a stout "midrib" and with a densely reticulated venation. Many are insects of striking beauty. Their larvae have been found beneath bark of trees. The family has a wide discontinuous range occurring in South Africa, Tibet, China and .Australia.

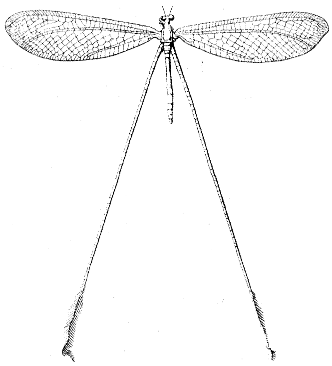

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FIG. 2.— NEMOPISTHA IMPERATRIX (NEMOPTERIDAE)

7. Nemopteridae differ from all other Neuroptera in having very long threadlike or ribbon-like hind wings (fig. 2). Their larvae occur in caves, on the floors of buildings. among debris. etc.. where they prey upon smaller forms of insect life. The family occurs in many of the warmer parts of the world, including southern Europe. but is absent from North America.

8. Myrmeliontidae or ant lion flies (*q.v.*) bear a general resemblance to dragonflies and have short knobbed antennae, Although most abundant in the warmer parts of the world. several species occur in Europe, one being found as far north as Sweden. but none are found in the British Isles: about 70 species inhabit the United States. Their larvae live on the ground, where some make pitlike snares for entrapping their prey, while others hide away under stones or debris.

9. Ascalaphidae are closely related to the preceding family but can he distinguished easily by their much longer antennae as well as by venational differences. Their larvae either hide away on the ground or live concealed on the bark of trees. They are chiefly tropical insects. only a few species occurring in southern Europe and North America.

10. Coniopterygidae or mealywings (*q.v.*), number about 70 species and are the smallest and most aberrant of all Xeuroptera. They are covered with a white powdery secretion. their wings have comparatively few veins and the hind wings are much reduced in size. Their larvae roam about plants, preying upon aphides, scale insects and mites. About six species are found in Great Britain and many more in the Cnited States.

NATURAL HISTORY, DISTRIBUTION AND IMPORTANCE

The eggs of Neuroptera are ovoid and in several families, including the green lacewings. the female exudes a sticky secretion which she draws out into a hairlike stalk upon which the egg is laid for safety. The larvae are mostly terrestrial or arboreal and in the Planipennia they are all characterizeci by the greatly drawn out mandibles and maxillae which are used for seizing and perforating the prey. The mandibles are grooved along their ventral surface; the maxillae. which closely resemble them in form. fit one into each groove: in this way the two sets of appendages function as a pair of tubes through which the body juices of their victims are sucked out. Larvae of the Phanipennia are further remarkable for the fact that six out of their eight Malpighian tubes become transformed into silk glands, the silk being emitted through an anal spinneret. (*See* fig. 3.)

Larvae of ail Neuroptera are carnivorous and prey mostly upon other forms of insect life. When mature those of the Planipennia construct silken cocoons and, prior to the emergence of the perfect insect, the pupa cuts open the cocoon with its mandibles and, being mobile. often travels some little distance before the imago emerges. Little is definitely known respecting the specific nature of the iood of the perfect Insects; many are nocturnal in habits and are attracted to lights, while most of the day-flying species are rarely seen on the wing.

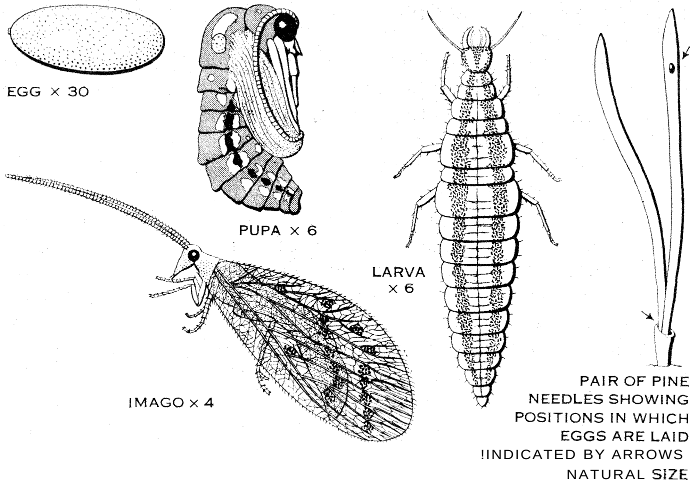

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FIG. 3.—LIFE CYCLE OF THE BROWN LACEWING (HEMEROBIUS STIGMA)

Geographical Distribution.— Certainfamilies of Neuroptera are nrarly world-wide in their distribution. Chrysopiclae, for example. are found in almost all extensive areas of land except New Zealand; Sialidae have an almost world-wide though discontinuous range, while the Raphidiidae are mainly restricted to the northern hemisphere. Several families, on the other hand. are almost confined to Australia. which has a more diverse fauna of Planipennia than any other region of the globe. although the Megaloptera are represented there only by a few species. Only 7 families of Neuroptera occur in the British Isles and 13 families are found in the United States.

Geological **Distribution.**—Megaloptera are evidently an archaic group but their fossil remains. unless very perfect. are difficult to identify. The earliest undoubted remains of this suborder have been found in the Permian rocks of the U.S.S.R. The Planipennia first appear as fossils in Permian beds of the U.S.S.R. and Australia.

Economic Importance.— Neuroptera as a whole are distinctly beneficial to man in their larval stages. Larvae of the Sialidae form food for trout and other fishes. while those of the Planipennia prey upon many soft-bodied noxious insects. In Europe and North America the most beneficial families are the Hemerobiidae. Chrysopidae and Coniopterygidae. and in Australia larvae of the Ithonidae destroy numbers of scarabaeid grubs in the soil.

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NEUROSES are psychological disorders which arise from a person's unsuccessful attempt to deal with inner conflicts and stressful life situations. They are adaptive in that they aim at the resolution of opposing forces within the personality through the discharge of accumulated inner tension and anxiety. The anxiety may he experienced directly or manifested in the form of bodily disconifort, phobias, obsessional thoughts, compulsive acts, mild depression. altered states of consciousness or physical complaints in the absence of organic and structural pathology. The neuroses represent attempts to obtain partial gratification for impulses and drives in a manner which was more or less successful in an earlier period of development. The disorders are benign disturbances within the personality and are to be differentiated from psychoses (*q.v.*) in that total disorganization and ioss of contact with reality do not occur.

Although recognizable neurotic syndromes have been described since the Hippocratic period. the tendency for many centuries was to consider the illness a result of demonic possession or willful simulation. With the development of scientific medicine based on pathology, the 19th century considered neuroses as a primary functional disorder of the central nervous system. The French neurologist Jean Martin Charcot (*q.v.*) laid the foundations for a psychological understanding of neuroses through the use of hypnotic techniques for the treatment of hysterical disorders. The psychological approach was further developed by Sigmund Freud (*q.v.*), who demonstrated the effect of unconscious forces within the mind, the symbolic meaning of neurotic symptoms, the significant etiological agents in childhood experience. the importance of unacceptable repressed sexual and aggressive drives and a technique of treatment based on psychological principles. The modern psychiatric outlook is largely based on the discoveries of Freudian psychoanalysis.

Freud divided the neuroses into two major categories, the actual neuroses and the psychoneuroses. Although not universally accepted, this division is useful in understanding and classification. The actual neuroses include symptomatic disorders which are primarily reactions to acute stressful situations and arise as a result of excessive stimulation originating either environmentally or internally.

Symptoms are simply the discharge of accumulated tension rather than an attempt at the resolution of psychological conflict. The traumatic neuroses—such as the "shell shock" of World War I, the combat fatigue of World War II or the emotional disorders following civilian disaster—are essentially neuroses of this type. The symptoms are an attempt to deal with catastrophic external events of such magnitude that the personality has no recourse but the immediate dissipation of the accumulated tension. These reactions are short-lived and usually disappear with the removal of the stressful situation.

The actual neuroses also include reactions to endogenous stresses, that is, stimuli which arise within the organism. If a weakened personality becomes flooded by sexual or aggressive excitation, a paniclike state may result. When a state of overstimulation and insufficient motor discharge becomes chronic, diffuse symptoms such as general fatigue, tension: dizziness, insomnia, pressures and pain in the head, neck and back occur. This general state of exhaustion and bodily preoccupation is characteristic of neurasthenia and hppochondriasis.

These actual neurotic reactions may in turn become converted into psychoneurotic reactions in which the symptomatic response carries a more elaborate psychological content.. The reaction in the psychoneurotic condition is a result of the meaning of the stimulus rather than its magnitude. An objectively insignificant stress may produce a psychoneurotic reaction in a person who is particularly vulnerable because of his inability to handle such frustrations. To illustrate: in wartime a traumatic neurosis may develop following prolonged and threatening bombardment during combat. A psychoneurosis may intervene when under similar conditions the death of a comrade arouses intolerable feelings of guilt in a soldier for whom the event recapitulates a childhood jealousy of an older brother. Since Freud first distinguished the two neuroses, clinical experience has demonstrated that most actual or traumatic neuroses are frequently elaborated into psychoneuroses.

Causes of **Neuroses.**—Modern psychiatry considers many factors in the causation of the neuroses. Although in a particular patient one factor may be more important than others, all must be evaluated in attempting to understand the origins of neuroses. Since these factors fall into a complementary series, it is unlikely that a single linear relation between specific cause and end result will be found.

Socio-Economic and Cultural Factors.—These may be causative in the development of neuroses because of the presence of conflicting and opposing values within a society. A person may strive toward the gratification of ends, such as "belongingness" and competitiveness, which are essentially contradictory. The satisfaction of one value may make it impossible to satisfy the other. A group of neo-Freudian psychiatrists have tended to relate the findings of psychoanalysis to the social sciences in order to elucidate the mutual interactions between culture and disturbances in personality. Among these, Erich Fromm and Karen Horney (*q.v.*) have considered neurotic conflict to be primarily the result of reactions to social institutions.

One type of social organization or ethnic group may encourage neurotic responses either by its own nature or by its mode of relating to a larger group. Attitudes toward class position, urbanization, sharp transitions in prevailing social codes. and prejudicial attitudes toward minority groups affect the development and content of neuroses. It is well established that social position affects to a large extent the type of treatment a neurotic patient will seek for his illness.

Constitution.—Although psychiatry does not deny the significance of heredity. this factor is not credited with the overwhelming importance attached to it prior to the 20th century. A therapeutically oriented psychiatry is inclined to minimize hereditary influences and to deal more with experiential factors subject to observation and change.

Parental Attitudes and Early Childhood Experiences.—These are considered to play a critical role in the development of faulty patterns of neurotic interaction. The experiences of the child in the family setting determine to a large extent the subsequent personality development.

An attitude of love. acceptance and security in the family tends to foster healthy behaviour patterns. Inconsistency, rejection and deprivation tend to create areas of vulnerability which may become sensitized in later life.

Oedipus Situation.—The parental attitudes and the constitutional predispositions converge at the time of the development of the Oedipus complex (*see* PSYCHOANALYSIS) to create the basic personality pattern with which the person handles situations of stress subsequently. At the ages of three to five, the child begins to develop a close. positive bond with the parent of the opposite sex and to resent and feel jealousy toward the parent of the same sex. If the previous relationships with the parents have been relatively nontraumatic, and if the parental attitudes during this stage. cnlled by Freud the Oedipus situation, are not excessively prohibitive or stimulating, this phase of development is passed through harmoniously. Should trauma occur, regressive techniques which have been found useful in handling stress in early phases of development are again used and may become a consistent mode of handling emotional difficulties in the future. The early attempt to resolve the problems of the Oedipal situation by regression is called the infantile neurosis, and it is a forerunner of similar reactions which occur during the adult neurosis.

Following the resolution of the Oedipus complex the character structure becomes consolidated as a habitual mode of relating to situations in later life.

Precipitating Stress.—Should living provide no major frustrations, the character defenses prove adequate for adaptation and the person may then remain free of a symptomatic neurosis unless a precipitating stressful event occurs.

Inter-Relations.—The five causative factors are related to one another dialectically; that is, in order for a symptomatic neurosis to occur. one factor may be quite significant while another may not. Thus, socio-cultural factors may be of minimal importance but the parental influences may be markedly traumatic, or the resolution of the Oedipus complex may have left only minor psychological scarring while the precipitating event may present a major and insurmountable frustration.

Psychopathology of Neurotic Conflict.—The causative factors in neuroses were described above in a primarily chronological manner. The shifts in forces as they occur in the development of the adult neurosis can be understood as a retracing of a similar sequence.

The precipitating event is the actual life stress uith nhich the person has difficulty in coping. It may be either a temptation or frustration. and the stress itself may penetrate consciousness only dimly. Following a period of unsuccessful attempts at adaptation through fantasy or action, a regression to earlier adaptive pattern occurs. 'Ihe patterns, which resernhle the infantile neurosis, were a source of gratification in early life and are thus called into play to help the person adjust to the immediate stress.

Such regressive maneuvers consume great energy, since the struggles are worked out on an unconscious level. Much effort is expended in keeping the nature of the conflict removed from awareness. because the original wishes and impulses which make up the content of the primary conflict were and continue to be highly unacceptable to the self. The apparently irrational quality of the adult neurosis thus is due to the fact that the mechanisms used to handle psychological stress, though appropriate to the unique childhood situation, are not suitable for adult life. The extent of the neurotic disability is determined by the amount of energy expended in keeping repressed and inactive the impulses which strive toward fulfillment.

The symptom itself is a symbolically expressed compromise of the conflict between unacceptable impulses and prohibitive restraints, permitting partial expression for both opposing forces.

Neurosis, Normality and Psychosis.—The distinction between normal and neurotic expression is not so great as is commonly believed. It must be realized that all persons share similar childhood experiences, and the repression of primitive impulses by the ego is a universal phenomenon in human development. Thus there is a potentiality for a neurotic reaction in most so-called normal persons, and it is likely to arise when the environment presents to the person a stress which stimulates his unique vulnerability.

In most instances. however, such neurotic reactions are not clinically significant, because they are either socially acceptable, psychologically rationalized as idiosyncrasies, or transient in appearance so that they appear as trivial occurrences such as dreams, errors or slips in speech.

The differentiation between neuroses and psychoses is more meaningful. though here too it is frequently difficult to make a rigid and meticulous distinction. For legal. social and therapeutic purposes, many psychiatrists feel a distinction is justified. In the psychoses the degree of social disorganization and loss of contact with reality is of major proportions. In contrast to the neuroses, the inner assessment of external reality in the psychoses is greatly impaired. and reality is imbued with attributes which are projections of inner experiences. The neurotic, unlike the psychotic, does not form delusions or hallucinations, nor does he engage in forms of thinking n-hich are bizarre and grossly illogical. The distinction is greatest in the area of social adaptiveness. The neurotic is often able to continue to function within the social unit, and others may remain unaware of the extent of his suffering.

The psychotic, on the other hand. is much more obviously a misfit, a threat to himself or to others, and markedly dissimilar in attitude and action to those around him. This does not imply that the criteria for diagnosis are social and cultural, although it is frequently stated that a particular reaction which appears in one social group as extreme deviance may be positively sanctioned and accepted in another. Though cultural relativity must be taken into account, the differentiation between neuroses and psychoses is ultimately made on the basis of the inner psychological attitudes and behaviour.

TYPES OF PSYCHONEUROTIC DISORDERS

Most classifications of neurotic disorders have been inadequate because of the multiplicity or' causal factors, the general overlapping of clinical syndromes and the changing historical aspect of the neurotic illness. Whereas in the 19th century massive hysteria involving major bodily dysfunction was a common type of psychiatric illness, by the middle of the 20th century it had largely disappeared as a clinical entity, and most neurotic illness appeared to be based on disorders in character structures and personality types. Though a tendency to classify on the basis of predominant symptom complexes remained, symptomatic manifestations were found to be secondary to defects in total personality development.

In 1952 a standard nomenclature was adopted by the American Psychiatric association. Neurotic disorders and personality disorders were differentiated largely on the basis of clinical clustering rather than on the basis of etiological antecedents.

In the standard nomenclature the psychoneurotic disorders are classified as follows: (1) anxiety reaction, (2) phobic reaction, (3) dissociative reaction, (4) conversion reaction, (5) obessive-compulsive reaction and (6) depressive reaction.

Anxiety Reaction.—Anxiety is a diffuse fear which is not restricted to definite situations or objects. It is subjectively experienced as dread, apprehension or tension and may arise in any situation in which the integrity of the personality is threatened. The anxiety is not controlled by any specific psychological defense mechanism as in other neurotic reactions. Anxiety frequently arises when there is a failure of repression of forbidden sexual impulses or aggressive urges, usually in association with major life adjustments related to shifts in vocational, interpersonal, sexual or marital adaptations. The patient is in a constant or periodic state of apprehensive expectancy. Since defense mechanisms are not brought into play to handle the anxiety, it can be considered the simplest type of neurosis from a structural point of view.

The tension is frequently expressed in the form of insomnia; outbursts of irritability, agitation, palpitations of the heart and fears of death or "insanity." These patients are frequently fatigued as a result of the excessive effort they must expend in managing the distressing fear. Occasionally the anxiety is expressed in a more acute form and results in physiological concomitants such as nausea: diarrhea, urinary frequency, suffocating sensations, dilated pupils, perspiration and hyperventilation.

Phobic Reaction (Anxiety Hysteria).—A phobic reaction resembles an anxiety reaction in that the discomfort experienced by the patient is also fear. In this condition, however, the fear is of a definite external situation. The anxiety of phobic patients has become detached from a specific inner idea, object or situation and is displaced to a symbolic idea or external situation in the form of a specific neurotic fear. The patient cannot avoid experiencing acute discomfort if he is exposed to the external situation which he fears, even though he is consciously aware that no actual danger exists. The fear actually is derived from unconscious sources, such as forbidden impulses and wishes of a sexual and aggressive nature: and is displaced to an object which is symbolic of the fulfillment of the threatening wish. The commonly observed forms of phobic reactions include fear of venereal disease: fear of small enclosed places (claustrophobia), fear of high places (acrophobia) and fear of open places (agoraphobia).

The phobic patient can control his anxiety if he avoids the phobic object or situation. If he were to carry out a phobic activity it would unconsciously mean to him that he was performing the forbidden activity and gratifying the forbidden wish. The anxiety and suffering serve as a form of self-punishment for the unconscious tendencies and impulses.

Dissociative **Reaction.**—At times a person may handle his anxiety in such a manner as to obliterate certain functions of the personality, such as consciousness or memory. Though this is essentially a neurotic disturbance, the extent of the dissociation occasionally may reach psychotic proportions.

One of the commonest of the dissociative reactions is amnesia. Dissociative amnesia is a blotting out of awareness of highly unpleasant memories. These are experiences involving great terror. as in military combat, or experiences which have aroused great shame, guilt or loss of self-esteem.

Amnesic patients frequently accept their loss of memory indifferently and casually, indicating that a valuable protective function is performed by the reaction.

Dissociative reactions also are characterized by disturbances of consciousness such as dream states, stupor, coma and sleepwalking.

Such phenomena are usually preceded by strong emotional experiences and represent the wishful reliving of an unacceptable fantasy in a dramatic and colourful manner.

In the dissociative fugue there is a temporary loss of personal identity, and actions are performed which in the patient's normal state would be firmly prohibited by the conscience. The patient may protect himself against punishment by assuming a false identity, later developing an amnesia for the experience when he returns to his usual self.

Although there appears to be a conscious deliberate element in the patient's behaviour, the dissociative reactions are actually motivated and set in action by parts of the mind that do not involve conscious volition.

Conversion Reaction. — In the conversion reactions anxiety, instead of being consciously experienced either diffusely as in the anxiety reactions or displaced as in the phobias, is "converted" into symptoms involving organs or parts of the body innervated by the sensorimotor or voluntary nervous system. The symptoms serve to prevent or lessen conscious anxiety, and usually are symbolic of the underlying mental conflict. Such hysterical symptoms represent an attempt to resolve a conflict symbolically. Thus, an essentially mental content is converted into a somatic expression. To illustrate, the wish of a female patient to withhold medication from her dying father and thus hasten his death is converted into a hysterical paralysis of an arm: this partially serves to carry out the wish and also to punish the patient for entertaining the wish. The form of the conversion symptom may be determined by a somatic symptom which is contiguous to the conflictual situation. In the above example, the symptom began when the woman's arm fell asleep while she watched over her father in his illness.

Persons with a hysterical type of personality are prone to self-display and dramatic behaviour. Many are adept at ruling others directly by bids for sympathy or attention or indirectly by frightening others or by appearing pitiful and appealing. Egocentricity, predilection for fantasy and day dreaming, emotional liability and suggestibility are predominant character traits.

The physical symptoms may be either sensory or motor. Among common sensory symptoms are pain, anesthesias, numbness and such disturbances of the special senses as blindness or deafness. The symptoms are found to have a specific symbolic relation to psychologic conflict, and they differ from organic disturbances by revealing absence of neurological findings upon physical examination. The motor disturbances — common among them paralyses, tics, tremors, inability to speak (aphonia) and writer's cramp— also occur without demonstrable physiological or anatomical change.

• The patient with a hysterical conversion reaction may utilize the symptom to provide himself with secondary gratifications. The secondary gain is the material, emotional and social advantage contributed by the symptom. The presence of the symptom permits a self-justifiable escape from anxiety-provoking life situations. The symptom also provides dependent satisfactions of a regressive nature as a result of the sympathy with which the sick are frequently treated.

The successful conversion reaction, like the dissociative reaction, is accompanied by a marked absence of anxiety or conscious concern. Though the disability may mobilize concern in others, the patient may appear tranquil and content. See also HYSTERIA.

Obsessive-Compulsive Reaction. — .In this reaction the anxiety is associated with the presence in consciousness of unpleasant and morbid thoughts or repetitive impulses to perform apparently meaningless and ritualistic acts. Although the patient may regard his ideas and behaviour as unreasonable, he is unable to control them. Either the obsessive thought or the compulsive ceremonial may arise singly or both may appear in sequence. The patient. regularly repudiates the distressing thoughts, which are often highly repugnant and concerned with violently aggressive or sexually perverse impulses. However, the more he struggles to dispel his thoughts, the more insistently do they intrude. Great fear may be associated with such ruminations, and a ritualistic act frequently serves as an attempt at mastery of the fear. Although patients may fear that they are likely to act out the disturbing impulses. an obsessively neurotic patient almost never carries out the thought against which his conscience rebels so strongly.

Occasionally the preoccupations may be with absurd trivialities or circular speculations on abstruse religious or philosophical issues.

The personality of obsessive-compulsive patients is characterized by inflexibility, constant doubt, vacillation and adherence to excessive standards of morality. They tend to be overconscientious and inhibited in the expression of pleasure and in the capacity for relaxation. A tendency toward checking and rechecking of the simplest acts contributes toward lack of productivity and the consumption of much energy in unprofitable and wasteful labour.

The recurrent thought may he the direct expression of a primitive impulse or it may represent a substitute or concealment for it. A further attempt to handle the guilt and anxiety associated with the impulse is provided by the compulsive act. Should the act be obstructed in some manner, the patient will experience anxiety directly. Although most compulsive rituals are rather simple — such as persistent handwashing, counting, touching or the repetition of stereotyped words or phrases — occasionally elaborately formalized and time-consunling ceremonials are necessitated. The compulsive acts are similar to the magical expiatory rituals of nonliterate societies and similarly attempt to deal with potentially threatening situations.

The predominant psychological mechanisms utilized by the compulsive patient are undoing and isolation. The compulsive act is an attempt at undoing, since the action essentially nullifies any harm the patient feels he may cause by his wishes. The mechanism has originated in early childhood and is related to the child's propensity for utilizing magical fantasies and superstitions to master disorganizing traumatic states within the developing ego. Isolation is observed in the separation of the obsessive wish from any emotional content aside from anxiety. The wish is reacted to as if it were alien to the total personality.

Depressive Reaction. — A psychotic depression is a major disturbance involving the entire personality and disrupting contact between the patient's self and external reality. The neurotic depressive reaction is a less malignant condition, which may be precipitated by the loss of a valued person, object or idea. The emotional state is characterized by melancholy, brooding, hopelessness and an attitude of self-criticism and self-depreciation. Psychological processes, such as thought, and physical activity are retarded. There is a lack of initiative, curtailed concentration and preoccupation with feelings of guilt for past failures which are exaggerated beyond their just proportions.

Commonly. the depressive reaction folloms the loss through abandonment or death of someone to whom the patient was closely attached, and in this regard it resembles a normal reaction of grief; the difference resides in the prolongation and severity of the depressive reaction and the appearance of guilt and self-accusations. A neurotic reaction results when the lost or abandoned person is regarded ambivalently, that is, when intense feelings of both love and hate are experienced toward the other person, and the hatred is felt to be unacceptable and thus repressed. In depression, since guilt prevents the outward expression of rage, the hatred is turned on the self, accounting for the feelings of unworthiness and occasional thoughts of self-destruction.

Depressive feelings may arise in situations of helplessness, frustration and great loss of self-esteem. In persons who are habitually inhibited in the expression of aggressive impulses, a depressive reaction may intervene if an external situation mobilizes the expression of such forbidden impulses. In contrast to the compulsive person, who handles his guilt by rituals of expiation, the melancholic attempts to handle his guilt by turning his hostility against his own person. The more malignant symptoms which accompany psychotic depressions, such as suicide attempts, profound stupor and physical debility, are absent.

Character Neuroses. — A large group of personality disturbances in which the defect is expressed primarily in the character rather than in symptoms are described as character neuroses or neurotic characters. The patient may not suffer from any of the usual psychological symptoms such as anxiety. depression, obsessions or compulsions, but instead may manifest generalized pathological patterns of action or behaviour.

The inner psychological problems are expressed in interaction with the environment rather than in symptom formation.

TREATMENT

The treatment of the neuroses takes two main forms: it is directed either toward the alleviation oi environmental pressures or toward effecting changes within the person which allow him to cope with his external and internal conflicts more suitably.

In the acute traumatic neuroses environmental manipulation is the most desirable treatment. Temporary removal from the scene of battle during combat is effective for many in whom the neurosis was primarily a reaction to a stress of overwhelming magnitude.

Treatment directed toward the individual may be either somatic or psychological. Somatic treatment is essentially symptomatic, in that no attempt is made to eradicate the roots of the psychoneurotic condition. Therapy is directed toward ameliorating the discomfort associated with the symptoms through the use of sedation, postural relaxation or pharmacological tranquilizing agents. The symptoms frequently recur when somatic treatment stops.

Psychotherapy is an attempt to deal with the patient through psychological means either through the use of reassurance and suggestion or through the provision of insight and understanding of the conflicts. In both forms of psychotherapy the essential vehicle is the communicative potential of the doctor-patient relationship. Psychoanalysis is the most thorough form of insight psychotherapy, and various modifications of psychoanalytic techniques and principles are commonly used in the treatment of the neuroses.

See also DEFENSE MECHANISMS; EGO; PERSONALITY; PSYCHIATRY; PSYCHOANALYSIS; PSYCHOLOGY, ABNORMAL; PSYCHOTHERAPY.

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NEUROSES, EXPERIMENTAL are complex behavioural disturbances in animals produced experimentally by behavioural methods as opposed to direct assault on the nervous system by drugs, poisons, brain lesions or other physical or chemical agents.

Historical **Background.**—The first experimental neuroses were discovered by accident. During the normal course of his research on conditioned salivation reflexes in dogs, I. P. Pavlov occasionally noted that the general behaviour of an experimental subject might change radically. A previously manageable and co-operative dog would become unmanageable and unco-operative. Changes in behaviour were dramatic and included frequent vocalizations, restlessness or inactivity. avoidance of the experimental situation and everything associated with it. insomnia or somnolence and loss of appetite. Also noted were a number of physiological symptoms including changes in heart rate: breathing rate and changes in the frequency of elimination functions. Symptoms varied depending on the dog.

The following description of the onset of an experimental neurosis illustrates the profound changes in behaviour that typically occurred. In the experiment reported, the dog was being trained to salivate n-hen a luminous circle was projected onto a screen (directiy in front or' the animal) and not to salivate n-hen an ellipse was shown. This training was accomplished by giving the dog a small quantity of food whenever the circle appeared but withholding the food whenever the ellipse was presented. Eventually, the animal learned to salivate when the circle was presented and not to salivate when the ellipse was shown. After this differentiation had been established, the shape of the ellipse was approximated by stages to that of the circie by changing the ratios of the semiaxes until the ratio 9:8 was reached. At this point the differences between the circle and ellipse were so minimal that the ability of the animal to tell ihe difference between them practically disappeared; *i.e.,* the animal's discriminating ability became severely taxed. The animal's behaviour soon changed drastically. Pavlov wrote

> After three weeks of work upon this differentiation [*i.e.,* ellipse 9:8 versus circle] not only did the discrimination fail to improve, but it became considerably worse, and finally disappeared altogether. At the same time the behavior of the animal underwent an abrupt change. The hitherto quiet dog began to squeal in its stand, kepi wriggling about, tore off with its teeth the apparatus for mechanical stimulation of the skin, and hit through the tubes connecting the animal's room with the observer, a behavior which never happened before. On being taken into the experimental room the dog now barked violently, which was also contrary to its usual custom; in short it presented all the symptoms of a condition of acute neurosis. On testing the cruder differentiations they also were found to be destroyed, even the one with the ratio of the semi-axes 2:1. *(Conditioned Reflexes, p. 291,* Oxford University Press, London, 1927.)

In addition to difficult discriminations Pavlov found that sudden changes in the experimental procedure or the use of painful stimuli might also cause similar behavioural disturbances.

Pavlov's choice of the term neurosis was unfortunate. As pointed out by H. S. Liddell, F. A. Beach and others, the term implies that behavioural disturbances in animals are analogous to behavioural or psychic disorders in man. Although a few investigators believe that such is the case, most are unwilling to make such an assumption. The general consensus is that much more compelling evidence is needed to establish the hypothesis that animal and human "neuroses" are fundamentally the same; a position that such is the case is more an act of faith than anything else. Theorists believe that human neuroses are largely dependent upon the distortion or breakdown of symbolic processes—higher mental processes that are responsible, among others things, for thinking and language development.

The difference between man and animal in symbolic abilities is tremendous. Although similar to lower animals in physiological make-up, man is probably millions of "psychological light-years" removed from the highest animal in symbolic abilities. One author commented that he had yet to observe an animal attempt to solve its "neurosis" by assuming the personality, language and demeanour of Sapoleon.

Pavlov's subsequent descriptions of behavioural disorders in other dogs. together with an enumeration of some of the variables that affected such responses. established the first meaning of the term "experimental neurosis"—its historical or classical meaning. For Pavlov, an experimental neurosis was said to exist when the animal's performance in the conditioning situation changed so that previously learned conditioned reactions were disrupted and the animal became more or less incapable of further use as an experimental subject unless given a vacation or unless other steps were taken to reduce its aversion and resistance to the conditioning situation (*e.g.,* injections of bromide had a beneficial effect on some dogs).

Once a neurosis had occurred the animal's disturbances were not confined to the laboratory but might also be observed in his pen and in his relations with humans or with other animals. Also, once established, a neurosis might last a week, a month or even years in the absence of remedial treatment.

Pavlov identified two types of neuroses, inhibitory and excitatory, distinguished from each other in terms of the performance of the animal in the conditioning situation. A failure to respond to the conditioned stimulus altogether (as in the case reported above) identified an inhibitory neurosis. Conversely, a tendency to respond to *any* change in the environment—that is, to respond at the slightest provocation—identified an excitatory neurosis.

Since Pavlov's classic studies, the meaning of the term experimental neurosis has changed greatly. It has been applied, both as a descriptive and as an explanatory concept: to widely divergent forms of behaviour (possibly sharing some common elements, however) observed in a great many species (*e.g.,* sound-induced convulsive seizures in rats and aggressive resistiveness in the pig). Such an extension in meaning has been an almost inevitable consequence of the great world-wide interest in animal behavioural disturbances that followed Pavlov's pioneering studies, and the hundreds of research studies that resulted. Because of this extension in meaning, however, the term has acquired an omnibus character. and the establishment of defining criteria acceptable to most workers in this area has not been possible. Accordingly, the term experimental neurosis has tended to fall into disuse in favour of purely behavioural descriptions of less complex experimentally produced changes in emotional (and other forms of) behaviour.

In effect. researchers have tended to analyze experimental neuroses into simpler, more conceptually manageable component parts, and to study these parts intensively in the laboratory. Experimental techniques uniquely suited for producing select symptoms at will have been developed, and factors influencing rather limited but well-defined behavioural disorders continue to be investigated in a variety of disciplines. Studies of conditioned emotional responses of the fear or anxiety variety, conditioned avoidance responses, conditioned reactions to punishment, conditioned conflict behaviour, conditioned physiological reactions and studies of body damage resulting from psychological or physiological stress have largely replaced the broader study of experimental neurosis.

Nevertheless, as pointed out by R. W. Russell and Liddell, the term experimental neurosis is important because of its historical significance and because later observations of experimentally produced behavioural abnormalities in animals may be referred to the systematic writings of Pavlov on this subject. Also, a number of investigators have continued Pavlov's classical methods for studying experimental neuroses in animals.

Extensions of Pavlov's Work.—W. H. Gantt, at the Johns Hopkins university. and Liddell, at Cornell university, continued and extended Pavlov's work in the United States. They and their co-workers, after about 1930, worked to verify Pavlov's findings and to investigate further the variables that influence classically defined experimental neuroses and associated conditioning phenomena in a variety of mammals.

Gantt thoroughly investigated the visceral and autonomic conditioned reactions (mostly heart rate, respiration, sexual functions) that accompany motor or salivary conditioned responses in dogs. He studied these reactions—their onset, course and duration—for periods ranging from 5 to 14 years in dogs. One important consequence of Gantt's research is the finding that heart rate is a much more sensitive indicator of conditioning effects than overt emotional reactions or conditioned motor or secretory responses. Not only were conditioned increases in heart rate established sooner, but also they continued to occur in many subjects long after overt emotional, salivary or motor components had been extinguished (in one case, even after an 18-month vacation from the experimental regimen).

Another important finding was that neurotic symptoms not previously observed might occur several years after the original behavioural trauma Gantt reported spontaneous sexual erections in a dog, for example. both in the sound-proof enclosure in which the dog was placed for conditioning or observation and at the country retreat where the animals were taken for periods of rest and vacation. This symptom (as well as very frequent urination) became most pronounced about two years after the main experimentation had been completed, and frequently appeared whenever an event reminiscent of the early conditioning procedure occurred (*e.g*, the appearance of Gantt at the country retreat).

Liddell extended pavlovian conditioning methods to other mammals He and his co-norkers studied experimental neuroses in the goat, sheep, rabbit and pig as well as in the dog, but the sheep was his standard experimental subject. After preliminary attempts to establish conditioned salivation in sheep and goats, he abandoned this procedure in favour of the defensive leg-flexion conditioned reflex.

In this procedure a signal, usually a sound or light, is turned on for a few seconds before the onset of a momentary mild shock to a foreleg of the animal. The signal and shock are terminated together. Eventually, leg-flexion, which initially occurs only at the moment that the shock is given, begins to occur at the moment the signal is turned on. At this point the animal is said to have acquired a conditioned leg-flexion reflex.

Liddell has emphasized the mildness of the shock, which, he indicates, is barely perceptible to the human hand. Although the animal starts slightly when the shock is delivered, it soon quiets down. Using this procedure Liddell has produced marked behavioural deviations in his subjects. The animals develop highly stereotyped responses which vary widely from somnolence dnd immobility to hypersensitivity and overactivity, both in and out of the experimental situation. "Neurotic" sheep will occasionally lose their gregarious tendencies and stray away from the main flock. In at least one case this tendency caused the death of an animal. which, separated from the main flock, fell victim to maurading dogs.

The relative nonsignificance of the level of shock used by Liddell is illustrated by control experiments in which sheep were subjected to the same procedures known to produce abnormal behaviour in this species, with the difference that the conditioned stimulus or signal was omitted. Under these conditions the sheep did not become neurotic. That is, if the sheep were spared from having to listen to or see the conditioned stimulus (sound or light) they did not become behaviourally disturbed by the shock, even after hundreds of trials.

This does not mean that the animal would not eventually become neurotic, however. if shocks were given indefinitely. More than anything else, Liddell's findings demonstrate that very specific conditioned stimuli (*e.g.,* a tone) result more readily in neuroses when paired with mild shock than do very diffuse conditioned stimuli (*i.e.,* features of the experimental room, the time of day, persons present during conditioning, etc.). If a neurosis were established to such a diffuse conditioned stimulus, however, it undoubtedly would be a much more pervasive one and much more difficult to remedy. This expectation is in line with other research which has shown that emotional behaviour that is conditioned to a diffuse, ambiguous stimulus situation lasts longer and is harder to eradicate than are behavioural disorders that are conditioned to a clearly defined conditioned stimulus (*e.g.,* a light or tone).

Liddell emphasized the temporal relations between the various phases of the conditioning procedure in the production of experimental neuroses. Two types of reproducible abnormal responses that are dependent upon the duration of the interval between trials have been observed in sheep and goats. The first is a forced extensor rigidity of the foreleg to which the shock electrodes are taped; this symptom occurs when a regimen of ten conditioning trials each day. separated by two minutes each, is employed. The second type is an increase in the number of leg flexions, beginning with the onset of the conditioned stimulus and continuing until the shock is delivered; this symptom is seen when the same number of daily trials is given (*i.e.,* ten) but the interval between trials is extended to seven minutes. The first case was likened by Liddell to Pavlov's inhibitory neurosis, the latter to Pavlov's excitatory neurosis.

Other Approaches.—?;. R. **F.** Maier, B. W. Lichtenstein and J. H. Masserman among others, produced atypical responses in rats, cats. dogs and monkeys using conditioning methods other than those of Pavlov.

Maier trained rats to jump across a space to one of two distinctive stimulus cards in order to receive a food reward. If the animal jumped to the correct card. the card fell over and the animal landed on a platform where a piece of food was found. A jump to the incorrect card resulted in a bump on the nose (the incorrect card was locked in place) and a fall into a net below. The correct card was changed from right to left, at random, to prevent the animal from learning to jump always to one side.

The animals readily learned to jump to the correct card. Then the procedure was changed so that the previously correct card was locked in place during 50% of the trials, randomly determined. With this change in procedure a jump to the card previously designated correct resulted in a bump to the nose and a fall into the net on half the trials. After a few trials with the changed procedure, the animals showed great hesitancy before jumping, and eventually stopped jumping altogether.

Maier then forced the animals to jump by directing a jet of air at them, or by applying an electric current to the stand. Under these conditions the animals soon developed abnormal jumping responses, punctuated by stereotypy, and some animals showed violent running fits (after leaping to the floor instead of jumping to a card), or convulsive seizures.

Maier argued that the "neurotic" seizures of his rats were caused by the conflict engendered in them when forced to make a choice in the unsolvable choice situation. Although conflict may play a role, C. T. Morgan, F. W. Finger and J. Wolpe are unconvinced of the necessity of a conflict formulation. Morgan, for example, produced similar convulsions in rats by exposing them to the sound frequencies produced by a hissing air stream, in the absence of any conflict.

Lichtenstein and Masserman produced feeding inhibitions in dogs, cats and monkeys. The procedure involves shocking or blowing a stream of air at the animal or exposing it to a "psychologically traumatic" stimulus at the moment food is taken. A psychologically traumatic stimulus is a fear-arousing but physically innocuous stimulus. Monkeys, for example, are afraid of toy snakes. When a feeding inhibition is established, the animal refuses to eat in the experimental situation, even though he may be intensely hungry. The animal may also refuse food in its home cage.

The most striking result of Lichtenstein's experiments was the alleviation of the learned feeding inhibition in dogs by prefrontal lobotomy. The inhibition was reconditioned after the operation and alleviated again by a cut posterior to the first one. Finally, the response was again conditioned and alleviated once more after a third sectioning of the forebrain.

The extensive and systematic work of Masserman on experimental neuroses in cats, dogs and monkeys cannot be reviewed because of space limitations. The reader is referred to his monograph listed in the bibliography. In brief, Masserman's work emphasized the role of motivational conflicts, or conflicts between basic needs of the animal, as causative factors in the development of experimental neuroses. His dynamic formulations reflect his psychoanalytic orientation and are couched in terms to make them applicable to human as well as to animal behavioural disorders. The need for a conflict formulation, however, is not established. Wolpe showed that the same sort of behavioural disorders reported by Masserman may be produced by shocking cats or directing air at them, even though these disagreeable events are never associated with eating or food getting.

Theories About Causes.—Many theories attempt to explain experimental neurosis. Perhaps the most frequently quoted are those of Pavlov, Gantt and Liddell.

Pavlov believed that behavioural disturbances in both man and animal are caused by a conflict between cortical processes of excitation and inhibition which, under normal conditions, are kept in balance. His theory can be understood best perhaps, in the terms of a conditioning experiment.

In the circle-ellipse experiment quoted above the cells of the salivary gland presumably were stimulated (ultimately) by cortical brain cells whenever the circle was presented: this stimulation defined a cortical excitatory process. Secretion of saliva presumably was inhibited whenever the ellipse was presented: this defined a cortical inhibitory process. When the stimulation entering the central nervous system from the circle and the ellipse became so similar that both excitatory and inhibitory processes tended to be aroused simultaneously (*e.g.,* when the semiaxes of the ellipse were in the ratio of 9:8), the pronounced conflict between these processes became too much for the animal's nervous system, and experimental neurosis resulted.

Cortical conflicts might occur also, Pavlov believed, if either excitatory or inhibitory processes became overstrained. Excitatory overstraining might occur if conditioned stimuli of greater intensity than normal were introduced during a conditioning experiment; inhibitory overstraining, if the animal were forced to wait longer than usual for a reinforcement—*e.g.,* food during salivation experiments. (A reinforcement is an object or event that causes an unlearned response or reflex to be elicited; see ANIMAL BEHAVIOUR.)

Gantt enunciated two principles that he considers fundamental for understanding the causes of experimental neurosis—principles evolved from his intensive, long-term study of individual dogs, lasting from 3 to 14 years in some cases. The first he terms schizokinesis and the second autokinesis.

Schizokinesis refers essentially to the animal's propensity to over-react, autonomically, during the process of acquiring adjustive reactions (*e.g.,* conditioned responses). Thus, Gantt considers as pathological the persistence of conditioned heart rate responses long after overt conditioned reactions have disappeared. He suggests that other autonomic effects associated with conditioning (such as increased stomach acidity and the release of adrenalin by the adrenal medulla) may disturb the normal functioning of the organism and pave the way for later behavioural pathology.

In this connection, scientists at the Walter Reed Army Medical Research centre reported that monkeys trained to press a lever in order to postpone a regularly scheduled mild shock to the feet developed stomach and duodenal ulcers. "Yoked" control monkeys that received an identical sequence of shocks, but did not have to go through the conditioning procedure (apparently stressful), did not develop ulcers. The close positive relationship between stomach secretions and stress have been regularly emphasized by other investigators.

The term autokinesis refers to another organismic propensity which further contributes to the formation of behavioural disorders. This is the tendency for earlier traces of long-past incidents to undergo dynamic change in the nervous system (to ferment, as it were) and eventually make their presence known as new symptoms which may appear years after the original disturbance. Unlike schizokinesis, however, autokinesis may also work in favour of the organism. Gantt suggests that autokinesis may be responsible for long-term effects of therapeutic efforts which may not be visible in the short run.

Liddell's theory emphasizes the strains and stresses of the conditioning situation itself as instrumental in causing experimental neurosis. He was greatly impressed by the resistance of his animals to the Pavlovian conditioning situation. He sees the whole conditioning procedure as stressful, constantly taxing the nervous system of the animal, forcing it to maintain a state of readiness or vigilance. This state has been compared to what H. Selye termed the alarm reaction, the first stage of the organism's physiological response to stress. The restriction imposed on the animal by the chamber and restraining harness used during conditioning, and the animal's self-imposed restriction in attending and responding to the monotonous and regular conditioned signals? inevitably followed by relatively inconsequential amounts of shock or food, are the sources of its neurosis, according to Liddell. He suggests that the conditioned signal triggers innate, tense, preparatory reactions in the animal (*i.e.,* vigilance) which, in the animal's natural environment, prepares it for fight or flight.

In the conditioning situation, however, in which the "danger" for which the animal's nervous system is prepared is inconsequential, however, this repeated triggering of the vigilance reaction, trial after trial, day after day, month after month, has an accumulative effect on the nervous system, Liddell suggests, which accumulation eventuates in disturbed, abnormal behaviour.

Gantt's and Liddell's theories point up the reality and primacy of autonomic conditioning, and the effects of monotonous provocations, respectively, in the causation of abnormal animal behaviour. The degree to which these findings may be generalized to man, however, remains an open question, which further research will settle.

Many other theories have been proposed to explain experimental neuroses, both as classically defined by Pavlov and as defined by some of the later workers. Space limitations, however, do not permit an adequate review of these theories (*see* articles by Liddell, Russell and Wolpe listed in the bibliography for a review of the most important of them). Notwithstanding the extant theories, however, most workers in the area of emotional behaviour agree that a better understanding of the more elemental emotional reactions of animals (*e.g.,* conditioned "fear," conditioned avoidance behaviour, conditioned punishment reactions, etc.) must precede a better understanding of a phenomenon as complex as experimental neurosis, however defined. Happily, the investigation of such simpler emotional reactions is being vigorously pursued in many behavioural laboratories. See also CONDITIONING; NEUROSES; PSYCHOLOGY, EXPERIMENTAL.

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NEUSS, a town in the *Land* of North Rhine-Westphalia, Germany. 4 mi. W. of Diisseldorf and 1½ mi. from the west bank of the Rhine, with which it is connected by the Erft canal. It lies at the junction of lines to Cologne, Viersen, Zevenaar (the Netherlands), Diisseldorf, Diiren and Rheydt. Pop. (1950) 63,478, of whom the majority were Catholics.

Neuss, the *Novaesium* of the Romans, mentioned by Tacitus, formerly lay close to the Rhine. Drusus, brother of the emperor Tiberius, threw a bridge across the Rhine here. and his name is preserved in the Drusustor, the lower half of which is of Roman masonry. In 1474–75 Charles the Bold besieged the town in vain for 11 months, but it was taken and sacked by Alexander Farnese in 1 j86. Extensive excavations have been made and many Roman treasures have been unearthed.

The church of St. Quirinus is a fine example of the transition from the Round to the Pointed style. The town hall was built in the 17th and altered in the 18th century.

NEUSTADT AN DER WEINSTRASSE, a town of Germany, in the Rhineland-Palatinate, under the eastern slope of the Haardt mountains and at the mouth of the valley of the Speyerbach, 14 mi. W. of Speyer, and at the junction of railway lines to Worms, Weissenburg and Kaiserslautern. Pop. (1950) 26,764.

Neustadt is one of the centres of the Rhenish grape cure. It does a large trade in wines.

NEUSTRELITZ, a city of the German Democratic Republic, in the Neubrandenburg district, situated 60 mi. N. of Berlin, on the railway to Stralsund. Originally a settlement around the new ducal castle (built in 1710), it became a city in 1759. Until 1918 it was the capital of the grand duchy of Mecklenburg-Strelitz. A machinery manufacturing centre, the city suffered heavy damage during World War II. Pop. (1946) 24,692; (1950) 26,780.

NEUSTRIA, the old name for the western kingdom of the Franks, as opposed to the eastern kingdom, Austrasia (*q.v.*). The most ancient form of the word is *Niuster*, from *niust*, which would make the word signify the "most recent" conquests of the Franks. The word Neustria does not appear in Gregory of Tours. but is found for the first time in Fredegarius. Under the later Merovingian kings the princes reigning in the west mere called kings of Neustria, and those reigning in the east, kings of Austrasia. Under the new Carolingian dynasty, the word Seustria was restricted to the district between the Loire and the Seine, together with part of the diocese of Rouen north of the Seine; while Austrasia comprised only the Frankish dominions beyond the Rhine, together, apparently, with Mainz, Worms and Spires on the left bank. The districts between Neustria and Austrasia were called *Mediu Francia* or simply *Francia.* In 843 Brittany took from Neustria the countships of Rennes and Nantes; and gradually the term Neustria came to be restricted to the district which was later called Normandy. By a similar usage, the term Neustria was applied in Italy in the 8th century to western Lombardy.

NEUTRALITY has been defined as the legal status arising from the abstention of a state from all participation in a war between other states, the maintenance by it of an attitude of impartiality in its dealings with the belligerent states, and the recognition by the latter of this abstention and impartiality. From this legal status arise the rights and duties of neutral and belligerent states respectively. Under the conception of absolute sovereignty prevalent before World War I one state might go to war with another for a good or bad reason, or for no reason at all, and a violation of international law by one state was regarded as no concern of any other, except that immediately affected by such violation. With the creation of the League of Nations and the ratification in 1928 of the Paris pact for the renunciation of war, the concept of permissive sanctions or nonbelligerency arose. States asserted a privilege to manifest varying degrees of partiality toward the warring parties, stopping short of war, and ceased to observe the duty of impartiality. Though the United Nations charter sought to change the privilege of neutrality to a duty to support collective sanctions against aggressor states, it seemed likely that the legal status of neutrality would remain an important problem in international law.

Rights and Duties **of** Neutrals. — These may be subdivided into the rights and the duties of neutrals; and the rights and liabilities of trade. A neutral state is entitled to have the integrity of its territory and territorial waters respected by all the belligerents. Consequently, belligerents may not use a neutral's territory as a base of operations or engage in hostilities therein. The privilege of 'the inviolability of its territory is accompanied by a duty to prevent therein acts by belligerents in derogation of its sovereignty. It is entitled to use, and must use, the means at its disposal, including measures of force if necessary, to prevent within its territory the commission of any act which, if tolerated. would constitute a nonfulfilment of its neutral duty. It is also entitled to exact compliance by belligerents with its own domestic regulations, designed to maintain its neutrality and to perform its international obligations. If such regulations are enforced equally upon all the belligerents. they are not to be regarded as hostile or unfriendly. It is entitled to maintain its diplomatic intercourse with other neutral states and with the belligerents alike. except for such temporary interruptions as may be demanded by military necessity. It is entitled to offer its good offices or mediation to the belligerents with a view to the cessation of hostilities without the exercise of this right being regarded as an unfriendly act (*Hague Convention*, **I,** 1907). Finally it is entitled to require belligerents not to interfere with the commercial intercourse of its subjects, unless such interference is warranted by international law.

Duties **of** Neutral States. — The primary duty' of a neutral state is strict impartiality in its relations with both belligerents, whether such impartial conduct is obligatory or discretionary. There must not be any discrimination or preference. Even a favour granted to one must be extended to the other. A neutral state must not allow a belligerent to move troops, munitions of war or supplies across its territory or to erect or use therein wireless or other telegraphic apparatus for military purposes. It must intern belligerent forces which have taken refuge in its territory, but may leave at liberty escaped prisoners of war and permit the passage of the sick and wounded belonging to the belligerent forces (*Hague Convention*, V, 1907). It must not allow any act of war, including the exercise of visit and search or capture, to be committed by a belligerent within its territorial waters. It must release a prize so captured with its officers and crew and intern the prize crew. It must not allow a prize court to be established on its territory nor on a vessel within its territorial waters. It must not allow either belligerent to use territory or territorial waters as a base of military operations against its adversary, nor may it furnish either belligerent with troops, ships, munitions of war, money or with commodities of direct or indirect use in the war. It must use due diligence in preventing the fitting out or arming of vessels within its jurisdiction and the departure of vessels intended to engage in hostile operations; the issue of commissions by either belligerent or the enlistment of men (*Hague Convention, XIII*, 1907).

Rights and Liabilities **of** Neutral Trade. — Restraint on neutral trade with belligerents rests upon a compromise between two conflicting principles. On the one hand the subjects of a neutral state contend that they are entitled to carry on their normal trade with either belligerent, provided such trade is not directly calculated to prejudice the military operations of one belligerent, nor to promote those of the other. On the other hand a belligerent state claims that the subjects of a neutral state are not entitled to supply his enemy with commodities which are of direct and indirect use to his enemy in the conduct of the mar. Between these two contentions there have been great divergencies both in theory and practice. A state is apt to take a different view when belligerent from that which it maintained as a neutral. Rut upon onr matter there is no difference of opinion. It is generally recognized that it is for the belligerent and not for the neutral state to enforce the restraints on neutral trade; that it is the duty of the neutral state to acquiesce in such restraints insofar as they are not unwarrantable; and that the violation of such restraints by the subjects of a neutral state arc nut criminal and only involve the perpetrators in the seizure and loss of their property. The most important restraints on neutral trade are those imposed by the rules relating to blockade (*q.v.*), pacific blockade, contraband (*q.v.*), continuous voyage, convoy (*q.v.*), unneutral service, and visit and search (*q.v.*).

Neutrality in World War I.—At the outbreak of World War I the warring powers qualifiedly announcetl their acceptance of the rules of naval warfare as laid down in the Declaration of London of 1909 hut subsequent modifications of the declaration in practice eventually rendered it insignificant. The U.S. government accordingly took the position that it would in any event demand that its rights under existing rules of international law and treaties be respcctcd. Resort by the German government to the laying of mines and submarine warfare and by the British government to a system of blockade, rationing, requisitioning and black lists resulted in a vast disruption of neutral rights of trade. The loss of life as well as of property caused by Germany's methods of naval warfare finally led to U.S. intervention on behalf of the Allies.

Basic Concepts of Neutrality.—The developments in neutrality occurring between World War I and World War II were concerned with n-hat had hitherto been regarded as two essential characteristics of neutrality: its voluntary and its absolute quality. First, it was conceived to be a voluntary status in the sense that each state had the sovereign right to abstain or to take part in the hostilities as it might see fit. Second, it was conceived to be absolute in the sense that the neutral state must refrain from any form of participation in the hostilities and any manner of assistance to one of the belligerents.

Neutrality as a Voluntary Status.—In his war message of April 2, 1917, Pres. Woodrow Wilson declared that "neutrality is no longer possible or desirable when the peace oi the world is involved and the freedom oi its peoples." The council of the League of Nations amplified this thought in Sept. 1920, when it said: "The idea of neutrality of members of the League of Nations is not compatible with the other principle that all the members of the League will have to act in common to cause their covenants to be respected." The members, subject to certain qualifications. solemnly agreed not to resort to war. From this fact arose the question as to whether the obligation to apply sanctions to a member who had resorted to mar in disregard of its covenants made the status oi neutrality impossible for League members. The assembly concluded on Oct. 4, 1921. after a study of the question, that "the unilateral action of the deiaulting state cannot create a state of war; it merely entitles the other Members of the League to resort to acts of war" against the covenant breaker. The members were not compelled to take such action; each member could "decide for itself whether a breach of the Covenant has been committed." The Pact of Paris of 1928 raised the problem whether non-League members who had signed or adhered to the treaty were thereby precluded from assuming the status of neutrality upon a violation of the treaty by another state party thereto. I: was generally felt, however, that the pact did not eliminate neutrality and that each state was privileged to decide for itself whether or not it would ignore a breach of the treaty.

Doctrine of Permissive Sanctions.—A group of jurists, sometimes referred to as the sanctionist school, developed the view that the covenant of the League and the principles of the Pact oi Paris. if they did not create the duty, at least created the privilege to discriminate against aggressors. It was advanced that those states who had resorted to war in breach of their treaty obligations were no longer entitled to claim the benefits of impartial conduct as against third parties. Nonbelligerents who had suffered such a breach of treaty obligations were permittecl to apply sanctions short of mar against the aggressor; the former obligation to be neutral, *i.e.*, impartial, no longer applied. The International Law association, meeting in Budapest, Hungary, in 1934, suggested that a state resorting to mar in violation of the pact could not require from other parties thereto observance of the traditional obligations of neutrality. In other words, as between parties to the pact, a nonbelligerent mas free, though not obliged, to refuse to a violator of the pact the benefits of impartial treatment.

U.S. Neutrality Legislation Prior to World War 11.—The obligations of a neutral state under international law are the same for all nations. A number of nations. including Great Britain, the United States and France, have endeavoured to enforce their obligations under international lam through their municipal statutory penal law. This statutory law in the United States is known as the "neutrality laws." In Great Britain the statutory provisions are found in the Foreign Enlistment acts. Such domestic legislation may impose more stringent obligations than those required by international law. In the neutrality legislation of the United States in 1935 and 1937, and to a lesser extent in 1939, a more severe standard of neutral conduct was imposed.

The United States neutrality legislation of the 1930s was a complex of the vicars of three schools of thought. It was the view of the noninterventionist or isolationist school that war could be avoided by avoiding rconurnic and other contacts with those engaged in hostilities. This view resulted in the embargo and rash-and-carry provisions of the 1937 act whereby (1) the president was empowered, through proclamation, to make it unlawful to export arms. ammunition and implements of war, as determined by him, to the belligerent states named by him, and (2) other trade with the belligerents could be prohibited by the president unless title to the goods was first transferred to the belligerent and the belligerent transported such goods in other than U.S. ships.

The sanctionist school, with its view that impartiality was no longer obligatory as against an aggressor, succeeded to a certain extent in granting discretionary power to the president in enforcing the act by making its operation dependent on a finding that a state of war existed, a discretion which Pres. Franklin D. Roosevelt used in the Chinese-Japanese conflict by failing to make such a finding.

The traditional school oi neutrality sought to preserve the requirement of equal and impartial treatment to both belligerents. The Neutrality act approved Nov. 4, 1939. relaxed the embargo on arms, ammunition and implements of war and permitted any foreign transieree of title to remove its own acquisitions of such munitions from U.S. territory. It also empowered the president to proclaim the existence of combat areas into which U.S. citizens or vessels might not enter. The cash-and-carry and the combat area provisions were eliminated by an act approved Nov. 17, 1941, just prior to the attack on the United States at Pearl Harbor.

Transfer of Destroyers to Great Britain.—With the growing success of the axis powers in 1940, the United States was confronted with the question of whether maintenance of its traditional neutral attitude of impartiality would not result in the fall of Great Britain and impair the ability of the United States successfully to defend itself. Accordingly, pursuant to an executive agreement of Sept. 2, 1940, 50 over-age U.S. destroyers mere transferred to Great Britain in exchange for leases of valuable naval and air bases on British territory in the western hemisphere. Though some opinion sought to justify the transfer as a permissive sanction against an aggressor, other U.S. authorities considered it clearly to be "a violation of our neutral status, a violation of our national lam, and a violation of international law."

Lend-Lease Act.—The continuing successes of the axis powers in World War II led to the enactment by the United States on March 11, 1941, of the Lend-Lease act, whereby the president mas given full discretion to determine that the defense of any specific country was vital to that of the United States. The president was authorized to manufacture in government arsenals, factories and shipyards, or otherwise procure, deiense articles for the government of any such country, "and to sell, transier title to, exchange, lease, lend or otherwise dispose of, to any such government any defense article." The requirements of self-defense and the doctrine of permissive sanctions were used to justify this otherwise manifest departure irom traditional neutrality.

Freezing and Export Controls.—Beginning April 10, 1940, the freezing control of assets of countries invaded and occupied by the axis mas begun as a protective measure for such countries. On June 14, 1941, freezing control was extended to the remaining countries of Europe, including Germany and Italy, and on July 26, 1941, to Japan, thereby frankly becoming another instance of application of sanctions. This control involved the prohibition of all transactions in the property of such countries subject to U.S. jurisdiction except under licence. The ireezing control was used in conjunction with a system of export controls.

Seizure of Foreign Ships in U.S. Ports.—By act of June 6, 1941, the president was authorized to requisition any foreign merchant vessel lying idle in U.S. waters. Italian, Danish and Finnish vessels were the most numerous of those seized under this act. The effect oi all the foregoing measures was an abandonment by the United States of its traditional principles of neutrality prior to World War II and an acceptance in its place of the emerging doctrine of nonbelligerency or permissive sanctions. From the standpoint of Germany and Italy, however, they could be regarded as *causae belli,* and were mentioned in the German declaration of war as a violation of the rules of neutrality.

Declaration of Panama.— The Declaration of Panamá signed Oct. 3, 1939, by the representatives of the 21 American republics proclaimed a noncombat zone extending to nearly 300 mi. of the high seas adjacent to the western hemisphere. The measure was sought to be justified as an exercise of protective jurisdiction to protect their neutrality. The declaration was put to the test in the British victory over the "Admiral Graf Spee" off Montevideo, Uruguay. Though the American republics protested this action in a joint statement of Jan. 1940, Great Britain replied that it could not be deprived of its belligerent rights by unilateral action and that it had clearly acted within such rights when they were exercised beyond the three-mile limit.

Neutrality During and After World War 11.—World War II presented sufficient instances involving the discharge of neutral duties by Sweden, Spain, Turkey and Argentina, and as between Japan and Russia prior to the latter's entering the war against the former, that the utility of the traditional rules of neutrality was shown not to be outmoded. They did furnish a standard by which the relations between a weak neutral and a relatively powerful belligerent could be judged.

The following developments are evident in the law of neutrality at mid-20th century: (1) The total character of modern war, with belligerents using economic as well as mechanized means of warfare, has greatly diminished the traditional area of freedom of the neutral. (2) The powers of the United Nations Security council, coupled with the agreement of the members to accept and carry out its decisions (arts. 25, 48), seemingly erected a compulsory system of collective sanctions against aggressors. The threat oi the "veto" power, however, renders this largely illusory (art. 27). (3) Neutrality will disappear as a permissive legal status for whatever members of the United Nations the Security council "calls upon" or "requires" in specific instances to take military or other measures oi coercion against an aggressor (arts. 41, 48). However, in such cases the legal possibility of neutrality will not so disappear as to other members not so designated. (4) The status of neutrality will also remain possible for non-warring states if the Security council should fail to act with respect to any specific armed conflict. The existence of the "veto" renders this probable in hostilities involving the interests of any of the five permanent members. However, the United Nations charter has strengthened the legal position of such nonbelligerent nations as may wish to adopt a policy of discrimination toward an aggressor and clearly permits such a policy if the general assembly has "recommended" it (art. 11), as under the assembly's "Uniting for Peace" resolution of 1950. (5) The socialization of many national economies may result in a corresponding lessening of neutral trade. Many business enterprises which could formerly trade with a belligerent as private traders subject to the risk of capture may no longer be legally able to do so as state enterprises. (6) The emergence of a political attitude called "neutralism" in the bipolar struggle for power between the Western free nations and the Eastern Communist states following World War II is to be distinguished from "neutrality" in the legal sense.

Neutralism represents an abstention from, or independence of, this power struggle and has nothing to do with "neutrality" as a legal concept.

See also LAWS OF WAR.

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NEUTRALIZATION is a setting of limitations upon the belligerent capacities of a sovereign state, which thereupon becomes bound not to do or to suffer certain things, such as the building of fortifications or the presence or passage of armed forces in a defined area. This area is usually smaller than the whole territory of the state, but a similar situation may be created in respect of a whole state, when that state undertakes not to take part in wars except in self-defense. The resulting situation is in this case commonly called perpetual neutrality. For instance, when Austria's status was regulated by the state treaty of 1955, Austria unilaterally and voluntarily declared by a separate instrument that it would be perpetually neutral, defend its neutrality, join no military alliances and allow no foreign bases on Austrian territory. The state treaty prohibited Austria from possessing atomic and similar weapons. Neutralization agreements affect other states, if and so far as these assume obligations in the event of a breach of the agreement or if they undertake themselves to abstain from certain actions.

A state is not, of course, bound by a neutralization agreement which it has not signed, and therefore the only way to ensure complete immunity from attack is by a universally signed convention. In practice, considerations of geography and comparative power determine what signatures are necessary to make a particular agreement effective.

Neutralization, which is the outcome of agreement, is to be distinguished from neutrality (*q.v.*), which is an attitude adopted by a state at will, in face of a particular situation, and for no specifically prescribed period—as, for instance, with Sweden or the Irish republic during World War II, these states choosing to remain outside the contest.

Among islands, Corfu was neutralized upon its cession to Greece in 1863, Spitsbergen (Svalbard) and the Aland Islands were neutralized in 1920 and 1921 respectively. Norway undertook in 1920, by a convention signed by eight other states, not to build a naval base in Spitsbergen or to use it for any military purposes. Russia, which acquired the Aland Islands from Sweden in 1809, agreed in 1856, upon the instance of Sweden and other powers, not to fortify the islands or to maintain any military or naval establishment in them. After World War I Finland, to which the islands then passed, gave a similar pledge in a convention signed in 1921 in company with nine other states (excluding the U.S.S.R.); this promise was repeated in 1947 in the peace treaty with Finland.

Instruments declaring the neutrality of whole states were signed in respect of Switzerland in 1815, of Belgium in 1839, of Luxembourg in 1867 and of the Vatican city-state in 1929 (the last was signed only by the Holy See and Italy). Switzerland continued to maintain its neutrality, but Belgium abandoned that attitude after World War I and Luxembourg after World War II.

(P. J. A. C.)

NEUTRON, a particle in the atomic nucleus which has no electrical charge. The discovery of the neutron played an important part in opening the way for the development of atomic energy. Fission of the atomic nuclei of various isotopes of uranium, plutonium, etc., it was learned, could be induced by bombarding them with the electrically neutral particles. In this process, additional neutrons are released, creating the so-called chain reaction. This is the principle of the atomic fission bomb developed during World War II. Also, the released energy may be harnessed for industrial use by controlling the reaction so as to prevent it from going substantially beyond the point where the chain reaction is self-sustaining.

The neutron and the proton are now considered to be the basic building materials of which all atomic nuclei are composed. The neutron has a mass slightly greater than that of the proton.

History.—Following publication in 1911 of his concept of the atom as a structure built around a nucleus, Lord Rutherford conducted experimental studies of the atomic disintegration of light elements. In 1920, in a lecture to the Royal Society, he offered laboratory proof that the long-range particle emitted by nitrogen under bombardment with alpha rays is the proton, which is the nucleus of the hydrogen atom and part of the nucleus of all other atoms. The proton is the simplest of all nuclei, and carries a positive electrical charge.

With the discovery of this first nuclear reaction, Rutherford's nuclear hypothesis was further validated. In this connection, it should be explained that he had a theory concerning the value of theories. They were useful tools to the scientist, he said, only in proportion to the number of established facts they explained, and to the paths of fresh research they opened. In the lecture in which he demonstrated the existence of the nucleus he had postulated, he offered a further hypothesis that measured up to these conditions. The observed reactions of the proton, he said, were consistent with the supposition that it was linked with another, still undiscovered factor in the nucleus—a particle that was electrically neutral.

In 1932, Sir James Chadwick demonstrated that the radiation created when beryllium is bombarded by alpha particles consists of a stream of nuclear particles carrying no electrical charge. Rutherford's hypothetical particle, now an established fact, was named the neutron. Earlier, Frédéric Joliot and Mme. Irène Joliot-Curie in Paris had investigated a penetrating radiation emitted by beryllium when bombarded by alpha particles. They found that this radiation which had previously been interpreted by W. Bothe and H. Becker as a gamma radiation (see RADIOACTIVITY, ARTIFICIAL), was capable of propelling hydrogen nuclei (protons) with very high speed. Chadwick, after a very thorough experimental investigation of all the properties of the new radiation, came to the conclusion that it must consist of neutral particles of a mass very nearly equal to that of the proton. The major argument in this conclusion was the speed given by the newly discovered particle to various atomic nuclei in collisions.

It was soon found that neutrons, because of their lack of electric charge, are particularly effective in causing nuclear transformations (see ATOM; NUCLEUS). In 1934 Enrico Fermi and his collaborators showed that nearly every element in the periodic table may undergo a nuclear transformation when bombarded by neutrons. In very many cases, radioactive isotopes of the elements are formed in this way (*see* ISOTOPES: Radioactive *Isotopes*). Slow neutrons were found particularly effective in producing many of these transformations.

Fermi found that uranium was among the elements in which neutron bombardment induced transformations. This element was investigated in greater detail by Lise Meitner and Otto Hahn in Berlin in subsequent years. Their results were difficult to interpret, until late in 1938 Hahn and F. Strassmann found that at least one of the radioactive elements formed by bombardment of uranium was an isotope of barium. This was immediately interpreted by Otto E'risch and Meitner (also two weeks later and independently, hy Hahn and Strassmann themselves) as indicating that the uranium nucleus had Seen split into two almost equal parts, a process later called fission. 'The important technical developmerits resulting from this discovery will be described in the last section of this article.

Properties of Free Neutrons.— It is most appropriate to discuss the properties of the neutron hy comparing them with those of its counterpart in the atomic nucleus, the proton.

'The neutron, as already mentioned, has no electric charge, whereas the proton has one positive elementary charge (4.8×10^{-10} electrostatic units). This causes great differences in the passage of the two particles through matter: a fast-moving proton ejects electrons from atoms which it encounters, and thereby produces heavy ionization along its path. Because of this, the track of a proton can easily be observed in a cloud chamber. The neutron. having no electric charge, cannot produce ions but can only make direct collisions with atomic nuclei. Its track, therefore, cannot be observed; but the presence of neutrons can be deduced from the visible tracks in a cloud chamber of recoil nuclei which have been set in motion by collisions with neutrons. (See *Detection* of *Neutrons,* below.)

Another consequence of the absence of ionization is that neutrons do not lose energy so long as they do not collide with atomic nuclei. Since such collisions are very rare. a neutron travels far before losing its speed. Protons, on the other hand. travel only very short distances because they lose their energy by ionization. For instance, a proton with a velocity of 3×10^{9} cm./sec., which is the order of magnitude of the velocities common in nuclear physics, will travel about 0.005 cm. in a material such as iron or copper. A neutron of the same velocity will travel about 5 cm. before it makes its first collision with a nucleus; and since it loses only a fraction of its energy in each collision, it will continue to travel for 10 to 100 times this distance before it is finally captured by a nucleus. Neutrons are. therefore, very penetrating.

Mass.—The mass of the neutron is very nearly the same as that of the proton. In the physical scale of atomic weights (in which the isotope O^{16} has a mass of exactly 16). the mass of the neutron is 1.00898. On the same scale. the mass of the hydrogen atom is 1.00814 and that of the proton 1.00759. The neutron is, therefore, slightly heavier than the proton and even slightly heavier than the hydrogen atom (proton plus electron).

This fact has two important consequences. First of all it makes the neutron unstable and subject to beta disintegration (*see* below).

The second consequence is that the neutron cannot be considered as a proton and an electron bound together in some nay. If two particles are bound together, then, according to the Einstein relation, $E=mc^2$, the mass of the combination must be less than the sum of the masses of the parts (see *Neutrons* as *Building* Blocks *of Nuclei,* below). Therefore. the neutron and the proton have to be regarded as fundamental particles which are closely related to each other in a manner the details of which were still unknown as of the latter 1950s although hy that time much was known of the forces between them.

Spin, Magnetic Moment a726 Statistics.—Just like the more familiar fundamental particles. the electron and the proton, the neutron has a "spin"; *i.e.,* it has properties which are analogous to those of a spinning top. The value of the spin (angular momentum) is $\frac{1}{2}\cdot\frac{h}{2\pi}$, nhere h is Planck's constant just as for proton and electron. It also shares with proton and electron the property of obeying Fermi's statistics, which makes it impossible for two neutrons to he in the same quantum state. The value of the spin and the fact that neutrons obey Fermi statistics are further arguments against the interpretation of the neutron as a combination of electron and proton.

The neutron has a magnetic moment whose direction is opposite to that of its spin, as if a negative electric charge were revolving in the rotation of the spinning top. The value of the magnetic moment was measured with great accuracy and is 1.9135 nuclear magnetons. The proton has a positive magnetic moment (as if a positive charge were revolving) whose value is 2.7928 nuclear rnagnetons. The magnetic moment of the electron is negative and is one Bohr magneton (1,840 nuclear magnetons). as predicted by Paul A. M. Dirac's theory.

Bctu Decay.——According to the theory of radioactive beta decay (*see* RADIOACTIVITY, NATURAL), the process taking place is $n\rightarrow H+\beta+\nu$ indicating the formation of a proton. negative electron and neutrino respectively. This fundamental process was first observed in 1949. A. H. Snell and collaborators at Oak Ridge, Tenn., detected the simultaneous occurrence of a proton and an electron coining from the decay of neutrons in a high intensity beam issuing from the nuclear reactor (see *Atomic Energy,* below). In 1950 John M. Robson at Chalk River in Canada observed the decay of the neutron and also measured the energy spectrum of the decay electrons. In a sensitive mass spectrometer he identified the heavy particles as protons. The negative particles in coincidence with the protons were detected in a beta ray spectrometer which measured the electron energy. The observed maximum energy of the decay electrons gives a value for the mass of the neutron which compares very well with the more accurate measurements (*see* above) made from observations on numerous nuclear transmutations in which all the masses and energies, except the neutron's mass. are known.

Free neutrons decay according to the usual laws of radioactive decay. Robson deduced a value for the half life of the neutron of 13 min.. in excellent agreement with the value estimated from the theory of beta decay.

Wave Properties.—Quantum mechanics (*q.v.*) postulates that every particle exhibits wave properties with a characteristic wave length $\lambda=h/mv$, where λ is the wave length. h is Planck's constant, and mv is the momentum of the particle. Neutrons are no exception and the existence of this property gave rise to an active field of research in neutron optics. Experimental methods for obtaining monochromatic neutrons, or neutrons of a single momentum, and ways of measuring their diffraction by crystals were devised, much as X-rays (*q.v.*) were used to study crystals. Because neutrons are strongly scattered by lighter nuclei. as mentioned below, they help to disclose the part taken by light atoms in crystal lattices where X-rays are affected scarcely at all. Promising results are found in the study of magnetic substances. As the neutron has a magnetic moment but no electric charge, passage of a neutron beam through strongly magnetized iron causes the neutrons to show polarization effects not exhibited by other particle waves. A slow neutron of kinetic energy 0.13 electron volts, about five times the energy of thermal neutrons. has a particle wave length of 1×10^{-8} cm. (1 Å). The marked resonance absorption of slow neutrons appears to be closely linked with this wave nature of the neutron and its likelihood of being captured for appreciable lengths of time within the potential barrier of a nucleus.

Neutrons **as** Building Blocks of Nuclei.— According to present theory any nucleus is composed of neutrons and protons This theory replaced the older one, now completely discarded, that protons and electrons nere the building stones of the nucleus. This older theory had encountered grave difficulties For example, according to quantum mechanics. electrons cannot be compressed into such a small space as the inside of a nucleus. Additional arguments arise from the spin and the statistics of atomic nuclei, and the peculiar phenomena connected with beta radioactivity.

The proton-neutron hypothesis had however met nith considerable success by the latter 1950s and had been used to explain a number of fundamental properties of atomic nuclei. It is fairly well established that protons and neutrons inside the nucleus can be considered to conform to the laws of quantum mechanics.

According to the proton-neutron hypothesis the atomic number Z (charge) of a nucleus is equal to the number of protons contained in it. The mass number A, *i.e.*, the integer nearest to the atomic mass, is the sum of the numbers of protons and neutrons since each of these particles contributes about one atomic mass unit. The isotopes of a given element, therefore, all contain the same number of protons but varying numbers of neutrons; for instance, any isotope of the element carbon contains 6 protons, the most abundant isotope C^{12} contains in addition 6 neutrons, whereas the less abundant stable isotope C^{13} contains 7 neutrons, and the radioactive isotope C^{14} contains 8 neutrons.

Perhaps the most important information about a nucleus is provided by its exact ueight. From it the binding energy of the nucleus can be deduced, with the help of Einstein's relation, $E=mc^2$. For instance, the helium nucleus has a mass of 4.00288. Since its atomic number is 2 and its mass number 4, it contains 2 neutrons and 2 protons; the combined weight of these 4 particles is 4.03425. The difference between this and the weight of the helium nucleus represents the binding energy with which the 4 particles are held together in the nucleus. The energy represented by this mass difference is tremendous. The formation of 4 gr. of helium from 2 gr. of hydrogen and 2 gr. of neutrons would release as much energy as the burning of about 100 tons of coal.

A binding of this tremendous strength cannot be the result of electric forces; moreover, no such forces act on neutrons anyway, because of the absence of electric charge. Gravitational forces are even more inadequate to account for the tight binding. A new force must therefore be assumed which is known as nuclear force. The exact character of nuclear forces was only partially known as of the latter 1950s; but it was known that they act only over very short distances, having a range of about 3×10^{-13} cm. and being negligible outside this range. The exploration of nuclear forces is the prime objective of nuclear physics. The scattering of neutrons of various velocities by protons has given the most fundamental information about nuclear forces.

Neutron-neutron and proton-proton forces are found to be about equal within the nucleus, and there is a strong tendency for equal numbers of neutrons and protons to form the lighter atoms. In the heavier atoms, the number of neutrons exceeds that of protons. For example, uranium 238 has 92 protons and 146 neutrons; uranium 23j has the same number of protons but only 143 neutrons. The binding energy of a neutron, or the energy that must be supplied to extract a neutron from a nucleus, ranges from j to 13 Mev (million electron volts) except for some of the lighter elements.

Neutron Production.— Since the neutron is not stable and is readily captured by a nucleus (see Properties of Free Neutrons, above, and Nuclear *Reactions* Prodzaced by Neutrons, below), few neutrons are found in nature in the free state, *i.e.*, outside of atomic nuclei. Therefore, if an experimenter wishes to work with neutrons, he must produce them by means of nuclear reactions. These reactions fall into three types: (a) reactions initiated by a charged particle, such as the nucleus of light or heavy hydrogen or helium, commonly called proton, deuteron and alpha particle, respectively; (b) reactions initiated by gamma rays (electromagnetic radiation); (c) nuclear fission.

Reactions Produced by *Charged* Particles.—This type of reaction was historically the first method to produce neutrons and, until 1942, the only way to produce them in quantity. It is still the most versatile method, being capable of producing neutrons of specified kinetic energy. Chadwick, in his first experiments, obtained neutrons by bombarding beryllium or boron with alpha particles, according to the nuclear equation ${}_2He^4+{}_4Be^9\rightarrow{}_6C^{12}+{}_0n^1+Q$ where Q, the increase in kinetic energy is in this case 5.76 Mev. At mid-20th century, neutrons were mostly produced by bombarding various atomic nuclei with deuterons and sometimes with protons which are accelerated in a cyclotron or some similar device. This has the advantage that the number of particles obtainable from accelerating devices is very much greater than the number of alpha particles emitted by available amounts of radioactive material. Particular nuclear reactions useful for the production of neutrons will be discussed below.

One of the prime considerations for choosing a particular nuclear reaction for the production of neutrons is the yield. This depends sensitively on the kinetic energy ($\frac{1}{2}mv^2$) of the bombarding particle, and on the nature of the bombarding particle as well as of the target nucleus. The bombardment of beryllium with deuterons gives in general a higher yield than any other combination of nuclei. However, even for this reaction, the yield is very small and changes rapidly with the energy of the deuterons: at 1 Mev deuteron energy, it is about 1 neutron for 100.000 deuterons; at 10 Mev, about 1 in 1,000, and further increase of the deuteron energy, to 40 Mev is expected to increase the yield to about 1 in 100. The yields are so small because the deuteron loses kinetic energy continuously by ionizing the atoms of beryllium through which it passes, and in general it will have lost all its energy before it has had a chance to hit a beryllium nucleus and disintegrate it. A cyclotron may give a current of deuterons of about 100 microamperes; if the deuteron energy is 10 Mev, this will produce about 10^{12} neutrons per second.

The yield from the bombardment of beryllium with alpha particles is about 1 neutron for 4,000 alpha particles (if the alpha particles come from radon). One curie of radon (*i.e.*, the amount which is in radioactive equilibrium with 1 gr. of radium), intimately mixed with beryllium will give about 10,000,000 neutrons per second. An average cyclotron is thus equivalent in neutron production to about 100,000 curies, *i.e.*, to the radioactive rays from 100 kg. of radium.

At very low energy the yield decreases rapidly. The reason is that the incident particle (deuteron or alpha particle) cannot come close to the beryllium nucleus because there is a strong electrostatic repulsion between them, and there is not sufficient kinetic energy to overcome this repulsion. For instance, the yield for deuterons of 500,000 ev (electron volts) on beryllium is only 1 neutron per 2,000,000 deuterons, and at 250,000 ev it is immeasurably small.

Neutrons can also be produced by deuteron bombardment of other light nuclei such as dentrium, lithium, boron, nitrogen, etc. The yields are usually smaller by a factor between two and ten than the yields from beryllium at the same energy.

In any nuclear reaction energy is either released or absorbed. When neutrons are proddced from deuterons, there is normally an energy release because the proton is not very strongly bound to the neutron in the deuteron and can be bound more strongly to the target nucleus. For instance, with a beryllium target, the energy release is 4 Mev, with a deuterium target, 3 Mev. Higher energy releases are obtained from lithium or boron targets, namely 15 and 13 Mev, respectively. These targets can, therefore, be used to produce very high energy neutrons from deuterons of quite low kinetic energy, which can be accelerated by apparatus of only moderate size and cost. Still higher energy neutrons can be obtained by deuteron bombardment of tritium, the hydrogen isotope of mass 3, with an energy release of 18 Mev; this reaction is also useful because of its high yield at deuteron energies of a few hundred thousand volts.

An important problem in experiments on fast neutrons is the obtaining of neutrons of a well-defined energy (monochromatic neutrons). In general, a nuclear reaction will give neutrons of many different energies because the residual nucleus (which remains after emission of the neutron) can be left in several different energy states. Thus, the deuteron bombardment of boron gives, besides the fast neutron group with 13 Mev energy release, at least 3 other groups with energy releases of g, 6 and 4 Mev, respectively; the reaction with lithium gives neutrons of all energies below the maximum, and that with beryllium gives also many energy groups.

On the other hand, the reaction between two deuterons is satisfactory because in this case the residual nucleus (helium 3) does not have any excited states. The deuteron-deuteron reaction ${}_1H^2(d,n){}_2He^3+3.28$ Mev has, therefore, been the standard reaction for producing monochromatic neutrons. The reaction between the deuteron and tritium also fulfils this criterion and does at the same time give very high energy neutrons according to the reaction $_1H^2(t,n)_2He^4+17.6$ Mev where t stands for tritium or H^3.

Neutrons can also he produced by bombarding a nucleus with protons. In this case energy is always absorbed and the reaction: therefore. begins to take place only above a certain kinetic energy of the proton, the threshold energy. Measurement of this threshold energy is most valuable in making accurate comparisons between the masses of atomic nuclei arid has given an accurate value of the mass of the neutron. The reaction between lithium 7 and a proton $Li^7(p,n)Be^7-1.65$ Mev gives monochromatic neutrons with high yield, and is very valuable for the accurate study of neutrons of moderately low kinetic energy.

Neutron Production by *Gamma Rays.*—Neutrons can be released from nuclei by gamma rays, *i.e.*, by electromagnetic radiation of extremely short wave length. The energy of one quantum of gamma radiation. $h\nu$, must be greater than the energy with which the neutron is bound to the rest of the nucleus. In most nuclei this binding energy is about 10 Mev; notable exceptions are beryllium $Be^9(\gamma,n)Be^8-1.67$ Mev and deuterium $H^2(\gamma,n)H^1-2.23$ Mev for which the binding energies are 1.6; and 2.23 Mev, respectively.

The yield of neutrons is very small, even for gamma rays of high energy. This is because it is much more likely for the gamma rays to be absorbed by producing a pair of electrons than to be absorbed in the nucleus. Average yields are about 1 neutron for 1,000 gamma rays if sufficient material is provided to absorb the gamma rays completely (this requires a thickness of several centimetres of iron or about a metre of beryllium); in thin layers, the yield is proportionally less. The efficiency of gamma rays in producing neutrons usually rises with increasing gamma-ray energy and reaches a maximum at a gamma-ray energy of about 1 j to 20 Mev per quantum.

Neutron Production by Fission.—In the fission of uranium and other heavy nuclei, neutrons are emitted. This is the basis of the nuclear chain reaction which is the most economic means of producing large quantities of neutrons.

The fission of uranium can be induced by neutrons; in each fission one neutron is absorbed whereas more than one neutron is emitted. Each of the emitted neutrons can in turn produce fission in another uranium nucleus provided (1) the neutrons are not absorbed by other nuclei, and (2) a sufficient amount of uranium is used to prevent escape of the neutrons. In this way a nuclear chain reaction is obtained in which neutrons are continuously produced by fission and in turn cause fission in other nuclei.

There is virtuallv no limitation on the number of neutrons that can be produced in this way. The only practical limitation comes from the considerable amount of energy released in fission which must be dissipated. If 100,000 kw. can be dissipated or used in production of useful power, more than 10^{18} neutrons per second are produced; one such reactor thus gives a neutron production equivalent to 1,000,000 cyclotrons. For experimentation one has to consider that the neutrons will be distributed over a larger area which makes their density not so much larger than that from a cyclotron. Moreover, in working with large numbers of neutrons, the health hazards must be considered.

Nuclear Reactions Produced by Neutrons.—The most important physical property of neutrons is the absence of electric charge. This enables them to approach an atomic nucleus without being repelled by its positive charge. Therefore. a neutron can enter an atomic nucleus no matter whether it is fast or slow. On the other hand. a charged nuclear particle like a proton or deuteron can enter a nucleus only when it has a sufficiently high velocity to overcome the electric repulsion; hence the usefulness of a charged particle for producing nuclear reactions is exhausted after it has been slowed down. Accordingly, the yield of nuclear reactions produced by a charged nuclear particle is only of the order of 1 in 1,000 or less (see *Reactions Produced* by *Charged Particles,* above); on the other hand, the yield of nuclear reactions from neutrons is nearly 100%; almost every neutron which is produced will ultimately he captured by a nucleus and will produce some nuclear reaction.

Several types of reaction between neutrons and atomic nuclei will be discussed in the following. Which of these reactions takes place in any given collision between neutron arid nucleus is a matter of chance; the probability of any given type of reaction depends on the particular nucleus with which the neutron collides, and on the velocity of the neutron. Some reactions. notably the capture of neutrons with the emission of gamma radiation, are enhanced by reducing the velocity of the neutrons while others can he initiated only by fast neutrons.

Scattering of Neutrons.—The simplest process which may occur when a neutron hits an atomic nucleus is scattering, *i.e.*, a change of the direction in which the neutron moves. This scattering may be elastic like the collision between two billiard balls; in this case, the kinetic energies of the neutron and the nucleus after the collision add up to the kinetic energy of the neutron before the collision; or the scattering may be inelastic. ic., kinetic energy may be lost and transformed into internal energy of the bombarded nucleus.

Only elastic scattering is possible in collisions between neutrons and protons (nuclei of ordinary hydrogen). In collisions with other nuclei, in general both types of scattering may occur; but if the kinetic energy of the neutron is small, again only elastic collisions are possible, because then the energy will not be sufficient to excite any of the higher energy levels of the nucleus. Depending on the particular nucleus involved. the neutron must have a minimum energy of from 0.1 to about 10 Mev in order to make inelastic scattering possible. Once the neutron energy is above this limit. inelastic scattering becomes rapidly more important and predominates over elastic scattering when fast neutrons collide with heavy nuclei. In the majority of cases, a very large fraction of the kinetic energy is lost in inelastic collisions. so that the neutrons emerge after the collisions with an average kinetic energy of about one-quarter of their initial energy or less. The remainder of the energy has been transformed into excitation energy of the nucleus and usually appears afterward in the form of gamma rays.

Collisions between neutrons and atomic nuclei are. of course, relatively rare because of the very small size of the atomic nucleus. This size can be determined from the frequency of collisions with fast neutrons. The frequency of collisions is commonly measured in terms of the effective cross section, *i.e.*, the target area which the nucleus appears to present to the neutron. If the cross section is σ, a thin slab of material, of thickness t and containing N nuclei per unit volume, will scatter (or absorb) a fraction

$$f=Nut$$

of the neutrons incident upon it. The cross section σ is conveniently determined by measuring the fraction 1-f, of neutrons which penetrate the slab without being deflected.

The cross sections of nuclei for collisions with fast neutrons are all of the order 10^{-24} sq.cm. This corresponds to a radius of the nucleus of about 10^{-12} cm. which confirms the result obtained from other experiments. (A unit of area 10^{-24} sq.cm. has become commonly known as a "barn.") Neutron scattering experiments further confirm that the volumes of nuclei are roughly proportional to the number of particles contained in them, *i.e.*, to the atomic weight. The most important deviation from this rule is that the lightest nuclei tend to present a relatively greater cross section to neutrons of moderate energy (a few million electron volts). In solid materiais neutrons travel on the average about 2 to 10 cm. between collisions.

For the theory of nuclear forces, the scattering of neutrons by protons is particularly important. The effective cross section of the proton for slow neutrons is usually large. namely about 20×10^{-24} sq.cm., whereas that of nuclei such as Al. Si, etc., is only about 2×10^{-24} sq.cm. The large cross section of the proton has been explained in terms of a resonance effect. At higher neutron energy, the proton cross section decreases but it is still 3×10^{-24} sq.cm. for neutrons of 2 Mev and falls in line with heavier nuclei only at extremely high neutron energy.

Whether the scattering is elastic or inelastic, some kinetic energy will be transferred from the neutron to the nucleus. The scattering is, therefore, connected with a slowing of the neutron which will be discussed in more detail under *Neutron Diffusion,* below.

Nuclear Reactions Leading to *the* Emission of Charged Particles.—In many cases the collision between a neutron and a nucleus leads to a true nuclear reaction in which a nuclear particle other than a neutron is emitted. These reactions are the inverse of the reactions in which neutrons are produced by an incident-charged particle.

Many reactions have been observed in which a proton or an alpha particle is emitted when a nucleus is bombarded by a neutron. These are designated as (n,p) and (n,α) reactions respectively. Reactions in which a proton is produced in general absorb energy and can, therefore, be caused only by neutrons of considerable kinetic energy. There are some exceptions, the most important being the reaction $n+N^{14}\rightarrow H+C^{14}$ which releases an energy of 0.6 Mev; this reaction is caused with considerable probability by very slow neutrons, and occurs in the atmosphere where neutrons of cosmic ray origin form radioactive C^{14} from atmospheric nitrogen. Archaeological dating by the activity of C^{14} in organic remains employs the assumption of a constant supply of C^{14}, of half-life 5,600 years, and its uniform distribution in the carbon of living matter.

The reactions in which alpha particles are emitted often release energy. The most important ones of this type are the reactions of neutrons with lithium 6 and with boron 10; the cross section for these reactions is extremely great, especially for slow neutrons: $4{,}000\times10^{-24}$ for ${}_5B^{10}(n,\alpha){}_3Li^7$; $10{,}900\times10^{-24}$ for ${}_3Li^6(n,\alpha){}_1H^3$.

Many neutron-induced nuclear reactions lead to the formation of a radioactive nucleus, which subsequently emits a beta ray (electron). An example is the nucleus C^{14} mentioned above. It can be shown from general arguments about nuclear stability that all reactions caused by a neutron in which a proton is emitted lead to a radioactive nucleus. If an alpha particle is emitted in the reaction, the resulting nucleus may or may not be radioactive; for instance, the reaction between neutrons and lithium 6 leads to the important radioactive isotope of hydrogen of mass 3, whereas the reaction with boron 10 gives the stable nucleus lithium 7.

Reactions Leading to *the Emission* of Several *Neutrons.*—When a neutron of very high energy (more than 10 Mev) hits a nucleus, 2 or more neutrons are frequently emitted from the nucleus. In the case of heavy nuclei and of neutrons of sufficiently high energy, theory shows that this $(n,2n)$ reaction is the most likely process to occur. If two neutrons are emitted, the bombarded nucleus loses one unit of weight; this results frequently in a radioactive nucleus which emits positrons (positive electrons). Reactions of this type are often useful because they provide specific detectors for neutrons of high energy.

Capture oj *Neutrons.*—Neutrons colliding with an atomic nucleus may simply be captured and incorporated into the nucleus, the energy of binding and the kinetic energy of the neutron being transformed into the energy of one or several gamma rays in an (n,γ) reaction. This simple capture process can occur with any nucleus except helium 4. In many instances, neutron capture leads to the formation of a radioactive nucleus which subsequently emits beta rays as in C^{14}; this makes the capture easily observable and makes it possible to use this process for the detection of neutrons. The probability of capture varies greatly; it is generally greater for slow than for fast neutrons, and greater for heavy than for light nuclei. For fast neutrons and light nuclei the capture probability is immeasurably small, for heavy nuclei about 1 collision in 20 to 200 leads to capture. The capture cross section for most nuclei for slow neutrons is less than 10 barns. Notable exceptions are found in boron 430, cadmium 2100 and gadolinium 22,000 barns respectively. For slow neutrons and light nuclei, scattering still predominates over capture, *e.g.,* in ordinary hydrogen in the ratio 200 to 1, and in heavy hydrogen or carbon even more strongly.

Accordingly, neutrons have very different lifetimes in different substances, the lifetime being the average time from the production of the neutron until it is captured (or causes a nuclear reaction). In solid boron, this time is about $\frac{1}{10{,}000{,}000}$ sec., in most solids of high atomic weight about $\frac{1}{10{,}000}$ sec., in such special substances as graphite it becomes more than $\frac{1}{100}$, while in gases it ranges from about $\frac{1}{10}$ sec. for air to many seconds in pure heavy hydrogen. Even the longest of these times is short compared with the half life (13 min.) of the neutron as a radioactive particle.

The capture of slow neutrons shows the interesting phenomenon of resonance. For each nucleus there exist certain characteristic values of the kinetic energy of the neutron which make the capture of the neutron very likely. For instance, cadmium absorbs very strongly all neutrons less than 0.4 ev, indium absorbs neutrons of 1.4, 3 and 9 ev.. gold those of 5 ev., whereas iodine has resonances at about 20, 30 and 40 ev and some at higher energies. The resonances are very sharp; *e.g.,* indium absorbs strongly only neutrons between 1.2 and 1.7 ev, and its capture cross section at 1.44 ev is more than 100 times as large as that at 2.5 ev. To study these neutron resonance levels, special devices, known as velocity selectors, have been built which measure the time of flight of the neutron from its source to a detector. Studies of resonances give important information on the structure of nuclei; in fact, the resonance effects in the capture of slow neutrons gave rise to the modern theory of the compound nucleus, first developed by Niels Bohr, which forms the basis for the general understanding of reactions involving heavy nuclei.

Fission.--h'eutrons can produce fission in heavy nuclei, especially in uranium, thorium and plutonium. Fission consists in the splitting of the heavy nucleus into two parts of almost equal weight. This is possible because the mass energy in the heavy nucleus is considerably greater than the sum of the mass energies in the two nuclei of medium weight which are produced by fission. The difference in mass energy is released in kinetic energy of the fragments; it is approximately zoo Mev per fission. In a 1,000,000 kw. power plant approximately 1 kg. of uranium must undergo fission per day.

The use of fission for practical purposes is based on the fact that neutrons are emitted in the fission process and that more than one neutron is emitted per fission. This makes it possible to have a nuclear chain reaction. As was pointed out in Neutron *Production* by Fission, above, this process is the most suitable one for the practical production of neutrons in large quantities. For example, in the Chalk River nuclear reactor a neutron flux density in excess of 10^{13} per sq.cm. per sec. was obtained.

Detection of Neutrons.—One of the most important problems in neutron experiments is the detection of the neutrons. Since the neutron produces no direct ionization, it can be detected only through its interactions with other nuclei. Three types of effects may be used for the detection of neutrons, viz.:

(1) The recoil of a nucleus with which a neutron has collided; (2) the emission of charged particles in a nuclear reaction produced by a neutron and (3) the production of a radioactive nucleus by any nuclear reaction caused by the neutron (this reaction may be simple capture).

The first effect will occur only with fast neutrons and can, therefore, be used only to detect these neutrons; on the other hand, it has the advantage that it permits the determination of the energy of the neutron. The second and third effects can be used for the detection of slow as well as fast neutrons; different nuclear reactions are used in the two cases.

Fast Neutron Detectors.—Recoil Detectors.—In an elastic collision between a neutron of mass m and a nucleus of mass M the latter receives the kinetic energy

$$E'=\frac{4mM}{(M+m)^2}E\cos^2\theta$$

where E is the kinetic energy of the neutron before the collision and θ is the angle between the direction of motion of the incident neutron and the recoil nucleus. For ease of observation, a large kinetic energy of the recoil nucleus is usually desirable; therefore, protons are preferred because their mass & is practically equal to that of the neutron. If the recoil proton goes in the same direction as the incident neutron it will receive the entire kinetic energy of the latter, as shown above.

Protons are also favourable because the probability of their collision with a neutron is particularly large and can be calculated with great accuracy on theoretical ground. Furthermore, the recoil protons produced by neutrons of a given energy E are distributed uniformly in kinetic energy from 0 to E, which simplifies the determination of the energy of neutrons.

The most important types of proton recoil detectors are cloud chambers filled with hydrogen or a gaseous hydrogen compound, photographic emulsions and ionization chambers with linear pulse amplifiers. The cloud chamber or emulsion is then exposed to neutrons coming from a definite direction and the direction as well as the length of the proton tracks are observed. From the length of the track the energy of the proton can be deduced. In an ionization chamber the energy is measured by the number of ions formed (by a single proton). The ionization chamber can be filled with hydrogen or provided with a layer of paraffin or some other solid material containing hydrogen. For the observation of large numbers of neutrons and determination of their energy, the ionization chamber is the most satisfactory instrument.

The efficiency of neutron counters is low, because of the small probability of collision between neutrons and nuclei. A proton recoil counter containing a thick layer of paraffin in an ionization chamber is the most efficient counter known for fast neutrons. If the neutron energy is E Mev, the counter will give about $2E$ pulses for every 10,000 neutrons incident upon it. Thin paraffin layers, of course, give even smaller efficiency but are more convenient for measuring the neutron energy. "Thick" and "thin" are to be understood in comparison with the range of the recoil protons.

Deuterons and alpha particles have also been used successfully for the observation of neutrons by the recoil method; in these cases, however, the energy distribution of the recoil nuclei is not uniform as it is in the case of protons. The recoil of still heavier nuclei, such as carbon, comes in mainly as a disturbing effect when compounds such as paraffin are used in a recoil detector.

Nuclear Reactions. — The $B^{10}(n,\alpha)Li^7$ reaction of neutrons with boron 10, giving alpha particles, can be used for the detection of fast neutrons. An unsatisfactory feature of this detector is that the reaction is produced with much higher probability by slow neutrons than by last ones.

Fission is a very convenient means of detecting neutrons: because it gives rise to very large pulses of ionization which can easily be distinguished from any disturbing effect. It is usually desirable that the detector respond only to fast not to slow neutrons; this can be accomplished by using uranium 238 or thorium, rather than U^{235} or plutonium. The detection efficiency is about 100 times lower than for a proton recoil counter.

Radioactivity. — Many nuclear reactions produced by neutrons lead to radioactive nuclei. These can be observed after the end of the irradiation with neutrons, a fact which is often an advantage. For the detection of fast neutrons, reactions are preferable which can be produced only by fast neutrons. The reaction $n+Al^{27}=Mg^{27}+H$ is a good example; Mg^{27} is a radioactive nucleus emitting beta rays with a lifetime of about 10 min. The reaction can be produced only by neutrons of more than 2 Mev kinetic energy and increases in probability with increasing neutron energy. similar threshold detectors can be obtained by using Mg, Si, P, etc.

Of particular interest are threshold detectors sensitive to neutrons of extremely high energy. Such detectors are provided by nuclear reactions in which one neutron enters the nucleus and two neutrons are ejected. A useful reaction of this $(n,2n)$ type occurs with copper, leading to the formation of the radioactive nucleus Cu^{62} of 10 min. half life; it occurs with neutrons of more than about 11 Mev energy. For still higher neutron energy carbon is a good detector; a reaction of the same type leads to the formation of C^{11}, a radioactive nucleus of 20 min. half life. The minimum neutron energy required in this case is about 20 Mev.

Detectors for Slow *Neutrons*.—The recoil type detector is not usable in this case, which leaves only two types:

Nuclear Reactions.—The most generally useful detector of slow neutrons is based on the (n,α) reaction $n+B^{10}=Li^7+He^4$. This reaction has an extremely high probability for slow neutrons (cross section, $4{,}000\times10^{-24}$ sq.cm.). The alpha particles have an energy of about 1.5 Mev and are easily observed. The most commonly used detector consists of an ionization chamber filled with boron trifluoride gas; the ionization pulses are detected with the help of a linear amplifier. Moderate size chambers of this type (about 10 cm. long) at atmospheric pressure will detect about 10% of the neutrons of thermal velocity (2 km. per second,! incident upon them. Increase in the pressure and size, and use of separated boron 10, will increase the efficiency. It is obvious that the detection of slow neutrons is much more efficient than that of iast ones.

Boron can also be used in the form of thin foils of boron metal or boron carbide, the alpha particles being detected in some neutral gas.

Fission is a very convenient means of detecting slow neutrons because of the large pulses of ionization from the fission fragments. Uranium 23j or plutonium must he used because only these nuclei undergo fission when bombarded with slow neutrons.

Radioactivity.—There are many ways of observing slow neutrons by using the formation of radioactive nuclei. The most useful type of nuclear reaction for this purpose is the simple capture of neutrons (with emission of gamma rays). which is generally much more probable for slow neutrons than for fast ones and thus provides a specific detector for slow neutrons. As has been mentioned before. neutron capture leads often. although not always, to the formation of a radioactive nucleus. Indium foils have been found especially useful as detectors of slow neutrons, but also silver, gold, rhodium. bromine, iodine and other substances have been used successfully. The radioactivity is observed promptly after the irradiation by neutrons.

By making use of the resonance capture of neutrons, detectors of this type can be selected so as to indicate slow neutrons of fairly definite velocities. In order to measure the number of thermal neutrons (very slow, with energy less than 0.4 ev), one uses the fact that cadmium absorbs these neutrons very strongly while it is transparent for neutrons of higher energy. If one measures the radioactivity produced, for instance. in an indium foil with and without a shield of cadmium around the foil, the difference indicates the number of thermal neutrons incident upon the foil. On the other hand, the radioactivity observed with the foil covered by cadmium, is almost entirely because of neutrons whose kinetic energy corresponds to a resonance in the indium nucleus (see *Capture of Neutrons,* above). Thus, by using different detectors with different resonance energies, one can observe the properties of neutrons of various energies.

Neutron Diffusion. — Neutrons cannot be accelerated; they must be accepted with whatever energy they have on formation: but they can be retarded. This can be done by permitting the neutrons to collide with nuclei; in each collision some kinetic energy is transferred from the neutron to the nucleus according to the equation given above. If this process is continued for a sufficient number of collisions. the velocity of the neutrons will be reduced until they come into equilibrium with the thermal motion of the atoms with which they collide.

In this manner so-called thermal neutrons are produced. The thermal neutrons have a velocity distribution similar to that of molecules in a gas; their mean energy at room temperature is about 0.03 ev. The thermal neutrons continue to make collisions with atomic nuclei; but since they are now in thermal equilibrium, these collisions no longer slow the neutrons down, there being equally many collisions in which the neutron gains and in which it loses energy. Ultimately, the neutron will be captured by a nucleus.

The production of slow neutrons. and of thermal neutrons in particular, is important from the scientific as well as from the practical point of view. The investigation of thermal neutrons has yielded most of the information about the radioactive nuclei formed by neutron capture. The investigation of neutrons of somewhat higher energy showed the existence of resonance levels in nuclei and thus laid the foundation for the modern theory of the compound nucleus (see *Capture* of *Neutrons*, above). For nuclear reactors in which natural uranium is used, slow neutrons are important in order that the fission of uranium 23j may predominate over the capture of neutrons in uranium 238. Whatever the purpose of the slowing down, it is important that not many neutrons are lost by capture during the process.

The most commonly used moderator for the slowing of neutrons is hydrogen in the form of paraffin or of water. Hydrogen has the advantage that the neutron loses a large fraction of its energy in each collision (see *Fast Neutron Detectors,* above) and that the effective cross section is large. Neutrons of an initial energy of 2 Mev become thermal at an average distance of about 10 cm. from the source, in paraffin or water. This corresponds to about 18 collisions per neutron with protons. However, a paraffin block of at least 50 cm. radius is required to prevent a sizable fraction of the neutrons from escaping. If the neutrons are emitted from the source with higher kinetic energy, larger amounts of paraffin are needed to slow them down and vice versa.

For nuclear reactors or piles, hydrogen-containing substances are not suitable because protons capture neutrons with considerable probability. Jn this case, either heavy water or graphite are commonly used. The energy transfer in a collision is in this case much less than in the case of protons, and the effective cross sections are also smaller. Therefore, much larger amounts of material are required to slow the neutrons down to thermal energy; this is one of the reasons for the large size of atomic energy piles. On the other hand, there is practically no capture in either graphite or heavy water until the neutrons have been slowed to thermal energy, and even at thermal energy they will make hundreds of collisions before being captured.

The mathematical treatment of neutron diffusion is usually done in two stages; namely, first the slowing down to thermal energy and then the diffusion of the thermal neutrons. The second stage can be treated according to the ordinary methods of diffusion theory, using the diffusion equation

$$\tfrac{1}{3}\, lv\nabla^2 n - \frac{n}{\tau} + q = 0$$

where n is the density of neutrons (number per cubic centimetre), q the strength of the neutron source (number produced per cubic centimetre and second), l is the mean free path of the neutrons between two collisions, v their mean velocity and τ their mean lifetime, that is, the mean time which elapses before they are captured.

The mathematical treatment of the first stage, the slowing process, is quite difficult because the mean free path of the neutron changes with its velocity. A very useful although not exact concept in this theory is the age of the neutron. defined as one-sixth of the mean square distance traveled by the neutrons from the source to the point at nhich their energy drops below a certain arbitrary energy. E. The age η can be calculated as a function of E from experimental data and the density of neutrons of energy E at the distance r from the source in a homogeneous medium is given approximately by

$$n\ (\eta, r) = (4\pi\eta)^{-3/2}\exp(-r^2/4\eta).$$

Atomic Energy.—Neutrons supplied the key for the release of nuclear energy. As was mentioned already, fission of uranium can be caused by neutrons, and in each fission a certain number of neutrons, ν, are released. For uranium 23j, for example, ν, has the value 2.5. This is the basis of the nuclear chain reaction in which each of the neutrons produced in fission is again available to react with a uranium nucleus and can cause another fission.

Conditions are simplest in the rare isotope uranium 235, or in plutonium 239. These substances can be made to undergo fission by neutrons of any velocity; in fact, slow neutrons are most effective. Therefore, the slowing down of the neutrons by their unavoidable collisions with the uranium nuclei does not diminish their effectiveness. In a large mass of uranium 23j, every neutron which has been released in a fission may in turn cause fission. Since the number of neutrons released in each fission is greater than one, the total number of neutrons will increase in this process. The increase is rapid because very little time elapses between the production of a neutron and its causing fission in another nucleus. With large amounts of uranium 235 or plutonium, therefore, cne obtains an explosive multiplication of the neutrons and an explosive release of fission energy. This is the principle of the fission bomb.

If the amount of uranium 235 is reduced, a fraction of the neutrons produced in it will escape and, thus, not produce further fission. If the amount of uranium is made small enough, so that only one neutron out of every v neutrons produced will stay in the uranium, whereas the remaining v—I escape, the reaction will cease to lead to a multiplication of the number of neutrons hut will merely be self-sustaining. This is the principle of the power reactor for the production of energy without explosion. It is ordinarily desirabie to keep the amount of the expensive material, uranium 235 or plutonium, to a minimum. This is accomplished both in the controlled reactor and in the bomb by surrounding the active material with a reflector, *i.e.,* any substance which can scatter neutrons back to the active material, and thus minimize the number of escaping neutrons. Conditions are somewhat more complicated if ordinary uranium is used instead of the separated isotope 235. In this case the abundant isotope of uranium, 238, undergoes fission only when bombarded by fast neutrons, whereas slower neutrons are simply captured, leading to the formation of uranium 239. In this capture the incident neutron disappears and no new neutron is emitted. Only the rare isotope uranium 235, which comprises about 0.7% of natural uranium, undergoes fission with slow neutrons, and thus can keep the chain reaction going. But in general the fission in 235 is much weaker than the capture in 238; only for neutrons of very low velocity, less than 1 ev, is the ratio reversed. Since it is not possible to avoid nuclear collisions and thus keep the neutrons at very high energies (at which they could produce fission in 238), it is necessary to slow them down completely, *i.e.,* to energies less than 1 ev, so that they can cause fission in 235 with high probability.

On the basis of these considerations atomic energy reactors are designed to include a moderator, usually graphite or heavy water (see *Neutron Diffusion,* above), which serves to slow the neutrons down to thermal energies. The neutrons produced by fission have kinetic energies of several million electron volts; they are then permitted to diifuse in the moderator and come back as thermal neutrons to the uranium. Then some of them will cause fission in 235 and thus produce new neutrons to sustain the chain reaction. Other neutrons returning to the uranium will be captured in 238 and produce uranium 239. This is a radioactive nucleus which decays successively by β emission into neptunium and then into plutonium 239. The plutonium can be separated chemically from the uranium and can be used in its turn for atomic energy production. The production of plutonium in a chain-reacting pile is the first instance in which one chemical element has been transmuted into another in large quantities by man. Plutonium is fissionable by slow neutrons. In the so-called breeder reactor, plutonium is created from U238 as the reactor generates power from fission of U235.

These reactors are very useful for the production of neutrons in large quantity. By letting the emerging neutrons diffuse through large additional amounts of moderator, it is possible to obtain thermal neutrons which are almost entirely free of fast neutrons. A great variety of radioactive nuclei which are useful as tracers in biology, chemistry and for industrial research may be produced by introducing samples into nuclear reactors where they are exposed to intense flux of neutrons and become radioactive by neutron capture.

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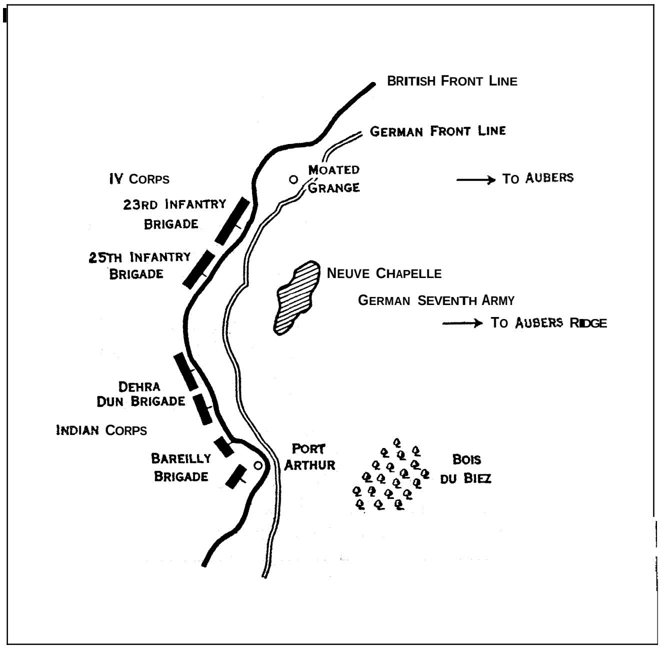
(H. A. BE.; M. GN.; R.M. SN.)

NEU-ULM, a town in Bavaria, Germany. Pop. 14,866 (1950). The town is situated on the Danube, opposite Ulm, and is a railway centre. It was incorporated as a town in 18j7.

NEUVE CHAPELLE, BATTLE OF (March 10–13, 1915). Neuve Chapelle is a village in Pas de Calais west of Lille. Pop. (1954) 447. To understand the tactical idea upon which this World War I battle was founded (the first of the siege warfare battles undertaken by the British army in France) it must he clearly kept in view that the British higher command had not grasped the fact that the war was an engineer-artillery war. not a cavalry-infantry one. They considered that infantry could "open a door for an inroad of horsemen against the enemy's rear," and in spite of the failure of Neuve Chapelle, this idea governed the tactics of Sir John French and Sir Douglas Haig up to the end of the war.

Plan of **Attack.**—On Feb. 12, General Haig recommended an



PLAN OF THE BATTLE OF NEUVE CHAPELLE. MARCH 10–13, 1915

offensive toward the Aubers ridge on a frontage of 2,000 yd. between Port Arthur and the Moated Grange. Neuve Chapelle was to be the first objective, then a line east of the village, and finally the Aubers ridge, the occupation of which would threaten the enemy's communications between La Bassée and Lille. Sir John French. the commander-in-chief, approved of this plan. and fixed its date as soon after March 9 as weather would permit. The attack, or rather assault, was to be carried out by two corps, the Indian corps on the right and the 4th corps on the left. It was to be made after an intense artillery bombardment of 3j minutes' duration. Having broken the enemy's front. it was proposed to extend the attack to five miles in width, and so make room for the cavalry corps to pass through and pursue. The bombardment was to be carried out by 530 guns and howitzers. and the ammunition available was approximately 216,380 rounds.

Operations of March 10.—It 4.30 A.M. the assaulting hattalions were in position. The morning was cold and misty, and visibility was bad. Sunrise was at 6.30 A.M., and exactly one hour later the general bombardment was opened. At 8.05 A.M. the attack was launched. and its first phase was carried out with considerable success. At 8.50 A.31. Neuve Chapelle was entered. but here the advance of the right was brought to a standstill by the British artillery barrage which had lifted. and was now falling between the village and the Bois de Biez. The first real trouble was experienced on the two flanks. on the right from the Bois de Biez. and on the left from Manquissart, from both of which a heavy fire was directed on the attackers rendering it impossible for them to extend their front rapidly. By 1 P.M. the whole of the first objective. except part of the Port Arthur salient. was in British hands. Then came a delay. Sir Douglas Haig proposed to advance on the Xubers ridge at 2 P.M.. but this attack had to be postponed. This enabled the Germans to push forward reserves to their second line position east of the village. which was only partially dug. From this line an effective cross fire was brought to bear on the north of Neuve Chapelle.

Operations of March **11.**—During the night the Germans strengthened their new front lirie. The main attack was carried out by the 4th corps, and was directed on Aubers. the Indian Corps supporting it on the right. It was launched at 7 A.M.. but was at once crushed by heavy machine gun fire opened from the concave position now held by the enemy. A little after noon the attack had to be abandoned. It was then clear that until the infantry assault could be prepared by an effective bombardment, to continue the action would lead to unprofitable slaughter.

Operations of March **12.**—At j A.M. on the 72th the Germans made a strong counter attack which. however. failed in its object. This was followed by an order from Sir Douglas Haig to continue the attack. It was ordered and then postponed with the inevitable confusion resulting. The 4th Corps was instructed to "push through the barrage of fire regardless of loss." The Bois de Biez was to he taken '(at all costs." The 7th and 8th divisions were to push on "regardless of the enemy's fire." with the inevitable result that hundreds of men were at once shot down. By nightfall it became obvious that the battle could not be continued, and early on the 13th Sir John French. having lost 12,892 officers and men. nired to Lord Kitchener: "Cessation of the forward movement is necessitated . . . ahove all by want of ammunition."

Comments.— The true reason for the iailure was lack of understanding. An attempt was made to attack a fortress as if it were a deployed army in the field. The conception of surprise was admirable. but it was useless to expect to capture the Aubers ridge from a frontage of 2,000 yd. To do so the frontage should have been at least 12,000 yd., because the ridge was some 6,000 yd. distant. and because in siege warfare the normal depth of penetration is half the length of the initial base. Nevertheless. in this battle. the first of the British grand attacks, and the first in which the "barrage" was used, more common sense was shown in restricting the artillery bombardment to the shortest possible time thsn in any subsequent battle up to that of Camhrai in November 1917. The German defenses were only half a mile deep. and it was possible to fracture them by artillery fire if the bombardment were rapid, for rapidity carried nith it surprise. (J. F. C. F.)

NEUWIED, a town in Rhineland-Palatinate. Germany. on the Rhine. 8 mi. below Coblenz. on the railway from Frankfort-on-Main to Cologne. Pop. (1950) 24,284. Neuwied was founded by Count Frederick of Wied in 1662. on the site of the village of Langendorf. Among those who sought refuge there was a colony of Moravian Brethren; occupying a separate quarter of the town. they carried on manufactures of porcelain stoves. Sear Neuwied one of the largest Roman *castra* on the Rhine was excavated. The principal building is the château, which contains a collection of Roman antiquities.

NEVA, a river of the U.S.S.R., which carries off into the Gulf of Finland the waters of Lakes Ladoga. Onega. Ilmen and many smaller basins. It issues from the southnest corner of Lake Ladoga in two channels. which are obstructed by sandstone reefs. so that the better of the two has a depth of only 7 to 16 feet. A little farther down it becomes completely navigable. and attains a breadth of 4,200 ft.; but between the village of Ostrovki and that of Ust-Tosna it passes over a limestone bed. which produces a series of rapids. and reduces the width of the river from 1,050 to 840 and that of the navigable passage from 350 to 175 feet. Nine or ten miles before reaching its outfall the river enters Leningrad. and 5 or 6 mi. lower down hreaks up into the Great Neva (8jo to 1,700 ft. wide). the Little Neva (945 to 1,365), and the Great Nevka (280 to 1,205), this last. 2 mi. farther on, sending off the Little Nevka (370 to 1,130 ft.). Its total length is only 46 miles. In front of the delta are sandbanks and rocks which prevent the passage of vessels except by a canal, 18 mi. long. 124 to 226 ft. wide, and admitting vessels with a draft of 18½ ft., from Kronstadt to Leningrad.

When Lake Ladoga sends down its vast accumulations of block ice, inundations of a dangerous kind occur, as in 1777. 1824. 1879, 1903. and especially in 1923.

NEVADA, popularly known as the "Sagebrush state;" or the "Silver state," is one of the far western states of the U.S.. admitted to the union on Oct. 31. 1864, as the 36th state. It is bounded north by Oregon and Idaho. east by Utah and Arizona, south and west by California. The Colorado river. separating it in part from Arizona, is the only natural boundary the state possesses, the others being arbitrary lines of geodetic measurement. Nevada ranks seventh among the states in size, having an area of 110,540 sq.mi., 752 sq.mi. of which are water surface. Its extreme length north and south is 483 mi.. and its extreme width east and west is 320 mi. Its name, a Spanish word meaning "snow-clad," was originally applied to the snon-capped Sierra Nevada on the Pacific slope. The capital is at Carson City. The state motto is "All for Our Country." The state flower is the sagebrush. The state flag is of solid cobalt blue, with. in the upper left quarter, crossed sprays of sagebrush surmounted by a scroll bearing the words "Battle Born" and by a single silver star.

PHYSICAL GEOGRAPHY

Physical **Features.**—With the exception of its northeast and southeast corners, the state (between approximately 35° and 42° N. lat. and 114° 2' and 120° W. long.) lies wholly nithin the Great Basin, the floor of which is really a vast tableland between 4,000 and 5.000 ft. above the sea. This plateau. however, is not a plain, but contains many buttes, mesas and isolated mountain ranges, the latter running generally in a north–south direction and rising 1,000 to 7,000 ft. above the level of the plain. These ranges are from 5 to 20 mi. wide at their bases, and the valleys between are of about the same width. The total area of the valleys is about equal to that of mountainous land.

In the northeast an unnamed range of highlands, broken and ill-defined, with a general east–west trend. forms the water parting between tributaries of the Humboldt river in the Great Basin region and those rivers that flow to the Snake river in Idaho and Oregon and from there via the Columbia to the Pacific ocean. This drainage area of the Snake amounts to about 5.000 sq.mi., the Owyhee, Little Owyhee and Bruneau rivers and Salmon Falls creek being the principal streams. In the southeast corner is the third drainage system. There the Virgin river from Utah, after crossing the northwest corner of Arizona, enters the state and flows southwest for 60 mi. until it joins the Colorado river. The latter stream flows for 150 mi. along the southeastern boundary toward the Gulf of California.

The Colorado leaves Nevada at an altitude of only 470 ft. above sea level, the lowest point in the state. The mean elevation of the state is 5,500 ft. and, with the exception of the dip to the Colorado in the southeast, all of it lies above the 2,000-ft. line.

The Sierra Kevada, which forms the western rim of the basin, sends into the state a single lofty spur, the Washoe mountains. At the foot of this range there is, relatively speaking, a depression, with an altitude of about 3,850 ft. above the sea, which receives the drainage of the eastern slopes of the Sierra, and what little drainage there is in the northern half of Kevada. From this depression eastward the general level of the plateau rises to an elevation of 6,000 ft. near the eastern borders of the state.

The mountain ranges also increase in height and importance as far as the East Humboldt range, a lofty mass about 60 mi. W. of the Utah boundary. This range is the water parting for nearly all the westward-flowing streams of the state, and is by far the steepest and most rugged within Nevada, a number of its peaks attaining a height of more than 8.000 ft. On its eastern slope the waters soon disappear within the bed of narrow canyons, but break out again at the foot in ice-cold springs that form the source of the Ruby and Franklin lakes; on its western side the descent is more gentle, and the waters form the south fork of the Humboldt river. The two highest mountain peaks in the state are Boundary peak of the White mountains in Esmeralda county (13,145 ft.) and Wheeler peak of the Snake range in White Pine county (13,063 ft.).

The Humboldt is the most important of the basin streams. Rising in the northeast it flows in a tortuous channel in a general southwesterly direction for 290 mi. and drains 7,000 or 8.000 sq.mi. It empties into Humboldt lake, the overflow from which goes into the so-called Carson sink. At no part of its course is the Humboldt a large river, and near its mouth its waters are subalkaline. The Truckee, Carson and Walker rivers flow with more vigour, receiving their waters from the eastern slopes of the Sierra Nevada and discharging them into alkaline lakes. Of these lakes Pyramid is the largest. being about 30 mi. long and 4 to 13 mi. wide. Walker lake is 33 mi. long but only six or seven miles in width. These larger lakes always contain water. varying only in area and depth. but the smaller lakes usually evaporate in the course of the summer. The latter are formed by waters that fall on barren mountainsides and rush down in torrents, forming in the valleys shallow bodies of water yellow with mud held in suspension.

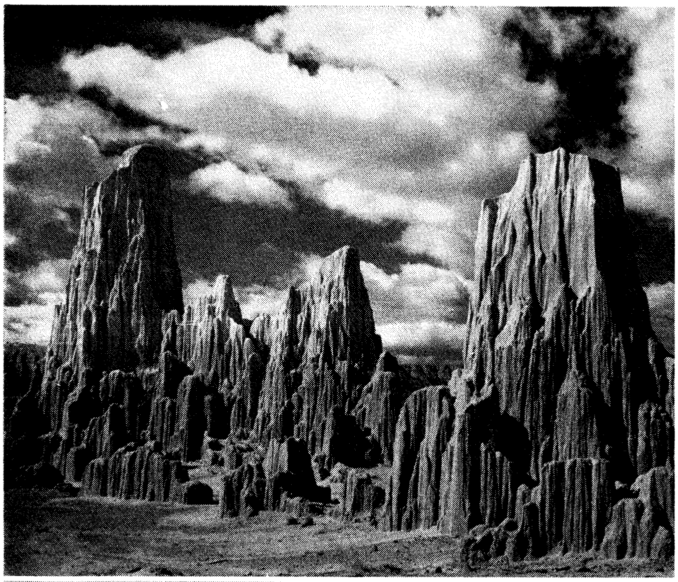
Climate.—The skies of Nevada are clear nearly every day in the year. The mean annual precipitation varies from 3 in. in the southwest (Esmeralda county) to 12 in. in the east (White Pine county), and varies also according to altitude. Snow rarely lies on the ground in the valleys. Prevailing winds are from the south, southwest and nest.

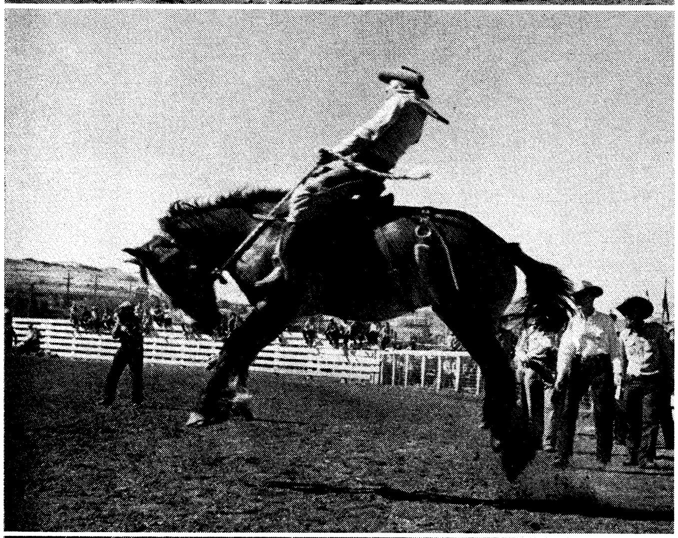
Soil.—There are three general types of soil in Nevada. Gray desert soils are found in the arid low country and on the low slopes going up into the mountains. The mountains. generally arid or semiarid, have various mountain varieties of soils. Alluvial soils are found along the rivers.

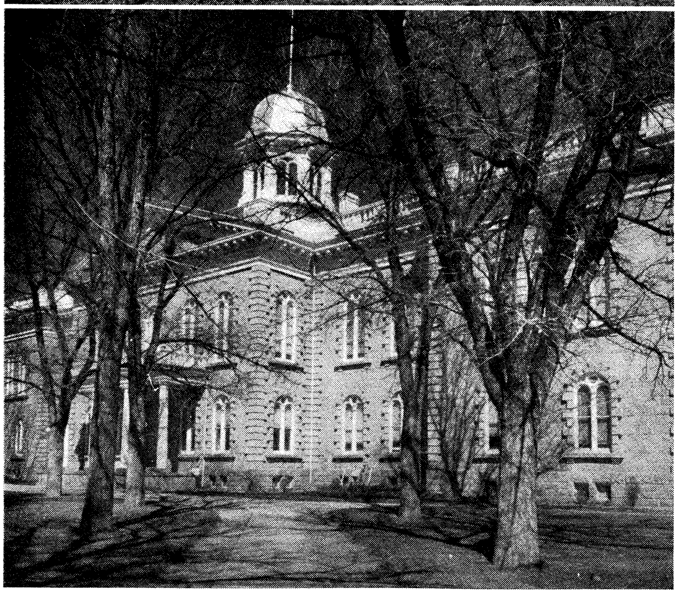
Vegetation.—Except for the alkali flats no portion of the desert is devoid of vegetation, even in the driest seasons. In the Washoe mountains there is a heavy gronth of conifers extending down into the valleys. but in many places these mountains have been almost deforested to provide timber for the mines. In other places these areas have been incorporated into national forests, in the endeavour to protect and foster the growth of timber and vegetation so as to regulate the drainage of the state. On all but the lowest ranges of the basin the piiion and juniper are found, but these rarely grow to a height of more than 15 ft., on the principal ranges above 6.800 ft. is the stunted mountain mahogany. But except for these infrequent wooded areas, the mountains are even more bare than the valleys, because their shrubs are dwarfed from exposure. The valleys are covered with typical desert shrubs, greasewood, creosote bushes and sagebrush, and with bunch grass, which is valuable for grazing. The three-dented leaf sagebrush (*Artemisia tridentata*) is the commonest of the many species of sagebrush, growing sometimes to a height of ten feet with a silvery green leaf and yellow flower stalk. The creosote bush (*Covillea tridentata*), typical of the vegetation of the southern part of the state. has conspicuous yellow flowers. About 30 species of cacti are found in Sevada, and a number of yuccas, most conspicuous of which is the Joshua tree (Yucca *brevifolia*), which may reach a height of 40 ft.

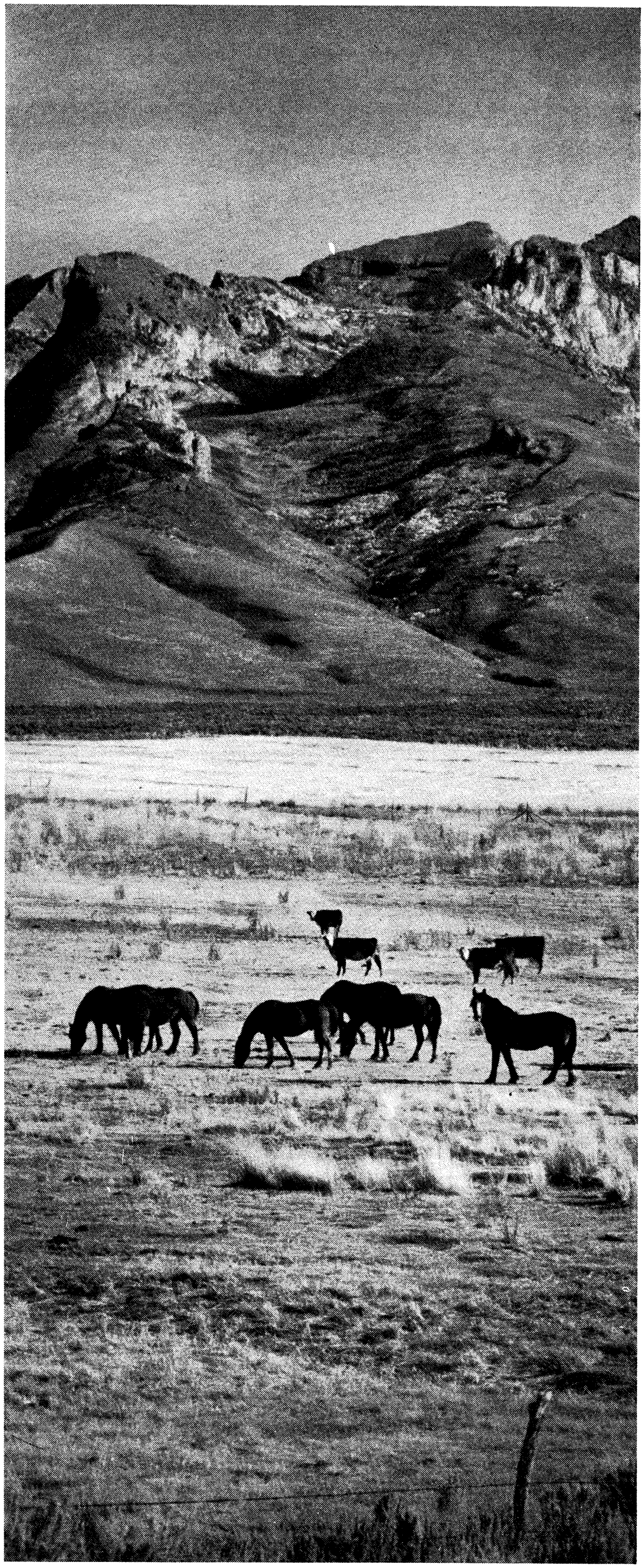
Animal Life.—Deer are very common in Nevada. along with certain predatory animals such as the coyote. badger and bobcat. Among the rodents. several varieties of jackrabbits and many types of ground squirrels and desert mice and rats are prevalent in the desert country. The magpie and western varieties of sparrow are common, while the golden eagle is found sparingly in the state.

Parks and **Recreation.**—Nevada has many scenic attractions. many of them. such as the Death Valley National monument and the Black Rock desert, in the desert country. The Lehman caves, a limestone cavern, is 68 mi. S.E. of Ely and the Jarbridge canyon is in northern Elko county. The \'alley of Fire. 50 mi. N.E. of Las Vegas, has thousands of prehistoric Indian drawings and fragments of petrified forest intermixed with red sandstone. Cathedral gorge in Lincoln county has been called a Bryce canyon in miniature. Hoover dam is 30 mi. from Las Vegas. Lake Mead! created by the dam and one of the largest man-made lakes in the world. provides year-round fishing and water sports, Walker and Pyramid lakes (remnants of the prehistoric Lahontan lake) are scenic and sporting attractions. Lake Tahoe lies across the California-Sevnda boundary and its beaches attract many sports enthusiasts. The state also has several excellent winter sports areas. largely in the Sierra Nevada. Reno is the central point for the ski country of the Sierras. but other ski resorts are found in the Ruby mountains near Elko. the Ward mountains near Ely and the Charleston park area 35 mi. N.W. of Las Vegas.









PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) JOSEF MUENCH (CENTRE LEFT) A DEVANEY. (BOTTOM LEFT DEANE DICKASON FROM EWING GALLOWAY

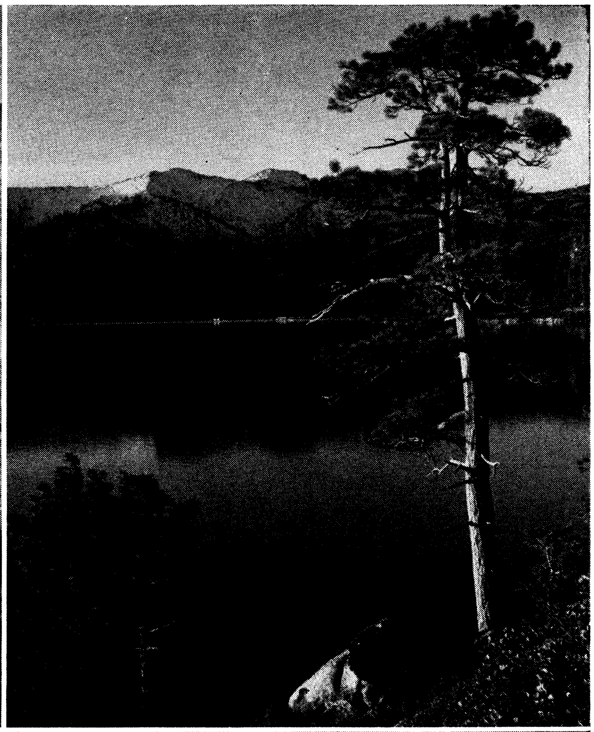
SCENES IN NEVADA

Top left: An erosion in Cathedral Gorge State park. Wind and rain have eroded the chalky clay into Gothiclike formations

Right: Horses and cattle grazing on pastures leading to the western slopes of the Ruby mountains. At the highest point the mountains rise nearly 7,000 ft. above the range iands

Centre left: "Broncho-busting" at Reno. During the annual rodeo all persons in the city are required to wear western dress

Bottom left: The state capitol. Carson City is the smallest capital city in the U.S.



PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) JOSEF MUENCH, (BOTTOM) EWING GALLOWAY

MINING AND MOUNTAINS IN NEVADA

Top *left:* The Kennecott open-pit copper mine at Ruth is more than a mile in diameter and 1,000ft. deep. Copper leads in value among the state's mineral products

Top *right:* Lake Tahoe, with the Sierra Nevadas in the background. The lake, ringed by high Sierra peaks, is blue-green in coiour because of its great depth, at one point, 1,776ft.

Bottom: Virginia City, one of the famous mining camps of the old west, was a boom town during the exploitation of the Comstock lode, one of the richest deposits of silver ever recorded

HISTORY

The first recorded person of European descent to enter the limits of Nevada was Francisco Garcés of the Order of St. Francis, who set out from Sonora in 1775 and passed through what is now the extreme southern corner of the statr ori his way to California. Hali a century later trappers of the Hudson's Bay company led by Peter Skene Ogden entered Nevada from the north and discovered the Humboldt river. In 1827 Jedediah Smith, an American trader from St. Louis, crossed the state from west to east on his return from California after the first recorded journey from the Mississippi to the Pacific by the central route. In 1833 Capt. Benjamin Bonneville's men were on the Humholdt. and during 1843–45 John C. Frémont made a series of explorations in the region.

The first recorded emigrant train to California crossed the state in 1841.

Territorial Period. — By the treaty of Guadalupe Hidalgo, negotiated in 1848 at the close of the war with Mexico, Xevada became U.S. territory. It was then a part of California known as the Washoe country and so remained until 1850, when most of the present state was included in the newly organized territory of Utah (*q.v.*). One of the first settlements was made in 1849 by Mormons at Genoa in the valley of the Carson river. There in 1851 the earliest recorded public meeting in the state was held to frame a government for the settlers since the seat of the territorial government of Utah was considered too remote to afford protection to life and property. But the Utah authorities intervened, and in 1854 the Utah legislature created the county of Carson to include all settlements in western Ctah.

In 1858 Carson City (*q.v.*) was laid out. and in the following year the people of Carson county chose delegates to a constitutional convention which met at Genoa and drafted a constitution. It was adopted by vote of the people, but this attempt to create a new state government proved abortive. and it was not until the mineral wealth of the Washoe country became generally known that congress took action.

In 1861 the territory of Utah was divided at 39° W. of Washington. D.C. and the western portion was called Xevada. The Comstock lode. one of the richest deposits of precious metal known in the world, was discovered in 1859, and Nevada ceased to be merely a highway for gold seekers on the way to California and became a stopping place. Virginia City became the most famous of all the mining camps of the far west (see VIRGINIA CITY).

Statehood. — An attempt to win statehood in 1863 was defeated, but in 1864 when it became evident that two more Republican votes were needed in the U.S. senate for reconstruction purposes, party leaders at Washington urged the people of Nevada to adopt a constitution and enter the union as a patriotic duty. The third constitutional convention met at Carson City and drew up a constitution which was duly ratified and in October of that year, Pres. Abraham Lincoln proclaimed the new state. The eastern boundary was pushed eastward to its present location on the 37th meridian west of Washington, D.C., in 1566; the southern boundary also was fixed in that year.

Nevada was loyal to the union throughout the Civil War. In 1861 the territory furnished a company of troops that was joined to a California regiment. In 1863 the territory raised six companies of infantry and six of cavalry (about 1,000 men). which saw no actual service against the Confederates but were useful in subduing hostile Indians.

The history of the state since its organization has been largely a history of its mines. From 1864 to 1868 there mas a general reaction in the industry caused by unwarranted speculation and inflated values. After 1868 there came a period of consolidation, of more systematic workings. and of deeper development. In 1873 came the discovery of the "big bonanza" by John Mackay, James Fair. William O'Brien and James C. Flood. who became the four "bonanza kings" of Nevada. In 1873. $21,000,000 was taken from the Comstock and production increased until a maximum of $36,000,000 was reached in 1878. The Sutro tunnel intersected the lode in the latter year and drained the mines. But the richer workings soon proved below the tunnel level and the shafts were sent deeper. In 1882 an immense flow of hot water was struck which flooded the principal mines up to the Sutro tunnel level. The miners were forced to return to the upper levels and work the lower-grade ores. Production decreased, and with the end in sight the market slumped. Also, the national government had abandoned its artihcial maintenance of the price of silver.

The period of depression lasted until about 1900 when the discovery of a new mineral belt in southern Nevada brought renewed prosperity. Tonopah, 60 mi. from the railroad. became the new Mecca. Fast upon the heels of the Tonopah discovery came that at Goldfield (*q.v.*). A railway mas completed to the new camps in 1903, and Tonopah proved to be one of the largest and steatliest producing districts of the state. Copper ores of vast extent were discovered at Ely at about the same time. and the Nevada Northern railway was completed to this camp in 1907.

The depression immediately before 1900 served a good purpose in turning attention to the agricultural and livestock possibilities of the state. Accessibility of markets through improved rail nnd highway transportation facilities aided in the expansion of the livestock industry. The river valleys under irrigation proved most fertile. and these were soon settled by large-scale ranchers. On the river bottoms the ranchers raised their hay and controlled a still larger acreage of the upland grazing ground. Private irrigation systems were supplemented by federal undertakings. the most notable being the Truckee-Carson project. 'The prosperity of many beautiful valley towns came to be founded on the permanent basis of agriculture rather than the uncertain one of mining.

Until the silver agitation of the 1890s Nevada was safely Republican. The state's politics in the early period were highly corrupt, and many rich mine owners were accused of buying their seats in the United States senate. For iour state elections the Silver party swept the state. After the issue subsided the old parties came into control.

After the legalization of gambling in 1931 and the reduction to six weeks of the residence requirement for divorce. Nevada became a marriage. divorce and resort centre. The principal resort areas are Las Vegas, Reno (*qq.v.*) and Lake Tahoe. Las Vegas attracts most of its tourists from the Los Angeles area. and it is famous for its resort hotels and gambling casinos. Reno draws many pleasure seekers from the San Francisco bay area. The gambling tax is second only to the sales tax in revenue from taxation for the state. Nevada's liberal divorce laws attract people from all parts of the country; because of the no-waiting period for marriages, however, many more weddings than divorces are performed in the state.

In the post-World War II years. Yucca Flats near Las Vegas became the primary testing ground for atomic and hydrogen bombs.

GOVERNMENT

Nevada is governed under its original constitution, adopted in 1863 and since amended in important respects. The usual method of amendment is the passage of a proposal by a majority of both houses of two consecutive legislatures followed by popular approval at a general election. In the 1958 election. for the fir:-t time in the history of the state, an amendment proposed by initiative petition was passed by the people.

Executive. — The principal executive officers of the state are the governor. lieutenant governor. secretary of state. attorney general. controller and treasurer, all elected for four-year terms. The governor possesses a limited pardoning power in that he must have the support of two other members of the Pardons and Parole board (the three justices of the supreme court and the attorney generalj. There are many administrative boards and commissions, the most important of them being the tax commission. board of education, welfare board. board of health, board of examiners, public service commission, industrial commission, highway board, fish and game commission and Colorado river commission.

Legislative. — The legislature; composed of a senate and assembly, meets in regular session in January of odd-numbered years. There is no constitutional limit on the length of a regular or special session. but salaries of legislators cease after 60 and 20 days. respectively. The constitution requires the number of assemblymen (apportioned according to population, with each county having at least one) shall not be less than twice nor more than three times the number of senators (each county having one). With the overwhelming majority of the population of the state concentrated in two counties (Clark and Washoe), the rural areas have been traditionally over-represented in the legislature. Senators are elected for four years, approximately one-half the membership retiring every two years; the entire assembly is elected biennially. Nevada joined in the Populist movement for more direct control of the government. by the people in adopting the referendum in 1904 and initiative and recall in 1912.

Judiciary.— The supreme court consists of a chief justice and two associate justices elected for six-year staggered terms. The number of district courts and judges (elected for four-year terms) is determined by the legislature. The great number of divorce cases made it necessary to expand the number of district judges who sit in Las Vegas and Reno. Each township has a justice of the peace who is elected for a two-year term.

Finance.— The state legislature authorizes all expenditures, and in turn fixes a tax levy which is intended to produce revenue enough to meet these expenditures. The supervision of the assessment and collection of taxes is in the hands of the Nevada tax commission. consisting of the governor. acting as chairman, and six commissioners appointed by him. The director of the budget prepares the annual state budget and exercises control of departmental spending. The director and the state hoard of examiners scrutinize every expenditure item. The post audit function is performed by the legislative auditor responsible to the legislature and the legislative counsel bureau.

The major sources of tax income to the state are general sales tax. gambling tax, motor fuel taxes, motor vehicle licence taxes, cigarette tax and liquor tax. Almost all of the property tax is turned over to local units—schools. cities and counties. For the property tax there is a constitutional limit of $5 on each $100 valuation. Also, the state indebtedness cannot exceed 1% of the total assessed valuation of property in the state.

POPULATION

The population of Nevada in 1860 was 6.857; in 1880 it was 62,266 (as a result of the ore discoveries); in 1910, 81.875; in

*Nevada: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	285,278	160,083	110,247	77,407	42,335
Carson City	5,163	3,082	2,478	1,685	2,100
Elko	6,298	5,393	4,094	2,173	—
Henderson	12,525	3,643	—	—	—
Las Vegas	64,405	24,624	8,422	2,304	—
North Las Vegas	18,422	3,875	—	—	—
Reno	51,470	32,497	21,317	12,016	4,500
Sparks	16,618	8,203	5,318	3,238	—

*Populations are reported as constituted at date of each census. Note: Dash indicates place did not exist during reported census, or data not available.

1940, 110,247; in 1950, 160,083; and in 1960, 285.278. This last figure represented an increase of 78.2% over the population in 1950. The population per square mile in 1960 was 2.6, as compared with 1.5 in 1950 and with 49.6 for the U.S. in 1960.

Of the 1960 population 200,704 or 70.4%, lived in incorporated places of 2,500 or more, as compared with 52.5% in 1950 and 39.3% in 1940.

The state has two standard metropolitan statistical areas, which are Las Vegas and Reno. These areas had a total population of 211,759 or 74.2% of the total population of the state in 1900.

The number of occupied dwelling units (or households) in 1960 was 102,694. as coinpared with 56.515 in 1950. The average population per household had declined from 3.3 in 1940 to 3.1 in 1950 and increased to 5.0 in 1960.

The population of the state was distributed by colour and nativity in 1950 as follows: 87.1% native white; 6 6% foreign-born white; and 6.3% nonwhite. mainly Indians. There were 113.4 males per 100 females in the native white population and 159.9 in the foreign-born. Seven per cent of the population was 65 years old or over; 58.8% of the population 14 years old and over was in the labour force. Of the total number of employed males, 13.1% was engaged in agriculture, 6.8% in mining. 11.2% in construction, 6.1% in manufacturing, 11.0% in transportation and 17.5% in wholesale and retail trade.

There are 14 Indian reservations, in addition to several Indian colonies, in the state. The two dominant tribes are Paiutes and Shoshones (*qq.v.*j.

EDUCATION

The state board of education is composed of eight lay members. Six of these are elected—one from each of the six educational supervision districts of the state—and two members are appointed by the elected members. The board appoints a superintendent of public instruction who is the executive head of the state department of education. The superintendent has no fixed term, serving at the pleasure of the board. The school districts are coextensive with the counties; and the districts receive substantial grants from the state treasury, with the amount based on the number of pupils attending school in a particular district. School attendance is compulsory for children between the ages of 7 and 17.

The only institution of higher learning in the state is the University of Nevada, with the main branch situated in Reno and a southern division at Las Vegas. (The university was originally established at Elko in 1874 but was moved to a 60-ac. Reno campus in 1886.j The university is divided into the following colleges: agriculture, arts and science. business administration, education, engineering, mines and a school of nursing. in addition to a graduate division. The extension division carries on an ambitious program of taking classes to various parts of the state. The university library numbers 125.000 volumes.

The governing body of the university is a nine-man board of regents, with three members elected from Washoe county, three from Clark county and three from the 15 small-population counties. The board members serve four-year terms.

HEALTH, WELFARE AND CORRECTIONS

A state orphans' home is located at Carson City, a state hospital for mental diseases at Sparks and a home for male juvenile delinquents at Elko. The state penitentiary is at Carson City. The departments of health and welfare are two of the most important in the state from the standpoint of expenditures of funds.

THE ECONOMY

Agriculture.—Nevada is the most arid state of the United States because the high Sierra Nevada interrupts the moisture-laden clouds from the Pacific. East of these mountains, the valleys. however rich their soils, are covered with sagebrush and appear like monotonous desert wastes, except where some stream annually overflows its banks to create natural meadows, or where the land has been cleared of sagebrush and artificially watered. Agriculture is dependent almost entirely upon irrigation.

Principal crops in Nevada are hay, barley, wheat, oats and corn. In the southern part of the state, hay and forage. wheat, tomato plants and barley are the principal corps, with berries, apples and other orchard fruits growing on both irrigated and unirrigated lands.

In this arid region livestock are a far more important source of farm income than are crops. Approximately 65% of the agricultural income of the state is derived from grazing sources, and in 14 of the 17 counties livestock raising and farming dominate over any other industry (with the exception of gambling in Washoe and Clark counties). The average sized ranch in mid-20th century was 3.428 ac., with the larger ranching operations found in Elko, Humboldt and I'ershing counties in the north and in Eureka, Lander and White Pine counties in the central and eastern sections. Many Basque sheepherders have settled in White Pine and Humboldt counties.

Mining.——Nevada metal production (see *History* above) reached its peak in 1917, when gold, silver, copper, lead and zinc were produced to the value of $54,424,580. The pears 1918–21 were years of swift decline, the production in 1919 being less than half that of 1918, and that of 1021 only half that of 1919. There was an upward turn in 1023 and a steady rise from their through 0 2 Then the depression of 1929 caused a sharp decline.

Gold and silver were first to recover from the depression because of the revaluation of the gold dollar and the passage of the Silver Purchase act in 1934. The production of both metals declined sharply, however, during World War II. 'The production of copper was stimulated by defense needs during World War II, but after the war this need declined also.

In the early post-World War II years, Nevada continued to be an outstanding producer of mercury, tungsten, antimony and gypsum. However. in the late 1950s the reduction of the federal government's price-support program and foreign competition resulted in the shutting down of most of the mines in Nevada. 'The Ely and Pioche areas were especially hard hit.

Manufacturing.—Manufacturing is very limited in scope and production. The 1954 census of manufactures showed 177 industrial establishments in the state. producing lumber and wood products; stone, glass and clay products; chemicals, insecticides and allied products: gypsum board; and titanium sponge.

Transportation and Communication.—Nevada is crossed east and west by three main lines of railway, the Southern Pacific and the Western Pacific in the northern part and the Union Pacific system in the southern part. Branch lines connect the more important mining towns with these lines. Railway mileage in the state reached a peak in 1915 when it amounted to 2.332 mi.: by the early 1960s it had decreased to about 1,500 mi. There are about 4.500 mi. of road in tht: designated state highway system, mostly paved. Several airlines operate in the state. There are more than 20 radio and television stations, the majority being in the Reno and Las Vegas areas.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history. are summarized annually in the *Britannica* Rook of *the Year,* American edition.

(E. C. D. M.; J. E. Spr.; D. W. Ds.)

NEVAI, ALISHIR (1441–1501), Turkish poet and scholar. is the greatest representative of Chagatai Turkish literature. He was horn in 1441 into an Uygur family in Herat, where his father was a member of the court chancellery. 'The king of Khorasan took him under his protection and thus he met the leading poets and scholars of the day. Under Hüseyin Baykara, his school friend, who succeeded to the throne of Herat, Nevai held a number of offices, but the latter part of liis life lie devoted to poetry and scholarship. His poetry includes four *divans* (collections) belonging to different phases of his life, arid five romances on conventional themes, inspired by the *Khamsa* of Nizami (*q.v.*). His main prose works are: *Muhakemet-ul-lugateyn,* a comparison of the Persian and 'Turkish languages; *Mecalis-un-nefais,* the first collection of biographical articles on Turkish poets; and *Mizan-ul-evzan*, a treatise on Turkish poetic art. His mastery of the eastern Turkish language both in poetry arid prose was such that classical Chagatai came to be known as "the language of Nevai."

See A. Bombaci, *Storia della litteratura turca* (1956). (F. I.)

NEVERS, a town of France, capital oi the *département* of Nièvre, 159 mi. S.S.E. of Paris by the P.L.M. railway to Nîmes. Pop. (1954) 33,918. *Noviodunum,* the early name of Nevers, was Inter altered to *Nebirnum.* Many medals and Roman antiquities found there show its importance when Caesar chose it as a military depôt. In 52 B.C. tlie town was the first place siezed by the revolting Aedui. It became the seat of a bishopric at the end of the 5th century.

Having formed part of the duchy of Burgundy, the county of Nevers (Nivernais) was given by Duke Henry I in 987 to his stepson Otto Williams, afterwards count of Mâcon from nhorn it passed to his son-in-law, Landri The first house of the hereditary counts of Severs originated in Landri, and was brought to an end in 1192 by the death of Agnes, countess of Sexers, wife of Pierre de Courtenay (d 1217).

'The county subsequently passed into the houses of Donzy, Châtillon and Bourbon. Severs is on the Loire where it joins the Nièvre Narrow minding streets lead from the quay through the town, with many old houses (14th to the 17th centuries). The cathedral of St. Cyr is a combination of two churches, one Romanesque (11th century), the other Gothic (14th century). There is a fine squ ire (16th century) tower on the south side. The church of St. Étienne is 11th century Romanesque. 'The ducal palace at Nevers (now occupied by the courts of justice and an important ceramic museum) was built in the 15th and 16th centuries arid is one of the chief feudal buildings in central France An octagonal middle toaer contains the great staircase. and its windows are adorned by sculptures relating to the history oi the house of Clèves The Porte du Croux a square toner, with corner turrets (14th century) is among the remnants of the old fortifications.

Nevers is the seat of a bishopric under the archbishop of Sens, of tribunals of first instance and of commerce and of a court of assizes and has a chamber of commerce.

NEVILLE or Nevill, the family name of a famous English noble house, descended from Dolfin, son of Uchtred, who had a grant from the prior of Durham in 1131 of "Staindropshire," Co. Durham, a territory which remained in the hands of his descendants for over four centuries, and in which stood Raby castle. their chief seat.

His grandson, Robert, son of Meldred, married the heiress of Geoffrey de Neville (d. 1192–93), who inherited from her mother the Bulmer lordship of Brancepeth near Durham. Henceforth Brancepeth castle became the other seat of the house, of which the bull's head crest commemorates the Bulmers; but it adopted the Norman surname of Neville (*Neuville*). Robert's grandson, another Robert jd. 1282), helti high position in Northumbria, and sided with Henry III in the Barons' War, as did his younger brother, Geoffrey (d. 1285), ancestor of the Nevills of Hornby. This Robert's son, Robert id. 1271), extended the possessions of the family into Yorkshire by his marriage with the heiress of Middleham. 'The summons of their son, Ranulf id. 1331), to parliament as a baron (1294) did hut recognize the position of the Nevills as mighty in the north country. Ralph (d. 1367), the second baron—whose elder brother "the Peacock of the North" was slain by the Douglas in 1318—was employed by Edward III as a commander against the Scots and had a leading part in the victory of Nevill's Cross (1346), where David Bruce was captured. and by which Durham was saved. His active career as head of his house (1331–67) made the name of Nevill a power on the Scottish march.

Of his younger sons, Alexander became arclibishop of York (1374–88) anti was a supporter of Richard II, attending him closely and encouraging his absolutist policy; he was one of those "appealed of treason" by the opposition in 1388 and was outlawed. He died abroad in 1392.

His younger brother, William, a naval commander, was a leading Lollard and a friend of Wycliffe, and in 1388–89 acted with the lords appellant.

John, the 3rd baron (d. 1388), a warden of the Scottish marches and lieutenant of Aquitaine, a follower of John of Gaunt and a famous soldier in the French wars of Edward III., continued the policy of strengthening the family's position by marriage; his sisters and daughters became the wives of great northern lords; his first wife was a Percy, and his second Lord Latimer's heiress; and his younger son, Thomas, became Lord Furnival in right of his wife, while his son by his second wife became Lord Latimer. His eldest son Ralph (1364–1425), 1st earl of Westmorland (see Westmorland, Earls of), married as his second wife a daughter of John of Gaunt and secured heiresses for five of his sons, four of the younger ones becoming peers, while a fifth, Robert, was made bishop of Durham (1438–1457). Among his daughters were the duchesses of Norfolk, Buckingham and York (mother of Edward IV. and Richard III.) and an abbess of Barking. The Nevills were thus closely connected with the houses of Lancaster and York, and had themselves become the most important family in the realm. Of the earl's sons by his second marriage, Richard, earl of Salisbury (and three of his sons) and William, earl of Kent, are the subjects of separate notices.

The greatness of the Nevills centred in the "kingmaker" (Richard's son) and the heads of his house, after the 1st earl, were of small account in history, till Charles, the 6th earl, at the instigation of his wife, Surrey's daughter, joined Northumberland in the fatal northern rising of 1569 to the ruin of his house. His estates, with the noble castles of Brancepeth and Raby, were forfeited; Middleham, with the Yorkshire lands, had been settled by the 1st earl on the heirs of his second marriage.

Although the senior line became extinct on the earl's death abroad (1601), there were male descendants of the 1st earl remaining, sprung from George and Edward, sons of his second marriage. George, who was Lord Latimer, was father of Sir Henry, slain at Edgcote fight, and grandfather of Richard, and lord (1469–1530), a soldier who distinguished himself in the north, especially at Flodden Field. His grandson (d. 1j77) was the last lord, but there were male descendants of his younger sons, one of whom, Edmund, claimed the barony, and after 1601 the earldom of Westmorland, but vainly, owing to its attainder.

The heirs male of Edward, Lord "Bergavenny" (now "Abergavenny" co. Monmouth), who died in 1476, have retained their place in the peerage under that style to the present day. In 1784 the then Lord Abergavenny received an earldom, and the next lord erected at Eridge, Sussex, the present seat of the family, on which the marquisate of Ahergavenny and earldom of Lewes were conferred in 1876. Its Sussex estates are derived through the Beauchamps, from the Fitz Alans, heirs of the Warennes.

See Rowland's *Historical and Genealogical Account of the Family of Nevill* (1830); Drummond's *Noble British Families (1846)*; Swallow's *De Nova Villa* (1885); and Barron's sketch in *The Ancestor*, So. 6 (1903). Also Dugdale's *Baronage;* G. E. C[okayne]'s *Complete Peerage;* J. H. Round's *Feudal England;* and for the Nevill castles Mackenzie's *Castles of England*. For the Kingmaker, *see* Oman's monograph (1891).

NEVILLE'S CROSS, BATTLE OF. This battle of Oct. 17, 1346, took place after Crécy (*q.v.*) and while Edward III. was still abroad, besieging Calais. It foiled the opportunist Scottish invasion, and assured Edward's freedom to continue his French projects. But its main interest in military history is that it affords an example of the offensive power of the new tactical combination of archers and spearmen, in contrast to Dupplin, Halidon Hill, Crécy, Poitiers and Agincourt, which were all won by awaiting the enemy's onslaught. After crossing the border, King David Bruce was surprised by the quickness with which the English, under William de la Zouch, archbishop of Yurk, concentrated to meet him. Driven to accept battle near Durham, the Scottish king took up his position to resist attack, his pikemen formed in three great "schiltrons." The English advanced, with their left leading, and the archers on this wing overlapped and swarmed round the Scottish right flank "schiltron." When this broke under the arrow-storm, they closed on the centre "schiltron" —already attacked in front. Its collapse, in turn, under the converging pressure, led to the capture of the king and the hurried retreat of the remaining left division of pikemen. Thus the archers proved their power against an immobile foe to pave the way for a successful assault by knights and men-at-arms,

NEVIN, ETHELBERT (1862–1901), American composer, was burn at Edgeworth, Pa., Nov. 25, 1862. His musical talent displayed itself in childhood. He studied in Boston, 1884, before going to Berlin to continue work under Klindworth and Von Buelow, who encouraged his ability as composer. After teaching in Boston (1887–93), he returned to Europe residing for a time in Paris, Berlin, Florence and Venice as well as in Algiers. In 1900 he went back to the Cnited States, becoming associated with Horatio Parker in the department of music at Yale university. He died at New Haven, Conn., Feb. 17, 1901. Ranked with the foremost of American song-writers, he was also the composer of many instrumental pieces, mostly in miniature form, marked by a delicate, melodious originality. Among his compositions were *Water Scenes* for the piano, including the favourite *Narcissus;* a piano suite, *In Tuscany;* the song cycles, *In Arcady* and *The Quest of the Heart's Desire,* the latter posthumously published as was also *Tempo di Valse;* a *Sketch Book* of songs and piano music; and *The Rosary,* the song that became instantly popular at a concert at Madison Square Garden, New York, Feb. 15, 1898.

See J. T. Howard, *Ethelbert Nevin* (1935).

NEVIS, an island in the British West Indies Federation, forming with St. Kitts one of the four presidencies in the colony of the Leeward Islands. Pop. (1946) 15.698. It lies in 17° 14' N. and 62° 33' W., and is separated from St. Kitts by a shallow channel 2 mi. wide at its narrowest point. The island is almost circular, and from the sea has the appearance of a perfect cone. rising gradually to a height of 3,596 ft. Total area, 50 sq.mi. Average temperature. 82° F. Sea-island cotton is the chief crop, and some sugar is raised. Agriculture is almost entirely in the hands of small proprietors. Charlestown, the chief town and port. lies on the southwest coast. Alexander Hamilton, drafter of the U.S. constitution, was born there in 1757. Discovered by Columbus in 1493. Nevis was first colonized by the English in 1628; captured by the French in 1782, it was restored to Britain the next year.

NEVUS: *see* NAEVUS.

NEW ALBANY, a city of southern Indiana, U.S., is near the falls of the Ohio river. opposite Louisville. Ky., and is the seat of Floyd county. (For comparative population figures *see* table in INDIANA: *Population.*) In 1806 what is now New Albany was the site where hoats and volunteers were gathered for Aaron Burr's ill-fated expedition down the Mississippi. Joel Scribner and his brothers. Nathaniel and Abner. laid out the town in 1813. Local trade flourished and from 1840 to 1850 New Albany was the most populous city in Indiana, having been chartered in 1539. Some noted river steamboats were built there, including the "Eclipse" (1852), the "A. L. Shotwell" (1853) and the first "Robert E. Lee" (1867). An era of diversified industrialization began in the 1870s centring around the enterprises of Washington C. DePauw (1822–87). Most prominent of these was one of the first plate glass factories in the U.S. After 1000 manufacture of plywood, home construction materials. furniture, fertilizer, clothing and leather goods were leading industries. (V. M. B.)

NEWARK, DAVID LESLIE, LORD (1601–1682), Scottish general. fifth son of Sir Patrick Leslie of Pitcairly, Fifeshire, commendator of Lindores, and Lady Jean Stuart, daughter of the 1st earl of Orkney. In his early life he served in the army of Gustavus Xdolphus, where he rose to the rank of colonel of cavalry. In 1640 he returned to Scotland. He was major general under Alexander Leslie. earl of Leven, at Marston Moor. He was then sent into the northwestern counties, and besieged and took Carlisle. When. after the battle of Kilsyth, Scotland was at the mercy of the earl of Montrose and his army, Leslie was recalled from England in 1645, and made lieutenant general of horse. In September he surprised and routed Montrose at Philiphaugh near Selkirk. He was then declared lieutenant general of the forces. After a short period of service in England he returned to Scotland, and reduced several of the Highland clans.

In 16jo Newark was sent against Montrose, who was defeated and captured by Maj. Archibald Strachan, Leslie's advance guard commander; and later in the year, all parties having for the moment combined to support Charles II, Leslie was appointed to the chief command of the new army levied on behalf of Charles II. The result, though disastrous, abundantly demonstrated Leslie's capacity as a soldier, and it might be claimed for him that Oliver Cromwell and the English regulars proved no match for him until his movements were interfered with and his army reduced to indiscipline by the representatives of the Kirk party that accompanied his headquarters. After Dunbar Leslie fought a stubborn defensive campaign up to the crossing of the Forth by Cromwell, and then accompanied Charles to Worcester, where he was lieutenant general under the king. On the defeat of the royal army Leslie was committed to the Tower, where he remained till the Restoration in 1660. In 1661 he mas created Lord Newark, and received a pension of £500 per annum. He died in 1682. The title became extinct in 1790.

NEWARK, a city and port of entry in northeastern New Jersey. U.S., is located on the west bank of the Passaic river and Newark bay. 8 mi. TT. of lower Manhattan (New York city); the seat of Essex county. Newark, which is part of the New York standard consolidated area. had a population (1960) of 405.220. The Newark standard metropolitan statistical area. which includes Essex. Morris and Union counties, had a population of 1,689,420.

The city. which has 13 mi. of water front, is generally level but rises gradually from the Passaic river westward. It is laid out in an irregular pattern and closely built up in the downtown section.

History. — Sewark was founded in 1666 by Puritans who migrated from Connecticut under the leadership of Capt. Robert Treat. The settlement was established on land purchased from the Hackensack Indians for arms. ammunition. horses, clothing. uniforms and liquor. The purchase included almost all of what is now Essex county and part of Union county. It mas first named Pesayak Towne and later New Milford after Milford, Conn.. from which some of the original settlers had come. The name was changed to Newark in honour of their pastor. Rev. Abraham Pierson (1608–1678), who came from Newark-on-Trent, Eng. Newark was chartered as a township in 1693 and incorporated as a city in 1836. For more than a century after its iounding, Newark remained a quiet village of about 1.200 persons: but then experienced a sudden manufacturing and population expansion. Moses Combs. a local shoe cobbler: is credited with giving the industrial beginning to the town by starting its first shoe factory. Newark soon became a centre for leather tanning and shoe manufacture. and its industries included quarries. mills and iron ioundries, as well as stage coach and jewelry manufacturing. Its leading inventors were Seth Boyden. who developed the processes for making patent leather (1818) and malleable cast iron (1826); Rev. Hannihal Goodwin, inventor in 1887 of the flexible film used in motion pictures and Edward Weston, mho invented electrical measuring instruments.

Between 1850 and 1920 the city underwent rapid growth and expansion, its population increasing from 38.894 in 1850 to 414,-524 in 1920. Between 1020 and 1930 the rate of increase fell off, and the next decade saw a slight drop in population (2.8%). This decline was mainly attributed to problems of urban blight that have plagued industrial centres and the resulting flight to the suburbs. During the 1940s, partially because of World War II, this tide was temporarily reversed and in the mid-1950s Newark experienced the beginnings of rejuvenation, with large-scale construction projects designed to stem urban blight. These projects, however, were not effective enough, and in 1960 Newark had nearly 8% fewer inhabitants than in 1950. At the same time its suburban population increased more than 24%. For comparative population figures see table in NEW JERSEY: *Population.*

Government. — EffectiveJuly 1, 1954. Newark had abandoned the commission form of government established in 1917 and adopted a charter form of the mayor-council type. Executive power is exercised by the mayor, administrative power is vested in an appointed business administrator and legislative power is exercised by the council.

Transportation, Commerce and **Industry.**—Newark has long been a centre for highway, rail, sea and air transportation and a major east coast distributing point for many of the nation's leading products. Both the Newark airport and the Port of Newark are operated by the Port of New York authority *(see* NEW YORK [CITY:]: *Commerce and Industry)* as part of the great Sew York industrial and transportation complex.

The airport, one of the pioneer U.S. airports, was established in 1928 on a 2,200-ac. site three miles from the city's centre. Until the completion of La Guardia field in 1939, it was the principal air passenger terminal for New York city. The Port of Newark, started by the city in 1914 and later leased and operated by the Port of New Tork Authority, has terminal and industrial facilities which make it one of the most efficient ports in the C.S.

Newark has long been noted for industrial diversification and concentration; its products include electrical equipment, chemicals, paints. malt liquors, bread products, processed meats, machinery, leather goods and jewelry. It is also a financial. retail, wholesale and insurance centre with a number of life, fire and casualty companies having their home offices in the city.

Education. — Locatedin Newark are the state-supported Newark College of Engineering (1881); the New Jersey College of Pharmacy (1891), now affiliated with Kutgers university. the state university of New Jersey (see NEW JERSEY: *Education*); other divisions of Rutgers. including the college of arts and sciences, school of business administration, college of nursing and school of law; and the Newark divisions of Seton hall (Roman Catholic, 1856).

Parks **and Recreation.**—Near the centre of town is Military park used as a drill ground in colonial times and preserved as an oasis arnong the department stores and large office buildings. In the park is an imposing bronze group of figures. "The Wars of America." by Gutzon Borglum. To the north is Washington park, flanked by the public library. the Newark museum and several Rutgers university buildings. Branch Brook. a county park, is noted for one of the finest displays of Japanese cherry trees in the eastern United States. In front of the county courthouse. designed by Cass Gilbert, is Borglum's seated statue of Abraham Lincoln. Among churches of historic interest are Trinity Episcopal cathedral (1746), used as an American Revolution hospital. House of Prayer with its two-century old stone rectory. and Old First Presbyterian church (1791). (S. N. W.)

NEWARK, a city of central Ohio. U.S.. 33 mi. N.E. of Columbus is the seat of Licking county. In pre-Columbian times the area was a cultural centre for the Mound builders (*q.v.*). This is attested to by extensive. well-preserved earthworks to be seen in Moundbuilders and Octagon State parks. When first seen by Newark's settlers, these mounds were covered by dense forests containing trees more than 500 years old. The basic reason for the importance of this region to the Stone Age aborigines were the outcroppings of flint in the hills as at Flint Ridge State park nearby.

From its founding in 1801 by migrants from the middle Atlantic states. who settled at the forks of the Licking river, Newark was the trading centre for a prosperous agricultural region. Named for Newark, N.J., the home of an early settler. Newark was platted in 1802. incorporated in 1826 and chartered as a city in 1860. In 1825 the Ohio canal system was initiated at Licking Summit, 4 mi. S. of town and for a time the canal contributed greatly to the city's prosperity. The first railroad reached Newark in 1852, and by 1880 the population had grown to about 10.000. largely the result of industrial expansion. In mid-20th century leading industries included glass fabrication. aluminum processing, truck axles and transmissions, lawn mowers, corrugated boxes and other containers, plastics and petroleum products.

In Granville. 6 mi. E. of Newark, is Denison university (Baptist. 1831), a coeducational college. Buckeve lake is 10 mi. S. For comparative population figures *see* table in *OHIO: Population.* (W. T. U.)

NEWARK-ON-TRENT, a market town and municipal borough in the Newark parliamentary division of Sottinghainshire, Eng., 23 mi. N.E. of Nottingham by road. Pop. (1951) 22.917. Area 5.3 sq.mi. It lies on the navigable Trent river and at the crossing of the Fosse way with the Great Korth road and is the centre of an agricultural district. Though Roman coins and pottery have been found nearby, there is no evidence of its having been a Roman settlement. *Niweweorce* ("the new work") was an important town in Saxon times. In 1055 Newark belonged to Lady Godiva who granted it to the monastery of Stow near Lincoln and it remained in the hands of the bishops of Lincoln until 1549, when it was incorporated.

A castle. probably wooden, and a bridge over the Trent were built by Bishop Alexander between 1123 and 1135, the castle being replaced by a stone building about 1173 by Geoffrey Piantagenet. Of this castle only the gatehouse and west tower stand; the other parts are remains of the rebuilding of about 1280. During the Civil War the castle was garrisoned for Charles I and Newark siege coins were minted there. On its surrender in 1646 a large part of it was destroyed by Cromwell. The cathedrallike parish church of St. Mary Magdalene is one of the finest in the country, its tower and spire being 246 ft. high. The crypt and four piers at the transept crossing are Norman; the lower part of the tower is Early English; the upper part and spire are Decorated; the nave dates from 1384–93 and the chancel from 1489. It contains one of the largest 14th-century brasses in the country and a fine 16th-century oak screen. An interesting monument in the town is the Beaumond cross (possibly 15th century) and among old brick buildings are the 16th-century grammar and song school, part of which contains the museum, and 18th-century town hall in the market place.

The varied trades of Newark consist principally of brewing, malting, the quarrying of limestone and gypsum, the manufacture of ball and roller bearings, plaster and bricks, agricultural implements and beet sugar.

NEWARK WORKS. An elaborate and complicated group of prehistoric works at the junction of two branches of Licking river, near Newark, Licking county, Ohio. Situated on a plain 30 to 50 ft. above the bottom land, the works consist of a series of square, circular, and octagonal enclosures, with mounds, ditches and connecting avenues spreading over nearly 4 sq.mi. They are composed of two groups, nearly 2 mi. apart, connected by two walled avenues averaging 200 ft. wide. The western group consists of a large circle, 3 to 14 ft. high and with a mean diameter of 1,054 ft., connected with a symmetrical octagon by an avenue 300 ft. long and 80 ft. wide. Outside the octagon are two small circles. and at each corner of the octagon is a gateway, opposite which and 60 ft. within is a small mound 3 to 6 ft. in height.

The length of the walls between the centres of the gateways averages 621 ft., from which the greatest variation is only four ft., except in one wall that falls 8 ft. short of the average. From the south side of the octagon a walled avenue stretches southward 2 mi. or more, and from near its east side two similar avenues extend eastward with a low wall on each side, one connecting with the square of the eastern group, the other running east to the descent to the lowland north of the square. Disposed along these avenues are circles.

The eastern group of the works consists of a large circle connected with the square mentioned by a broad avenue and several adjoining lines of walls. The wall of the circle is accompanied with an inside ditch 28 to 40 ft. wide and 8 to 13 ft. deep. while the wall itself is 35 to 55 ft. wide at the base and 5 to 14 ft. high.

NEW BEDFORD, an industrial port of Massachusetts, U.S., 56 mi. S. of Boston at the mouth of the Acushnet river near Buzzards bay. is a port of entry and one of the seats of Bristol county. Pop. (1960) 102,477; standard metropolitan statistical area (Bristol county, Dartmouth, Acushnet, Fairhaven, Plymouth county, Marion and Mattapoisett) 143,176.

Settled in 1652 by colonists from Plymouth who were joined in 1665 by Quakers from Rhode Island, there was no village on the site until 1760, at which time it was part of Dartmouth.

Bedford, as it was then known, assumed importance in 1765 when Joseph Rotch, a Nantucket merchant, built wharves and warehouses and expanded the village's infant whaling industry; in 1787 Bedford was set off from Dartmouth and incorporated as a town; it was chartered as a city in 1847. Fairhaven was separated in 1812. Originally named Bedford by Joseph Russell, one of the founders, in honour of his family's estates in England. it was later changed to New Bedford to distinguish it from Bedford in Middlesex county. During the American Revolution the use of the harbour by American privateers led to an attack on Sept. 5, 1778, by the British under Earl Grey in which 70 ships were burned and the village almost completely destroyed by fire.

By 1820 New Bedford was the leading whaling port of the world, reaching its peak in 1857 with the registry of 329 whaling ships. From 1767 when the "Dartmouth," later one of the Boston Tea Party ships, slid down the ways, New Bedford was also an important shipbuilding centre. With the shifting of whale hunting grounds after 1791 from off Virginia and the Carolinas to the Pacific and after 1848 the arctic waters, the whaling industry began to decline. This decline was accelerated in 1859 by the discovery in Pennsylvania of petroleum, which displaced whale oil as an illuminant in oil lamps and as a lubricant for machinery.

The manufacture of fine cotton fabrics replaced whaling as the chief economic activity. From the founding of the first cotton mill in 1847 to the 1920s New Bedford was a leading textile centre. With the movement of the weaving industry to the southeast after the 1920s, apparel manufacturers moved into the vacated New Bedford mills and constituted the leading economic activity. There was, however, a trend toward diversification of industry with the manufacture of electrical equipment being the most notable development, although a wide variety of products including rubber goods, screws and bolts, twist drills, copper and brass goods and electrical machinery were manufactured.

The port business consisted of coal and petroleum products although over 75,000,000 lb. of fish were landed annually. New Bedford is in the heart of the southern New England resort area.

Local landmarks include Ft. Rodman built during the American Civil War on Clark's Point to guard the harbour, the Bourne Whaling museum and the Seamen's Bethel on Johnny Cake hill made famous in Herman Melville's *Moby Dick.* (I. T. S.)

NEW BERN, a city and port of entry in eastern North Carolina, U.S., is on the Keuse river at the mouth of the Trent, about 110 mi. S.S.E. of Raleigh; the seat of Craven county. Founded in 1710 by about 400 Swiss and Germans under the leadership of Christopher von Graffenried, of Bern, Switz., the settlement was nearly wiped out by Tuscarora Indian uprisings between 1711 and 1713. The town, however, second to be established in North Carolina under the Lords Proprietors, was repopulated and incorporated in 1723.

North Carolina's first printing press (1749) and first tax-supported school (1764) were established there under Royal government. The provincial assembly began meeting in New Bern in 1737 and the city's status as colonial capital of North Carolina was assured by the erection of a costly governor's house by Gov. William Tryon in 1767–70. The main building of "Tryon's Palace" burned in 1798, but was restored, along with its two wings, and opened to visitors in 1959. In 1774 the first provincial congress in North Carolina in opposition to the English was convened at New Bern to elect delegates to the first Continental congress. After the American Revolution, despite the fact that the assembly met in various other towns, New Bern remained the legal capital of North Carolina until the seat of government was moved to Raleigh in 1794.

As in the Revolution. the city suffered little damage during the American Civil War, having been captured early (March 14, 1862) by Federal troops. A yellow fever epidemic in 1864, however, took 1,300 lives in the area.

Prior to the American Revolution New Bern mas one of the leading seaports of North Carolina, trading with New England and the West Indies through Pamlico sound at the mouth of the Neuse, 30 mi. to the east. After the American Revolution, shipbuilding became important and timber and rope were produced. Exports consisted mostly of tobacco, lumber and naval stores.

In the 20th century New Bern, connected by a 12-ft. channel with the Atlantic Intracoastal waterway (*q.v.*) and state-developed deepwater port at Morehead City, became the commercial centre for nearby summer resorts, the large marine corps air station at Cherry Point and farmlands which produce corn, tobacco, soybeans, pulpwood and cotton. Manufactures include lumber products, boats, processed foods, clothing and chemicals.

Noteworthy among the city's older buildings are the Stanly house, now the public library (1780), Attmore house (1790), Presbyterian Church (1822) and Christ Church, with its communion service presented by George II in 1752.

For comparative population figures see table in NORTH CAROLINA: *Population.* (A. T. D.)

NEWBOLT, SIR HENRY JOHN (1862–1938), English author and poet, was born on June 6, 1862, the son of H. F. Newbolt, vicar of St. Mary's, Bilston. He was educated at Clifton college; and at Corpus Christi college, Oxford. He was called to the bar at Lincoln's Inn in 1887 and practised until 1899. His first book was a story. *Taken from the Enemy* (1892), and in 1895 he published a tragedy, *Mordred;* but the publication of his ballads, *Admirals All* (1897). created his literary reputation. These were followed by other volumes of stirring verse. *The* Island *Race* (1898), *The Sailing* of *the Long-ships* (1902). *Songs of the Sea* (1904). From 1900 to 1905 he was editor of the *Monthly Review*. His novels *The Old Country* (1916) and *The New June* (1909), attracted attention. During World War I he was controller of wireless and cables. He was knighted in 1913. In 1914 appeared *Drake's Drum and other Sea Songs*, and *Aladore;* his chief contribution to war poetry was *St. George's* Duy *and Other Poems* (1918). In 1920 he published his *Naval History of the Great War*.

His other works *include:— Tales of the Great War* (1916), *The Book of the Happy Warrior* (1917), and *Submarine and* Anti-*Submarine* (1918), written *primarily* for the young; *A New Study of English Poetry* (1917); *Poetry and Time* (1919); *An English Anthology* (1921); *Studies Green and Gray* (1926); *New Paths on Helicon* (1927); *and Naval Operations—1917 to the Armistice.*

NEW BRIGHTON, residential community of New York city. U.S., is located on the northeast shore of Staten Island (borough of Richmond) at the junction of Kill Van Kull and upper Sen. Tork hay, about 6 mi. S.W. of Manhattan. New Brighton had its beginnings in the New Brighton association. founded in 1834 under the leadership of Thomas E. Davis who purchased extensive property in that area.

In 1536 New Brighton was described by the association as a community that "combines advantages, which it is believed. are unrivalled in this country. Added to its proximity to the great commercial mart of the western hemisphere it possesser a beauty of location. extent of prospect and salubrity of climate that will in vain be sought elsewhere."

In 1866 New Brighton was incorporated as a village enabling the residents to provide themselves with more urban facilities. Horse cars were introduced to connect Ten· Brighton with other villages on the island. the first sewers and street lights appeared. and more and better schools were built. In the latter part of the 19th century New Brighton became one of the most fashionable summer resorts in the east. Only a few of the stately mansions remain as a link with this period when the wealthy patronized the hotels and villas of this area. After 1808 New Brighton was a part of New York city.

Among the points of interest in New Brighton are the Neville house. said to have been built in 1770 and one of the best-preserved colonial houses on Staten Island: the Sailors' Snug Harbor. a home for retired seamen. opened in 1833; and Silver Lake park (207 ac.) which surrounds Silver Lake reservoir. (D. L. D.)

NEW BRITAIN, the largest island of the Bismarck archipelago (*q.v.*), situated to the north of the "tail" of New Guinea. With the adjacent islands. it forms a district of the Trust Territory of New Guinea (*q.v.*), administered by Australia. Indigenous pop. (1954) 87,892. Area (including adjacent islands) 14,100 sq.mi.

The island is arc shaped and about 300 mi. long with an average width of 50 mi. It is rugged and mountainous, several peaks exceeding 7,000 it. and plains are restricted to the coasts. The Whiteman range in the south trends east-west. but farther east the Sakanai mountains extend in a southwest-northeast direction, and in the Gazelle peninsula in the north the Baining mountains have north-south alignment. The mountains are composed of massive limestones. shales and sandstones, nith a number of volcanic cones. There are three areas of active volcanism: at the western extremity of the island southeast of Borgen bay; on the Sakanai coast southeast of Open bay where the Father (Mt. Ulawun) and the South Son (Mt. Bamus) both exceed 7,000 ft.; and in the northeast of the Gazelle peninsula near Rabaul. where the Matupi and Vulcan cones constitute a hazard to the development of the town. An eruption in 1937 killed 263 people. Volcanic activity is, however. responsible for the rich soil in parts of the Gazelle peninsula, the most economically advanced part of New Guinea.

New Britain has an equatorial type of climate, with heavy rainfall owing to the mountains and to a position athwart both prevailing winds. the northwest monsoon (December–March) and the southeast trades (May–October).

The island is divided into four areas: Rabaul and Kokopo. both on the Gazelle peninsula, Talasea on the Willaumez peninsula on the northwest of the island. and Gasmata on the south coast. Phe most populous area is the Gazelle peninsula where the Tolai people have made greater advances than any other Melanesian peoples. The chici town of the island and administrative centre of the district is Rabaul, an important port of the southwest Pacific, on the northeast shore oi Blanche bay. There is a small community of Chinese traders there, and most of the larger settlements have at least one Chinese trader and storekeeper. Rabaul was formerly capital of the Territory of New Guinea, but after the volcanic eruption of 1937 the capital was moved to Lae on the mainland.

Only a small proportion of the island is cultivated, but it has the largest area under plantation crops in New Guinea. Most of the plantations are on the Gazelle peninsula coasts. Copra is the principal product and output from native groves has been increasing. The cultivation of other commercial crops, including cacao, has developed further in the Gazelle peninsula than in other parts of the territory. A feature of this development was the success of native co-operative societies with their own driers and fernientaries. a success likely to continue owing to the acute shortage of labour for the plantations, such labour being recruited from the Sepik area of the mainland 500 mi. away. A variety of crops is gronn on village garden land ior local consumption but in the more primitive interior a system of shiiting cultivation is practised, involving a rotation of plots, only used at long intervals.

New Britain was discovered and named in 1700 by William Dampier, but not explored until late in the 19th century. As Neu Pommern (later New Pomerania) it became part of the German protectorate in 1884, and after World War I was mandated to Australia. It was taken by the Japanese in Jan. 1942 and during 1943–45 Rabaul was severely damaged by U.S. air attacks. The island was re-occupied by Australia in 1945. *See* also PACIFIC ISLANDS.

NEW BRITAIN, a city in central Connecticut. U.S., conterminous with New Britain town. about 10 mi. S.W. of Hartford. is known as the "hardware city." The population of New Britain in 1930 was 73.726: in 1960 it was 82.201. (For comparative figures *see* table in CONNECTICUT: *Population.*) It is the central city of a standard metropolitan statistical area including Hartford county and the towns of Berlin. Plainville and Southington which in 1960 had a population of 129,397. Prior to the census of 1950 the standard metropolitan area included also the cities of Bristol and Plymouth. New Britain's predominant nationalities of foreign-born are Polish. Italian: Irish, Swedish. German and English.

Formerly known as the Great Swamp, New Britain came into being in 1754. The township of New Britain was incorporated in 1850 and the city received its first charter in 1870. The township and the city were consolidated by act of the state legislature in 1905.

New Britain and the rurrounding area long has been the scene of industrial and manufacturing enterprises. Metalworking began there in the 18th century. Berlin. now a suburb. was the home of the brothers Edward and William Pattison who in 1740 turned out the first tinware made in North America and generally have been credited with inaugurating the tradition of the Yankee pedlar. Berlin also n-as the home of Simeon Sorth. contemporary of Eli Whitney and a pioneer in the use of interchangeable parts in the manufacture of small arms. Principal modern products include building hardware. household appliances. builders' tools. .ball bearings. automatic machines and heating equipment.

An ecclesiastical society. the forerunner of the First Church of Christ Congregational. was organized there in 1760. By 1850. churches for three other Protestant denominations, Baptist, Methodist and Episcopal. had been organized. The first Roman Catholic parish was organized in 1884. A distinguished son. Elihu Burritt (*q.v.*), who was born in New Britain in 1810 and later was known as the '.learned blacksmith." gained an international reputation for his efforts in behalf of international peace and brotherhood.

Central Connecticut State college was chartered as Sem Britain

State Normal school. the first in the state. in 1849 and the first instruction was given in 1850, the same year in which a high school was established in the town. The normal school became a four-year college and was renamed Teachers College of Connecticut in 1933; the present name was adopted in 1959. The college offers advanced placement in some subjects and in 1961 inaugurated new programs leading to bachelor's and master's degrees. (A. J. M.)

NEW BRUNSWICK, one of the four original Canadian provinces of the confederation in 1867, lies on the Atlantic coast between 44" 37′ and 48° 3′ N. and 63° 46′ and 69° 3′ W. Roughly square in shape, it measures about 160 mi. in width and 193 mi. from north to south, and has a total area of 28,354 sq.mi. The province has a coast line of approximately 600 mi. along Chaleur bay in the north, the Gulf of St. Lawrence and Northumberland strait in the east and the Bay of Fundy in the south. The province of Quebec forms the northwest boundary, and the state of Maine the international border on the west. In the southeast, New Brunswick adjoins the province of Nova Scotia in the 17-mi.-wide isthmus of Chignecto. The interior is rolling and of moderate altitude. and is well drained by many rivers and streams of great importance to the early settlement and exploitation of the area. Of these, the St. John is the largest, flowing the full length of the province from north to south and navigable for 88 mi. as far as Fredericton. 'The coast line offers a number of harbours, of which Saint John is the most notable. Being ice free throughout the year, it is one of Canada's most important winter ports. Approximately 80% of the province is forested. Cleared agricultural land is largely confined to coastal areas and the major river valleys, particularly the St. John valley; fishing is an active industry around the coasts. The major manufacturing industries are based on these primary resources, with the production of forest products being by far most important to the province's economy.

Physical Geography. — Geology *and Physiography.*—New Brunswick is an extension of the system of uplands and highlands of the Appalachian region which sweeps up the eastern flank oi North America. Paralleling the Bay of Fundy in the south are the southern highlands, underlain by the oldest rocks in the province (pre-Cambrian granites). Extending from the southwest to the northcast of the province are the central highlands, a broad band of igneous and metamorphic rocks culminating in Mt. Carleton, elevation 2,690 ft., the highest point in New Brunswick. Associated with the central highlands in the northeast (Bathurst-Newcastle area) are large bodies of valuable base metal ores. To the northwest are the northern uplands, an undulating area underlain by folded Paleozoic sedimentary rocks. To the east is an extensive lowland. developed on flat carboniferous sandstones. Associated with it are the coal seams in the Chipman-Minto area and the natural gas in the vicinity of Moncton.

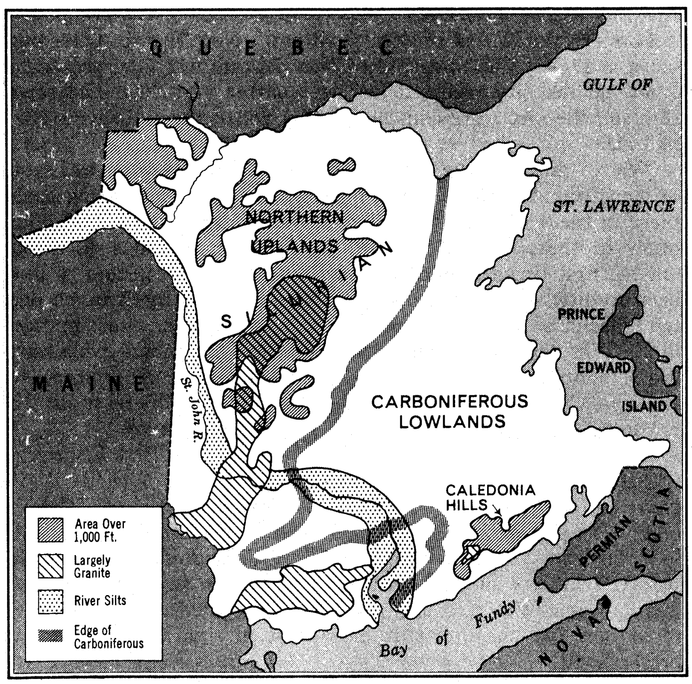

FIG. I. - -TOPOGRAPHICAL MAP OF NEW BRUNSWICK

With the exception of the St. John and St. Croix, nearly all the major river valleys follow the southwest to northeast physiographic trend. Of these the more important are the Restigouche and Nipisiguit flowing into Chaleur bay, the Miramichi flowing into the Gulf of St. Lawrence and the upper section of the Petitcodiac flowing into the head of the Bay of Fundy, Many of the rivers have shallow tidal estuaries. The exceptionally high tides of the Bay of Fundy (over 50 ft.) occasion the peculiar phenomena of the reversing falls at the mouth of the St. John, and the tidal bore which rushes up the I'etitcodiac river.

Climate.—Like the other Canadian maritime provinces, New Brunswick has a climate characteristic of inland rather than maritime regions. This is especially true in the upper St. John valley and interior areas more directly connected with the continental land mass. The prevailing westerly winds bring with them the weather systems passing from the continent to the North Atlantic. At Saint John, average summer and winter temperatures differ by as much as 42° F. (January 19°, July 61°), while in the interior variations are even more extreme. Summer highs in excess of 90° F. are occasionally recorded in the interior valleys. while readings of 30° below zero have been observed in the highland areas. Precipitation is normally ample and well distributed throughout the year (the annual average is approximately 40 in. at most stations with 3 to 4 in. monthly). About half falls in the form of snow. The average length of the frost-free season varies from 165 days at Saint John on the coast to 115 days in the upper St. John valley and to fewer than 90 days at higher interior elevations.

Vegetation.—Over four-fifths of New Brunswick was forested in the 1960s (about 14,000,000 ac.). Exploited since the early days of settlement, the forests were largely secondary growth in the second half of the 20th century. About two-thirds were conifers or needle-leaved trees in the following order of importance: spruce (three species), balsam fir, pine (three species), cedar, hemlock and tamarack (larchj. The other third comprised hardwood or broadleaved species including birch, maple, beech and poplar, with smaller quantities of elm, ash, oak, basswood and butternut. Typically, the hardwood species grow on the ridge tops while the conifers are found in the valley bottoms and on the lower slopes, There are large areas of peat bog in the poorly drained coastal areas in the northeast of the province, especially in Gloucester county, including Miscou and Shippigan islands, where the extraction of peat moss is an important industry. Along the estuaries of the rivers flowing into the head of the Bay of Fundp are large areas of tidal marshlands developed on the vast accumulation of silts washed in and deposited by the tides. Originally covered with broadleaf and other salt marsh grasses, they have been reclaimed for agricultural use.

Animal Life.—The abundant wildlife of New Brunswick attracts many sportsmen to the province. Deer are especially common, and moose, once almost exterminated, were increased through the enforcement of stringent game laws. In addition there are a large number of fur-bearing animals including the bear, raccoon, marten, otter, lynx, beaver, muskrat, woodchuck, rabbit and red squirrel. The porcupine and skunk are also common. There are over 200 species of birds of which the grouse, duck and Hungarian partridge are the most popular for game. The St. John, Restigouche and Miramichi rivers have a wide reputation as the habitat of the Atlantic salmon, and trout are fished in nearly all the brooks and streams.

History. — Before 1784 New Brunswick formed part, first of the French province of Acadia, second, of the British province of Nova Scotia. The first settlement within its borders was made in 1604 by Pierre de Guast, sieur de Monts, with whom was Samuel de Champlain. Their colony at the mouth of the St. Croix river was soon abandoned, but throughout the French regime the district was frequented by bands of fur traders. In 1762 the first English settlement was made at Maugerville, on the St. John river, and in 1764 a body of Scottish farmers and labourers took up land along the Miramichi.

Scattered French settlers located themselves on the mainland side of the Bay of Fundy. They numbered about 4.500 at the time of the expulsion of their kindred across the bay, and their number: were increased by about 500 of these as refugees.

After the American Revolution the great influx of loyalists into the valley of the St. John led to the separation of New Brunswick from Nova Scotia in 1784. The close of the Napoleonic Wars in 1815 brought a constant influx of immigration from Great Britain. The province had 74,000 inhabitants by 1824.

New Brunswick shared with Nova Scotia. in the middle period (1815–67), the prosperous development that arose from lumbering, shipbuilding and the fisheries and (until 1849) from the preference of the British market for colonial timber and the effect of the Navigation acts (until 1849) in giving the maritime provinces the West Indian trade denied the United States. This occasioned a relative neglect of agriculture and led many immigrants to prefer settlement in Upper Canada.

The landmarks in the provincial history include the long diplomatic struggle between Britain and the Gnited States over the delimitation of the boundary according to the cryptic terms of the treaty of 1783 which ended in the compromise of the Ashburton treaty of 1542.

Provincial history turned also on the question of responsible government. granted after its adoption in Canada (1841–49), and then on reciprocity of trade with the United States (1854). The 1864 plan of confederation for British North America, urged by Canada as a remedy for deadlock and by Great Britain after the warning of the American Civil War, found little favour in the province but in 1866 was voted by the legislature as a reaction from the Fenian raids.

The 1867 union with Canada led to marked improvement in the economic welfare of the province. The Intercolonial railway, promised under the terms of confederation, ran through the east side of Kew Brunswick and connected Halifax with Montreal in 1867. Other provincial rail lines, including the Saint John to Montreal connection by way of northern Maine, were completed shortly after. However, the introduction of the steamship and the exhaustion of the white pine timber led to the demise of the traditional wood, wind and water economy of the province. Protective tariffs and the concentration of population and industry in central Canada made competition difficult and led to the closing of many local industries. The opening of the Canadian west after 1900 and employment attractions in the rapidly expanding industries of central Canada and the United States started an emigration from New Brunswick which still continues. Various federal

County	Total Land Area (sq.mi.)	Population (1961)	County Seat
Albert	681	12,485	Hopewell
Carleton	1,300	23,507	Woodstock
Charlotte	1,243	23,285	St. Andrews
Gloucester	1,854	66,343	Rathurst
Kent	1,734	26,667	Richibucto
Kings	1,374	25,908	Hampton
Madawaska	1,262	38,983	Edmundston
Northumberland	4,671	50,035	Newcastle
Queens	1,373	11,640	Gagetown
Restigouche	3,242	40,973	Dalhousie
St. John	611	89,251	Saint John
Sunbury	1,079	22,796	Burton
Victoria	2,074	19,712	Andover
Westmorland	1,430	93,679	Dorchester
York	3,545	52,672	Fredericton

government assistance programs—including grants, subsidies and railway freight subventions—proved only moderately successful. In the second half of the 20th century, aith the more efficient use of timber resources (chiefly for pulp and paper). the development of local electric-poner supplies and the discovery of new mineral deposits, the prospects for economic development seemed more promising.

Population.— The population of New Brunsuick grew slowly after 1900 despite the high birth rate; because of heavy emigration, it passed 500,000 only in 1951. In 1961 the population was 597.936. of which the majority were either Anglo-Saxon or French in origin. About 40% of the total were living in the larger cities and towns, of which the cities of Saint John and Lancaster had a combined population of 108,001; Moncton had 43,840; Fredericton, 19.683; and Edmundston 12.791. Other important centres were Campbellton, Dalhousie, Bathurst, Chatham, Newcastle, Woodstock, and St. Stephen. Fredericton replaced Saint John as the provincial capital in 1785 and became a city in 1845 at the command of Queen Victoria. On a broad terrace at the head of tidewater on the St. John river, it has enjoyed a certain importance as a lumber and railroad centre. Persons of French origin made up an increasingly larger proportion of the total population. Descended from the early Acadian settlers and the French Canadians from Quebec who later joined them, they settled chiefly in the upper St. John valley and along the northern and eastern shores. The English speaking population originates from the Loyalists of 1783 and the large numbers of immigrants who arrived from Britain in the first half of the 19th century. The religious affiliations of the population are, roughly; Roman Catholic, 50%; Baptist, 18%; United Church of Canada, 14%; Anglican, 12%; Presbyterian, 3%; and other, 3%.

Government and Public Finance.— Since 1891 the provincial government has been a one-chamber legislature with 52 elected members representing the province's 15 counties and 2 of its cities. It is headed by the lieutenant governor, who is appointed by the federal government and acts on the advice of the executive council. The executive council is chosen from the legislative assembly and consists of the premier and the heads of departments. In 1960 New Brunswick was represented in the parliament at Ottawa by ten senators appointed for life and by ten members elected to the house of commons for a period not exceeding five years. The counties are organized as municipalities with the parish as the unit of representation in the county councils. In addition there were 6 cities (Saint John: Moncton, Fredericton; Lancaster, Edmundston and Campbellton), 20 incorporated towns and 1 incorporated village in 1960. The sources of revenue collected for provincial purposes embrace various licences, permits, fines, penalties, sales taxes and royalties, augmented by federal government subsidies, health grants, certain equalization and development payments and various tax-sharing agreements.

Education.— Public-school education dates from the act of 1871 and is compulsory and free. The system of regional high schools developed after World War II greatly improved the educational facilities, especially in the rural areas. In addition the major centres have institutions which provide vocational training. Degree-granting universities with enrollments over 1.000 after mid-20th century were the University of New Brunswick at Fredericton and Mount Allison university at Sackville; others, with smaller enrollments, were St. Joseph's university, St. Joseph; University St. Louis, Edmundston; Université du Sacre Coeur, Bathurst-Quest; St. Thomas college, Chatham. There is a provincial teacher's college in Fredericton.

Agriculture.— Until about 1900, New Brunswick agriculture was largely a subsistence operation. Mixed farming was carried on with cash income derived from winter lumbering operations or from fishing in the coastal areas. With the opening of the Canadian west in the early 1900s. beef, mutton and grain products could be imported more cheaply than they could be raised locally and maritime agriculture became depressed. Moreover. the enormous expansion of industry in central Canada and the United States provided job opportunities away from home. The result was a large decrease in farm population, farm production and in improved farm acreage. Agriculture has been increasingly confined to the more favoured areas. About one-third of the farm income is derived from potatoes, a cash crop concentrated in the upper St. John valley. Dairying, although centred near the larger urban centres, is important in most areas. More than half of the total cropland (about 600,000 ac.) is normally in hay. with a large additional acreage in pasture, Apples, small fruits and vegetables are grown commercially in the lower St. John valley, and blueberries are a source of income in Charlotte county. Attempts were made after World War II to increase the numbers of sheep and beef cattle in the province and more attention was given to farm wood-lot management.

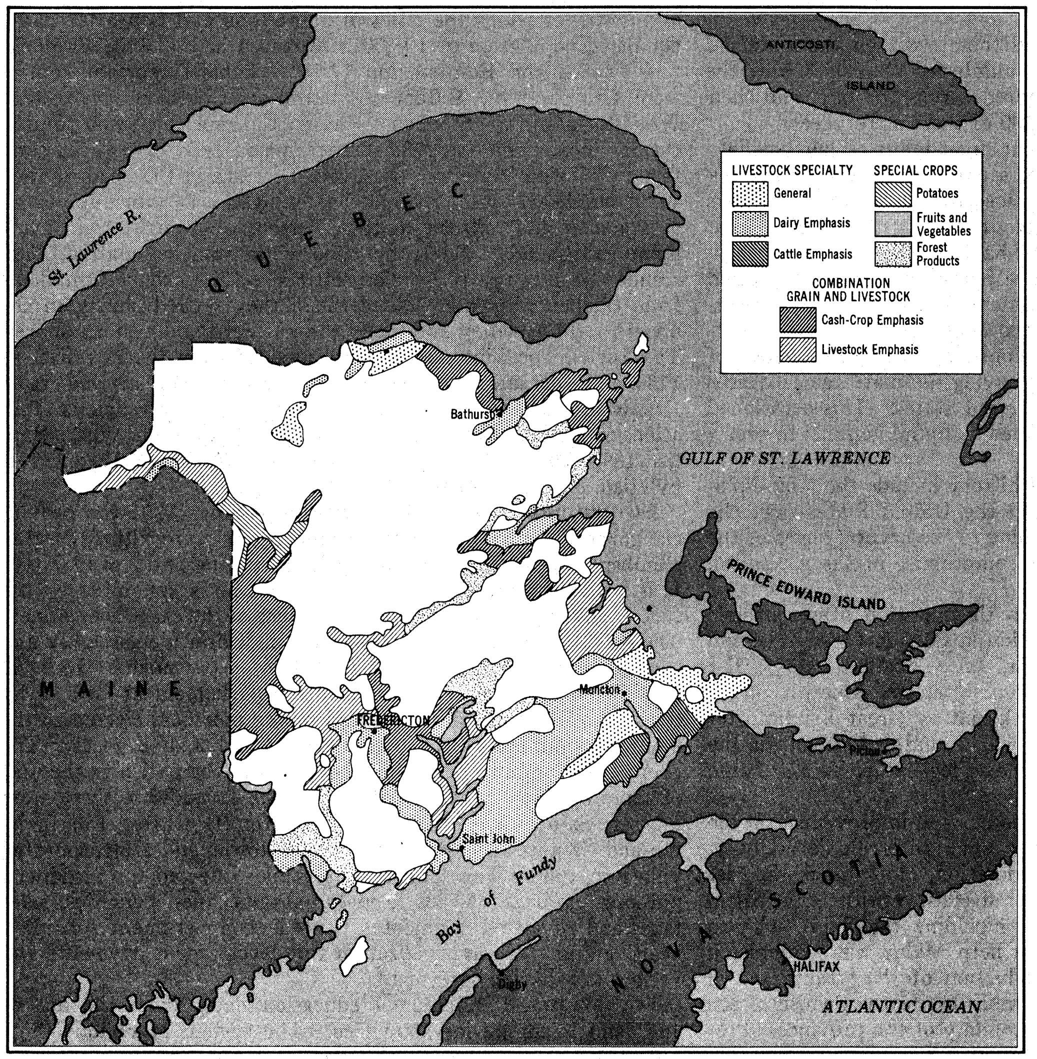

FIG. 2.—AGRICULTURAL MAP OF NEW BRUNSWICK. FARMING AREAS CORRESPOND RATHER CLOSELY TO THE TOPOGRAPHY WITH THE BEST FARMS IN THE ST. JOHN VALLEY AND CARBONIFEROUS LOWLANDS

Forestry.—New Brunswick's forests still provided in the second half of the 20th century the largest source of income in the province (approximately $175,000,000 in the typical year of 1958, for example). Most of this income was produced by pulp and paper mills at Campbellton, Dalhousie, Bathurst, Newcastle, Saint John, St. George and Edmundston; the balance was accounted for in lumber (approximately 200,000,000 bd.ft. annually) and other wood products. New Brunswick had more than 1,000 industrial establishments in the latter 1950s, of which more than half were based on the use of wood. The province owns nearly half of New Brunswick's forest land and disposes of cutting rights in the form of timber licences and stumpage permits. Over half of the remaining acreage is in farm wood lots and other small holdings from which pulpwood and saw logs are sold to the highest bidder. The balance of the privately owned land is held mainly by operators of forest industries. Growth rates are rapid and compare favourably with other parts of Canada.

Mining. — Large deposits of base metal ores (lead, zinc, copper, silver. pyrite) were discovered in the Bathurst area in the early 1950s and later in the Newcastle area. A large deposit of manganese ore in the Woodstock area and the oil shales in Albert county also were investigated. Soft bituminous coal, mined for many years in the Chipman-Minto area, was chiefly used in the production of electricity. Gypsum, the second important mineral mined in the mid-1950s, was used principally for the production of cement at Havelock near Saint John. Small quantities of oil and gas are extracted in the Moncton area, and there is a small tungsten production at Burnt Hill.

Fishing. — Of the more than 30 commercial species of fish caught in New Brunswick coastal waters, four varieties normally account for over 80% of the total value of the catch (lobsters and sardines are most important, followed by cod and herring). Most of the lobsters were taken from the northern and eastern shores; the sardines from the western Bay of Fundy. With federal government assistance, fishing methods and processing facilities were greatly modernized after World War II, and in the ten years after 1945 the value of the industry almost doubled ($13,000,000, 1945, compared with $23,000,000 in 1956). There were approximately 11,000 fishermen and over 60 fish processing plants in the mid-1950s.

Power. — The development of New Brunswick's electrical facilities proceeded rapidly after World War II reaching a total installed capacity of 242,000 kw. in 1956 (132,000 kw. thermal; 110,000 kw. hydro). The 102,000 kw. Beechwood hydroelectric unit on the upper St. John river was completed in 1958, and in that year there were 13 steam units and 9 hydro installations. The steam units were at various points in the province while the hydro installations were on the St. John and its tributaries (Grand Falls, Tinker Falls, Tobique Narrows, Beechwood and Edmundston), the St. Croix, illusquash and Nepisiguit rivers. To meet demands of new industries, in particular mining, further plants with a total capacity of over 500,000 kw. were projected in the second half of the 20th century. In addition. the possible use of tidal power in Passamaquoddy bay was under international investigation.

Industries.—Although the value of New Brunswick's manufacturing industries increased from $66,000,000 in 1939 to around $300,000,000 in 1956, it had consistently declined in relation to the national total (7.8% in 1930 compared with less than 2% in 1956). blanufacturing traditionally has been based on the natural resources of the province, particularly wood. Pulp and paper accounted for about one third the total value in the mid-1950s while other wood products, food, shipbuilding, fish products and textiles followed in that order.

Communications.—New Brunswick is serviced by both the Canadian National and Canadian Pacific railways. The main C.N.R. passenger line from Halifax to Montreal (the old Intercolonial completed in 1876) services communities on the northern and eastern shores, while the main C.N.R. freight lines passes diagonally across the province from Edmundston to Moncton. Other C.N.R. lines connect Saint John and Moncton and serve the lower St. John valley. The main C.P.R. "short line" from Montreal to Saint John via the state of Maine was completed in 1890; branch lines connect with Fredericton, Edmundston and St. Andrews. The C.P.R. operates a ferry service between Saint John and Digby, N.S., as does the C.N.R. between Cape Tormentine and Port Borden, P.E.I. In the latter 1950s New Brunswick had over 13,000 mi. of roads, of which about 2,600 mi. were improved. Trans-Canada Air Lines service was established on a regular basis from Montreal to Moncton in 1940, and later, direct communications commenced between Halifax and Sydney, N.S., and Moncton, and between Fredericton and Montreal. The Maritime Central Airways began flying in 1941, with flights between Saint John and Charlottetown, P.E.I., via Moncton, and later branched into Nova Scotia and to the Magdalen Islands.

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NEW BRUNSWICK, a city of New Jersey, U.S., is on the Raritan river, 30 mi. S.W. of New York city and 60 mi. N.E. of Philadelphia, Pa.: the seat of Middlesex county. The site was settled in 1681 by a party from Long Island, led by John Inian who established a ferry across the river in 1686. Known originally as Prigmore's swamp, the settlement was called Inian's Ferry in 1713 and finally, about 1724, was named New Brunsmick in honour of King George I, who was also the duke of Brunswick. It received a charter from George II in 1730, about the time a number of Dutch settlers from Albany hegan arriving. Its location at the head of navigation of the Raritan meant that during the colonial period New Brunswick was an important port for the shipment of agricultural products from northwestern New Jersey. During the American Revolution, George Washington and his troops, retreating from New York, occupied the town for about a week in 1776, but had to evacuate at the approach of the British under Sir William Howe who remained there about seven months. Washington again occupied the city after the battle of Monmouth in 1778 and it was there that he issued orders for the march south that culminated in the victory at Yorktown. During this time, small privateers sailed from the city's docks at night to prey upon British ships operating in the waters adjacent to Manhattan. After the war Xew Brunswick continued to grow and was incorporated as a city in 1784.

In 1834 the city became the eastern terminus of the Delaware and Raritan canal which quickly declined, but continued nominal operations until 1933. The Camden and Amboy (later the Pennsylvania) railroad crossed the Raritan to New Brunswick in 1838 and by mid-century the city was producing wallpaper, rubber products, machinery, shoes and hosiery. In 1896 Robert W. and James W. Johnson established a firm to produce gauze, adhesive tape and surgical dressings. Other manufactures include pharmaceuticals: chemicals, clothing and leather goods.

New Brunswick is the seat of Rutgers university *(see* NEW JERSEY: *Education),* founded as Queen's college in 1766, which became the state university of New Jersey in 1945. New Brunswick Theological seminary: a school of the Reformed Church of America and the oldest theological school in the U.S., founded in 1784, has been situated in New Brunswick from 1810. Joyce Kilmer, the World War I soldier-poet. was born in New Brunswick. The national headquarters of the Boy Scouts of America is also there.

For comparative population figures for New Brunswick (part of the New York-Northeastern New Jersey standard consolidated area) *see* table in NEW JERSEY: *Population.* (E. R. D.)

NEWBURGH, a royal and small burgh of Fife, Scot., on the Firth of Tay, 11 mi. E.S.E. of Perth by road. Pop. (1951) 2,367. It is the headquarters of the Tay salmon fisheries and other industries are the manufacture of linoleum and of waterproof fabrics. Whinstone (road metal) is exported to England from the harbour. About 1 mi. S.W. of the town stand the remains of a monolith called Macduff's cross where the murderer of the clan Macduff was granted rights and sanctuary. A short way east of Newburgh are the ruins of Lindores abbey, a Benedictine establishment founded in 1178 by David, earl of Huntingdon, brother of William the Lion.

The ruined Denmylne castle, slightly farther east, belonged to the Balfours. At Blackearnside, a forest of alders east of the village, Sir William Wallace defeated the earl of Pembroke in 1298. A Pictish fort with a triple line of earthworks is at Clachard Craig.

NEWBURGH, a city of Orange county in southeastern New York, U.S., lies on the west bank of the Hudson river, opposite Beacon, about 60 mi. N. of New York city and 85 mi. S. of Albany. Temporarily settled in 1709 by German refugees from the Rhenish Palatinate, Newburgh was permanently founded by Scottish and English settlers in 1752 and named after Newburgh, Scot. During the American Revolution, it became prominent as a key command post of the strategic Hudson valley. As Washington's headquarters after 1782, it was there that the general wrote his letter of May 27, 1782, rebuking Col. Lewis Nicola for the suggestion that he assume the title of king; made his reply to the "Newburgh Addresses" calling for action by the army to force congress to redress its grievances, and dissolved his armies in 1783. The headquarters building, a Dutch farmhouse built by Jonathan Hasbrouck in 1750, is now a state museum.

Prospering as a river port and for a while as the terminus of important turnpikes to the west, the city shared in the Hudson river whaling boom and other seafaring activity of the 19th century, but eventually its economy became based on manufacturing and, for a while, the city served as the seat of Orange county. It also became the hub of an agricultural region dominated by dairying and fruit growing.

Newburgh's varied industries include the manufacture of textiles, fabrics and leather goods. Stewart air force base: an installation of the North American air defense command. is located a few miles to the west. Newburgh was incorporated as a village in 1800 and was chartered as a city in 1865. In 1916 it adopted a manager-council form of government. For comparative population figures *see* table in NEW YORK: *Population.* (D. H. K.)

NEWBURN, an urban district in the Newcastle upon Tyne West parliamentary division of Korthumberland, Eng., on the Tyne and adjoining Newcastle upon Tyne to the east. Pop. (1951) 21,956. Area 7.3 sq.mi. It has collieries and steel, glass, rope and brick works; there is also horticulture. The Romans left inscriptions and relics, including parts of Hadrian's wall which runs through the area. In 1204 the name was Xiewburgh.

NEWBURY, a municipal borough in the Newbury parliamentary division of Berkshire, Eng., 17 mi. W.S.W. of Reading by road, on the Kennet river and the Kennet and Avon canal. Pop. (1951) 17,783. Area 4.1 sq.mi. The site seems to have been occupied since Mesolithic times. Newbury ("new town" or "borough," possibly to distinguish it from the older village of Speen) is first mentioned by Odericus Vitalis; it is probable, however, that the manor of Ulvritone entered in *Domesday Book* as held by Ernulph de Hesdain, covered a large part of the site. The manor subsequently passed to the crown and was held by Elizabeth I before her accession. In 1627 it was granted by Charles I as a fee-farm to the corporation. Newbury was a borough by prescription and incorporated by a charter of Elizabeth I (1596). It was extended in 1878 and in 1934. Newbury sent two representatives to the parliament of 1302. The Weavers' company was incorporated in 1601, but the woolen industry began to decline in the next century.

Newbury castle, of which traces remained until the 17th century, is said to have been besieged by Stephen in 1152. The church of St. Nicolas is an early 16th-century Perpendicular building on an older site built mainly at the charge of John Winchcombe or Smallwood (Jack of Newbury), an eminent clothier, a part of whose house still remains. The Jacobean cloth hall is now the borough museum. The almshouses called King John's court are supported by a foundation known as St. Bartholomew's hospital, to which in 1215 King John granted by charter the profits of a fair on St. Bartholomew's day. The grammar school dates from 1466. The town has the right of presentation of boys and girls to the educational foundation of Christ's hospital. Shaw house, on the outskirts, is an Elizabethan mansion, now a secondary school; to the north is Donnington castle (14th century), retaining a Perpendicular gateway and other fragments. The suburb of Speenhamland, formerly an important posting station on the Bath road, gave its name to the so-called Speenhamland system in 1795. At Sandleford priory. to the south of Newbury, the site and part of the buildings of an Augustinian priory (about 1200) were used in the erection of a mansion, now St. Gabriel's school, in 1781. Newbury is an agricultural centre with flour milling, marine and aircraft engineering as its principal industries. Newbury racecourse is east of the town.

Battles of Newbury (1643 **and 1644**).—These two important battles occurred during the Civil War. The first, on Sept. 20, 1643, arose out of the attempt of the royal army to bar the path of the parliamentary forces under the earl of Essex. which was returning to its base at Reading after raising the siege of Gloucester. Essex's army failed to break the royalist line, but it made so strong a moral and material impression that the royalists withdrew.

The situation was reversed in the second battle, Oct. 27, 1644, when a large parliamentary army failed to prevent the royalists' relieving Donnington castle. See CIVIL WAR, ENGLISH.

NEWBURYPORT, a city oi northeastern Massachusetts, U.S., at the mouth of the Merrimack river, 37 mi. N.N.E. of Boston, is one of the seats of Essex county.

Newbury, including the site of Newburyport, was settled in 1635 under the leadership of Rev. Thomas Parker (1595–1677) who had lived in Newbury, Eng. While the western portion of the town was primarily interested in farming. Newburyport's location at the mouth of the river drew merchants. tradesmen and seafarers. This division of interests led to the incorporation of Newburyport as a separate town in 1764. Fishing, whaling, shipbuilding and subsidiary industries brought wealth and fame to the town in the years before the American Revolution. During the war business was virtually destroyed and the shipowners temporarily turned to privateering. By 1790 shipbuilding had recovered and retail trade boomed. but the Jefferson embargo of 1807–08 against all foreign trade, a disastrous fire in 1811 and the War of 1812 brought the end of Newburyport's pre-eminence as a commercial port, although during the clipper ship era of the 1840s Newburyport built a number of those famous ships.

Incorporated as a city in 1851. Newburyport turned to the manufacture of textiles and shoes. along with its traditional products, rum and fine silver. In the second half of the 20th century the electronics and electrical machinery industries were the largest sources of employment. Newburyport contains the birthplace of William Lloyd Garrison (*q.v.*), American antislavery leader, and many of the stately federal-style houses built by early shipowners and their captains.

For comparative population figures *see* table in MASSACHUSETTS: *Population.* (L. G. BA.)

NEW CALEDONIA: *see* PACIFIC ISLANDS.

NEWCASTLE, DUKES OF. Within the space of a century there were no less than four successive creations of dukes of Newcastle in the British peerage. William Cavendish (*see* below); nephew of the 1st earl of Devonshire, was raised to the dignity of duke of Newcastle-upon-Tyne in 1665. His son and successor, Henry (1630–91), died leaving daughters only, and one of these married John Holles (1662–1711), earl of Clare, who was created duke of Newcastle in 1694. This duke died also without male issue. leaving his estates to his sister's son, Thomas Pelham (*see* below), who, with other dignities. had the title of duke of Newcastle-upon-Tyne conferred on him in 1715, and a second and similar ducal title (that of Newcastle-under-Line, *i.e.,* Lyne) in 1756.

The first dukedom became extinct at his death, but the second title was granted him with remainder to Henry Fiennes Clinton, earl of Lincoln. at once his nephew and nephew-in-law. From that time the dukedom has remained in the Clinton family. The two principal dukes are noticed below.

1. WILLIAM CAVENDISH, duke of Newcastle (1592–1676), only surviving son of Sir Charles Cavendish and of Catherine, daughter of Cuthbert, Lord Ogle, and grandson of Sir William Cavendish and "Bess of Hardwick," was born in 1592 and educated at St. John's college, Cambridge. On the occasion of the creation of Prince Henry as prince of Wales in 1610 he was made a knight of the Bath, subsequently traveled with Sir Henry Wotton, then ambassador to the duke of Savoy, and on his return married his first wife, Elizabeth, daughter of William Basset of Blore, Staffordshire, and widow of Henry Howard, 3rd son of the earl of Suffolk. His fortune was immense, and several times he entertained James I and Charles I with great magnificence at Welbeck and Bolsover. In 1620 he was created *Viscount Mansfield*; in 1628, earl of Newcastle; and in 1629 the barony of Ogle was restored to his mother, this title. together with an estate of £3.000 per annum, descending to him. In 1638 he was made governor of the prince of Wales, and in 1639 a privy councilor. When the Scottish war broke out he assisted the king with a loan of £10,000 and a troop of volunteer horse. In 1641 he was implicated in the army plot, and in consequence withdrew for a time from the court. He was sent by Charles on Jan. 11, 1642. to seize Hull, but was refused admittance. When the king declared open war, Newcastle was given the command of the four northern counties. In Nov. 1642 he advanced into Yorkshire. raised the siege of Pork and compelled Lord Fairfax to retire. Subsequently his plans were checked by Lord Fairfax's son's recapture of Leeds in Jan. 1643. and he retired to York. He escorted the queen. who returned from abroad in February, to York and thence to Oxford. and subsequently captured Wakefield, Rotherham and Sheffield, but his successes were once more ravished from him by Fairfax.

On June 30 he defeated the Fairfaxes at Adwalton Moor and obtained possession of all Porkshire except Hull and Wressel castle. He might then have joined the king against Essex, but continued his campaign in the north. advancing into Lincolnshire to attack the eastern association, and taking Gainsborough and Lincoln.

Thence he returned to besiege Hull. and the force which he had left in Lincolnshire was defeated at Winceby by Oliver Cromwell on Oct. 11, 1643, which caused the loss of the whole county. On Oct. 27. 1643, he was created a marquis. Next year his position was further threatened by the advance of the Scots. He retreated to Pork, where the three armies of the Scots, Fairfax and Manchester surrounded him. On July 1. Prince Rupert raised the siege, but on the next day threw away his success by engaging the three armies in battle. contrary to Newcastle's desire, at Marston Moor. After this disaster Newcastle announced his intention of abandoning the cause and quitting England. He sailed from Scarborough accompanied by a considerable following, including his two sons and his brother, resided at Hamburg from July 1644 to Feb. 1645 and moved in April to Paris. There he married as his second wife Margaret (*see* below). daughter of Sir Thomas Lucas of St. John's, Colchester. He left in 1648 for Rotterdam to join the prince of Wales in command of the revolted navy, and finally settled at Antwerp. In April 1650 he was appointed a member of Charles II's privy council. and in opposition to Edward Hyde, earl of Clarendon, advocated the agreement with the Scots. In Antwerp he established a famous riding school. exercised "the art of manage" and published his first work on horsemanship (1658; translated as *A General System of Horsemanship*, 1743).

At the Restoration Newcastle returned to England, and succeeded in regaining the greater part of his estates, though burdened with debts, his wife estimating his total losses in the war at L941.303. He was reinstated in the offices he had filled under Charles I; was invested in 1661 with the Garter; and was advanced to a duliedom on March 16, 1665. He retired, however, from public life.

He established a racecourse near Welbeck, and published *A New Method and Extraordinary Invention to Dress Horses and Work them According to Nature* . . . (1667). He also wrote several comedies and with Sir John Dryden's assistance translated Molière's *L'Étourdi* as *Sir Martin Mar-All* (1688). He was the patron of Ben Jonson, James Shirley, Sir William Davenant, Dryden, Thomas Shadwell and Richard Flecknoe, and of Thomas Hobbes, Pierre Gassendi and René Descartes.

He died at Welbeck on Dec. 25. 1676, and was buried in Westminster abbey. By his first wife he had ten children, of whom one son, Henry, survived him and became 2nd duke of Newcastle. Henry died in 1691 and the title then became extinct.

His second wife, Margaret (c. 1623–73), had been maid of honour to Henrietta Maria. The duchess cultivated literary composition with exuberant fervour, and kept a bevy of maids of honour obliged to be ready at all hours "to register her Grace's conceptions." Among many high-flown philosophical works she published two of real merit: her *Nature's Pzcture Drawn by Fancie's Pencil to the Life,* which includes an autobiography (1656), and *The Life of William Cavendish, Duke of Newcastle,* of which the best edition is that by C. H. Firth (rev. ed., 1906).

2. THOMAS PELHAM HOLLES, duke of Newcastle (1693–1768), was the elder son of Thomas, 1st Lord Pelham, by his second wife, Lady Grace Holles, younger sister of John Holles, duke of Newcastle-on-Tyne. Both the families of Pelham and Holles had amassed large fortunes and estates during the 16th and 17th centuries by consistently good marriages and careful attention to their interests. In 1711 Thomas Pelham Holles inherited the wealth of his mother's family, and the following year he succeeded his father in peerage and estates. When he came of age in 1714 he was, in consequence, one of the greatest landowners in the kingdom. The whole of his influence he threw into securing, in that year, the succession of George I and the triumph of the Whigs. He was rewarded with the earldom of Clare, and in 1715 he became marquis of Clare and duke of Kewcastle-on-Tyne. He extended his Whig family connections by marrying Lady Henrietta Godolphin, daughter of Lord Godolphin and granddaughter of the duke of Marlborough. He became lord chamberlain in 1717 and was sworn of the privy council; and the next year, at the age of only 25, he was created a knight of the garter.

If his inherited possession and wealth gained him early pre-eminence among the Whig families who governed Hanoverian England, it was his long retention of ministerial office which won him most of the personal power and influence which he so much desired. In 1724 Sir Robert Walpole made him secretary of state, and he held this important office for 30 years. He survived the fall of Walpole in 1742. gained even greater power when his brother. Henry Pelham (*q.v.*), became prime minister in 1743, and on Henry's death in March 1754 Newcastle became prime minister until Nov. 1756. He was then created duke of Newcastle-under-Lyme. He resumed the premiership in July 1757, and it was in this ministry that William Pitt earned so great a reputation as an efficient, inspiring and brilliant national leader in the Seven Years' War. In May 1762 Newcastle was replaced by Lord Bute, favourite of the young king George III, who proceeded to make the peace of Paris in 1763. The last five years of Newcastle's life were spent mainly in opposition. though for a few months in 1765 he became lord privy seal. He died in Nov. 1768.

The two ruling passions of Newcastle's life were devotion to the Hanoverian succession and the cause of the Whigs, and a love of personal power, influence and the "game of politics" for its own sake. So long as party organization in country or parliament hardly existed. the only means of giving a government cohesion and stability were the systematic management of elections and the distribution of patronage to secure parliamentary support for a ministry. Newcastle won a unique reputation for inexhaustible patience and skill in the arts of managing elections by borough-mongering and influence. and of securing a ministerial majority in the commons by distributing posts, sinecures. pensions and all forms of patronage. The extent to which his personal wealth brought him such power has often been greatly exaggerated. What brought him power was his long and unbroken tenure of ministerial office, which put at his disposal the rich resources of the crown. He used these resources not for his own pecuniary profit, for he spent much of his own wealth on similar ends, but for making himself an almost indispensable manager in all the ministries of these years. Jealous of his own dignity and position, and of much abler rivals such as Chatham, fussy and disturbing in his incessant intrigues. he lacked the intellect and the will to shape policy. Although so active in political life for about jo years, he remained always the political manager rather than the statesman. Ridiculed as "hubble-bubble." distrusted and thought more sinister than he was, this kindly and generous man performed a role in Whig politics which was distasteful to abler men yet was inevitable in the structure of politics of his time.

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NEWCASTLE, a city and port of New South Wales, Australia, on the southern shore of the estuary of the Hunter river, where it enters the Pacific ocean, about 100 mi. N.N.W. of Sydney. Pop. (1954) 134,079.

With a large and fertile hinterland (Hunter valley, northern tablelands and Liverpool plains) and abundant coal resources at its doors, Newcastle was early a notabie centre for the export of coal and primary produce. The possession of fuel, water, food supply and a good commercial position, and access to raw materials, have steadily attracted manufacturing industries and Newcastle has become one of the leading industrial areas in the southern hemisphere. Its iron and steel industries, established in 1915 by the Broken Hill Proprietary Company Limited, expanded to proportions rivaling its renowned coal trade. The black coal produced on the Newcastle-Cessnock field and iron and steel output represent 50% of Australia's total annual production. After 1950 a large-scale rayon yarn and cord factory near Newcastle and cotton mills and a wool processing plant were indicative of the importance of textile manufacture.

Newcastle's industries may be generally classified as metallurgical and metalworking; constructional engineering and shipbuilding; coke and chemical industries; textile manufacture; the making of fertilizer, cement, firebrick, pottery and woodworking. There are also flour and food product industries.. The harbour (comprising Korth harbour, the Basin and Port Waratah) has ample accommodation, is well sheltered and has modern installation for handling cargo and especially for loading coal and bulk wheat.

Newcastle is the third port of Australia and the second of New South Wales in respect of trade. Its exports are coal. coke, tar, etc.; frozen meat; butter, eggs; timber; pig iron, steel rails and plates, etc.; and fertilizers; and they usually exceed the imports. (W. Bs.)

NEWCASTLE, a seaside resort and urban district in County Down, Northern Ireland, on the west side of Dundrum bay, and 31 mi. S. of Belfast by road. Pop. (1951) 3.051. Area 2 sq.mi. Newcastle lies at the foot of Slieve Donard (2,796 ft.), the highest of the Mourne mountains. Electrical goods are manufactured. In the mountains is the Silent Valley reservoir, completed in 1933 for the supply of Belfast, with a capacity of 3,000,000,000 gal.

NEW CASTLE, a city of eastern Indiana. U.S., located about 40 mi. N.E. of Indianapolis. is the seat of Henry county. It is the trade centre of an extensive agricultural area which produces livestock. poultry, wheat, corn and tomatoes. Founded in 1819 it was incorporated in 1839.

In 1900 a decade of expansion began when automobile and piano manufacturing, as well as other industries were started there. During this same period, the commercial growing of roses gave New Castle the name "rose city." In the second half of the 20th century manufactures included automobile parts, steel products, pianos and children's clothing.

In 1955 New Castle was the scene of a bitter strike at the automobile parts plants. Rioting at the strike-bound plants led to calling out the Indiana national guard and for a short time the city was under martial law.

The historical novel *Raintree County* (1948). by Ross Lockridge, Jr., had New Castle and Henry county for its fictional setting.

For comparative population figures *see* table in INDIANA: *Population.* (H. L. HE.)

NEW CASTLE, a city of western Pennsylvania, U.S., is about 45 mi. N.N.W. of Pittsburgh and 20 mi. S.E. of Youngstown, Ohio, at the point where the Shenango and Mahoning rivers meet to form the Beaver, and is the seat of Lawrence county. Located in the foothills of the Allegheny mountains near the Ohio plain, the city commands a strategic industrial location. Deposits of coal, limestone and fire clay found in the area give it a natural base for manufacturing. Originally a Delaware Indian tower and trading centre, it was settled about 1798 by John Stewart who set up a furnace for making pig iron and named the area after Newcastle upon Tyne, the English industrial city. Laid out in 1502. New Castle was incorporated as a borough in 1825 and as a city in 1869. Manufactures include vitrified china, pottery, steel and steel products, brass and bronze castings, cement, firebrick, chemicals and rolling mill machinery. For comparative population figures see table in PENNSYLVANIA: *Population.* (C. C. G.)

NEWCASTLE-UNDER-LYME, a market town, municipal and parliamentary borough of Staffordshire, Eng., bounded on three sides by the city of Stoke-on-Trent. Pop. (1961) 76,433. It takes its name from the "new castle" erected by the earl of Chester, the feudal overlord in the reign of Stephen, for the greater protection of his fief lying under what was during the Roman occupation the *Limes Britannica,* separating the provinces of Flavia Caesarensis, on the east, from Britannia Secunda, on the west. The castle served as a bastion during the long war against Wales. The fortification, being low-lying. became obsolete in Tudor times, and fell into decay. The town received its first royal charter of incorporation from Henry II in 1173, and the liberties and privileges were confirmed and extended by succeeding monarchs down to James II. In 1267 the borough and manor were granted by Henry III to his youngest son, Edmund Crouchback, and ever since then it has formed part of the duchy of Lancaster. The borough has sent representatives to parliament at least since 1354.

The parish church of St. Giles, the fourth or fifth on the same site. was rebuilt, with the exception of the tower, by Sir Gilbert Scott (1876). The University College of North Staffordshire was founded in 1949 and opened in 1950 at Keele hall, about 3 mi. west. In 1932 the borough was enlarged by the inclusion of Wolstanton (with a fine old church), Clayton and part of Keele. Chesterton (the site of a Roman camp). Knutton and Silverdale also lie within the borough.

Industries of Newcastle-under-Lyme include collieries, brick and tile works, a cotton mill, a uniform-clothing factory and light engineering. (H. G. Ss.)

NEWCASTLE UPON TYNE, a city and county, parliamentary borough and port, standing on the River Tyne, Northumberland, England, 8 mi. from the mouth of the river and 272 mi. N. of London by road. Pop. (1961) city 269,389. It is the metropolis of the shipbuilding and industrial area of Tyneside.

One of England's principal railway stations, Newcastle is an important centre for rail communications with London, northwestern England and Scotland. Five principal bridges over the Tyne link Newcastle and Gateshead: the Tyne bridge (1928), taking traffic to the Great North road; the King Edward High Level bridge (1906), for the railway; the hydraulic swing bridge (1876), for foot passengers and vehicles; the Redheugh bridge (1900), for general traffic; and the old High Level bridge (1849) for the railway, road and foot passengers. The municipal airport was opened at R'001sington, 6 mi. N.W. of Newcastle, in 1935.

Municipal and commercial offices, the main shopping centre and principal places of entertainment in the city are concentrated in the square mile between the Tyne and the Town Moor. There broad, well-planned thoroughfares were introduced by Richard Grainger (1798–1861) and John Dobson (1787–1865) in place of the maze of narrow streets which had formed the old town centre. Grey street in particular is a superb example of town planning. Beyond lie pleasant, modern residential suburbs—Jesmond, the oldest, to the north, Walker, Walkergate and Heaton to the east, Denton, Fenham and Kenton to the west and northwest. There are 535 ac. of public parks in addition to the Town Moor (82j ac.).

History.—Newcastle was originally the site of a Roman station known as Pons Aelii. It takes its name from the Norman castle. built in 1080 by Robert, eldest son of William the Conqueror and replaced between 1172 and 1177 by the impressive stone-built keep still standing today. Noteworthy features include the wellshaft, almost 100 ft. deep and surrounded by masonry 28 ft. thick at its broadest. The chapel is a fine example of late Norman architecture. In the Black gate adjoining, the museum of the Society of Antiquaries houses the best-known collection of inscribed and sculptured stone illustrating the Roman occupation of Britain. The best remaining portion of the town walls lies between Westgate road and Gallowgate. A fragment of the Roman wall is visible on the south side of Denton bank. The guildhall, rebuilt in 16jj–j8, stands in the Sandhill.

The diocese of Newcastle, covering Northumberland. Berwick and small areas of Cumberland and Durham. was instituted in 1882. The church of St. Nicholas, adopted as the cathedral, is mainly 14th-century in date, though there is documentary evidence of a church on that site as early as 1123. The tower and steeple. added in the 15th century. are particularly beautiful examples of early Perpendicular. In particular the steeple is the finest known work in the style termed "Scottish Crown." The church of St. John the Baptist disputes with St. Andrew's the honour of being the city's oldest church though the huilding is mainly 14th and 15th century work. St. Andrew's is mainly 14th century but interesting earlier work remains, including the 12th century chevron-decorated chancel arch. This church was extensively damaged during the Civil War when Newcastle was twice occupied by the Scots and Charles I held prisoner by the army in 1646.

Administration.—Newcastle upon Tyne was a borough with its own written constitutions before the reign of Henry II. One of its most important charters was that of King John. granted in 1216, which authorized the burgesses to have a guild merchant. This association of traders: whose chief concern was to establish their monopoly of the town's trades. speedily assumed responsibility for town government. Thus, for example, the first reference to the office of mayor occurs in 1216. Henry IV by his charter of 1400 created Newcastle upon Tyne a county separate from and independent of the county of Northumberland, Accordingly it held its own court of quarter sessions, confirmed by William IV in 1836. and its own court of assize. Newcastle has been represented in parliament since 1283 when Edward I summoned two burgesses to his parliament at Shrewsbury. Since 1918 the parliamentary borough has been divided into four divisions of central, east, north and west. each returning one member to parliament. Since 1948 the constituency of West Newcastle has included Newburn urban district.

Education and Culture.—Of the independent schools in the city, the most famous are the royal grammar school, since 1907 occupying premises at Jesmond, which was founded by Thomas Horsley in the time of Henry VIII and incorporated by Queen Elizabeth I in 1600, and Dame Xllan's school, since 193j established at Fenham, which was endowed in 1705. The Municipal College of Commerce and Rutherford College of Technology provide both full and part-time further education. University education is provided by King's college which was founded in 1937 by the merging of Armstrong college and the University of Durham college of medicine. The former was founded in 1871 as a branch of the University of Durham and was the first university college to establish a department of mining. The latter. founded as the Newcastle School of Medicine and Surgery in 1834, was incorporated in Durham university in 1852.

The Municipal Museum of Science and Industry is devoted to the development and history of engineering, electrical engineering, mining, shipbuilding, transport and other industries with special reference to those of Tyneside; its exhibits include George Stephenson's locomotive. The Hancock Museum. named after the John Hancock collection of British birds, houses the collections of the Natural History Society of Northumberland. Durham and Newcastle upon Tyne. founded in 1892. Both water colours and oils by British artists are shown at the Laing art gallery; in particular there are water colours illustrating the development of the art in England from the 17th century onward. The public library has an extensive local history collection which includes local newspapers from the early 18th century onward. a fine series of works illustrated by Thomas Bewick, the wood engraver, family papers and other manuscripts. The Literary and Philosophical society, founded in 1793, also maintains a library, reading and lecture room.

Industry and Transport.—Coal. the basic element in industrial development, is Tyneside's most important natural resource. Mining began in the 13th century though coal exports were of little importance until the 17th century and industrial expansion proceeded slowly prior to 1800. Tyneside's achievements in shipbuilding are world-famous while its yard constitute one of the largest ship-repairing centres in the world. The Tyne itself has been navigated since Roman times.

The conservancy of the river was originally vested in the corporation of Newcastle upon Tyne but in 18jo control passed to the Tyne Improvement commission. The commissiuners accelerated development by undertaking large-scale dredging operations and providing improved docking facilities. The corporation owns the quayside at Kewcastle almost 1½ mi. long which accommodates even the largest cargo ships. Exports include iron and steel products, coke and its by-products and chemicals. Tyneside is one of the principal wheat-importing centres in England and flour is milled locally. (E. M. Hw.)

NEWCBWANG (YING-K'OU), a Chinese port city in the province of Liaoning (40° 41′ N.; 122° 15′ E.), some 30 mi. above the mouth of the Liao river which enters the Gulf of Liao Tung. At the treaty of Tientsin (1858), Newchwang was chosen as one of the ports to be opened to foreign trade, but it was Yingtze (or Ying-k'ou) near the mouth of the Liao river which actually became the centre of foreign settlements and was opened to trade in 1864. In later years there was a tendency to designate the port correctly as Ying-k'ou, though Newchwang remained the official name of the Treaty port. The town was in 189j occupied by and later ceded to Japan, only to be retroceded to China under foreign pressure. During the Russo-Japanese War, it was first in Russian and later in Japanese hands, but was finally restored to China at the end of the war. The outlet of the Liao river is obstructed by a bar and the port is closed by ice for three or four winter months. It has railway connection with Peking and with the main Mukden-Dairen line of the South Manchuria railway by means of a short branch. Until 1907 Newchwang was the only treaty port of Manchuria and it shared in the rising prosperity of south Manchuria; thereafter, its development was, however, checked owing to the remarkable rise of Dairen, though "prosperity" was returning with the new "Manchukuo" industrial development. With the Japanese occupation of Manchuria Newchwang was included in the puppet state of Manchukuo.

The chief imports were foreign cotton piece goods, cotton yarn, native cottons, aniline dyes; exports, mainly beans, bean oil, bean cake, maize, cotton seed and coal. Until 1908 Newchwang was the centre of the bean oil and bean cake industry of Manchuria and of the export trade in these and other Manchurian products, but it has since been supplanted by Dairen. Before the outbreak of World War I it was, however, the main Manchurian port for China trade, especially in bean cake for south China and bean oil for Shanghai. A main product of Newchwang is salt for industrial use. The reed of the neighbourhood is used for reed sacks and reed plants produce pulp material. Tashihchiao, 22 mi. east, is an important centre of magnesite mining. Cotton cloth weaving factories work for local consumption. Other products are hosiery, ribbons, towels, matches, soap, glass, knitting needles, bricks and dyes, etc. The sea fisheries of the neighbourhood are very important. Newchwang came under Communist control in 1948. The population in 1953 was estimated at 200,000.

NEWCOMB, SIMON (1835–1909), was the greatest American astronomer of the 19th century, although in depth and originality of mathematical invention he was excelled by George W. Hill. his associate for 15 years. Newcomb was born in Wallace, N.S.. on March 12, 1835. His father, an itinerant country schoolteacher, records that he taught Simon to count at the age of four, and that before he was five his son was spending several hours a day making calculations in addition and multiplication; before he was seven he had finished the arithmetic book, including the extraction of cube roots.

Newcomb had little or no formal education. At the age of 16 he was apprenticed to a quack herb doctor in Salisbury. N B. After tno or three years he ran anay to join his father, widowed in the meantime, in the Cnited States. settling in Maryland as a country schoolteacher. In the libraries at Washington, D C , he found the first ample opportunity to indulge his intellectual curiosity. After avidly exploring many technical fields he concluded that his principal talent lay in mathematics. He nas especially attracted to the *American Ephemeris and Nautical Almanac,* an annual handbook for astronomers, containing predicted positions of the principal celestial objects and other astronomical phenomena. Of this work he says. "Its preparation seemed to me to embody the highest intellectual power to which man had ever attained." He thereupon applied for employment in the American Nautical Almanac office, then at Cambridge. Mass., and became a computer there in 1857. He also enrolled in the Lawrence scientific school of Harvard university, receiving a degree in 1858. In 1861 he applied for and received a commission in the corps of professors of mathematics in the United States navy and was assigned to the United States Naval observatory at Washington, where he worked for more than ten years determining positions of celestial objects with the meridian instruments and for two years with the new 26-in. refractor.

In 1877 Newcomb was put in charge of the American Kautical Almanac office. then in Washington, where almost at once he commenced the great work that he had had in his mind for some years. and which was to occupy the greater part of his time for the rest of his life: the calculation of the motions of the bodies in the solar system. Reaching the compulsory retiring age for captains in 1897, he later received the then unusual distinction of retirement with the rank of rear admiral. He died in Washington on July 11, 1909, and was buried in Arlington National cemetery.

In 1884 he had obtained the additional appointment of professor of mathematics and astronomy (which he held until 1893) at the Johns Hopkins university. Baltimore, Md., continuing. however, to live in Washington. For many years he was editor of the *American Journal of Mathematics.* He was one of the founders of the American Astronomical society and its first president (1899–1905). Newcomb received honorary degrees from ten European and seven American universities and was a member of 45 foreign societies. He was awarded the gold medal of the Royal Astronomical society (1874), the Huyghens gold medal of the Holland Society of Science (1878), the Copley medal of the Royal society (1890), the Bruce gold medal of the Astronomical Society of the Pacific (1898). the Schubert prize of the Imperial Academy of Sciences, St. Petersburg (1897) and the Sylvester prize of the Johns Hopkins university (1901). He was elected a member of the National Academy of Sciences in 1869, serving as home secretary, 1881–83; vice president 1883–89; and foreign secretary, 1903 until his death.

His most important work appeared in the *Astronomical Papers Prepared for the Use of the American Ephemeris and Nautical Almanac,* a series of memoirs that he founded in 1879 with the object of "a systematic determination of the constants of astronomy from the best existing data, a reinvestigation of the theories of the celestial motions. and the preparation of tables. formulae, and precepts for the construction of ephemerides, and for other applications of the same results." Of 37 articles filling up approximately 4,500 quarto pages in the first nine volumes, he was sole or principal author of 2j. Among them were his tables of the sun, Mercury, Venus, Mars, Uranus and Neptune. and Hill's tables of Jupiter and Saturn, which were in use throughout most of the world for calculating daily positions of the objects from 1901 to 1959. and even afterward for the sun. Mercury, Venus and Mars. This series of *Papers* is remarkable for its sustained high quality. Hardly anything in them has proved to be incorrect, and at mid-20th century they were still worthy of the attention of any student of celestial motions.

Possibly Newcomb's most far-reaching contribution was his inauguration, jointly with A. M. W. Downing, then superintendent of the British Nautical Almanac office. of a world-wide unified system of astronomical constants, which was later to lead to the outstandingly successful scheme of international collaboration among the principal almanac makers of the world that survived two world wars with increasing vigour. Newcomb and Downing were impressed by the "coniusion which pervaded the whole system of exact astronomy. arising from the diversity of the fundamental data made use of by the astronomers of foreign countries and various institutions in their work" (Newcomb, *Reminiscences of an Astronomer*). A conference of the directors of the national ephemerides of the United States, Great Britain. France and Germany, was held in Paris in May 1896. It resolved that beginning with 1901 a certain set of constants, substantially Newcomb's, should be used by all the ephemerides. The decision even included some work of Newcomb's that was not to be finished for several years. Although Newcomb was attacked by some astronomers at home for decisions in their opinion premature, time has proved the wisdom of his course. A similar conference, held at Paris in 1950, decided unanimously that the system of constants adopted in 1896 was still preferable to any other for practical use.

Newcomb wrote a number of books, including *Popular Astronomy* (1878), *The Stars* (1901), *Astronomy for Everybody* (1902) and *Compendium of Spherical Astronomy* (1906), some of which have been translated into as many as seven foreign languages. He also wrote on finance and economics and published some fiction. An autobiography, *Reminiscences of an Astronomer,* was published in 1903. A bibliography of his life and works (541 titles) is given by R. C. Archibald, in *Memoirs of the National Academy of Sciences,* xvii, pp. 19–69 (1924). (*G. M. Ce.*)

NEWCOMEN, THOMAS (1663–1729), English engineer, one of the inventors of the steam engine, was born at Dartmouth. While employed as ironmonger in his native town, he corresponded with Robert Hooke about the possibility of obtaining motive power by exhausting the air from a cylinder provided with a piston, Denis Papin and the marquis of Worcester having already made investigations on this subject. In 1698 he entered into partnership with Thomas Savery (*c.* 1650–1715), who had patented a method for raising water from mines. Newcomen's improvements on Savery's invention were so successful that they produced together a pumping engine which served as a model for nearly three-quarters of a century., For a description of the "atmospheric steam engine." then known as a "fire engine," which they constructed in 1705, *see* STEAM: *Steam Engine.* John Cawley (or Calley) was also associated with them in this invention. Newcomen died in 1729, probably in London.

NEW DEAL. The expression "New Deal" has come into use to describe the political policies and activities of the administration of Pres. Franklin D. Roosevelt. It was first used by him in his speech accepting the Democratic nomination for president on July 2, 1932. It had been written into the speech by his adviser and collaborator, Raymond Moley, who was the chief of what came to be known as the "brains trust." When it was first used by the candidate it was not intended to describe his philosophy or policies. But the press took it up, just as it had earlier taken up the New Nationalism or the Square Deal of Pres. Theodore Roosevelt and the New Freedom of Pres. Woodrow Wilson.

The terin was applied later to a series of proposals, policies and legislation sponsored by President Roosevelt in his first campaign in 1932, in the period between the election in 1932 and his inauguration in 1933, and enacted into law in the Hundred Days' congress of that year. Since the Roosevelt policies shifted abruptly in 1935, it has been said by some historians of the period that there originated in that year a second New Deal.

While the many policies and plans sponsored by President Roosevelt from 1932 to 193j can hardly be said to belong to any specific political or economic philosophy, most of them tended to emphasize the subordination of private interests to collective interests through the increased power and authority of the federal government. Agricultural subsidies, high taxes and deficit spending brought about a much greater equality in wealth and income than had hitherto existed. In some of the legislation that Roosevelt sponsored there is evidence of economic planning on a national and regional scale through the federal authority.

Since the earlier New Deal was designed primarily for agricultural recovery and for co-operation within industries to promote economic recovery, and since the Koosevelt financial and monetary policies were designed to raise domestic prices, the trend was nationalistic-intranational rather than international. This Roosevelt made clear in his famous "bomb-shell" message, which terminated the World Economic conference in London, July 1933.

Among the major policies enacted into law early in his administration at the instance of President Roosevelt were the Agricultural Adjustment act, the National Industrial Recovery act, the creation of the Tennessee Valley authority, two pieces of legislation regulating the issuance and sale of securities, and a broad reform of the nation's banking structure. The agricultural as well as the industrial planning reforms were later declared invalid by the supreme court. No substitute for the industrial planning reforms was proposed, although a bill greatly increasing the authority of the federal government in industrial relations and strengthening the organizing power of the unions was passed and approved by the president in 1935. This came to be known as the Wagner act, after its sponsor, Sen. Robert F. Wagner of New York. As a substitute for the invalid Agricultural Adjustment act, the president sponsored and congress enacted soil conservation legislation.

With enactment of the Wagner act and the Social Security act in 1935, the emphasis of the Roosevelt policies turned from recovery and agrarian reform to measures designed to favour labour and other urban groups. Thus began the so-called second New Deal, which continued until the crisis in Europe in 1939 brought about the rearming of the U.S. United States entry into World War II in 1941 substantially brought an end to further domestic reform under Roosevelt. He remarked as the U.S. entered the war that "Dr. New Deal" was to be supplanted by "Dr. Win the War."

The lasting effects of the Roosevelt reforms upon the economy and social structure of the United States were the acceptance as national policies of a great increase in the size and authority of the federal government with a consequent diminution of state and local powers; the projection of government authority into private business; large federal subsidies for agriculture, small business, urban housing and shipping; social insurance and old-age and unemployment assistance; high taxes and, with the exception of a few years, deficit financing; great public hydro-power projects; and the government-encouraged progressive growth of unionized labour. Following World War II, the Truman administration largely followed the policies of the prewar Roosevelt administration under the name "Fair Deal." *See* also UNITED STATES (OF AMERICA): *History.*

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NEWDIGATE, SIR ROGER (1719–1806), English antiquary, was born on May 30. 1719. He was the 5th baronet of Harefield (in Middlesex) and Arbury (in Warwickshire), and grandson of Sir Richard Newdigate, an English chief justice during the time of Richard Cromwell's protectorate. He had an active political career, but is chiefly remembered for his collection of antiquities including marbles, casts of statues and vases. Two marble candelabra found in Hadrian's villa at Rome he purchased for £1,800 and presented them to the Radcliffe library at Oxford. Among his other generosities to the university were a chimney piece, for the hall of University college, and the sum of £2,000 for the removal by Flaxman of the Arundel collection of marbles to the Radcliffe library. The "Newdigate" prize of 21 guineas for English verse, which is open for competition each year to the undergraduates of Oxford university, was founded by him and was first awarded in the year of his death. He died at Arbury on Nov. 23, 1806.

NEWEL, in architecture, originally the central shaft around which a spiral or semicircular staircase winds. Now more commonly any post at the intersection of a stair with a landing, in which case it is a vertical post which receives the rail and is framed into the supporting strings or beams of the stair construction. By extension, the term is also applied to any post in the railing larger than the other posts or balusters. *See* STAIR.

NEW ENGLAND, comprising the six most northeasterly states of the United States, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut, received its name of New England from Capt. John Smith who explored its shores in 1614 for some London merchants.

Throughout its entire length the coast line of New England is indented with harbours, large and small. Of New England seaports Boston early became the most important. Eastward from the coast stretches a broad continental shelf which rises in places near enough to the surface to make grounds favourable for fishing. About 80 species of edible fish live in these waters, made cold by the Labrador current. The most important of these are haddock, redfish, flounder, cod, whiting, pollack and hake. Inland from the coast stretches an uneven hill country that rises into rugged, forest-covered mountains. These. beginning in Maine at the Canadian border, extend into the White mountains of New Hampshire (seen and reported by Smith in 1614) and into the Green mountains, the giant ridge that runs north and south the length of Vermont. The Berkshire hills in western Massachusetts and the Litchfield hills in northnestern Connecticut form the southernmost extension in New England of this geologically ancient system. The last of the ice caps of the Glacial Age covered all of New England save for a very narrow band on Cape Cod. The receding ice left soil filled with stones and dotted in many places by great boulders. Glacial action in overdeepening old valleys and in depositing moraines or drifts, created over the entire area a profusion of large and small lakes. The largest of these, Lake Champlain, lying in the broad lowland between the Adirondack mountains and the Green mountains. separates the states of Vermont and New York. Of the innumerable streams that flow from the mountains across the rolling lonlands the Connecticut river is the largest and most important. This stream, while navigable in its lower reaches, provides access north of Massachusetts only to a region of little economic importance. In the 17th century the first settlers of New England found iron in bogs and their successors in the 18th and 19th centuries mined small veins of copper and iron in the ancient rocks of the uplands. But granite, marble and clay comprise the only important mineral resources of the 20th century.

This article deals with the influence of New England as a section on U.S. history. Additional historical details and chronology will be found in the separate articles on individual states and in UNITED STATES (OF AMERICA), THE: History. *See* also articles on various cities and biographies of persons cited.

Settlement. — The first attempt to settle New England, that of France in 1604 at the mouth of the St. Croix river, the boundary between Maine and New Brunsnick, proved abortive. The leaders took the colony to Nova Scotia in the spring of 1605. In 1613 an armed force of Englishmen captured a second French colony at Mt. Desert on the coast of Maine.

In 1620 a company of separatists who had found Holland an undesirable refuge from persecution, migrated, with the aid of some London merchants, across the Atlantic to found an English beachhead at Plymouth in New England. Ten years later the Massachusetts Bay company, chartered to trade and to colonize in a designated portion of New England established what its Puritan sponsors and members looked upon as a new Zion in the American nilderness. Bringing the charter to Massachusetts John R'inthrop turned the management of a trading company into the government of a colony. Persecution by the English government of the growing Puritan party caused some 20,000 persons to cross to Massachusetts between 1630 and 1640. In the new world the Puritans laid out villages whose centre of life was the parish church. Following the precedent set by the Pilgrims the government of the church became congregational. A systematic allotment of land reinforced the close social structure of the Puritan villages *(see* LAND SYSTEM [U.S.]).

Other Puritans from England founded New Haven colony in 1638. Some of the Massachusetts Puritans, dissatisfied with the government of that colony, moved westward to found three towns on the Connecticut river — Hartford, Wethersfield and Windsor. In 1662 New Haven, the Connecticut river towns and another settlement at Saybrook united to make the colony of Connecticut. Roger Williams, pastor of the church at Salem, opposed the religious intolerance of the Massachusetts magistrates and even questioned the right of the English crown to grant territory in America that had not first been purchased from its Indian owners. Williams circumventing a decree of banishment, led followers in the spring of 1636 to Narragansett bay where he founded Providence.

Iiorth of the Merrimack river Capt. John Mason received a grant from the crown and sent settlers to the mouth of the Piscataqua (Portsmouth). His plans for an aristocratic domain modeled on the medieval county palatine (q *v*) as well as his appointment as governor general of all New England all came to naught with his death in 163j. His settlers came under the rule oi the Massachusetts Bay company until organized as a royal province (New Hampshire) in 1679. Farther northeast another royal proprietor, Sir Ferdinando Gorges. planned to colonize. Ultimately his enterprise failed in competition nith Massachusetts settlers. His heirs sold their claims to Massachusetts in 1677 and the region, under the name of the district of Maine, remained a part of Massachusetts until erected into an independent state in 1820. In the latter half of the 18th century settlers moved into the region north of Massachusetts and west of the Connecticut river and occupied land under grants from New Hampshire. But the province of New York claimed the region. In 1764 an Order in Council adjudged the country between Lake Champlain and the Connecticut river to be part of New York but without prejudice to the grants from New Hampshire. The status of the region rzmained in dispute and unsettled until 1790 when New York state relinquished its claim. Congress admitted Vermont to the union in 1791.

Colonial New **England.**—New England was founded by religious refugees who were strongly influenced by the teachings of John Calvin. In America circumstances compelled them to set up a separate (Congregational) church. They were uncompromising Sabbatarians. They opposed the theatre as immoral. They replaced the ritual of the Church of England with a plain service in a plain meetinghouse. The centre of the service was the sermon and extemporaneous prayer. Puritan prudential ethics sanctified nork, insisting that faithful attention to the secular calling was, in itself, worship of God. Discouraging idleness and luxury and glorifying saving. Puritan ethics served admirably the needs of frontier communities where the work to be done was prodigious and the hands to perform it few.

Many of the leaders of the Puritans were university men, particularly from Cambridge. As a consequence New England Puritans held learning in high esteem and insisted on an educated clergy. Massachusetts required each town to provide education for its children. To train men for service in church and state Harvard college was founded in 1636 and Yale college in 1701 Sometimes local pastors prepared boys for admission to these institutions by teaching them Latin and Greek. Grammar schools (Boston Public Latin school and Hopkins Grammar schools in New Haven and Hartfordj arose to perform more effectively the same function.

From their beginnings the New England colonies (like the other mainland colonies) enjoyed representative government. The towns managed their affairs through the direct democracy of the town meeting. The Fundamental Orders of Connecticut. a kind of 17th century constitution of the three river tonns — Hartford, Windsor and Wethersfield — proclaimed the principle that government mcst rest on the consent of the governed and that liberty implied liberty under law. Roger Williams' Rhode Island from its beginning in 1636 guaranteed religious freedom. The charters granted to Connecticut and Rhode Island by Charles II after the Restoration were surprising documents for the 17th century in that they provided not only for representative government but for the election of the provincial governor within the colony. Save for the reserved power of the crown to disallow acts passed by their assemblies these corporate colonies were virtually tiny independent republics. In this characteristic they differed in the 18th century from Massachusetts which had lost her charter in 1684 and had become a royal colony.

The End of Colonial Status. — In the 18th century as the frontiers of New England pushed westward and northward the greater part of the population lived by agriculture. Husbandmen cleared fields high on the slopes of hills and mountains to take advantage of the fertility of the rich mold under the primeval forest. It was the day of the self-sufficient farm. The land on which the family lived provided materials for practically all its needs— timber for house and barn (often one continuous building in northern New England), fuel, food, wool and flax for cloth, leather for harness and shoes. Primitive roads and the almost complete absence of bridges made transportation and communication difficult. Self-sufficiency was an adjustment to isolation. But colonial New England enjoyed three advantages that led to special economic developments. Shipbuilding flourished in many harbours at the mouths of rivers. On these streams logs from the forest in the interior could be floated to the yards. The making of ships began with the founding of the Massachusetts Bay colony when Winthrop's "Blessing of the Bay" was launched in 1631. New England ships found a ready sale because the English Navigation acts admitted colonial built vessels to the status of English ships in the monopoly of the carrying trade of the expanding empire. Many boats were constructed for the fisheries which from the beginning of settlement remained an important part of New England's economy! providing food for the colonials and an important item of external trade. Good harbours and available ships stimulated the growth of the sea trade. Merchants in Boston and other coast towns ventured in commerce with England and with the British and French colonies in the West Indies.

New Englanders, like other colonials, resented the increasing enforcement after 1763, when New France fell. of the principles of mercantilism on which British imperial policy was based. They looked upon a succession of parliamentary acts as denials of their traditional rights as Englishmen.

The American Revolution broke out in 1775 when New England "minute men" engaged at Lexington and Concord in armed conflict with a detachment of British regulars sent from Boston to destroy military stores being gathered by the colonial militia.

New England played its chief part in the American Revolution during the years 1765–1775 in defining issues and precipitating hostilities. In the Continental Congress the New England colonies early supported the independence movement in 1775. After the evacuation of Boston by the British army on March 17, 1776 New England saw only minor military actions. but Connecticut became a major source of supply for Washington's army. After 1775 the irreconcilable temper of New England people convinced the British military leaders in America that attempts at conciliation or subjugation had a better chance of success elsewhere. Tories, while important as economic and social leaders did not comprise a large percentage of the New England population. Many of them fled to Nova Scotia, New Brunswick and England when the British army left Boston. The revolt against the mother country brought less civil war between rebels and Tories in New England than occurred farther south. Control of the governments of the newly independent states fell into the hands of conservatives who assumed the political offices and the economic and social leadership vacated by the fugitive loyalists.

New England in the New Nation. — The period of disorganization which followed the cessation of hostilities brought suffering to many communities. The disruption of the old courses of commerce within the British empire, no longer supplemented by privateering and wartime trade with other countries, caused a lack of specie. The departure of British armies which had purchased supplies in the colonies contributed to the same deficiency. Farmers who had gone into debt in the development of their holdings found themselves facing difficulties when interest payments and taxes were due. Distress led to a demand, most successful in Rhode Island, to print paper money whose depreciation would assist the debtor and work to the disadvantage of the creditor. In the western counties of Massachusetts and New Hampshire opposition to the tax collector and to court action against debtors was terminated by a show of force and belated remedial measures.

Although New England leaders played prominent parts in the constitutional convention, actual ratification proved a difficult matter in Massachusetts and New Hampshire. Rhode Island rejected the instrument until after the new federal government was organized. The creditor and mercantile sections of the population supported the stronger national government provided in the constitution in the hope that the national credit would be established and a national currency created that would have stability. Supporters of the constitution hoped that a national tariff might be used to persuade reluctant European governments to open their home and colonial ports to American trade. For nearly a decade after the inauguration of the new government under Washington the superior organization of the dominant commercial interests committed New England as a whole to the Federalist party. But Jefferson, representing the common man and the agrarian interests had sufficient success in organizing anti-Federalist and Democratic elements to carry several representative districts in the election of 1800.

The basis of New England's prosperity in the Federalist period seems to have lain in the application of Yankee energy and resourcefulness to the exploitation of the peculiar advantages of New England in foreign trade. Its ships, restricted in their enterprises in the older fields under the control of the British crown, turned to the Mediterranean and to the Pacific and Indian oceans. In 1786 Samuel Shaw established in Canton the first American mercantile house in China. In 1787 the "Grand Turk" brought to Salem the first of the many oriental cargoes which made that port famous. In 1787–90 Capt. Robert Gray's "Columbia" carried the flag of the new republic around the world for the first time and laid the foundations not only for the U.S. claim to Oregon but also to the very profitable trade with the northwest coast. There furs were obtained which could be exchanged in China for silks and tea. Salem became for a time the tea market of North America and Europe and the third city in the union.

The Napoleonic Wars shattered this prosperity. Jefferson's embargo, continued in milder form under Madison, struck a heavy blow at New England commercial interests. The War of 1812, strongly opposed in New England, brought opportunities for privateering and the profits of blockade running. But commercial interests suffered. The disaster of the war plus concern that westward expansion of the nation, made possible by the purchase of Louisiana. would seriously reduce the relative political power of New England led to a secession movement. This came to climax in the Hartford convention which formulated demands for drastic changes in the constitution. News of the signing of a peace treaty coming immediately after the convention adjourned made the New England effort abortive.

The sea trade revived after the war. In the 1840s New England shipyards created the clipper ships, in their day the fastest sailing vessels afloat. By reducing materially the sailing time to the orient, they brought large profits to their owners. In the 1830s and 1840s a large New England whaling fleet, mostly out of New Bedford and Nantucket, pursued their profitable prey in all the oceans.

Manufacturing using the machines of the Industrial Revolution began in New England near the end of the 18th century. The disaster of the embargo and the interruption of trade caused by the War of 1812 caused a shift of New England capital from commerce to manufacturing. Dams across the numerous rivers provided power. Textiles, shoes, clocks, hardware and articles of wood entered the market in increasing amounts. Itinerant Yankee pedlars distributed "Yankee notions!' in the middle states and the south and as far west as the Mississippi. The rapid expansion of the agricultural regions of the south and west from 1815 to 1850 brought into the eastern market cheaper cotton as well as cheaper foodstuffs. The former stimulated more textile activity; the latter drove the less well-situated farmers to abandon their farms and migrate to the west. In fact New England contributed greatly to westward expansion as migrants from New England came early to the old northwest and later to Iowa, Kansas and Oregon. Through these pioneers on new frontiers New England continued to exert the peculiar influence of its Puritan traditions.

The growth of manufacturing bound New England to the nation because of the need for cotton and for an expanding market Sectionalism gave may to a strong nationalism. Beginning with the tariff of 1816 New England supported protection but after 1833 the strong opposition of the agrarian south prevented the maintainance of a strong protective policy. New England was a pioneer in railroad experimentation. One of the first railroads in the U S. was built in 1826 to carry granite blocks from the Quincy quarries to tidewater. In the 1840s short lines were built connecting Boston with Providence. Lowell, Portsmouth, Springfield, New Haven and New York The railroad brought to an end the period of self-sufficiency in New England farming. Husbandmen raised crops to sell in the groning industrial towns. But location excluded New England from the competition in canal, highway and railroad building for access to the west which engrossed the attention of the states to the south. Although in 1850 Massachusetts ranked third to New York and Pennsylvania in railroad mileage these railroads failed to secure connections with the great productive areas of the Mississippi valley, so that Boston, as a port of export, fell behind its rivals. Yet New England had its own expansion. Its northern and eastern regions—Vermont, New Hampshire and Maine—were losing their frontier character. The northern boundary. long subject to dispute even to the extent of an armed clash in 1839 knonn as the Aroostook War, uas finally determined by the Webster-Ashburton treaty in 1842. By that arrangement a large area in northern Blaine came under the permanent jurisdiction of that state. The victory for New England claims stimulated the sentiment of nationalism. During the Civil War New England, nhere antislavery sentiment was very strong, stoutly supported the cause of the Union.

The nar brought to an end a phase of New England life. New England commerce had suffered severely. The whaling fleet was broken up by Confederate raiders. and its monopoly of the illuminating oil market was destroyed by the introduction of kerosene and gas. By the change from wooden to iron and then steel ships and by the rising costs of operation under the U S flag, all the natural advantages in construction and operation of ships which New England formerly possessed were lost.

New England in a Changing **America.**—Between 1855 and the subsequent development of the Bessemer process for making cheap steel and U.S. entry into World War I the country underwent its Industrial Revolution. By the end of that period the region east of the Mississippi and north of the Ohio and Potomac rivers had become thoroughly industrialized. New England, where industrialization had gotten under way early in the 19th century, kept its place in the forefront of the economic advance. Throughout the period it was a high income area. New England cities burgeoned as did those throughout the entire industrialized area. The need for labour brought a social change that has been called the "conquest of New England by the immigrant." The Irish came first to help build the railroads, to work in the mills and to transform Yankee Boston into something approaching an Irish city. North and south Italians. Poles, Swedes, Czechs. Slovaks, Ukrainians, Lithuanians, Magyars and French Canadians combined to bring about in New England a veritable ethnic revolution. The newcomers added colour, character and a cosmopolitanism to the communities of the region. In the great variety of manuiacturing enterprises they acquired the skills that enabled New England to hold fast to an old tradition. One of the most important assets of the region in the 19th century (continuing into the second half of the 20th) was the existence of a numerous and highly skilled labour force

In the 20th century, and particularly after World War I, New England's economic position was seriously disturbed by the impact of new trends in several fields. The demand for both granite and marble from the Maine coast and the Green mountains of Vermont declined with the extensive use of cement and steel in construction. Lumber for the building trade, which reached its peak in the 1860s, when 60 schooners came down the Penobscot river from Bangor, was displaced by lumber from Oregon and Washington or by other materials. Most timber by mid-20th century fell into the class of pulp for paper mills and had to compete nith Canadian and southern products. In the second half of the 20th century Aroostook county. Maine, the Connecticut valley and the area adjacent to Plymouth and Cape Cod remained the only sections where extensive agricultural operations were still profitable. There potatoes, tobacco, onions and cranberries are raised for export. Forests moved in to take over land no longer profitable for crops. The result was the paradox that in one of the most highly industrialized regions in the world 77% of the land area is occupied by forests. Though important national and state forests exist most of the uooded country is privately owned.

After World War I some New England textile industries moved to the south where they would be nearer to raw materials and also in a lower aage area. The danger that communities, such as Manchester, N.H , which had primarily depended upon textiles would become ghost towns was averted by the development of new and diversified industries. The existence in and near New England of important markets mas a prime factor in attracting industry The council of economic advisers reporting to the president in 1951 described that market in The *New England Economy:* "The northeastern part of the country is the most densely populated. Its inhabitants have higher than average personal incomes and conduct more than their proportionate share of manufacturing and much other business activity. The New England and Middle states alone contain 26 4 percent of the nation's population and receive almost one-third of the nation's income." The characteristics of New England industry and its relative position in the national economq is suggested by W. Storrs Lee's summary of Connecticut enterprises. "The state still produces more than half the nation's hats, firearms, fabricated brass products, ball bearings. typewriters, springs and counting devices; only one other state exceeds her productivity in machine tools, cutlery, needles. pins, hooks and eyes, snaps and zippers; it ranks first in the production of aircraft engmes firearms felt hats, non-ferrous metal products, silverware, clocks, hardnare, insulated wire and cable, office and store machines, and mechanical transmission." (Yankees *of Connecticut,* p. 230 Henry Holt & Co Inc., New York. 1957) As industrialization has spread over much of the United States New England lost its former pre-eminence Its rate of groath became slower than that of newer industrial areas. But in an absolute sense progress continues. Diversification has gone beyond manufacturmg. If the pre-Civil War merchant marine that sailed from New England's ports has disappeared. the region contains in Hartford, Connecticut, the "insurance capital" of the nation. New England's mountains, lakes, rivers and seashore are not only available for the enjoyment of the people of the region but attract a sufficient number from beyond its borders to make the tourist business a major industry.

Cultural Influences.—The first settlers of New England had a deep interest in religion and in education. In Jonathan Edwards New England produced one of the chief theologians and philosophers of the English-speaking world in the 18th century. From Edwards among other origins, stemmed the evangelical impetus that gave power not only to early 19th-century Congregationalism but to the other Protestant denominations that had become important in New England. At the same time Unitarianism under the leadership of William Ellery Channing softened the harsh rigidities of the old Calvinism by emphasizing the humanism and the emphasis on reason of the Enlightment. Transcendentalism as expressed by Emerson, Phillips Brooks and Horace Bushnell replaced the distant God of Calvin with an immanent deity abiding in the hearts of men. The concept of an immanent deity became central to the theology of the social gospel. important in New England churches at the turn of the 20th century. After the middle of the 19th century, however, the Protestant monopoly of New England religion rapidly disappeared. Beginning with the Irish, the immigrants brought Catholicism to the region and to the nation. By the middle of the 20th century Catholics comprised a large percentage of the population of the three southern states of New England.

After the founding of Harvard and Yale the interest of New Englanders in higher education expressed itself in the establishment of Brown (1764), Dartmouth (1770), Williams (1791), Amherst (1825), Massachusetts Institute of Technology (1861), Bowdoin (1794) and Smith (1871) to mention only the more famous of the institutions which appeared. In the 20th century all were independent institutions. Only in the middle years of that century did the state universities begin to reach a stature that could be said even to approach that of many of such institutions west of the Appalachians. In the 19th and 20th centuries New England became a centre for privately endowed preparatory schools. But Horace Mann of Massachusetts and Henry Barnard of Connecticut were the two most important pioneers in bringing about the American public school system supported by taxation and with trained teachers in the classrooms. In New England the Catholics created and supported their own school system from kindergarten through college.

In the first half of the 19th century evangelical Protestantism stimulated the development of many humanitarian and reform movements in the nation and particularly in New England. Dorothea Dix of Massachusetts pioneered in the reform of the treatment of the mentally ill. Lyman Beecher of Connecticut was an initiator of the temperance movement. William Lloyd Garrison of Massachusetts led a militant abolitionism. Elihu Burritt of Connecticut founded an international peace society. Beginning at Williams college early in the 19th century a missionary movement to foreign lands and to the American frontier carried outward from New England not only religion but education and medicine.

In two villages, Concord and Cambridge in Massachusetts, appeared the most important groups in the first flowering of American letters. Emerson, Thoreau, Hawthorne, Longfellow, Holmes and Lowell created an enduring literature. Outside the region Irving and Cooper preceded them and Whitman followed. Only Poe and Melville among the major figures were their contemporaries. After the Civil War the solitary Emily Dickinsen of Amherst wrote the poetry that gave her rank among the best. Henry James fled New England at the height of the Industrial Revolution to become an expatriate in England but one who in his writings could not escape the fascination of the American theme. Meanwhile his brother, William, borrowing an idea from the mathematician. Charles Peirce, formulated and named at Cambridge the American philosophy of pragmatism. In the 20th century Eugene O'Neil of Provincetown and New London brought American drama to eminence.

New England in the **20th** Century.— For roughly two centuries from the landing of the Pilgrims in 1620 to the Hartford convention in 1814 New England was a peculiar and self-conscious region whose leaders in the latter year gave serious thought to the possibility of setting up their own independent nation. In the century from the War of 1812 to World War I New England, accepting the role of a small region in a nation of continental size, led the way in the creation of industrial America, produced a literature that ranked with that of contemporary England and exported thousands of its people to the territories and the states beyond the Appalachian mountains. These migrants carried with them from their rocky eastern hills the New England ethics and regard for things of the mind. After World War I the forces making for standardization in a dynamic civilization rubbed away, for the most part, the angularities that had so long given New England its distinctive character. But uniformity did not triumph completely. The New England past was prologue in the mid-20th century to a present in which, in a new age, a traditional spirit of enterprise carried on in the face of continuing disadvantages.

In manufacturing, no giant mass-production industries took form. Limited supplies of power and lack of local raw materials suggested to New England enterprisers that they concentrate, like their counterparts in Switzerland? on products of small bulk and of high quality and value. In an age of relative decline on the part of railroads New England built arterial highways east and west across Connecticut and Massachusetts that connected with others running north and northeast in New Hampshire and Maine. The new highway network increased the mobility of goods and persons within the area and, by articulating with the highway system of New York state, maintained for New England effective contact with the rest of the nation. If transoceanic airways and seaways bypassed New England, the busy life of the region brought about a considerable air-borne and sea-borne commerce. Suburbs pushed out from the major coastal cities until the "long street" from Boston to New York and beyond became almost a literal reality. If the growth of suburbia threatened parent cities with decay at the centre. New Haven's thorough-going destruction of obsolete downtown commercial structures and its creation of a modern city centre demonstrated community readiness to face realities and determination to keep in the van of 20th-century progress. The fact that the many-times-elected mayor who led the community effort was of Irish extraction suggests that the new Yankee who appeared after the conquest of New England by the immigrant possessed an enterprise and vision equaling that of the early 19th-century Yankees who built Lowell, Mass. and Manchester, N.H.

In the arts the Boston symphony orchestra achieved a position second to none. Its Berkshire Summer festival became a national cultural event. In the same period Yale established the first school of music of graduate level in the United States. In architecture New England, while cherishing the tradition of 18th century Georgian expressed in carefully guarded old houses and churches, welcomed the new philosophies and new forms of modern architecture. The theatre and chapel at the Massachusetts Institute of Technology and the hockey rink at Yale expressed freedom and creativity. A concentration within its small area of institutions of higher learning made New England in the 20th century an intellectual centre unequaled in the nation. Thornton Wilder's *Our Town* summed up the region. Its theme is universal but "Our Town" remains a New England village. See also Index references under "New England" in the Index volume.

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(R. H. GA.)

NEW ENGLAND PRIMER, the "Little Bible of New England," was a famous children's schoolbook published sometime before 1690 by Benjamin Harris (fl. 1673–1716), who, in Sept. 1690, published the quickly suppressed first issue of the first newspaper printed in the colonies. *Publick Occurrences Both Forreign and Domestick.* The catechism contained woodcuts illustrating the alphabet, crude couplets and moral texts, including the child's prayer "Now I Lay Me Down to Sleep." Frequently revised, it was an important children's textbook for more than a century.

NEW FOREST, one of the most densely wooded regions of England, lies in southwest Hampshire between Southampton water, the Solent and the Avon river. Agriculture is important on the coastal fringes. Inland the infertile, sandy or gravelly soil supports only woodlands, or broad heaths grazed by the ponies and cattle of the "commoners," small farmers holding ancient grazing rights. This region of unique scenic beauty, administered under special acts of parliament, serves many of the recreational purposes of a national park.

The New forest, mentioned in Domesday Book, was a hunting ground of the West Saxon kings, but derives its name from being placed under forest laws by William the Conqueror in 1079. The deaths of two of his sons within its confines—Richard killed by a stag and William Rufus by an arrow—were regarded as a judgment of heaven for the injustice perpetrated by their father when appropriating the forest.

The New forest, being under the forest laws, mas affected by the forest clauses of Magna Carta and by the Forest charter (1217), which mitigated their severity. The chief officer was the justice in eyre who held the highest forest court. The lower courts were the swanimote and wodemote, the former of which is still held, in a modified form, in the Verderers' hall of the Queen's house at Lyndhurst.

The circuit of the justices in eyre, or their deputies, continued down to 1635; they were virtually ended by the Act for the Limitation of Forests (1640). The lower officers of the forest, who held local appointments, were the verderers, the regarders, the foresters, the woodwards and the agistors. There was also a lord warden: usually a nobleman who performed no judicial functions.

Though the extent of the New forest has been reduced since Norman times, its legal "perambulation" still embraces 130 sq.mi. Of this, 30 sq.mi. are privately owned, while 100 sq.mi. are controlled by the Forestry commission. The 45 sq.mi. of crown woodlands, largely of oak and pine, form a valued reserve of timber, managed on scientific lines. The main centres are Lyndhurst, with administrative offices; Fawley, with a great oil refinery on Southampton water; Lymington (*q.v.*), a yachting port and Georgian town beside the Solent; New Milton, a seaside resort; and Ringwood, a market town in the Avon valley. Beaulieu village on the estuary of the Beaulieu river has ruins of Beaulieu abbey, founded by King John for Cistercians. Many of Lord Nelson's wooden battleships, built of New forest oak, were launched from the slipway that may still be seen at Buckler's Hard nearby. (H. L. EN.)

NEWFOUNDLAND is the tenth province of Canada, having entered the confederation on April 1, 1949. It comprises two main areas, the Island of Newfoundland and the Coast of Labrador, a total area of 156,185 sq.mi. The Island of Sewfoundland, roughly triangular in shape, is separated from the Canadian mainland by the narrow Strait of Belle Isle on the northwest, the broad Gulf of St. Lawrence on the west and the 68-mi.-wide Cabot strait on the southwest. The island has an area of 43,359 sq.mi. of which 2,195 sq.mi. is fresh water. The Coast of Labrador extends northward from the Strait of Belle Isle to Hudson strait and inland to include the area draining eastward. Consequently, the Labrador-Quebec boundary follows the irregular and twisting drainage divide. Labrador has an area of 112.826 sq.mi. (of which 10.943' sq.mi. is fresh water), considerably larger than that of the island.

The population of Newfoundland in 1961 was 457.853, of which only 13.534 lived in Labrador. St. John's, on the island, is the largest city and capital of the province. Historically, the Newfoundland economy has been based essentially on the codfishery, but in the 20th century forest and mineral industries have become increasingly important. The fishing industry itself has changed in character, with greater mechanization and new methods.

This article deals with various aspects of the Island of Newfoundland and with the political history of the province, including the Coast of Labrador. For the physical geography, natural resources, etc., of the Coast of Labrador *see* LABRADOR-UNGAVA.

Following are the main divisions of this article:

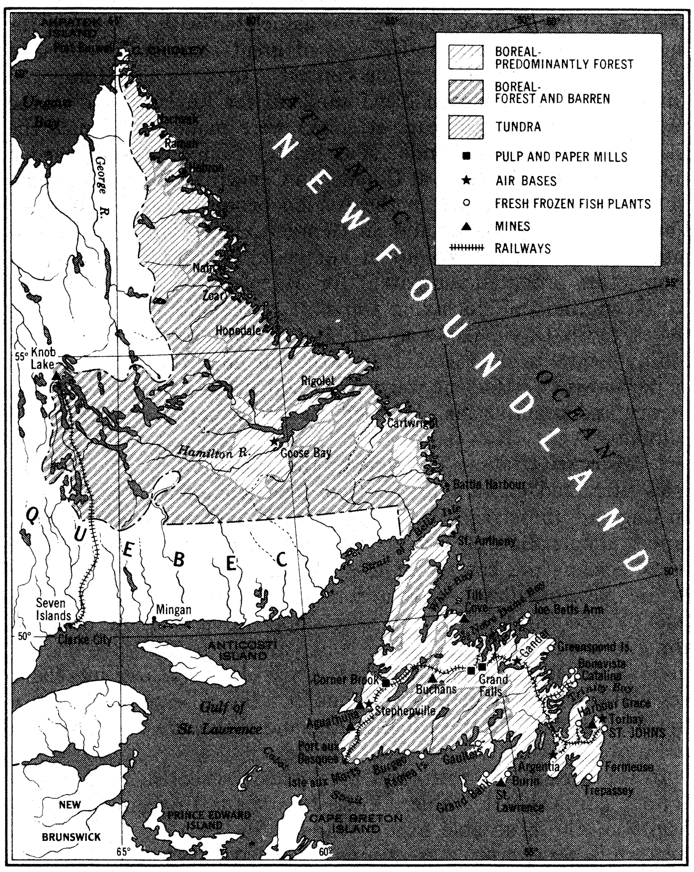
- I. Physical Geography
  - 1. Climate
  - 2. Plant and Animal Life
- II. History
  - 1. Mercantilism
  - 2. Representative and Responsible Government
  - 3. Economic and Social Development
  - 4. The Age of Local Enterprise
  - 5. The Era of Foreign Investment
  - 6. Labrador Coast Award
  - 7. Commission of Government
  - 8. World War II
  - 9. Confederation with Canada
- III. The People and Population
- IV. Government and Finance
- V. Education
- VI. Production
  - 1. Agriculture
  - 2. Forestry
  - 3. Mining
  - 4. Fisheries
- VII. Communications

I. PHYSICAL GEOGRAPHY

The Island of Newfoundland is considered to lie within the Appalachian physiographic province, related in structure to the whole eastern seaboard of North America (*q.v.*). The great diversity of rock types which have undergone metamorphism and faulting are complex in structure. Nevertheless, there is a marked northeast-southwest alignment of the rock formations which conforms with the trend throughout the Appalachian system. Rocks of Pre-Cambrian Age constitute the Long Range mountains which parallel the west coast, parts of the interior and the southern part of the island, including the Avalon peninsula, joined to the island by a narrow isthmus, at the extreme east. Much of the central portion of Newfoundland is made up of Paleozoic sediments, chiefly Ordovician in age, and intrusives of Acadian Age.

The island may be regarded as a rugged plateau sloping eastward from the Long range. The surface exhibits signs of glaciation such as numerous lake basins, ice-sculptured valleys, rounded rock knobs and glacial deposits in typical forms. Reaching a common level of about 2,200 ft., the tablelike summits of the Long range represent the remnants of an ancient peneplain that has undergone periods of uplift and erosion. Other peneplain surfaces at lower elevations have been recognized. Certain peaks in the Long range rise above the high peneplain level to elevations of more than 2,600 ft. The Humber is the only major river that crosses the range to reach the west coast. Notable among the eastward-flowing rivers are the Exploits, the Gander and the Terra Nova. In the interior of the island are several long, narrow lakes, the largest of which are the Grand, Red Indian, Gander and Deer lakes. The greatly indented coast line of the island is estimated to be more than 6,000 mi. long. Numerous embayments separated by peninsulas constitute the jagged east and south coasts, in contrast to the relatively straight west coast.

1. Climate. — In spite of the maritime location of Newfoundland, the climate is essentially continental in character. Air masses which cross Newfoundland come predominantly from the west, bringing the continental influence. Nevertheless, the cold Labrador current that flows southward along the east coast of Newfoundland affects the climate to a certain degree. A cooling effect of the sea in summer prevents especially high temperatures and postpones the warmest weather until August. In winter the presence of the sea moderates the temperature, preventing the very cold readings of mid-continental areas. The mean temperatures in January range from 15° to 25° F. and in July from 50° to 60° F.



AREAS OF NEWFOUNDLAND'S PRINCIPAL NATURAL AND ECONOMIC RESOURCES

Precipitation is highest, about 50 in.. in the southeastern part of the island and decreases northward to about 40 in. at the Strait of Belle Isle. Snowfall ranges from approximateiy 80 in. along the south coast to more than 120 in. in the northern half of the island. In winter the east and west coasts are icebound for periods of time ranging from five months in the north to one month in the south. Only the south coast is ice-free throughout the winter. Fog occurs frequently along the east coast, especially during the summer months. In fact, the Grand Banks, where the cold Labrador current (*q.v.*) meets the warm Gulf stream, are noted as one of the foggiest areas of the world.

2. Plant and Animal Life.—Newfoundland lies within the boreal forest region in which coniferous trees predominate. Balsam fir, white spruce, black spruce, white birch and yellow birch are among the most common trees. No more than one-half of the total land surface is forested, while the remainder is mostly moss barren and bog. The main forest areas lie within the watersheds of the principal rivers. On the barren lands and bogs vegetation is in the form of mosses, lichens, stunted trees, grasses and certain flowering plants.

The island is well endowed with wild life and fresh-water fish. The chief fur-bearing animals are beaver, muskrat, fox, lynx and otter. Game animals include caribou, moose, black bear and hares. Evidence points to the fact that numbers sf certain game animals are decreasing. Trout and salmon are abundant in the rivers and lakes of Newfoundland and attract sport fishermen from distant cities.

II. HISTORY

Investigation of the subject of transatlantic navigation suggests that Newfoundland and the Grand Banks fishing ground were well known by fishermen before John Cabot made his voyage in 1497. Cabot gave emphatic advertisement to the wealth of the western waters, an advertisement reinforced by the Portuguese explorer Gaspar Corte-Real in 1501. By the first quarter of the 16th century, French, Basque, English and Portuguese adventurers were fishing regularly off Ne~vfoundland.

The island occupied a vital place in the scientific and military activity of the 16th century; it was associated with the search for the northwest passage, and it was of great strategic importance in the Anglo-Spanish maritime contest. In 1583 Sir Humphrey Gilbert formally annexed Newfoundland for England, and in the course of the next 30 years attempts were made to colonize the island. In 1610 the London and Bristol company established a colony, led by John Guy, at Cupids, on Conception bay. Colonization was attempted also in the Avalon peninsula by Sir William Vaughan, Lord Falkland and Sir George Calvert, later Lord Baltimore. The Baltimore colony at Ferryland promised well, until its proprietors procured the patent for Maryland in 1632. In 1637 all Newfoundland, including the Baltimore holdings, was transferred to Sir David Kirke and his associates. Although the Kirke family seems to have retained possession until the 1670s, efforts at permanent settlement were at an end; 17th century economic theory and practice far preferred the cod fisheries to established colonies.

1. Mercantilism.—Throughout the 16th century the codfisheries attracted great annual expeditions from maritime Europe. In England, these reached the position of supreme national importance. Poole, Bristol, Exeter, Teignmouth and the other western ports became the centres of English enterprise, thus establishing in the Newfoundland trade a dominance that endured for more than two centuries. The cod were shipped overseas, the best fish going to the Mediterranean, the least valuable to the slave plantations in the West Indies. Marketing was done by large merchant vessels which brought to Newfoundland the all-essential salt; in the late autumn they returned to England with wine or oil, or with the more precious bullion from abroad.

In the eyes of the 17th- and 18th-century theorist, these transactions had a double value. First, they made England the beneficiary of the profitable export trade in dried cod. Second, the western fisheries were a great nursery of hardy seamen. It is not surprising, therefore, that the fisheries were regarded as being of fundamental importance to England's security and prosperity. It was manifestly contrary to national policy to permit permanent settlement or to allow the fishermen to winter in Newfoundland. It mas equally in the interests of the western merchants to discourage settlement. Accordingly, they adroitly identified their private interests with the widely accepted mercantilist theories, and argued that possession of the fisheries was synonymous with maritime supremacy.

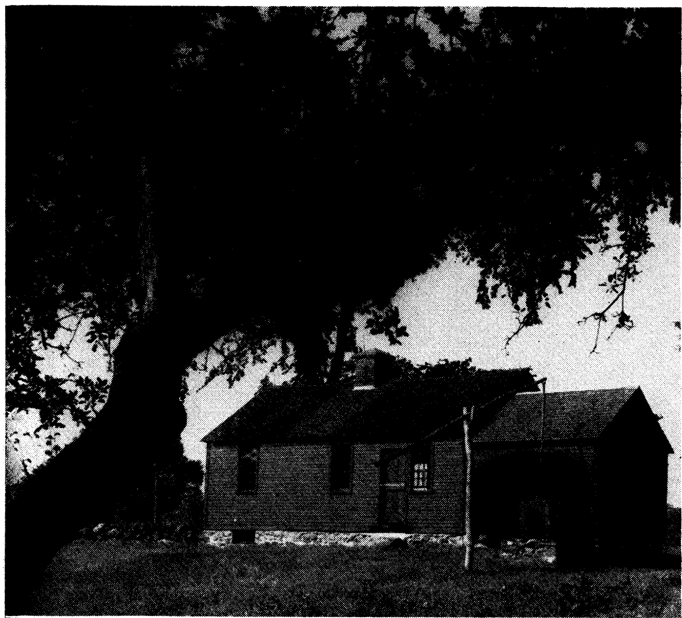
Intensification of maritime rivalry probably forced the issue. In 1662 the French established themselves at Placentia; in 1665 the Dutch burned St. John's, even at that early date a centre of English trade. Beginning with 1696, the French made concerted attempts to conquer Newfoundland with attacks on English establishments in 1697, 1705 and 1708. By the terms of the treaty of Utrecht (1713), the French recognized English sovereignty over Newfoundland, although they retained valuable fishing privileges between Cape Bonavista and Point Riche. These concessions graphically indicate the high value set on the fisheries by both French and English. The ultimate settlement of these claims was postponed for nearly two centuries. During the Seven Years' War (1756–63) Newfoundland again became a centre of conflict! St. John's being lost and retaken by the English in 1762. During the American and French Revolutionary wars, the island's coasts were ravaged again.

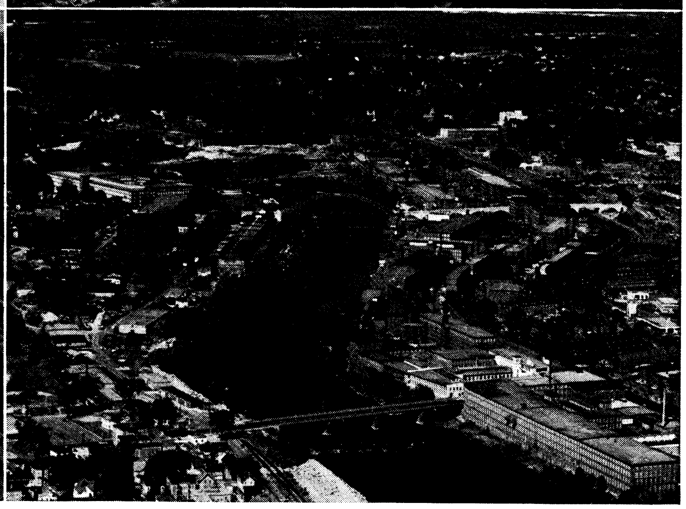
The subordination of Newfoundland's social and political development to the codfisheries was complete. After the failure of the early colonization schemes, authority was chaotically exercised by the fishermen themselves, under the title of "fishing admirals." In 1729 an officer of the Royal Navy, Capt. Henry Osborne, was appointed governor. His tenure was seasonal, as was that of his successors until 1817. The naval governors wholeheartedly sought to aid the overseas fisheries as auxiliary to national policy. In 1791 a civil court was instituted and in 1792 a supreme court. In this way the earliest attempt was made to introduce an element of constructive order into Newfoundland affairs.

The population of the island was almost entirely seasonal, the fishermen returning each autumn to England; as late as 1683–84 there were only 120 permanent residents on the island. Throughout the 18th century numbers increased from 3,400 in 1754 to more than 12,000 in 1774. The newcomers were drawn increasingly from Ireland to provide inexpensive labour for the codfisheries. Food and supplies were brought in from New England. The great prosperity enjoyed by the fisheries in the late 18th century probably accounted for the steady increase in population, which by 1804 reached 20,000. The peak year was 1814–15, when more than 11,000 immigrants arrived in St. John's from southern Ireland.

The operation of the shore fisheries was left chiefly to these newcomers. The prosperous deep-sea fishermen became resident merchants, buying dried cod, fish oil and sealskins for speculation abroad. Their headquarters were St. John's which became a distributing and financial centre! as well as a fishing station. By the end of the 18th century, therefore, the hold of the old system on Newfoundland life mas weakening.

2. Representative and Responsible Government.—As early as 1802 the governor, Lord Gambier, proposed that a form of representative government be granted the colony of Newfoundland. The leading advocates of self-government in the island were William Carson, a politically inclined Scottish physician, and Patrick Morris, an Irish-born merchant. In 1832 representative institutions were established with a bicameral legislature, the loner house of which was elected on a broad franchise. From an early period discord developed between the two houses. The legislative councilors were residents of St. John's and representative of the economically dominant merchants; the assembly was a much more popular body. The discord between the houses led to a temporary suspension of the constitution and amalgamation of the two houses. From 1848 onward, attempts were made for complete responsible government. In 1855 full legislative responsibility was admitted, on the analogy that what had been recognized in Nova Scotia and Canada could not be withheld

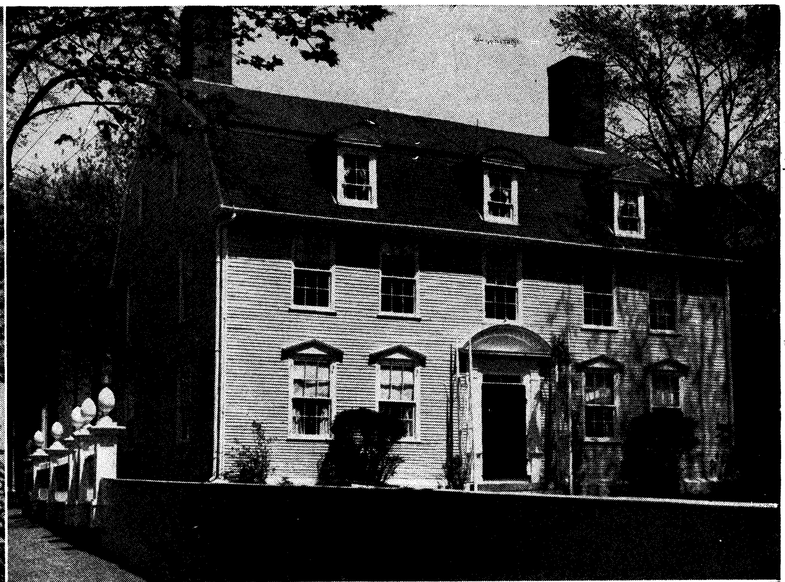




BY COURTESY OF (TOP LEFT) NEW HAMPSHIRE STATE PLANNING AND DEVELOPMENT COMUISSION, (CENTRE LEFT) JOHN SWENSON GRANITE COMPANY; PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) ERIC M. SANFORD. (TOP RIGHT) AARON G. FRYER. (CENTRE LEFT) ROBERT SWENSON. (BOTTOM LEFT) DOUGLAS ARMSDEN

HISTORICAL, INDUSTRIAL AND CITY SCENES IN NEW HAMPSHIRE

Top left: Two-room cabin where Daniel Webster was born, near Franklin
Top right: Maple-lined mall at Orford, the only street in the town
Centre left: Shaping granite blocks in a quarry near Concord
Bottom left: Aerial view of Portsmouth showing mouths of the Piscataqua river
Bottom right: Aerial view of Manchester; the Merrimack river flows through the city



BY COURTESY OF (TOP LEFT, BOTTOM LEFT) NEW HAMPSHIRE STATE PLANNING AND DEVELOPMENT COMMISSION: PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT) DICK SMITH. (TOP RIGHT, CENTRE RIGHT) ERIC M. SANFORD, (BOTTOM RIGHT) DON SIEBURG

VIEWS OF NEW HAMPSHIRE

Top left: Pinkham notch; in the background are the ski trails of Tuckerman ravine, Mt. Washington

Top right: The John Paul Jones house, Portsmouth, erected in 1758. It was a boardinghouse when Jones lived there while supervising construction of the "Ranger" for the continental navy

Centre right: Stack of pulpwood for paper mill on Upper Ammonoosuc river at Groveton

Bottom left: Mt. Washington cog railway taking tourists to the summit of the Presidential range. Mountains in the background are Adams and Jefferson. This railway was the first of its kind in the world and was later adapted for the Swiss Alps

Bottom right: The Old Man of the Mountain (Great Stone Face) in the White mountains is New Hampshire's best-known natural wonder in Newfoundland.

3. Economic and **Social** Development.— Increasing economic maturity underlaid the constitutional changes. The early 19th century was characterized by the growth of the inshore fisheries, as distinct from the bank fisheries. The war years, especially from 1800 to 1815, drastically curtailed the deep-sea fisheries. During the Napoleonic war years the Newfoundlanders established virtual control over the Mediterranean market for dried cod and about 1814 they established an important new market in Brazil. Peace brought a disastrous fall in the price of dried fish: occasioning a prostration in business that lasted until 1819. Thereafter, until the middle of the 19th century, the export of cod remained remarkably constant.

An important adjunct to economic prosperity was the seal fishery. From the middle of the 18th century, the people of the northern bays took a few seals annually by means of nets. Somewhat later, small boats were employed. These ships sailed each spring for "the ice," in order to intercept the great herds of seal on their migrations. In 1831 and 1844 phenomenal catches were made, 686,830 and 685,530 respectively. The industry gave employment to a large number of men and brought handsome returns to the capitalists who directed it. In 1857, 13.600 men shipped for the ice; the catch was valued at $1,700,000. After the middle of the century. sealing declined.

Throughout this period, concerted efforts were made to broaden the economic basis of island life. Under the direction of Sir John Harvey in the 1840s, agricultural societies were formed in an effort to put farming on a rational and extensive basis. The success of these efforts may be judged by the progressive increase of land under cultivation: 1836, 11,062 ac.; 1845, 29,656 ac.; 1855, 41,108 ac. The majority of such holdings were small, usually being worked as auxiliary to the all-absorbing fisheries. Nevertheless, they did impart a degree of self-sufficiency and permanency to island life. The first geological survey of Newfoundland was begun in 1839 by J. B. Jukes with the aim of developing mineral resources.

The social development of the colony kept pace with the economic. The merchant class became Newfoundland by birth and outlook and, with the rise of the enterprising Irish shopkeeper, began to lose its exclusively Anglican caste. The outport merchants, with the increasing importance of the seal fishery, played a more decisive role in business life. St. John's was transformed gradually into a commercial centre and colonial capital. In 1800 the population of the city was about 3,000 living along two narrow paths that straggled on the north side of the harbour. A series of disastrous fires in 1816, 1817 and 1819 largely destroyed the ancient malodorous fishing town and made possible a degree of planning. In 1846 another fire hastened this process and opened the way for such improvements as a general water supply system, the St. John's Water company being incorporated in 1846. In this period, some of the most conspicuous landmarks of St. John's took form. In 1841 the cornerstone of the Roman Catholic cathedral was laid and in 1855 the church mas consecrated. In 1843 the building of the Anglican cathedral was begun.

The Newfoundland churches owe their modern organization to the early 19th century. In 1856 the Roman Catholic diocese of St. John's was established. Catholic worship had been conducted regularly as early as 1623 in the Baltimore colony; a prefecture was created in 1784 and a vicariate in 1796. The Anglican diocese of Newfoundland mas created in 1839. Provision for Anglican worship was made as early as 1583, and the first Anglican minister reached the island in 1610. The consecration of Bishop Edward Field in 1844 introduced the modern period in church extension and education. Methodism was introduced into Newfoundland in 1764, establishing itself strongly in the northern outposts. In 1855 the Methodist churches joined the Eastern British-American conference, thus breaking the administrative connection with England. The entrance of the Methodist Church into the United Church of Canada was effected in 1925. Organized Presbyterianism dated from 1842. The other chief religious bodies, Salvation Army, Adventists and Pentecostals, came into being later.

4. The **Age** of Local Enterprise.— The quarter century 1870–95 was one of general prosperity, attributable to the progressive broadening of economic life through farming and mining and also to the stimulus of railway building. An additional reason was the high price the increasing exports of dried codfish commanded. In an era of general price decline, the price level of dried fish remained almost stationary. Thus the fisherman had the absolute advantage of a high selling price and the relative advantage of greater purchasing power. Moreover, the capitalistic enterprises of the period were locally managed and financed. The intrusion of alien direction and control following 1895 may be regarded as closing one period in Newfoundland history.

The search for economic self-sufficiency was initiated as early as the 1860s. The rapid increase in population (1857, 124,288; 1869, 146,536; 1874, 161,374) gave a note of urgency to these investigations. In 1862 two committees of the legislature examined the fisheries and agriculture, and in 1864 the geological survey of the island was reinstated. Also in this year a copper mine was opened at Tilt Cove on Notre Dame bay. The mine operated almost continuously until 1918 and produced 1,492,000 tons of ore. A number of smaller copper deposits were discovered around Notre Dame bay in succeeding years. Among the producing mines were those at Baie Verte, Betts Cove, Little Bay and Roberts Arm.

Railway construction became the great end of national policy. In 1875 Sir Sandford Fleming, the engineer of the Canadian Pacific, surveyed a practicable route from St. John's to St. Georges bay. In 1880 a joint committee of the legislature recommended the building of a railway northward, as the best means of making accessible the mining and agricultural regions of Notre Dame bay and Exploits valley. In 1881 a company was incorporated and construction begun. The company was aided by government subsidies of $180,000 per annum for *35* years, and a land grant of 5,000 ac. for each completed mile. At the same time, new enterprises were initiated at St. John's. In 1882 a ropewalk was established for the manufacture of fishing gear, netting, cordage and cables, thus freeing Newfoundland from its dependence on foreign sources for these indispensable supplies. Between 1882 and 1884 a large dry dock was constructed. Other industries developed locally included foundries, machine shops and engineering works, all associated with the railway or with shipping.

In the early 1890s two disasters altered completely the pattern of Newfoundland growth. In 1892 three-quarters of St. John's was devastated by fire. The damage to property was computed at $20,000,000, of which less than one-quarter was covered by insurance. In Dec. 1894 the two leading banks, the Commercial and the Union, failed, while the Government Savings bank was compelled to suspend payment. The notes of these banks, the normal currency of the island, became valueless, business stagnated and workingmen were dismissed. As the Gnion bank was under obligation to provide the half yearly interest (about $225,000) on the public debt, the crisis assumed serious proportions. A loan from the United Kingdom serving for immediate relief, Newfoundland sought permanent solution by union with Canada. The insistence of the Canadian government on certain debt settlements caused the negotiations to break down early in 1895. Left to their own devices, Newfoundland public men, directed by Sir Robert Bond, succeeded in raising loans in Montreal, New York and London, thus staving off the danger of complete financial collapse.

The bank failures brought to an end a distinct era in Newfoundland history. Local enterprise had been overwhelmed by disaster. The Canadian banks entered the island and their notes replaced the local Newfoundland dollar. Alien direction invaded the business life of the island.

5. The Era of **Foreign** Investment.— For the first 30 years of the 20th century, Newfoundland development followed a consistent pattern. Foreign enterprise increasingly sought, to exploit the island's natural resources. World War I intensified this process. The liquidation of long-standing differences with France and the United States was a feature of this period.

As early as the 1890s, foreign investment was attracted to railway construction and mining. Sir Robert Reid of Montreal, a Scottish-Canadian promoter, had become influential in pushing the construction of the transinsular railway. The financial disaster of 1894–95 induced the government in 1899 to transfer to Reid virtually all the island's communications; railway, shipping lines and telegraph, as well as the St. John's dry dock and extensive timber and mining rights. Strong protest produced an amendment of the contract in 1901, whereby the more objectionable monopolistic features were surrendered at the price of about $2,500,000. Construction was pushed vigorously; in 1893 the railway reached Norris Arm on the Exploits; in 1897, Port aux Basques. Fast steamships were put in service between this point and Sydney, N.S. The profitable operation of these enterprises proved increasingly difficult, until finally in 1923 the government assumed their operation. In 1895 the exploitation by a Canadian company of the iron deposits on Bell Island commenced.

In 1905 the Anglo-Newfoundland Development company was constituted for the manufacture of newsprint. The company was originated by Lord Northcliffe, who wished to make his chain of newspapers independent of foreign countries for supplies of newsprint. The location of the original plant was at Grand Falls, where the company received power rights on the Exploits river and timber limits amounting to 2.000 sq.mi. The first paper was produced in 1909. For export purposes the company installed docks and sheds at Botwood, which was connected with Grand Falls by private railway. The company expanded greatly. In 1923 it acquired the pulp mill of the Albert Reed company at Bishop's Falls. In carrying out surveys, officials of the company discovered outcroppings of copper-lead-zinc ore on Buchans river but it was not until 1925 that these deposits were made profitably exploitable. The American Smelting and Refining company undertook development under agreement with the Anglo-Newfoundland Development company, and mining operations were begun in 1927.

The participation of Newfoundland in World War I was distinctive. The large seafaring population enlisted in the Royal Naval reserve, an institution of long standing on the island. In all, over 1,500 men served at sea in all parts of the world. In Aug. 1914 the government determined to raise a small land force, ultimately known as the Royal Newfoundland regiment. This unit iought in Egypt, the Dardanelles and France. At the battle of Beaumont Hamel, in the Somme (June 30, 1916), it lost virtually its entire complement of 700 men. The regiment was immediately brought up to strength and served with distinction during the later phases of the war. In 1917 a forestry corps was recruited from among Newfoundland woodmen. A noncombat unit, it was employed in timber cutting in Scotland. Outside these purely Newfoundland formations there was extensive enlistment in the British forces.

In the era following World War I came the exploitation of the timber resources of the west coast. Between 1923 and 1925 the Newfoundland Power and Paper company built a paper mill at Corner Brook and a hydroelectric plant at Deer Lake. Costs of construction mere more than double the original estimates and the company decided to sell its interests to the International Paper company in 1928. Bowaters Newfoundland corporation acquired the plants in 1937 and greatly expanded the production facilities.

6. Labrador Coast Award. — This decision was rendered in 1927 by the judicial committee of the imperial privy council of Great Britain following litigation between Newfoundland and Canada over ownership of the ill-defined area of Labrador. The waters off the Labrador coasts were worked by French and English fishermen, the former irom Canada, the latter from Newfoundland. With the cession of Canada to Britain in 1763 by the treaty of Paris, disputes over the title to Labrador were referred to British tribunals. These were concerned primarily with the coastal areas, since until the late 19th century there was no economic attraction except fishing.

Between 1763 and 1825, four adjustments were made, the sum of which gave the Kewfoundland colony jurisdiction over the Atlantic iace of Labrador and Canada the north shore of the Gulf of St. Lawrence. In 1888 the exact location of the inland boundary was first disputed. The decision of the judicial committee in 1927 was in favour of Newfoundland, asserting that "the Coast of Labrador" included the hinterland to the watershed of the rivers draining eastward to the Atlantic. The award endowed Newfoundland with a continental dependency of 1I0,000 sq.mi., embracing among other assets the basin of the Hamilton river, and stretching from the Gulf of St. Lawrence to Cape Chidley.

7. Commission of Government. — In 1931 Newfoundland began to experience the effects of the world depression. These mere intensified by the heavy service charges on the Newfoundland debt. Throughout the 1920s, the program of railway consolidation and highway construction, along with increased aid to education, raised the national debt from $43,000,000 to $101,000,000. Moreover, the budgets had not been balanced after 1920, the annual deficits amounting to an average of $2,000,000. The deficits were met by loans, which, of course, added to the general indebtedness. The onset of the depression, therefore, found Sewfoundland in a dangerous position. Unfortunately, Newfoundland's best customers for newsprint, minerals and dried cod were themselves seriously affected. Employment declined in Canada and the United States, forcing home scores of seasonal workers. In 1931 a loan for $8,000,000 received no tenders. Upon request, a financial adviser for the government was dispatched from the United Kingdom. In 1932 loans were successfully raised from the Canadian banks and from local subscriptions. Drastic cuts were made in expenditures and taxes steeply increased. During 1933, however, no improvement was visible, and additional loans were sought from governments of Canada and the United Kingdom. At this time application was made for the appointment of a royal commission to inquire into Newfoundland affairs.

In February a royal commission was appointed. It consisted of three members, a Newfoundlander, a Canadian and a representative from the United Kingdom. The terms of reference stressed the examination of Newfoundland's financial situation and prospects. The royal commission met throughout the summer of 1933, gathering information on Newfoundland life. A report of these investigations, along with certain recommendations, was published in the autumn of 1933.

The report was a comprehensive document, containing an extensive survey of Sewfoundland's existing condition and past history. The ills of the dominion were set down to the functionings of a perverted parliamentary system which had been exploited for party and personal gain. As a solution the royal commission recommended the temporary suspension of government responsible to the people. It recommended: also, that the government of the United Kingdom assist Kewfoundland financially until such time as the dominion became self-supporting. Other recommendations concerned the rehabilitation of the fisheries, the revision of the educational system and so on. The constitutional proposals were startling since they envisaged the establishment of a unique body, the commission of government, which should exercise both legislative and executive functions.

The commission of government took office in Feb, 1934 and governed Newfoundland until union with Canada in March 1949. It was composed of six appointed members, three Newfoundlanders and three from the United Kingdom, under the chairmanship of the governor. The commission encountered a number of difficulties, virtually all of which proceeded from the low prices commanded by the island's primary products in the world market. The commission gave assistance to the fishing industry by creating a fisheries board, which made substantial progress in improving standards of production and methods of marketing. Aid was also given in building more modern fishing vessels. Other undertakings that enjoyed the commission's support were farming and land settlement, the former through education and cash bonuses, the latter by means of the land settlement board, later the department of rural rcconstructiun. Transportation was improved: the main line of the railway was restored to predepression standards, several new coastal steamers were put in service and a number of local roads were laid out. Expenditures were substantially increased in education and in health. The means of implementing these reforms came from improved finances. The commission simplified and reduced the customs duties (the traditional staple income of Newfoundland), and by thus encouraging imports secured substantial increases in revenue. It was also assisted by grants-in-aid from the Cnited Kingdom to cover ordinary expenditures, and loans from the Colonial Development fund for capital outlays. In terms of rehabilitation and reform, the record of the commission of government was impressive.

8. World War 11.—The outbreak of war in Sept. 1939 found Newfoundland without fixed defenses of any kind, and without even a garrison. A local defense force, the Newfoundland regiment, was immediately raised, and troops were recruited also for overseas service. The latter formed part of the British army not, as in World War I, a separate Newfoundland unit. The island provided the personnel of two heavy artillery regiments, one of which later became a field artillery regiment. They served in north Africa, Italy and western Europe. A total of 2,327 Newfoundlanders joined these units. A Newfoundland overseas forestry battalion, a civilian organization, was likewise raised, with a strength of about 1,500 men. Individual Newfoundlanders, both men and women, enlisted in the Canadian as well as in the British forces. Total enlistments were about 10,000.

The military collapse in western Europe in the summer of 1940 precipitated a crisis in Newfoundland. The security of the island was vital not only to Newfoundlanders themselves but to all North America. In June 1940 Canadian troops undertook the ground protection of Gander airport and the Botwood seaplane base. Two months later Canada assumed wide responsibilities for the defense of Newfoundland, both on the ground and in the air. The Canadian navy constructed and maintained a large base at St. John's. The United States also had a stake in the defense of Newfoundland. In virtue of the "base agreement" with Britain, the Cnited States secured leases on three areas, where it established bases. Newfoundland served as an important point of departure for aircraft and surface convoys throughout the entire war period.

World War II had a profound effect on the island economy. Newfoundland products were in steady demand at high prices. Jobs were easy to secure. War prosperity extended even into remote areas, drawing young men and women into employment elsewhere, principally in construction work at military bases. As early as 1941, the commission of government reported a surplus of revenue over expenditure, the first since 1919. As a result of this and of successive surpluses, the commission was able to extend to the United Kingdom an interest-free loan of $12,000,000. By March 1948 a cumulative surplus of $30,000,000, including the British loan, was built up.

9. Confederation **With** Canada.—The ending of the war raised the subject of constitutional status. In Dec. 1945 the government of the United Kingdom announced that a national convention would be elected to secure a representative view of what Newfoundlanders desired. The convention was elected in June 1916 and began its deliberations in September. Delegations were sent to London to ascertain British views and to Ottawa to sound out Canada on terms of union. A motion to send a similar delegation to Washington, D.C., was decisively defeated. The formal reply of the Canadian government was made in Nov. 1947. Nevertheless, in preparing the ballot, the convention recommended only two choices, continuation of the commission or restoration of responsible government. The government of the United Kingdom, however, insisted on adding to the ballot union with Canada. The first poll. held in June 1946. resulted in stalemate, no one of the choices received an absolute majority; responsible government received 69,400 votes, union with Canada 64,066, commission of government 22,311. A second poll, held on July 22, produced a majority in favour of union with Canada. 78.823 votes against 71,334 for responsible government. Representatives from Newfoundland went to Ottawa to discuss confederation.

The term confederation has an especial historical significance. Twice before. 1869 and 1895. Newfoundland and Canada had negotiated confederation. The first confederation effort was part of the general move to unite the British American colonies. Newfoundland had been represented at the Quebec conference of 1864, which drafted the plan of the original confederation. It was not until 1869, two years after the passage of the British North America act, that a decisive move was made in Newfoundland and then the proposal was rejected. The second attempt to bring about confederation in 1895, was the direct outcome of economic tensions, culminating in the Newfoundland bank failures of Dec. 1894. Negotiations were begun in April, but broke down on the financial terms Canada was prepared to oifer. Although both parties were anxious to make concessions, a gap of $200,000 remained between what Canada could extend and Newfoundland accept. This small sum wrecked the second confederation proposals, leaving among Newfoundlanders a sense of continued resentment.

Confederation discussions in 1948 extended over two months and produced a statement of the terms of union. Basically, these terms were the acceptance of provincial status by Newfoundland and the assumption by Canada of services normally provided for the other provinces, including the payment of stated annual subsidies. As in the instance of the other provinces, Sewfoundland was to be represented in the federal parliament, with seven members in the commons, and six in the senate. The terms also provided for the revival of the provincial constitution, suspended during the operations of the special commission of government. In place of the bicameral parliament of responsible government days, however, a single-chamber legislature composed of 28 members was envisaged.

In a different category were the taking over by the federal government of the Newfoundland railway (and shipping services) and the sterling debt, amounting to about $63,000,000. Canada agreed to make special transitional grants for a limited period, and to leave to Xewfoundland the surpluses amassed during World War 1 Finally, Canada agreed to appoint within eight years a royal commission to review Newfoundland's economic position and to make recommendations. These special features of the terms of union were in recognition of Newfoundland's unique position, economically as well as constitutionally.

The eight-year period having elapsed, a royal commission on Newfoundland finances was constituted and submitted its report in May 19jd. The commission recommended that Newfoundland thereafter be granted additional financial assistance of $8,000,000 per annum.

III. THE PEOPLE AND POPULATION

The population of Newfoundland illustrates the interplay of history and environment. The people are markedly homogeneous, over 90% being of English and Irish origin. Until the beginning of the 19th century the population was small! but thereafter it increased rapidly. The 1951 census placed it at 361.416 of which 7,890 lived in Labrador; the 1961 census set the total at 457,853 of which 13,534 lived in Labrador. Of this total about 98% was native born. Emigration is an established pattern, especially for young persons. Between 1891 and 1961 it is believed that more than 80.000 persons emigrated.

The early supremacy of the codfishery determined the location of settlement in the island. Convenience to the inshore grounds or to the more distant banks were decisive factors, as also shelter for boats and space for the stages required for curing fish. Thus, the population became widely scattered along the 6,000 mi. of coast. However, the Avalon peninsula was recognized as particularly desirable for settlement in relation to the Grand Banks fishery. To this day more than 40% of the island's population lives on this peninsula and about 20% lives in greater St. John's. During the 20th century population on the west and north coasts of the island increased more rapidly than on the south and southeast coasts. The bulk of the population still lives in about 1,300 small coastal settlements, almost 90% of which have fewer than 500 inhabitants. Strong attempts have been made by the government to encourage the abandonment of small, isolated settlements. Financial assistance has been offered to move family belongings to more suitable locations and in many cases wooden houses have been floated from small islands to mainland settlements. That progress along these lines has been achieved is indicated by census figures. The percentage of the population living in communities of over 1,000 increased from 34% in 1945 to 45% in 1956.

The smallness and scattering of the population have influenced the Newfoundland character. Isolation bred individuality and self-sufficiency, but it also extracted a heavy toll. Customs changed slowly; 16th-century methods of fishing and fish curing persisted; new ideas were rare and were resented; there was a marked weakness in co-operation, individualism of the most uncompromising sort having been nurtured on long years of near self-subsistence.

The church plays a very important role in the Newfoundland community. Denominationally, the population is divided into three main groups, about one-third Roman Catholic, nearly one-third Anglican and about one-quarter United Church. The remainder of the population is divided among several other denominations, the largest of which is the Salvation Army. Since one denomination frequently monopolizes an entire community, the church is a potential political force. This factor is tacitly admitted in political and administrative circles where efforts are bent toward maintaining a balance in denominational representation.

Two special characteristics of the islanders merit attention, the imagination and humour displayed in naming their numerous communities, and the marked poetic gifts possessed by many of them. Such place names as Heart's Delight and Heart's Content reflect feelings associated with the area; and indicative of isolation, Come by Chance. Nautical or navigational inspiration appears in Main Topsail (mountain peak), Pushthrough and Little Tickle (a tickle is a very narrow strait). Port aux Basques, Frenchman's Bay and Ireland's Eye recall the various nationalities long ago associated with the island. Poetry appears to be a natural medium of expression and has produced a growing body of published work. E. J. Pratt, a Newfoundlander, ranks among leading Canadian poets (see CANADIAN LITERATURE [ENGLISH]).

On a more popular level! sea chanties and folk songs are characteristic of the island. Many of these are traditional, the inheritance of an English or Irish past; others reflect the day-to-day life of the fisherfolk, often told with grotesque exaggerations. One of the most popular of Newfoundland songs is entirely modern, Arthur Scammell's "Squid Jiggin' Ground."

IV. GOVERNMENT AND FINANCE

The provincial government of Newfoundland has jurisdiction over education, crown lands and forests, municipal government, property and civil rights, and other matters assigned to the provinces by the British North America act. The house of assembly consists of 36 members elected for a period of not more than 5 years. The Liberal party under the leadership of the premier, J. R. Smallwood, was victorious in the first election after confederation in 1949 and maintained its majority position in the elections of 1951 and 1956. The Progressive Conservative party functioned as the official opposition.

After confederation the economic policy of the provincial government was one of energetic expansion. On taking office for the first time, Smallwood assumed the portfolio of economic development along with the premiership. Thus he clearly showed his appreciation of the predicament of Newfoundland—considerable potential wealth but small immediate resources and a small and scattered population. The general level of prosperity in Newfoundland has long been lower than that prevailing in the Maritime provinces (New Brunswick, Nova Scotia and Prince Edward Island). It was the declared aim of the provincial government to raise Newfoundland living standards to a level comparable with standards in these sister provinces. The federal government also recognized this lack of comparability of living standards and provided annual transitional grants to strengthen provincial revenue. These grants were reduced from year to year toward their eventual termination in 1962. A permanent annual grant of $8,000,000 to maintain public services at the level achieved in 1958 was recommended by the Royal Commission on Newfoundland Finances.

The two major aspects of economic policy were the further development of natural resources and the encouragement of industrialization. With respect to natural resources the government itself undertook mineral surveys both on the island and in Labrador through the agency of the Newfoundland Labrador corporation. Under an agreement made with the government the British Newfoundland corporation, an Anglo-Canadian syndicate, received mineral, timber and hydroelectric power rights on 50,000 sq.mi. in Labrador and 10,000 sq.mi. on the island. The company agreed to spend large sums of money annually on explorations. Direct investment by the government was involved in the industrialization program. Local industries mere aided financially and new industries were established. Also. European interests were offered assistance in establishing industries in Newfoundland. Among the new iridustries brought into production were cement and gypsum wallboard plants, a shoe factory. a rubber products plant and a cotton textile mill. Some were successful while others were not, but the net result was an expansion of employment opportunities.

V. EDUCATION

The Newfoundland educational system is denominational in character. The first school was set up at Bonavista in 1726 by the Society for the Propagation of the Gospel, the Church of England missionary organization. Schools for Roman Catholics were supplied by the Benevolent Irish society. The Education act of 1876 formally recognized the denominational principle by accepting Roman Catholic, Anglican and Methodist schools and by dividing the government grant to education on a proportional basis. Successive amendments to the act did not substantially alter this arrangement, the appearance of the Salvation Army, Seventh-Day Adventists and Pentecostals being marked by schools conducted by those bodies on the same basis as those of the older churches. By the 1950s there were also 33 nondenominational schools. All classes of schools are subject to the same regulations, follow the same curriculum and receive provincial grants on the same basis.

In 1925 Memorial University college at St. John's was opened as a permanent memorial to the Newfoundlanders who served in World War I. In the 1925–50 period the university gave courses in the first two years of arts and pure sciences and in the first three years of engineering, provided teacher training and sponsored an active adult educational program. In 1950 the college was expanded into Newfoundland Memorial university with degree granting authority.

The International Grenfell association carries on important educational and medical work in the northern outports and on the Labrador coast. Commenced in 1892 by Sir Wilfred Grenfell, the association maintains a number of schools and hospitals and an orphanage.

VI. PRODUCTION

The Newfoundland economy is based largely on primary industries. Certain primary products are manufactured for export, while others are marketed essentially in the raw state. Hydroelectric plants produce the only source of energy available on the island, while coal and petroleum are imported for additional energy and heating requirements. Historically, fishery products have been the mainstay of the economy and until the end of the 19th century provided as much as 90% of the exports. Mining developed gradually during the 20th century and the utilization of forest resources on a large scale did not occur until after World War I. The economy is strongly dependent upon external trade because most of the requirements of the population must be imported, and to balance these imports a high level of exports must be maintained.

1. Agriculture. — Agriculture in Newfoundland is subsidiary to other primary industries. Production is chiefly for domestic consumption and a large part of the farming activity is carried on by fishermen and forest workers on a part-time basis. The basic reasons for the relatively backward condition of agriculture are the unsuitability of climate and the scarcity of good soils. Although winter temperatures are not so low as they are in the main agricultural areas of Canada, spring arrives late, the growing season is short and there is risk of frost during the growing season. There is no large, continuous area suitable for cultivation; for the most part soil exists in depth only in river valleys or in pockets near the coast, and where it does exist in depth it often suffers from poor natural drainage.

Agriculture is best developed along the west coast near St. Georges. in the Humber valley near Corner Brook, and on the Avalon peninsula, especially near St. John's. Dairy farms are found near most of the large towns on the island. Outside these areas, commercial farming is almost nonexistent and agriculture is carried on chiefly in kitchen gardens. In connection with gardening, the numerous part-time farmers generally keep a cow, a few sheep or goats and some chickens. Hay and pasture land constitutes over half of Newfoundland's arable acreage, but additional feed must be imported. Oats, the principal grain crop, is usually cut green for fodder because grain seldom matures properly. except on the west coast. The most common vegetables grown are potatoes, turnips, cabbages, carrots, parsnips and beets.

Successive governments have attempted to stimulate farming. The commission of government began a land settlement scheme in 1934 to provide employment for families on relief. These settlements, comprising several hundred families established in eight different localities, met with little permanent success. A demonstration farm was established near St. John's where students were given practical instruction in crop production and livestock raising. A soil survey program was actively pursued with the aim of opening new agricultural land. After World War II a settlement scheme for veterans was undertaken in the upper Humber valley. In the second half of the 20th century the possibility of economically draining the extensive flat bogs of Newfoundland promised a moderate expansion of agriculture. Tests have been conducted on the Avalon peninsula to prove the efficiency of growing large quantities of hay for beef cattle. Expansion may take place also in the growing of blueberries which are frozen and shipped to the U S. market in considerable quantity.

2. Forestry.——Forests on the island of Newfoundland comprise about 35% of the total area. The major products based on these forest resources are pulp and paper. chiefly newsprint. Forest industries at mid-20th century contributed about 32% of the total Newfoundland income. There are two large pulp and paper mills in the province, which develop their own hydroelectric power near their mill operations. The location of the pulp and paper mills at or near tidewater gives them transportational advantages that make them fully competitive in the world market. Virtually all of their production is exported to foreign countries. A detailed study of the forest industries was made in 1953' by a government appointed royal commission. The report indicated that there remained on the island and in Labrador sufficient untapped reserves of timber to supply a third pulp and paper mill with a capacity of about 500 tons a day.

The production of lumber is carried on in more than 600 small sawmills scattered throughout the island. Most of the lumber is roughly finished for local consumption. Several other small industries are based on forest resources. Among these are producers of fiberboard. flooring, plywood and furniture.

3. Mining. — The mineral industries, based on a comparatively few producing mines, accounted for approximately 13% of the Newfoundland income at mid-20th century.

Iron ore is mined at Bell Island. Part of the ore moves to Sydney, N S., where steel is produced, and the rest is exported. Zinc, lead, copper and stnall quantities of gold and silver are produced at Buchans. The ore is concentrated at the mine site but is sent to export markets for refining. Most of Canada's fluorspar is mined at St. Lawrence on the Burin peninsula. The fluorspar is shipped to Arvida Que., for use as a flux in producing aluminum, and to export markets. Copper is mined at Little Bay and an old copper mine at Tilt Cove on the northeast coast has been reopened and brought back into production for the first time in 36 years.

Limestone is actively mined at several places. The quarry at Aguathuna on the west coast ships limestone to Sydney where it is used as a flux in the iron and steel industry. In the vicinity of Corner Brook, limestone is quarried to supply the cement plant. From a quarry at Cobb's Arm in Notre Dame bay limestone is shipped to Botwood and St John's. Gypsum is mined on the west coast at Flat bay for the manufacture of wallboard at the Corner Brook plant. There are several mineral prospects on the island, such as the asbestos deposits at Baie Verte, and their development was accelerated in the 1960s

4. Fisheries. — Among the primary industries the fishery has declined in value relative to the others, but still constitutes a major source of income for Newfoundland The main products are dried salt codfish and frozen filleted fish of various species Inshore fishing is mainly concentrated along the northeast coast and codfish is the principal species caught Bank fishing with larger vessels, chiefly draggers, is carried on from settlements on the northeast and south coasts By this method of fishing a number of species are obtained, including cod, haddock, halibut, flounder and rosefish.

Lobsters are procured on all coasts of the island, but are most abundant along the west coast. The herring fishery is concentrated in the Bay of Islands-Port au Port bay area on the west coast and in Fortune bay on the south coast. Salmon occurs in all Newfoundland waters and, although not plentiful, it is fished in many areas for a minor source of income.

Various fishery products are processed for market in different ways. Part of the catch of codfish is salted and dried artificially or in the sun and the rest is fast frozen in filleting plants. Many of the other species except salmon and herring are also fast frozen. The salmon is sold fresh chilled or canned and most of the herring is pickled The frozen filleted fish is exported to the United States. while the dried salt codfish is shipped to various European and West Indian markets. Because the markets for dried fish appear capable of greater expansion in the near future than the markets for frozen fish, the emphasis in Newfoundland is on the construction of artificial drying plants rather than freezing plants. There is no shortage of fish resources and the industry may expand its production under more modern and efficient methods of catching and processing the fish.

VII. COMMUNICATIONS

Water transportation has long been of utmost importance in linking the hundreds of small Newfoundland settlements. The Canadian National railways' coastal steamship fleet serves the larger trade centres and the isolated communities on all three coasts. Several scheduled shipping services connect St. John's and Corner Brook with various mainland and overseas ports. A daily ferry service across Cabot strait is operated by the Canadian National railways as part of the railway system.

The main line of the narrow gauge railway runs from Port aux Basques on the west coast, through Corner Brook, Grand Falls, and Gander to St. John's on the east coast. Branch lines connect Lewisporte, Bonavista, Carbonear and Argentia with the main line. The whole system totals a little more than 700 mi. of track. The Trans-Canada highway follows a route similar to that of the railway. Much of the highway is gravel surfaced. but all will be paved in the final construction stage. The road network of Newfoundland is still rather rudimentary. In the early 1960s there existed only 400 mi. of paved highway on the island. Nevertheless, road construction has been vigorously pursued and most of the larger settlements can be reached by land transportation. Frequent airline service is provided between the mainland and St. John's, Gander and Stephenville and between St. John's, the Burin peninsula and St. Pierre Island.

The Canadian National telegraphs serves nearly all of Newfoundland's scattered settlements, far more than are served by telephone. Several independent telephone companies provide service within the more populated areas. About 75% of the island's population has telephone service available. Newfoundland is the landing place of more than a dozen trans-.Atlantic cables.

Radio and television services are provided chiefly by the Canadian Broadcasting corporation. This publicly owned system operates radio stations in St. John's, Gander, Grand Falls and Corner Brook. In co-operation with the United States armed forces the corporation operates television stations at Stephenville and at Goose Bay, Labrador. In addition, there are several privately owned radio stations and one television station in St. John's. A satellite tracking station operated in connection with the U.S. space exploration program was opened near St. John's in 1961.

See also references under "Newfoundland" in the Index volume.

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(J.I.C.; G. Tr.; C. Cy.; C.N.F.)

NEW GRANADA (Span. *Nueva Granáda*), the title under Spanish colonial administration of that part of South America now known as the republic of Colombia, which at one time was extended to include Venezuela and Ecuador. It also was for a time the title of the united territories of Panamá and Colombia under republican auspices. In 1739, owing to the unmanageable size of the viceroyalty of Peru. it was divided and a new viceroyalty was created from the various provinces lying in the northwestern angle of the continent. extending from Tumbez northward to the northern limits of Panamá. and eastward to the Orinoco, to which the name of Nueva Granada was given. The new viceroyalty included the provinces of Tierra Firma (now the republic of Panamá); Maracaibo, Caracas, Cumaná and Guyana (now included in Venezuela); Cartagena, Santa Marta, Rio Hacha, Antioquia, Pamplona, Socorro. Tunja, Santa Fé, Neiva. Mariquita, Popayán and Pasto (now included in Colombia); and Quito. Cuenca and Guayaquil (now included in Ecuador). In 1777 the provinces of Maracaibo. Caracas. Cumana and Guyana were detached from the viceroyalty to form the captaincy-general of Caracas: otherwise it remained as above until the termination of Spanish rule in South America.

NEW GUINEA, the world's largest island after Greenland. stands on the Sahul shelf. a submarine extension of the Australian continent, between latitudes 0° 19′ S. and 10° 43′ S. and longitudes 130° 45' E. to 150° 48' E. Its total area is 304,650 sq.mi. At its nearest point the island is only 100 mi. from the Australian mainland. Political control is shared by the British Commonwealth and the Netherlands. the boundary being the meridian of 141° E., except for a short section n-here the Fly river forms the frontier. The political status of western New Guinea is disputed between the Netherlands and the Indonesian republic. Eastern New Guinea comprises the territory of Papua and the trust territory of New Guinea, both administered by the commonwealth of Australia.

PHYSIOGRAPHY

Natural Regions.—The geological structure is complex and little known; essentially the island forms part of a great circum-Australia mountain system. and in the Pleistocene Age was probably connected with Australia. The island possesses great physical diversity. with mountains rising above the snow line. high plateaus, extensive swamps and active volcanoes, though the latter are not so numerous as in either Java or Sumatra. The island can be divided into three major physiographic divisions; (1) the Bird's Head (Vogelkop) peninsula in the west: (2) the main body from 135° E. to 143° 30′ E., which contains the highest peaks; (3) the tail, also mountainous, but possessing much volcanic activity and narrowing east-southeast to the Louisiade Islands. Each division has a similar west-northwest to east-southeast or east to west trending zonation of structural elements. which are generally topographically continuous. The Vogelkop is almost completely breached by the shallow McCluer gulf; to the north is a mountain complex which in the extreme north contains the only active volcanic area in western New Guinea. An extensive lowland borders the McCluer gulf where subsidence still appears to be in progress, but a narrow neck of mountains connects with the Northern Dividing range and the Snow mountain system in the body of the island. Other isolated mountains appear in the Bombarai peninsula to the south of the gulf. The trend of the northern Vogelkop mountains is continued in Japen Island in Geelvink bay and isolated mountains along the north coast (Cyclops mountains). Elsewhere the north coast of the body of the island is bordered by a plain, rising southward to the complex Northern Dividing range which extends eastward from Geelvink bay to the mouth of the Sepik river: the ranges east of the Sepik constitute a topographic continuation. South of the Northern Dividing range lies a great median depression. the so-called Lake plain (Meervlakte), occupied by the Rouffaer and Idenburg rivers, tributaries of the Mamberamo river which flows to the north coast. A low sill separates this zone from the similar extensive lowland of the Sepik river. To the south of the median depression is a little known mountainous zone about 100 mi. in breadth, known generally as the Snow mountains (Nassau and Orange ranges), much of which is higher than 12.000 ft. and rises above the snow line (about 14,500 ft.) in a number of great peaks. Carstensz (16.535 ft.) is the highest point in the whole of the southwest Pacific. Idenburg (15,748 ft.) and Wilhelmina (15,584 ft.) also rise more than 1,000 ft. above the snow line and possess glaciers. The crest of the system lies on the southern side. and there is a series of precipitous drops to the great alluvial basins of the Digul and Fly rivers, which. lying between the Snow range and the rigid Australian block which extends to the southernmost shores of the island. have been likened to the Indo-Gangetic plain of India. The Digul-Fly lowland is not entirely swamp ior there are extensive stretches of drier land on the interfluves.

East of longitude 143° 5′ E. different structures appear. Volcanic activity reappears in islands off the north coast and is continued through the "Rabaul arc" into the Bismarck archipelago. The ranges east of the Sepik and in the Huon peninsula, and the Ramu and Markham valleys, resemble the structural elements to the nest. but in the Victor Emmanuel range the central mountain zone becomes relatively narrow. It broadens again with a change of trend from eastwest to west-northwest east-southeast in the Bismarck range of the trust territory. where the highest peaks, now on the northern side, again exceed 14,000 ft. (Mt. R'ilhelm, 15,400 it.). The Leonard-Murray mountains form an isolated volcanic area on the southern side of the central mountain complex. Considerable heights are also attained in the Owen Stanley range farther east (Mt. Albert Edward, 13,100 ft.), where a further change of trend is accompanied by widespread volcanic activity. In 1951 a Pelecan eruption of Mt. Lamington (5,850 ft.) caused much loss of life. 'The volcanic arc is continued eastward in the D'Entrecasteaux Islands. and a further volcanic zone can he traced through Buka and Bougainville in the northern Solomons, which also form part of the trust territory (*see* Solomon Islands).

Minerals. — Exploration for petroleum has added to the limited knowledge of mineral wealth. 'Tertiary coals were discovered in the Wasian river basin of the Vogelkop. hut seemed unlikely to be worked. Despite extensive prospecting, by the mid 1950s successful petroleum strikes had been made only in Dutch territory. In British territory drillings were intensified in the lowlands at the head of the Gulf of Papua, where bores were being made at Omari and Hororo. The only other mineral of importance is gold, which is worked in the Bulolo area of the trust territory, where rich alluvial deposits occur.

Climate and **Soils.**—New Guinea experiences the uniformly hot and humid climate of equatorial regions. but elevation produces a marked lowering of temperature, and the highlands have a much modified climate. Rainfall is heavy. only a small part receiving less than 60 in. annually. On the north coast precipitation is generally about roo in.. but many places receive much more. November-April is the season of the northwest monsoon. which brings heavy rain to all parts and especially to the north coast of New Guinea and the Bismarck archipelago. May-October is the season of the southeast trades. which bring torrential rain to the south coasts of New Britain and New Ireland. and those parts of the main island that stand athwart the winds. In the Merauke district of western New Guinea and in the vicinity of Port Moresby the period of the southeast trades is a dry season; Merauke receives about 60 in. annually, and Port Moresby only 40 in., though precipitation increases rapidly to east and west.

Under the continuously high temperature and the heavy, well-distributed rainfall, the soils are badly leached and offer limited opportunities for agriculture. Coastal soils are often too sandy or coralline. The best soils are those of the volcanic areas, the Gazelle peninsula of New Britain being outstanding. Native agriculture. though primitive, frequently shows shrewd appreciation of the soil possibilities.

Flora and Fauna.— Forests of various kinds cover the greater part of the island below 11.000 ft. Lowland rain forest is the principal climax, giving place to swamp forest in areas of imperfect drainage. The flora has both Malaysian and Australian affinities, but endernism is also a marked feature. *Ficus*, *Aleurites*, *Pterocarpals*, *Eucalyptus* and *Melaleuca* are characteristic genera. Mangroves, nipa and sago occur in estuarine conditions. Above 2,000 ft. the rain forest is replaced by highland forests (*Libocedrus*, *Podocarpus*), which in many areas have been greatly altered by the shifting cultivation of the native peoples. This has encouraged the spread of the tough and pernicious spear grass or kunai (*Imperata*), which covers large areas in the highlands of the trust territory and in the drier parts. The fauna, especially the mammals. shows stronger Australian affinities, small kangaroos and spiny anteaters representing the two great Australian orders Marsupialia and Monotremata. Endemisin is again well developed, particularly among birds. The birds of paradise are probably the most \!,ell-known faunal element, and were formerly the basis of lucrative trade.

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(D. W. F.)

HISTORY

Early European Contacts.— For 400 years the history of New Guinea is of discovery, exploration and tentative annexation as one European nation after another led the world in navigation and commerce. A Portuguese, Antonio d'Abreu. sighted the coast in 1511, but discovery is usually attributed to the Spaniard. Jorge de Menezes. who landed on the north coast in 1527. Inigo Ortiz de Retes gave New Guinea its name in 1546. and claimed it for Spain. The subsequent supremacy of Dutch sea power brought Luis Vaez de Torres (1605), William Jansz (1605–06), Jacques le Maire and William Schouten (1616) and Abel Tasman (1642). The Dutch East India company claimed a large. undefined part of the mainland for the Netherlands in 1660, but failed to establish a profitable trade.

William Dampier (1699–1700) and Philip Carteret (1767) were the first Englishmen to navigate these waters. and charted the islands now known as New Britain, New Ireland and Buka. Later English visitors were James Cook (1770), T. Forrester (1774), Lieut. Shortland (1788), J. Hunter and J. McCluer (1791). New Guinea came within the monopoly area of the English East India company, which for some years after 1793 maintained a garrison at Restoration bay. A claim of annexation was made. but nothing came of it. L. A. de Bougainville initiated a series of French expeditions in 1768. In 1828 the Dutch government erected Fort de Bus, and declared northwest New Guinea part of the empire. Twenty years later, the frontier was stated to run from Cape Bonpland to the north coast.

From the 1840s European interest in the rest of the island steadily increased. The most notable explorers of this period were F. P. Blackwood (1842–46), Owen Stanley (1846–50), Charles Yule (1846) and J. Moresby (1873). The first German investigators were Gustav Schleinitz and Otto Finsch. E. Teysmann, P. van der Crab and others led expeditions on behalf of the Netherlands Indies government. A pioneer scientific survey was made by A. R. Wallace in 1858, and in the same year the Utrecht Mission society settled at Port Dorey. Twelve years later the London Missionary society sent Samuel MacFarlane and A. W. Murray from the Loyalty Islands to Darnley Island in Torres strait. A station opened at Port Moresby in 1873 became the centre of mission activity on the mainland, to which came during the 18jos W. G. Lawes and James Chalmers, two outstanding personalities.

By this time. expressions of the European interest in the riches of New Guinea had become more definite. From the 1840s miscellaneous traders, often unscrupulous and belligerent, took trepang, cedar. ebony, sandalwood, rubber, pearls and copra. Two abortive enterprises, the New Guinea company (1867) and the New Guinea Prospecting association (1871), were formed in Sydney; wild stories of gold discoveries caused a rush to the Mai-Kusi river in 1877. As so often in the history of New Guinea. the resources of the island had been exaggerated far beyond reality.

From 1857, when the Hamburg firm of J. C. Godeffroy was established in Samoa, German commercial power in the south Pacific had steadily grown. In 1880 Die Deutsche Seehandelgeschafte was formed in Berlin to exploit New Guinea resources. This expression of German interest considerably strengthened opinion in Australia that Great Britain should annex eastern New Guinea. In fact, Charles Yule and John Moresby had both officially claimed the southern coast. but their actions were disallowed by the British government. Following Moresby's move the colonial secretary. Lord Carnarvon, had circularized the governors of the Australian colonies on this question, but the replies indicated the absence of both enthusiasm and unanimity. However, fear of French and German expansion, and hope of profits, steadily grew and in March–April 1883. Sir Thomas McIlwraith, premier of Queensland, caused eastern New Guinea to be annexed in the name of Great Britain. The British cabinet again determined to disallow annexation. However, in 1884 Bismarck announced that he would protect German traders in the Pacific, where they possessed commercial preponderance. This step moved the British government to authorize the declaration of a temporary protectorate over an undefined area of southeastern New Guinea (Kov. 6, 1884). Ten days later the German flag was raised on the northeast coast.

Netherlands New Guinea.— The adjustments of 1884–85 established the meridian 141 E. as the division between Setherlands New Guinea and the areas annexed by both Germany and Great Britain, a division slightly altered in 1895 by the substitution of the Fly river as part of the boundary with the British territory.

The basis of the original Dutch claim to New Guinea had been the nominal suzerainty over a vague area of the western part of the island of the sultan of Tidore, a Dutch dependency. Southwest Sew Guinea was officially purchased from the sultan by the Ketherlands in 190j. West New Guinea was attached to the Amboyna residency in 1911, and after many years' negotiation, the northwest division was legally transferred to the Netherlands in 1949. During World War II the Japanese conquered all but the extreme southeast coastline. Gen. Douglas MacArthur's headquarters were established at Hollandia for a time. Following the establishment of Indonesia (1949), the new republic asserted that this territory, which it terms West Irian, should be released by the Dutch. Under the transfer of sovereignty to Indonesia it was ruled that the question should be further discussed after the lapse of one year. However the joint committee set up to do this in 1950 could not solve the deadlock and New Guinea therefore remained under Dutch control.

The Mandated Territory of New Guinea.— The area annexed by Bismarck in 1884 comprised the Bismarck archipelago (New Britain, New Ireland, Admiralty and North Solomon is. lands) and the mainland between 2° 15′ S. and 8° S. and 141° to 148° E. The mainland division was known as Kaiser Wilhelmsland. In May 1885 the Neu-Guinea Kompagnie was given an imperial charter of protection over the entire area. Rights of sovereignty and administration were vested in the company, although any laws had to be made by the German parliament.

The company's early years were unsuccessful. The science of tropical agriculture mas then insufficiently developed: native labour was inefficient; the importation of Chinese coolies became unworkable; disease killed natives, Europeans and cattle. At the company's request, its administrative functions were taken over by the German government between 1889 and 1893. The seat of government was removed from Finsch Harbour to Stephanscourt, then to Friedrich-Wilhelms Harbour. and finally to Herbertshohe. The German government ultimately assumed full control in 1899. when Rudolf von Benningsen was appointed governor. The following years were marked by greater stability in the plantation economy. The chief crop was copra. which was harvested extensively along the coast and on the islands. Notable progress was made in various scientific inquiries such as botanical research, tropical medicine and anthropology.

Following the declaration of war in Aug. 1914 Australian troops landed on the eastern shores of the Gazelle peninsula. Within a week the Germans capitulated and until 1921 the *status quo* was maintained by the Australian military administration. Former German New Guinea was then assigned to Australia as a C class mandate under article 22 of the covenant of the League of Nations. The New Guinea act. 1920 (proclaimed May 1921), established a civil administration and introduced a new set of ordinances. These aimed at achieving justice before the law. preservation of rights of cultivation, barter, fishing and hunting; and protection of tribal institutions. The supply of opium. intoxicating liquor, ammunition and firearms to the natives was forbidden.

When Australia took over, only a small part of the territory was under even partial control, but gradually district officers. patrol officers and the indispensable native constabulary pushed farther into the interior. An area would be put first under "partial influence" then "influence" and finally "control." Penetration was accelerated by the gold rushes to Edie Creek in 1926, and later to the headwaters of the Purari and Ramu rivers. Roman Catholic, Lutheran and Seventh Day Adventist missions were established south of the Bismarck ranges by the mid-1930s.

The problem facing the administration was the development of a trained civil service. Constant reorganization was necessary, and although a cadet system was instituted in 1926, the pressure of the gold rushes forced its suspension soon after, and it was not resumed until 1939. Copra remained the basis of the economy, but by 1938 experiments had also been made with kapok, tobacco, wood pulp and coir fibre; these were all grown on the islands rather than on the mainland. The value of external trade rose from £401,918 in 1913 to £A3,389,072 in 1937.

The administration aimed at strict and just control of the native indenture system, and attempted, during the later 1930s. to enforce a provision requiring the labourer's consent. Nevertheless, there was some criticism of this feature of the administration before the Mandates conimission. Education lay chiefly in the hands of the missions. Central hospitals and medical patrols were established to protect native health.

In 1942 the territory was invaded and occupied by the Japanese. By April the civil administration was suspended in both Papua and the mandated territory. and in their stead the Australian New Guinea Administrative unit established. Following the Japanese surrender, civil administration was progressively restored between Oct. 1945 and June 1946. On Dec. 13, 1946, the general assembly of the United Nations approved the trusteeship agreement by which the territory remained under Australian supervision. The Papua and New Guinea act. 1949, provided for the government of the two sections as one administrative unit.

Papua (or British New Guinea). — The administrative system established immediately after the declaration of a British protectorate over the southeast of the island (1884) provided that the Australian colonies should take political and financial responsibility, while Great Britain undertook to provide a special commissioner to lead the local government. This arrangement having proved unsatisfactory, it was altered by the British New Guinea (Queensland) act of 188;. Queensland (with the financial assistance of New South Wales and Victoria) was to supervise the administration and report back to the Imperial parliament: after ten years this "joint control" was to cease through Great Britain's withdrawal, the area was to be at once formally annexed. and a lieutenant governor appointed.

From 188; to 1897 this office was held by Sir William MacGregor. With the assistance of a legislative and executive council, both nominated by himself. he created a framework of government of which a notable feature was the role played by natives, both in the constabulary and as village police. Moreover. in administering justice an attempt was made to allow for native concepts. MacGregor determinedly tackled the essential features of colonial policy — native agriculture, land regulation, the protection of native labour and the preservation of the village unit. Although he has been accused of arrogance, his achievement appears, under the circumstances, to have been considerable.

From 1898 to 1903, during Sir George Le Hunte's lieutenant governorship. control passed to the commonwealth of Australia. The chief policy development was the improvement in health services However, after the status (and title) of Papua was defined in the Papua act. 1905, a more lively interest appeared in Australia. This was expressed by the appointment of the 1906 royal commission. which emphasized the desirability of European investment and settlement. Liberal terms for long leasehold were offered prospective settlers in a lands ordinance of the same year.

The next lieutenant governor (which office he combined with that of chief justice) was J. H. P. (Sir Hubert) Murray. As he held office for more than 30 years (1907–40) the extent to which his personality and abilities constitute the history of Papua will be appreciated. In pursuit of native welfare his basic policies were broadly the same as MacGregor's: for example, the Natives Plantation ordinance fostered indigenous agriculture and revenue —with some success, for in the following years not only copra but coffee, rice and rubber were grown by Papuans. The policy of indirect rule was kept to the forefront, and partially realized by the successful introduction of village councils. Financial stringency restricted provision of health and, even more, educational facilities.

The impression should not be given. however. that Murray was concerned only with native welfare and not with economic development. During his term of office the number of acres under cultivation rose from 1.467 to 63.609. But these figures give a rather false impression, for economic progress never came as fast or as easily as Murray hoped and many people expected. The Australian market was insufficient to absorb the production of copra and rubber. hence there was a great need for cheap freighting of these products so that they could compete in the world market. However, from 1921 to 1925 freights were forced up by the Navigation act. which required that all exports be shipped through Sydney, and limited competition among the shipping lines. Papua was barely recovering from the effects of the act. when the world depression of the 1930s dealt further severe blows. Gold and, to a lesser extent; copper added to the value of exports. But it was oil which aroused Murray's highest hopes: hopes which remained unrealized in 1956 despite tremendous sums spent in investigation.

The postwar years saw some quickening of official concern with Papua. In July 1945 the minister for territories, E. J. Ward, announced his intention to establish a new labour policy which would aim at the abolition of the indenture system — an ideal of Sir Hubert Murray. The post of administrator was created in place of lieutenant governor, the first holder of the office being J. K. Murray. The foundation of the School of Pacific Administration (1946). and the South Pacific commission (1947), as also the amalgamation for administrative purposes of Papua and the mandated territory (1949), represented further moves toward an efficient and informed administration. The appointment of D. M. Cleland in succession to Murray, who retired in May 1952 before his term of office had expired, coincided with statements that the Australian government was anxious to see a further acceleration of the development of New Guinea's resources.

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POPULATION

Despite the size of the island, the population of New Guinea is scanty. a reflection of the extreme difficulties presented by the environment. By the mid-20th century the native population had not been enumerated entirely; there were probably not more than 2,375,000, of whom about half were found in the trust territory of New Guinea. which has some of the best soils of the island. The areas and populations of the three administrative divisions of New Guinea are given in the table.

	Area (sq. mi.)	Population (1954 census)			Administrative Centre
		Native	European	Others	
New Guinea Trust Territory . . .	93,050	1,195,307	8,020	3,422	Port Moresby
Papua Territory . .	90,000	488,396	5,295	1,018	
Netherlands New Guinea	160,618	684,000*	8,000*	7,700*	Hollandia

*1954 estimate, including adjacent islands

The native peoples present a wide diversity of racial affinities. languages. customs and modes of living, and many peoples were still outside the control of the administrations. In 1954, indeed, Australian surveys discovered 100,000 Papuans living in remote valleys of central New Guinea. whose existence had never been suspected. The total European population was only about 21,000; Chinese. the only other important nonindigenous group. numbered a little more than 3.000. and were most numerous in the trust territory. The distribution of the nonindigenous peoples is entirely coastal except for the Wau-Bulolo gold mining area and isolated petroleum centres.

ANTHROPOLOGY

New Guinea is a region of considerable racial and cultural diversity. Before 1939 some research was carried out in widely separated areas along the coasts. the Fly and Sepik rivers, and on some of the adjacent islands—the Trobriands. Bismarck archipelago. Louisiades and D'Entrecasteaux. Knowledge of Netherlands New Guinea peoples. apart from the Marind-anim and Waropen tribes. remained slight in the 1950s; but systematic studies were being made in the British section. including the highlands, n-here the population numbered more than 500.000 and where the cultures differ from those of the Sepik to the north and of the Fly and Strickland rivers to the southwest.

Racial Types.—The inhabitants of New Guinea are generally considered to belong to the Negroid division of modern man. having dark pigmentation of hair. skin and eyes, and very curly (usually frizzly) hair. A pygmy (Negrito) type is represented in the highlands of Netherlands New Guinea by the Tapiro and Pesechem. The full-sized Negroids were traditionally subdivided into Melanesians and Papuans. but these terms should be restricted to linguistic and cultural groupings. Most of the Negroids have a low stature. relatively long and high skulls with well-developed brow ridges. and either a convex—Pseudo-Semitic—or a wide flat nose. Serologically they are distinguished from the Indonesians and Australian aborigines by combining a high frequency of the N gene with a moderately high frequency of the S gene: in the Rhesus series. they show very high frequencies of R_1, while r is probably entirely absent. In the XBO series they have a moderately high incidence of B and probable absence of &. The morphological and serological characteristics of New Guinea are the result of migrations and mixture at various periods, probably involving Negritoes, Australoids and, most recently. Indonesian-Malays.

Cultural Characteristics.—The languages spoken may be divided into two groups, Melanesian and the so-called "Papuan" or non-Melanesian. Those falling within the first category are found in many of the eastern island clusters. in the Schouten Islands, in the Markham valley, and in some villages along the northern coast. Papuan types are many; they differ from Melanesian in vocabulary and grammar; and the number of linguistic stocks is unknown. Frequent characteristics are multiple gender, extreme complication of the tense and mood scheme of the verb, occurrence of incorporation of the pronoun subject and object in a transitive verb and power of agglutination.

New Guinea is rich in the diversity of its cultural patterns. Nevertheless, broad similarities in economy. social structure and ritual emerge. The main distinction is that between the Melanesian cultures of the Bismarck archipelago and the southeastern coastal areas on the one hand. and the Papuan cultures of much of the mainland on the other. In the former, descent is predominantly matrilineal; chieftainship is sometimes well-developed; long overseas voyages for trade and exchange are made; and secret societies were formerly important. Among the Papuans, descent is usually patrilineal. The village is the autonomous political unit: leadership is based on age and achievement; initiation ceremonies are elaborate; and systems of ceremonial exchange are widespread.

Economy.—The traditional econoinv of most of New Guinea is based on subsistence agriculture, with pig-keeping. fishing and hunting as subsidiary activities. A variety of foods is produced: root crops, greens. sugar cane. bananas, coconuts and breadfruit. The main narcotics are betelnut and tobacco. In the Markham valley, banana constitutes the staple: in the Sepik and Pnpuan swamps, sago: and on the highlands, sweet potato. Taros and yams are cultivated in many areas. The yam is often the object of a cult: among the Abelam specimens 7 ft. or more in length are grown; they are brilliantly decorated at harvest, and later distributed in competitive exchanges.

In general, rights of inheritance and exploitation of land are dependent on membership of a lineage or clan. Land is often associated with ancestors and the living hold it in trust for the next generation. The leader of a group usually decides when bush is to be cleared and he allocates plots among his dependents. who may lend sections to other kin, affines and friends. Shifting cultivation is practised. Tools are simple but natives possess a considerable body of empirical knowledge.

The elementary family is the basic economic unit, but in situations demanding more labour, such as clearing. harvesting, house-building and canoe construction. large groups of kin and close neighbours co-operate. Underlying such assistance is the principle of reciprocity. Apart from the division of labour between the sexes, there is little specialization of occupation. It is impossible to do justice here to the richness of New Guinea art. Geometric designs with curvilinear and triangular motifs predominate. but in the Sepik area and Papuan gulf anthropomorphic masks are produced. Mention should be made of the fretted prow-boards of the Trobrinnds, the superbly painted and carved façades of the Abelam clubhouses, and of the delicately incised limegourds, spatulas. daggers and shields of Massim and the Sepik. The highlands. apart from polished greenstone blades. is relatively poor in the graphic and plastic arts. but is noted for the men's glowing headdresses of bird-of-paradise plumes, streamers, flowers and shell necklaces and armlets.

There are three types of exchange in New Guinea: the distribution of foodstuffs and artifacts among kin and affines: barter; and ceremonial exchange. Barter often involves a symbiotic relationship between villages: thus the people of Tubetube, Manus and Karkar receive vegetables for fish; the Motu journey west in canoes to obtain sago ior pots; and the Tchambuli hand over plaited mosquito bags for the canoes of the mid-Sepik. Strictly speaking, there is no traditional currency, but certain shell objects function as stores of wealth and to some extent as exchange media in restricted contexts. Such valuables, along with pigs and food, constitute wealth, but confer prestige only when distributed among kin, or at feasts and ceremonies. A widely ramifying network of ceremonial exchange is the *kula* of the Massim.

Social Organization.—fillapes are usually small with populations ranging from 50 to 300, but larger groupings of 500 to 1,000 occur in the Sepik area. The settlement pattern varies: houses may cluster in a compact group, and are sometimes palisaded (eastern highlands and western New Britain) or encircle or line both sides of a ceremonial ground (Trobriands, Banaro, Iatmul). Whatever the distribution of huts, it is common for close kin (usually connected unilineally) to build near one another. Sometimes a village or neighbourhood consists only of the male members of a clan or lineage with their wives and children; sometimes it is composed of a number of clans or sectors thereof, and members of the community are linked by both kinship and affinal ties. With few exceptions, a woman goes to her husband's residence at marriage; where descent is patrilineal, a man normally resides near his agnates; and where clans are matrilineal he frequently lives near his mother's brother.

A number of types of kinship terminology are represented: Omaha (Kwoma, Iatmul, Arapesh); Choctaw (Trobriands, Manus); and Hawaiian (Möwehafen, Koitapu); but the commonest is the Iroquois type in which parallel cousins are grouped with siblings, and there are special terms for cross-cousins. Everywhere the family is the important domestic unit, but ties with both paternal and maternal kin are stressed. Double descent systems have been recorded in Manus and Wogeo, but single descent systems are general. The clan, subclan or lineage is usually named, totemic, exogamous and of shallow generation depth. There is a constant tendency to subdivide into groups comprising a few males. Emphasis is laid on the fulfilment of obligations and peaceful settlement of disputes within the group.

Distinctions of rank occur in only a few areas (northern Massim and Manam); elsewhere societies are egalitarian, and status is determined by kinship, age and achievement. With few exceptions, authority is vested in the elders of small localized clans or lineages and they act as an informal council in matters affecting the community as a whole. Leadership is based on prowess in warfare, head-hunting, oratory and especially on the accumulation and distribution of wealth. Leaders act as entrepreneurs in economic activities and rituals, and they exercise an influence in the settlement of disputes over assault, adultery and theft; but in general the main sanctions are public opinion, fear of retaliation and sorcery and the need for group unity in the face of enemy villages. The political unit is thd village or neighbourhood comprising between about 70 and 500 members; intervillage relations are characterized by feud with intermittent periods of truce; and alliances with adjacent settlements are often temporary. Nevertheless it is rare for a village to be entirely self-sufficient.

Ritual and Belief.—These vary, but there is a widespread belief in spirits. They are frequently associated with parts of the bush or rivers; they may assume the guise of animals; and, along with the ancestors, may be impersonated in initiation ceremonies. Fully developed ancestor cults do not obtain, except perhaps in Manus, but a belief in spirits of the dead appears to be universal. Sacrifices are sometimes made to them in connection with warfare, gardening and hunting; and mortuary ceremonies are often complex, involving the distribution of food and valuables. Fertility cults associated with sacred flutes occur on the highlands; and everywhere elaborate initiation rites for men take place. Complex systems of productive magic for economic and other activities are typical of New Guinea, and the belief in sorcery and black magic is also widespread. Indeed, accusations of sorcery are one of the most frequent causes of intervillage hostilities.

A cultural phenomenon of New Guinea and of much of Melanesia is the so-called "cargo-cult," of which the Vailala Madness of the Purari delta and the Taro cult of the Orokaiva were early examples. During and after World War II many forms of these cults appeared; in general, they postulate the disappearance of the Europeans and the acquisition of their cargo (wealth) by the natives.

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(P. M. K.)

ECONOMIC DEVELOPMENT

The economic development of New Guinea has been hampered by the great physical obstacles and by the preoccupation of the two administrations concerned with other interests—the populous East Indies in the case of the Netherlands and strategic considerations in the case of Australia.

New Guinea Trust Territory.—Greatest progress had been made by the 1950s in the trust territory of New Guinea; this was due partly to the better soils, mineral wealth and denser population, and partly to the foundations laid by the former German administration. Coconuts are by far the most important commercial crop and formed the mainstay of the economy. In the mid-1950s there were about 370 plantations totalling nearly 300,000 ac., of which approximately half were situated in New Britain and New Ireland (*qq.v.*); the greatest concentration being in the Gazelle peninsula. In addition to the devastation caused by World War II, there had been losses through pests and aging trees which during the 1950s were not being compensated for by new planting. Native groves were in rather better condition and provided almost one-sixth of the copra exports of the territory. Gold mining was the other important activity, principally in the Wau-Bulolo area of Morobe district, with a little from Kieta in Bougainville. Three-quarters of the gold output, which was valued at £A1,410,000 in 1954, is obtained by dredging. The considerable transport problems were being overcome by the use of aircraft.

Papua Territory.—Progress had been slower in Papua than in the trust territory, and coconut plantations occupied only about 35,000 ac. in the mid-1950s. Rubber was grown on about 27,000 ac., not all of which was in bearing, but it constituted the most important single export of the territory. Ten large plantations grouped around Kanosia and Sogeri, within easy reach of Port Moresby, produced 70% of the output.

More labour is required per unit area for the cultivation of other crops, such as cacao, coffee and tea, and their cultivation had been hampered by the general shortage of labour. Cacao was little grown on plantations, and occupied about 12,500 ac. in the mid-1950s, mainly in New Britain; coffee and tea were grown on a small scale in the highlands of the trust territory. Other commercial crops included kenaf, a jute substitute, abaca or Manila hemp, peanuts and a little rice, all in small quantities, but capable of being developed. Yams and other tubers were the main subsistence crops grown by the natives. Labour recruitment, which before World War II was by the system of indenture, was afterward controlled by ordinance which limited the term of initial contracts to 18 months. The total number of natives in permanent employment in Papua and the trust territory was only 64,000 in 1951, and even to maintain this modest figure presented many difficulties. Some New Britain plantations recruited labour from the Sepik, 500 mi. distant. The labour problem would be greatly intensified by the finding of petroleum.

New Guinea possesses no railways, and roads are found only near the chief towns and plantations. A road linking Wau with the port of Lae was built during World War II by the Allied armies. Air transport is well developed, especially in the trust territory.

The chief port of Papua, and the administrative centre of the territory of Papua and New Guinea, is Port Moresby (nonindigenous pop., 1954, 3,688). The only other town of importance in Papua is the port of Samarai, which stands on a small island at the end of the "tail." The largest town in the whole of New Guinea is the port of Rabaul (pop. 24,137) in New Britain (*q.v.*), until 1946 the administrative centre of the mandated territory. Other ports in the territory are Lae, Finsch Harbour, Madang, Wewak and Aitape on the mainland, and Kavieng in New Ireland. The trade of Papua territory is almost entirely with the commonwealth of Australia, but the trust territory of New Guinea is heavily dependent upon the United Kingdom as a buyer for its exports.

Netherlands New Guinea.—The development of western New Guinea is overshadowed by the conflict between the Netherlands and the Indonesian republic for political control. Before 1939 western New Guinea (Irian Barat in Indonesian) was virtually undeveloped, but after 1948 the Vogelkop oil fields were brought into production. There was considerable Dutch immigration from the former Netherlands East Indies after 1949, arid a quickening in the rate of economic development seemed probable. The administrative capital of western New Guinea is Hollandia (pop. [1954 est.] 11,322), situated on the north coast close to the frontier.

See also PACIFIC ISLANDS.

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(D. W. F.)

NEW HAMPSHIRE, popularly known as the "Granite state." is one of the New England group of the United States and one of the original 13, being the ninth to ratify the constitution. It is bounded north by the Canadian province of Quebec; east by Maine, by the Salmon Falls river: mhich separates it in part from Maine, and by the Atlantic ocean: southeast and south by Massachusetts; west and northwest by Vermont (from which it is separated by the Connecticut river — the low-water mark on the west bank of the Connecticut is New Hampshire's west boundary). and by Halls stream. which separates it from Quebec. The state has an area of 9.304 sq.mi., of mhich 290 sq.mi. are water surface; it is the 44th state in size. The state flag of New Hampshire is a field of blue on which is a representation of the state seal surrounded by a wreath of laurel leaves with nine stars interspersrd. The state flower is the purple lilac (*Syringa vulgaris*), the state bird (unofficial) the purple finch. The capital of New Hampshire is at Concord (*q.v.*).

PHYSICAL GEOGRAPHY

Physical Features. — In the north-central portion of the state, which lies between approximately 42" 40' and 45° 18' N., and between 70" 37′ and 72° 37' W., the White mountains (*q.v.*), a continuation of the Appalachian system, rise abruptly in several short ranges and in outlying mountain masses from a base level of 700 to 1,500 ft. The highest, Mt. Washington (*q.v.*), attains an elevation of 6.288 ft. The principal ranges, the Presidential. the Franconia and the Carter-Moriah, have a northeastern and southwestern trend. The Presidential, in the northeastern part of the region. is separated from the Franconia on the southwest by the Crawford or White Mountain notch. about 2.000 ft. in depth, in which the Xmmonoosuc and Saco rivers find a passage, and from the Carter-Moriah. parallel to it on the east, by the Glen-Ellis and Peahody rivers. the former noted for its beautiful falls. On the Presidential range, which is about 20 mi. in length, are Mt. Washington and nine other peaks exceeding 5,000 ft. in height. On the Franconia. a much shorter range, are Mt. Lafayette. 5,249 it.; Mt. Lincoln. 5.108 ft.; and four others exceeding 4.000 ft. The highest peak on the Carter-Moriah range is Carter Dome. 4.843 it.: but seven others exceed 4,000 ft. Separating Franconia and Pemigewasset ranges is the Franconia notch. overlooking which from the upper cliffs of Profile mountain is the Great Stone Face, immortalized by Nathaniel Hawthorne.

The part of the state that lies north of the White mountains is occupied by ridges and wide rolling valleys. the ridges rising occasionally to heights of 2.000 ft. or more. South of the mountains a plateaulike surface — a part of the New England uplands — extends from the intervales of the Connecticut river to the eastern border of the Merrimack valley. Between the Merrimack valley and the sea is the only low surface in the state; a considerable portion of this region is less than 500 ft. above sea level. The seashore. about 18 mi, in length, is mainly a low sandy beach. The only harbour is at Portsmouth near the mouth of the Piscataqua. About 9 mi. from the shore are the bleak and nearly barren Isles of Shoals, divided between New Hampshire and Maine.

The lakes and ponds. numbering several hundred, were formed by glacial action; and the scenery of many of them is scarcely less attractive than that of the mountains. The largest and most widely known is Lake Winnipesaukee, 20 mi. long and from 1 to 8 mi. wide, dotted by 274 islands. mostly verdant. The rivers with their numerous falls and the lakes with their high altitudes furnish a vast amount of water power for manufacturing — the Merrimack, in particular. into which many of the larger lakes, including Winnipesaukee, find an outlet.

Climate. — The winters are usually long and severe, and the summers cool and fine. The mean annual temperature ranges from about 40" F. at only moderate elevations in the White mountain region and farther north to 47° at low altitudes in the southeast. The greatest extremes of temperature occur in the deep mountain valleys where it sometimes rises to 102° or above in summer and falls to −38° or below in winter; higher up on the mountains it is never so warm and along the seacoast both extremes are considerably less. The mean precipitation for the entire state is about 40 in. The distribution is even throughout the year, but summer and autumn are slightly wetter than winter and spring. Xmong the mountains and in the northern part of the state the annual fall of snow is from 7 to 8 ft., but in the southeast corner it is little more than one-half that amount. The prevailing winds are generally northwest, but in the vicinity of the sea they are southeast during summer.

Soil. — Fertile soil in New Hampshire is confined largely to the bottomlands of the Merrimack and Connecticut rivers. In the southeastern section is also a moderately productive soil derived largely from the disintegration of slate. Elsewhere south of the mountains, the surface soil is mostly hardpan or till, this being deepest on the drumlins. In the mountain region the soil is mostly a sandy loam composed of disintegrated granite gneiss and organic matter.

Vegetation.—Flowering shrubs and vines are found in abandoned fields and pastures and beside the roads. chiefly wild grapes, pin and choke cherries. sweet fern. red osier; American alder, several varieties of sumacs, sheep laurel or lambkill. elderberries, blackberries, blueberries, both dwarf and highbush, and raspberries. Mountain laurel is commonest in the Monadnock area, while the flowering dogwood is confined chiefly to the lower Connecticut valley region. The wild flowers of the state include goldenrod, asters, fireweed. paintbrush, daisies, black-eyed Susans, painted and purple trilliums, fringed gentian. blue, yellow and white violets, trailing arbutus, lady's-slippers. Indian pipe. several varieties of honeysuckle, lilies, wild iris, ferns and brakes. On the higher elevations are found Alpine plants such as Lahrador tea. Greenland sandwort, cinquefoil, as well as arctic rushes; sedges and lichens.

Animal Life. — Deer and Sear are the most abundant of the larger animals, and there are a few moose. Mink, beaver, raccoon, pine marten; otter, Canada lynx and fishercat inhabit the state, although the last two are decreasing in number. Red and gray squirrels. striped chipmunks, skunks, porcupines, moles, shrews. wood and meadow mice: the fox and the cottontail rabbit are common, while snowshoe rabbits are found in the northern part.

Historic Sites, Parks and **Recreation.**—New Hampshire has many places of historical interest. Xmong them are the Woodman institute in Dover, which includes the Dam Garrison, built in 1675, and the Gilman-Clifford garrison (1650–58) in Exeter, of which a part is claimed to be at least the second-oldest house in the state. Portsmouth has the Jackson house (1664), the Warner house (1718), the John Paul Jones house (1758), the Wentworth Gardner house (1760), the Moffat-Ladd house (1763), the John Langdon house (1784) and St. John's church (1807), all open to the public in the summer months. Nearby, in New Castle, is Ft. Constitution. formerly Ft. William and Mary, where on Dec. 14 and 15, 1774, New Hampshire patriots captured powder and arms, some of which was later used at the battle of Bunker Hill. At Peterborough is the >lacDon·ell colony for creative artists; the Saint-Gaudens memorial is at Cornish.

The state maintains 40 state parks. wayside picnic areas and historic sites, among which are the Hampton Beach. Crawford Notch and Franconia Notch parks and the Daniel Webster memorial (Franklin), Wentworth Coolidge mansion (Portsmouth) and Franklin Pierce homestead (Hillsborough) historic sites. About 805,000 ac. of forest are publicly owned, by towns, the state or the national government. The largest is the White Mountain National forest.

HISTORY

Martin Pring was at the mouth of the Piscataqua in 1603 and. returning to England in the same year. gave an account of the New England coast from Casco bay to Cape Cod bay Samuel de Champlain discovered the Isles of Shoals and sailed along the New Hampshire coast in 1605. and much more information concernıng this part of the nen world was gathered in 1614 by Capt. John Smith, nho in his *Description of New England* refers to the convenient harbour at the mouth of the Piscataqua and praises the country back from the rocky shore.

Colonization. — Under the leadership of Sir Ferdinando Gorges there was formed in 1620 the Council for New England, which procured from King James I a grant of all the country from sea to sea between latitude 40" and 48° N., and which made nine grants bearing upon the history of New Hampshire. The first of these grants was to John hfason, who has been called "the founder of New Hampshire," on March 9, 1622. The name New Hampshire was first applied to a grant which lay between the Merrimack and Piscataqua, and given to Mason on Nov. 7, 1629.

The first settlement of which there is indisputable evidence was established in 1623 by David Thomson at Little harbour, now in the town of Rye. Thomson was the head of a company which was organized for fishing and trading and whose entire stock mas to be held jointly for five years. He built a house on Odiorne's point overlooking Little harbour, and, although he moved to an island in Boston harbour in 1626, he may have continued to superintend the business of the company until the expiration of the five-year term. At least there was a settlement there which was assessed in 1628, and it may not have been completely abandoned when colonists sent over by the Laconia company, which had received a grant on Nov. 17, 1629, arrived in 1630.

The Laconia company received its first grant under the erroneous impression that the Piscataqua river had its source in or near Lake Champlain, and its principal object was to establish an extensive fur trade with the Iroquois Indians. The company sent over colonists who occupied the house left standing by Thomson and, not far away, built Mason hall or the Great house in what is now Portsmouth, a name (for the entire settlement) that replaced Strawberry Banke in 1653. Edward Hilton with a few associates appears to have established a settlement on Dover point about the time of Thomson's arrival at Little harbour, and in the Hilton grant of 1630 it is stated that he had already built houses and planted there; as early as 1630 this settlement was named Dover.

In 1638 the Rev. John Wheelwright, an Antinomian leader who had been banished from Massachusetts, founded Exeter on land claimed to have been bought by him from the Indians. In the same year hfassachusetts encouraged friendly Puritans to settle Hampton on the same purchase, and about a year later this colony organized Hampton as a town with the right to send a deputy to the general court.

Serious dissensions had already arisen between Puritan and Anglican factions in Dover, and Capt. John Underhill, another Antinomian, became for a time a leader of the Puritan faction. Puritan Massachusetts was naturally hostile to the Antinomians at Exeter as well as to the Anglicans at Strawberry Banke. Under these conditions Massachusetts discovered a new claim for its northern boundary. The charter of that colony was drafted under the impression that the Merrimack flowed east for its entire course, but now an investigation was in progress which was to show that its source in Lake Winnipesaukee was several miles north of any of the four settlements in New Hampshire. Accordingly. Massachusetts resolved to make the most of the clause in the charter which described the northern boundary as three English miles north of the Merrimack river, "or to the northward of any and every part thereof," to ignore the conflicting grants to Mason and to extend its jurisdiction over the offending settlements.

The heirs of Mason protested, but little was done about the matter during the period of Puritan ascendancy in the mother country. Immediately after the resignation of Richard Cromwell, however, Robert Tufton Mason (a grandson of the original proprietor), who had become sole heir in 1655, began petitioning, first parliament and later the king, for relief. The commission appointed by the king in 1664 to hear and determine complaints in New England decided that Mason's lands were not within the jurisdiction of Massachusetts, and made an attempt to set up a government under which his claims could be tried, but this was a failure. Mason then petitioned again, and this time Massachusetts was requested to send agents to England to answer his complaints. They arrived in Dec. 1676, and the case mas tried before the lords chief justices of the king's bench and common pleas in April 1677.

Mason presented no claim to the right of government, and as to the title to the lands claimed by him the court decided that this was a question between him and the several tenants to be determined by the local court having jurisdiction in such matters. Thereupon Mason, in Jan. 1679, petitioned the king to appoint a governor who should have jurisdiction over all the lands that he claimed. and on Sept. 18 of that year New Hampshire was constituted a separate province with a government vested in a president and council appointed by the king and an assembly chosen by the people.

Provincial Period. — From 1686 to 1689 New Hampshire formed a part of the dominion of New England, which, after the first few months, was under Sir Edmund Andros as governor general. There being no provincial authority in New Hampshire at the close of this period, a convention of the leading citizens of its four towns attempted to establish one. Upon the failure of this attempt, a temporary nominal union with Massachusetts mas formed, but in 1692 Samuel Allen, the assign of Mason, caused a royal government to be established with his son-in-lax, John Usher: as lieutenant governor, and during the remainder of the colonial era New Hampshire was separate from Massachusetts except that from 1699 to 1741 the two had the same governor.

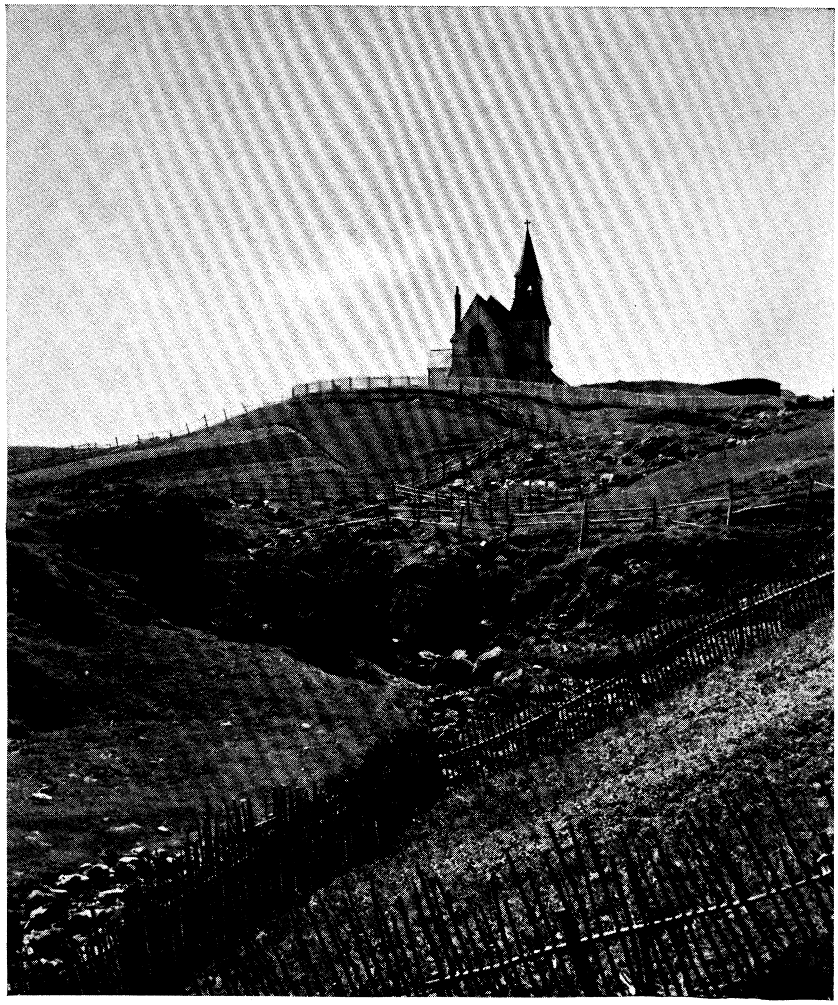
The boundary disputes between Massachusetts and New Hampshire were long and bitter. Both provinces granted townships within the disputed territory; Massachusetts arrested men there who refused to pay taxes to its officers, and sought to defer the settlement of the dispute. New Hampshire, being on more friendly terms with the home government, finally petitioned the king to decide the matter, and in 1737 a royal order referred it to a commission to be composed of councilors from New York, Nova Scotia and Rhode Island. This body agreed upon the eastern boundary but evaded deciding on the southern one. Both parties then appealed to the king, and in 1741 the king in council confirmed the decision of the commission in regard to the eastern boundary and established a southern boundary very favourable to New Hampshire. The western boundary was not yet defined, and as early as 1749 a controversy over that arose with New York. The governor of New Hampshire made 138 grants in the disputed territory which were rapidly settled, but there was a reluctance to incur the expense of a contest with so powerful a neighbour as New York. In 1764 New York procured a royal order declaring the western boundary of New Hampshire to be the western bank of the Connecticut river.

Revolution and **Independence.**—At the outbreak of the American Revolution New Hampshire had about 80,000 inhabitants, the great majority of whom were with the patriot or Whig party during the struggle. By June 1775 the once popular governor, Sir John Wentworth. n-as a refugee: on Jan. 5, 1776. the fifth provincial congress established a provisional government; on June 15 the first assembly elected under that government declared for independence; and on Aug. 16, 1777, the important victory at Bennington was won by New Hampshire and Vermont troops under the command of Gen. John Stark, who had a commission from New Hampshire. Six states had ratified the federal constitution when the New Hampshire convention met at Exeter on Feb. 13, 1788, to accept or reject that instrument, and so great was the opposition to it among the delegates from the central part of the state that after a discussion of ten days the leaders in favour of ratification dared not risk a decisive vote, but procured an adjournment in order that certain delegates nho had been instructed to vote against it might consult their constituents. Eight states had ratified when the convention reassembled at Concord on June 17, and four days later, when a motion to ratify was carried by a vote of 57 to 47, adoption by the necessary nine states was assured.

Statehood. — The American Revolution left the state heavily burdened nith debt and many of its citizens threatened with debtor's prison As a means of relief. a number of citizens demanded of the legislature the issue of paper money equal in amount to the state's debt; and, as this was refused, an armed

Extracting iron ore with electric drills at Wabana mine, under the ocean floor near Bell Island

Landing a catch on a trawler on the Great Bank of Newfoundland, part of the Grand Banks



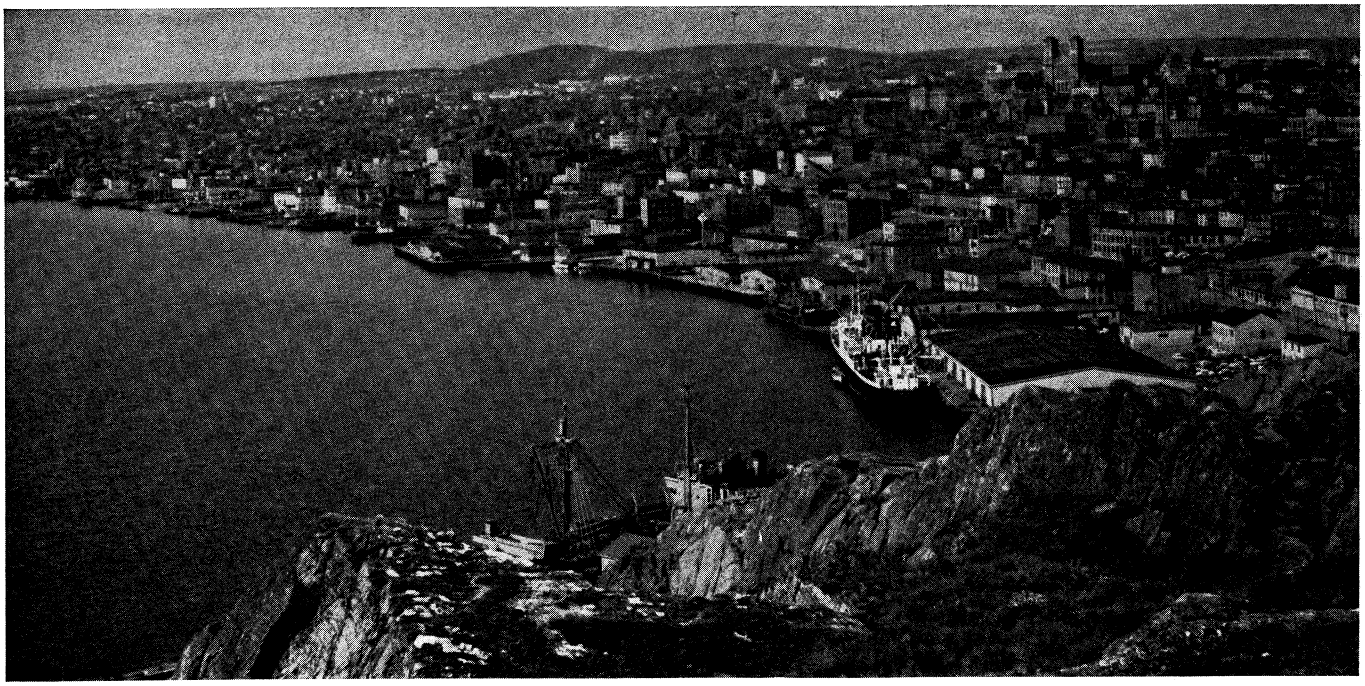
Hilltop church in Torbay, a fishing and farming village north of St. John's

Bowater's pulp and paper mill, Corner Brook, one of the largest such mills in the world

SCENES OF NEWFOUNDLAND

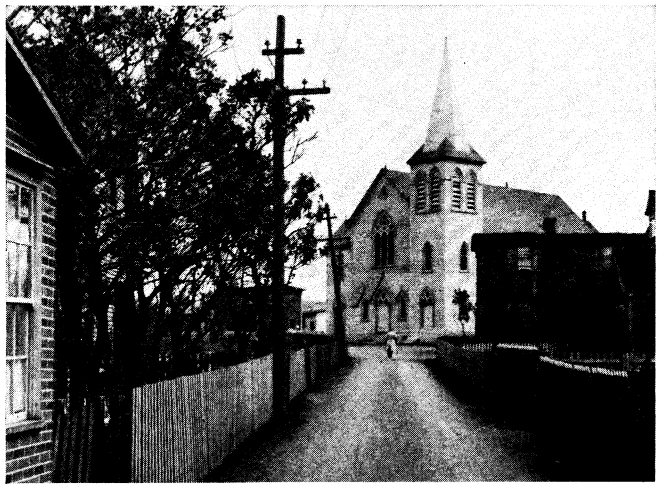
BY COURTESY OF (TOP LEFT, CENTRE LEFT, BOTTOM) NATIONAL FILM BOARD OF CANADA: PHOTOGRAPH. (TOP RIGHT) GILES FROM BLACK STAR

NEWFOUNDLAND

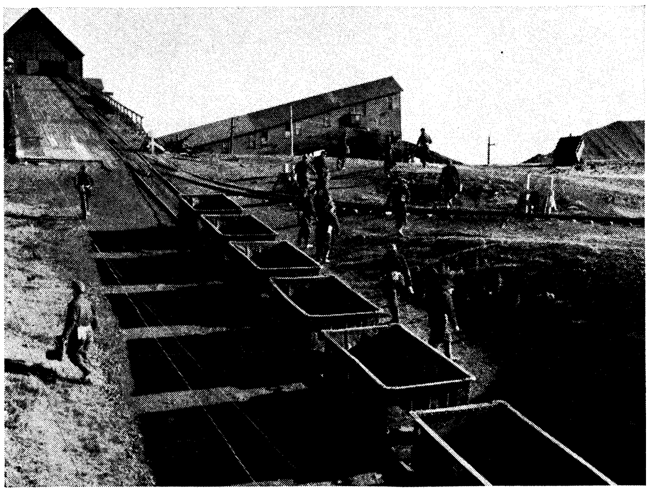


View at the harbour of St. John's, capital and largest city of the province

Drying codfish on platforms at Bonavista, village at the end of Cape Bonavista, Bonavista bay



Church street, Fortune, western end of Burin peninsula near the French islands of St. Pierre and Miquelon



Iron miners leaving the shaft, Dominion Steel and Coal company mines, Bell island

Falls on the Lomond river, Bonne bay, on the Gulf of St. Lawrence

ST. JOHN'S AND VIEWS OF ISLAND OF NEWFOUNDLAND

BY COURTESY OF (CENTRE LEFT, BOTTOM LEFT, CENTRE RIGHT, BOTTOM RIGHT) NATIONAL FILM BOARD OF CANADA; PHOTOGRAPH, (TOP) ARAU FROM MILLER SERVICES mob numbering about 200 surrounded the meetinghouse in Exeter in which the legislature was in session, toward evening on Sept. 20, 1786. But Gen. John Sullivan (1740–95) was at the time president of the state; and on Sept. 21 he, with 2,000 or more militia and volunteers, captured 39 of the leaders and suppressed the revolt without bloodshed.

National elections in New Hampshire were carried by the Federalists until 1816, except in 1804 when Pres. Thomas Jefferson won by a small majority; but within this period of Federalist supremacy in national politics the Democrat-Republicans elected the governor from 1805 to 1812 inclusive except in 1809. In 1816 the Democrats won both state and national elections; and out of the transition from Federalist to Democratic control, which was effected under the leadership of William Plumer (1759–1850), a prominent politician in New Hampshire, arose the famous Dartmouth college case. As the trustees of this institution were Federalists with the right to fill vacancies in their number, the Democrats attempted to gain control by converting it into a state university and increasing the number of trustees, but when the case reached the U.S. supreme court that body pronounced (1819) the charter a contract which the federal constitution forbade the state to violate. Heretofore the Federalist regime had taxed the people to support the Congregational Church, but now the Baptists, Methodists and Universalists joined the Democrats and in 1819 this state support was abolished by the Toleration act.

Because of Daniel Webster's eloquently successful arguments in the Dartmouth college case, and because his party had favoured the support of the Congregational Church by public taxation, he became very unpopular in this his native state. Accordingly, his denunciation of Pres. Andrew Jackson's bank policy added strength to the Jacksonian democracy, and, later, his Whig connections were the greatest source of the Whig party's weakness in New Hampshire. John Quincy Adams was an intimate friend of William Plumer, the Democratic leader, and carried the state in both 1824 and 1828. The Whigs never won a national or state election, and often their vote was only about one-half that of the Democrats. But the Democrats broke into two factions in 1846 over the question of slavery (see HALE: JOHN PARKER) ; the American or "Know-Nothing" party elected a governor in 1855 and 1856; and then control of the state passed to the Republican party, which held it until the presidential election of 1912 and 1916 when the Democrats won. Thereafter the state returned to its Republican tradition until 1936, 1940 and 1944 when it supported Franklin D. Roosevelt. The state government remained Republican although a Democratic governor was elected in 1922.

New Hampshire sent more than 20,000 men into the armed services during World War I. Many New Hampshire men were in the 26th or "Yankee" division. The Portsmouth navy yard was involved with building submarines and small boats and in repairing warships.

The industrial centres of New Hampshire suffered especially during the depression years of 1929–36. Many industrial plants decreased the number of employees and in some cases discontinued operation, especially in Hillsborough county and in the cotton industries. The depression was less severe outside the industrial centres, but there was a considerable return of people from city areas to small towns and farms. After 1936 conditions improved, especially in Manchester, where the Amoskeag mills were partly used by many small manufacturers.

About 60,000 men and women of New Hampshire served in the armed forces during World War II. The state was the site of the Bretton Woods conference (July 1944) at which representatives of 44 nations drew up plans for the International Monetary fund and the International bank.

GOVERNMENT

New Hampshire was the first of the original states to establish a government wholly independent of Great Britain. This was designed to be only temporary, but was in operation from Jan. 5, 1776, to June 2, 1784. The constitution provided for a general court consisting of a senate and a house of representatives and made the council a body advisory to the state president. The 1784 instrument was amended in 1792; with the amendments adopted in that year it is in large measure the constitution of today. For 60 years there was no change whatever, and only three amendments, those of 1852 (removing the property qualifications of representatives, senators and the governor), were adopted until 1877, when 12 amendments were adopted; the most important were those providing for biennial (instead of annual) state elections in November (instead of March), and those doing away with the previous requirement that representatives, senators and the governor "be of the Protestant religion." Five amendments were ratified in 1889, four in 1902 and four in 1912. Most important of those adopted in 1912 was one providing for the election of the governor and members of the council by a plurality instead of a majority vote. In 1956 two amendments became effective, one to permit the legislature to authorize absentee voting in primary elections and one to allow the governor to transact official business while absent from the state in line of duty.

New Hampshire is the only state in which amendments to the constitution may be proposed only by a constitutional convention, and once in seven years at the general election a popular vote is taken on the necessity of a revision of the constitution. By an act approved on April 9, 1909, provision was made for direct nominations of candidates at primaries. The government of the state was extensively reorganized as a result of legislation passed in 1949.

Executive. — There is a governor's council of five members, one from each councilor district: which has advisory duties and shares with the governor most of his powers. There is no lieutenant governor. The governor and the councilors are elected for terms of two years. The governor and council appoint all judicial officers, the attorney general; comptroller, important administrative boards and commissions and the medical referees; they have power to pardon offenses; and they may exercise some control over expenditure through the constitutional requirement of the governor's warrant for drawing money from the treasury. The governor may veto within five days, besides Sunday, after it has been presented to him any bill or resolution of which he disapproves, and a two-thirds vote of the members of both houses is required to pass over his veto.

General Court. — A senate and a house of representatives, which together constitute the general court, meet at Concord on the first Wednesday in January of every odd-numbered year, and at such other times as the governor may appoint for a special session, principally for the making of laws and for the election of the secretary of state and the state treasurer. The senate is composed of 24 members, one from each senatorial district. Membership in the house of representatives varies according to a plan adopted in 1931, by which towns having fewer than 600 inhabitants elect representatives according to a special schedule. Both senators and representatives are elected for two-year terms.

Judiciary. — For the administration of justice the state has a supreme court and a superior court, each county has a probate court, and some towns as well as the cities have a municipal court. The supreme court consists of a chief justice and four associate justices; the superior court comprises a chief justice and five associate justices. The supreme court sits at Concord on the first Tuesday of every month except July and August; while the superior court holds two or three sessions a year in each of the ten counties. Each county has a single probate judge, who has jurisdiction over the probating of wills, insolvency proceedings, decisions regarding adoption of children and similar judicial functions. Supreme, superior and probate judges are appointed by the governor and council to serve until they are 70 years of age.

Municipal judges are similarly chosen. Like justices of the peace, they have jurisdiction in criminal cases where the punishment is by fine not exceeding $20, by imprisonment not exceeding six months, or by both, and in minor civil cases. A municipal court has the same jurisdiction as that of justices of the peace, and municipal judges possess, in addition, concurrent jurisdiction with the superior court in certain cases where the title to real estate is not involved and the damage demanded does not exceed

$100. Justices of the peace are appointed for a term of five years only, but they may be reappointed.

Finance. — The chief sources of the income of the state government are the gasoline tax, motor vehicle and operators' licence fees. taxes on beer and taxes on or sale of liquor (sold in state liquor stores). the tobacco tax and income derived from the regulation of betting on horse racing.

Local Government. — Local affairs are administered by counties (ten in number). towns (townships), village districts and cities. In each county a convention, composed of representatives from the towns. meets every two years to levy taxes and to authorize expenditures for grounds and buildings whenever more than $1,000 is required. For the discharge of other county functions the qualified electors of each county elect every two years three commissioners, a sheriff, a solicitor, a treasurer, a register of deeds and a register of probate; two auditors also are appointed annually by the supreme court. The county commissioners have the care of all county property, as well as of county paupers; and once every four years they are required to visit each town of their county. inspect the taxable property therein, determine whether it is incorrectly assessed and report to the state board of equalization. In each town a regular annual meeting of the qualified electors is called on the second Tuesday in March for the transaction of miscellaneous business and the election of town officers.

POPULATION

The population of New Hampshire in 1790 mas 141.885; in 1840 it was 284.574; in 1880. 346,991; in 1910, 430,572; in 1940. 491,524; in 1950, 533.242; and in 1960, 606.921. The last figure represented an increase of 13.8% over the population in 1950. The population per square mile in 1960 was 65.2, as compared with 59.1 in 1950 and with 49.6 for the U.S. in 1960.

The urban area of New Hampshire in 1940 comprised 11 cities, the smallest having a population of more than 6.000. and 7 towns (townships) classified as urban under special rule. The population of this area was 283.225. or 57.6% of the state total. The population of the same area in 1950 was 301.249, or 6.4% more than in 1940, and represented 56.5% of the state total. According to the census of 1960 the state had two standard metropolitan statistical areas, which are Manchester and Lawrence-Haverhill, Mass.-N.H. These areas had a total population of 107,637 or 17.7% of the total population of the state. The urban population in 1960 was 353,766.

Analysis of the federal census of 1790 indicated that in that year better than two-thirds of the population of New Hampshire was of English or Welsh origin. There were small percentages of Scotch. Irish. Scotch-Irish, Germans, Dutch and French. While foreign immigration, especially Irish, to the state began in the first half of the 19th century, the ethnic composition changed most after 1860. By the middle of the 20th century French-Canadians represented one of the largest ethnic groups in the state, along with the English-Welsh. In the order of size the other ethnic groups are English. from both England and Canada, Irish, Poles, Greeks. Scotch, Italians, Germans! Russians, Swedes, Finns, Norwegians, Portuguese, Austrians and Hungarians.

While there was a large migration of younger people out of the state. this was partly offset by the choice of New Hampshire as a place for retirement. so that during the 20th century the population nas relatively stable.

The number of households in 1960 was 224.268, as compared with 190,563 in 1950 and 135,960 in 1940. The average population per household had declined from 3.7 in 1940 to 3.4 in 1950 and to 2.7 in 1960.

The population of the state was distributed by colour and nativity in 1950 as follows: 88.9% native white; 10.9% foreign-born white; and 0.1% nonwhite. Of the 58,131 foreign-born nhite, 60 0% were born in Canada, including 42 9% Canadian-French alone. There were 97.9 males per 100 females in the native white population and 88.9 in the foreign-born; 10.9% of the population nas 65 years old or over; and 53.7% of the population 14 years old and over was in the labour force. Of the total number of employed males, 9.1% was engaged in agriculture, 8.7% in construction. 40.0% in manufacturing, 22.6% in transportation and trade and 14 6% in services of various kinds.

*New Hampshire: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	606,921	533,242	491,524	443,083	411,588
Berlin	17,821	16,615	19,084	16,104	8,886
Ciaremont	13,563	12,811	12,144	9,524	6,498
Concord	28,991	27,988	27,177	22,167	19,632
Dover	19,131	15,874	14,990	13,029	13,207
Exeter	5,896	4,977	5,398	4,604	4,922
Franklin	6,742	6,552	6,749	6,318	5,846
Hanover	5,649	4,999	3,425	2,264	1,884
Keene	17,562	15,638	13,832	11,210	9,165
Laconia	15,288	14,745	13,484	10,897	8,042
Lebanon	9,299	4,614	7,590	6,162	—
Manchester	88,282	82,732	77,685	78,384	56,987
Nashua	39,096	34,669	32,927	28,379	23,898
Portsmouth	25,833	18,830	14,821	13,569	10,637
Rochester	15,927	13,776	12,012	9,673	8,466
Somersworth	8,529	6,927	6,136	6,688	7,023

*Populations are reported as constituted at date oi each census.
Note: Dash indicates place did not exist during reported census, or data not available.

EDUCATION

New Hampshire formed a part of Massachusetts when, in 1647, the general court of that province passed the famous act requiring every town in which there were 50 householders to maintain a school for teaching reading and writing, and every town in which there were 100 householders to maintain a grammar school. During the 19th and early part of the 20th century various experiments for improving the public-school system were tried.

The public-school system has at its head a state board of education composed of seven persons appointed by the governor and council. The administrative work is carried on by a commissioner of education, appointed by the board for an indefinite term, a deputy commissioner, nominated by the commissioner and appointed by the board, and a director of technical institutes, appointed by the board. Each town is constituted a school district, and some special districts are organized under special acts of the legislature. For the purpose of inspecting and supervising all institutions in which state money is spent, the several school districts in the state are combined into supervision unions consisting of one or more school districts. The schools are maintained chiefly out of the proceeds of a district school property tax.

All children between the ages of 8 and 16 are required to attend either a public or an approved private school for the full term unless they are more than 14 years old and have completed the studies prescribed for the elementary schools, or have been excused by the school board on account of physical or mental infirmity.

The only state institutions of higher education are the Plymouth Teachers college (1870) at Plymouth, the Keene Teachers college (1909) at Keene and the University of New Hampshire, organized in 1866 at Hanover as the New Hampshire College of Agriculture and the Mechanic Arts and moved to Durham in 1893. By an act of the legislature it became a university in 1923 and offers undergraduate work in agriculture, engineering and liberal arts. There is also a graduate school offering both the master's and the doctor of philosophy degrees. Other institutions of higher learning in the state are Dartmouth college (nonsectarian, 1770) at Hanover (*q.v.*); Saint Anselm's college (Roman Catholic, 1889) at Manchester and four other Roman Catholic colleges; New England college (nonsectarian, 1946) at Henniker; and Colby Junior college for women (academy, 1837; college, 1928) at New London.

HEALTH, WELFARE AND CORRECTIONS

The state charitable and correctional institutions include the New Hampshire school for feeble-minded children at Laconia (*q.v.*); the New Hampshire soldiers' home at Tilton; the New Hampshire industrial school at Manchester (*q.v.*); the New Hampshire hospital for the mentally ill, and the state prison at

Concord; and the New Hampshire sanatorium for tuberculosis patients at Glencliff in the town of Warren. The state also makes annual appropriations for the care and education of blind and deaf and dumb persons in institutions outside the state. Each county has an almshouse and house of correction.

ECONOMY

Agriculture. — Agriculture in New Hampshire was greatly modified in the 20th century, the production of vegetables, fruits, dairy products, poultry and eggs largely supplanting the production of cereals. The total acreage in farms decreased from over 3,000,000 in 1910 to less than 1,500,000 in the second half of the century. During the same period the number of farms decreased from 27,000 to 10,000 but the average acreage per farm increased from 120 to 143. Nearly all farms are worked by owners or part owners. Livestock. poultry and their products account for about 75% of annual value of farm products. Dairying, long an important New Hampshire industry, was supplanted by poultry and poultry products as the major source of farm income. Apples, potatoes and hay are the principal crops.

Forests and Fisheries. — Except on the summits of the higher mountains. New Hampshire was originally an unbroken forest of which the principal trees were white pine, hemlock. sugar maple, yellow birch, beech, red oak and white oak in the south, red spruce, balsam and white birch on the upper mountain slopes. and red spruce. white pine, sugar maple. white spruce and white cedar in the other parts of the north. The white pines of New Hampshire were an important source of masts for the royal navy during the colonial period. Even in the second half of the 20th century nearly 85% of the state was forested. Two-thirds of the tiniber harvested was saw logs, one-fifth was pulpwood and most of the rest was firewood. One-sixth of the state's commercial forest land is publicly owned, most being in the White Mountain National forest.

New Hampshire, with only one coastal county (Rockingham), ranks sixth among the New England states in its fishing yield.

Minerals.——Formerly granite was the most important of the mineral products oi New Hampshire, which has long been known as the "Granite state." New Hampshire granite was used for building as early as 1623, and at the beginning of the 20th century New Hampshire was one of the leading states in granite quarrying. But the use of steel and concrete in building caused a rapid decline in the industry, and by the second half of the 20th century New Hampshire's minerals, in order of value, were sand and gravel, stone, mica and feldspar. Sand and gravel, which account for about half the state's mineral output (value), are produced in nearly all counties. Stone. the second most irnportant mineral, is quarried in Rockingham, Merrimack, Grafton. Hillsborough, Carroll and Coos counties. Mica. first mined in Grafton. Grafton county. in 1803. was later found in other parts of the state in such quantities that for 60 years during the 19th century New Hampshire was the largest producer of mica in the United States.

Manufactures.——Since the beginning of the 20th century New Hampshire's chief source of employment and income has been in manufacturing. 'There were 1,618 manufacturing establishments in 1904 and 50 years later there were 1.609 (1954 census of manufactures). For the same period the number of persons employed increased slightly. from 68,032 to 77,071, the value added by manufacture multiplied, from $50.400.000 to $408,800,-000, and payrolls rose from $30,700,000 to $245,300,000. Most of the iactories are small. In 1954 fewer than 50 were employed in each of 1,307 of the manufacturing plants; only 80 establishments employed more than 250 persons. Until the late 1940s textiles and leather products (chiefly boots and shoes) were the major manufactures. After that time some cotton and woolen mills ceased operation or moved south. New industries, especially the production of electrical and electronic goods, partly replaced textiles. Other important industries in New Hampshire are non-electrical inachinery, pulp, paper and paper products, lumber and wood products and printing and publishing. Most of the manufacturing centres of the state are south of Lake Winnipesaukee. An exception is Berlin, the chief manufacturing centre north of the White mountains, important for its manufacture of paper and wood pulp.

Transportation and Communications. — Most of the railways in the state are owned or leased by the Boston and Maine. This company was the first to operate a railway within the state, service being maintained between Boston, Mass., and Dover, N.H., as early as 1842. Railway mileage decreased from more than 1,200 mi. in the 1920s to less than 1,000 mi. in the second half of the 20th century. There are over 13,000 mi. of public roads, oi which better than two-thirds are surfaced. The state maintains 3,700 mi. of highway, including three toll roads, the Everett, the New Hampshire and the Spaulding turnpikes.

Ten daily newspapers and about 40 weeklies are published in New Hampshire. The *New Hampshire Gazette*, founded in 1756, is claimed to be the oldest continuously published newspaper in the United States; it is printed as a part of the *Portsmouth Herald.* There are two television stations in the state, and broadcasting facilities for two out-of-state stations are located in Winchester and on top of Mt. Washington. Of the 16 radio-broadcasting stations; two are both AM and FM. New Hampshire has over 200.000 telephones, of which the majority are controlled by the New England Telephone and Telegraph company; however, 32 local telephone companies are still in business.

See also NEW ENGLAND.

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(H. W. K.; W. E. Ss.; P. M. M.)

NEW HARMONY, a town of Posey county in southwestern Indiana, U.S., about 22 mi. N.W. of Evansville is situated on the Wabash river. In the 19th century it was the scene of two famous experimental co-operative communities.

The site, a tree-studded meadow safely above flood stage of the Wabash, was occupied by prehistoric Mound builders and later became a camping ground for Piankashaw and Kickapoo Indians. In 1814 it was bought by the followers of George Rapp, a German Pietist preacher who had led disciples to the U.S. in 1803. Their original colony in western Pennsylvania had prospered but Rapp elected to move westward. On the Wabash the Rappites laid out their town and named it Harmonie. They planted the rich land, set out orchards and vineyards and built residences, two churches. shops and factories. They also built separate dormitories for men and women because "Father" Rapp advocated celibacy, though the practice was not enforced. Soon a winery, brewery, distillery, looms, smithy, hattery and other industries to supply frontier merchandise were in production. Rappite traders carried their products on all midwestern rivers, and their trade-mark, the Rappite. rose, soon came to be a guarantee of quality.

But neighbouring frontiersmen were suspicious of clannish, German-speaking Harmonie and its celibacy; or perhaps they were jealous of its prosperity. Besides, the market was smaller than Kapp had expected, and by 1824 Rappite leaders were ready to sell out and return to Pennsylvania. The buyer was Robert Owen (*q.v.*), British reformer who came to the U.S. to found a perfect co-operative community which would be based on his plan for the ultimate salvation of all mankind through "rational" thinking, co-operation and free education. In 1825 he bought Rapp's ready-built Harmonie with cash and notes, renamed it New Harmony and invited all to join him in Utopia and live at his expense until they could carry out his program and become self-supporting. William Maclure (*q.v.*), a geologist, businessman and philanthropist. who joined Owen and agreed to finance the schools, brought and paid his own teachers and supplied scientific equipment and a library.

Owen was adept at publicity. Myriads of persons talked of joining him and more than 1,000 actually arrived. With few exceptions, however, they mere incompetent, greedy or daydreaming misfits. They ate Owen's rations, argued about their own government and debated the merits of Owen's "new system" while the farms and factories lay idle.

By May 1827 Owen's available cash had been expended on payments for the land and groceries for his followers. Maclure paid the last Rappite note in 1828 and Owen returned to Great Britain. Maclure's teachers and the best of Owen's recruits, including his sons, stayed on and developed one of the most notable pre-Civil War cultural centres in the U.S.

In the 20th century New Harmony is basically an agricultural community. Although its population has remained less than 2,000 (1,121 in 1960), its many original Rappite buildings have made it a charming but little understood monument to an interesting phase of the U.S. past. (R. E. BA.)

NEWHAVEN, a seaport and urban district in the Lewes parliamentary division of East Sussex, Eng., 7 mi. S.S.E. of Lewes by road, on the English channel at the mouth of the Ouse. Pop. (1951) 7.783. Area 2.8 sq.mi. A fort dominates the entrance to the harbour—first granted to Newhaven in 1713 when it had a large shipping trade. It is the English terminus (since 1843) of a cross-channel steamer service to Dieppe, and there is a large and varied trade with the continent. The tidal harbour is enclosed by two piers and a breakwater 3,000 ft. long, the area being about 30 ac. and the quayage 1,400 yd. There is some light industry (on a factory estate) and boatbuilding. There is bathing on the sandy beach. The parish church of St. Michael is one of the earliest Norman churches in England.

NEW HAVEN, a city and port of entry in southwestern Connecticut. U.S., is located on Long Island sound at the mouth of the Quinnipiac river, about 70 mi. E.N.E. of New York city. It is the seat of Yale university (*q.v.*).

It was originally settled in 1638 by about 500 English Puritans under the leadership of John Davenport and Theophilus Eaton. Most of the settlers had come from England the previous year and had wintered in the Massachusetts Bay colony. Originally called Quinnipiac, an Indian word meaning "long water land," in 1640 the settlement was renamed for the port city of Newhaven in England. In 1643 New Haven and three adjacent towns, together with Stamford, 30 mi. W., and Southold on Long Island, joined to form the New Haven colony, of which Eaton was governor until his death in 1658. Strong Puritan sympathies made the colony a refuge, in 1661, for Col. Edward Whalley and Col. William Goffe, two officers in Cromwell's army, who had been members of the court that condemned Charles I and fled to New England seeking sanctuary. Although the political consequences of this sympathetic action are disputed, within four years New Haven colony was assimilated into Connecticut colony, which had been based on Hartford and enjoyed a royal charter.

In 1701, however, New Haven became co-capital with Hartford, a position it maintained in both colony and state until 1873, when Hartford became the sole seat of government. A collector of the port was appointed in 1760 and thereafter a flourishing shipping trade grew up with the West Indies, Newfoundland and other American ports. During the American Revolution New Haven, strongly supporting the Continental cause, was sacked (July 5, 1779) by Loyalist forces under Gen. William Tryon, colonial governor of New York. Tryon, however, was driven off before he could burn the town. New Haven was incorporated as a city in 1784 and, following the War of 1812 during which many local seafarers turned to privateering, trade with ports throughout the world sprang up and manufacturing began to make itself felt as an important part of the economy.

Around 1830 immigrants began to arrive from Ireland and Bavaria. A wave of Italian immigration commenced in 1870, and a decade later, partly as a result of pogroms in Russia, eastern European Jews began arriving in considerable numbers. Slavery was gradually eliminated in Connecticut after 1784, and by 1820 there were over 600 Negroes in New Haven; in the decades before the American Civil War the city was an important centre of abolitionist sentiment.

These waves of immigration greatly facilitated the economic growth of the area, as did the proverbial Yankee ingenuity. New Haven was where Eli Whitney developed interchangeable parts for firearms: thus ushering in the principle of mass production; where Charles Goodyear discovered vulcanized rubber; and where Samuel Colt improved his invention of the repeating revolver. In the second half of the 20th century New Haven industries included shipbuilding and the manufacture of firearms, ammunition, aircraft parts, hardware tools, rubber goods, watches, clocks, textiles and paper products.

The cultural life of New Haven is a blend of contributions from Yankees and later immigrants. The Puritans' deep interest in education led to the founding in 1660 of Hopkins grammar school, which still exists. Yale university, founded (1701) as the Collegiate School of Connecticut in Saybrook, moved to New Haven in 1 7 1 Other institutions of higher learning in New Haven include Albertus Magnus college (Roman Catholic, 1925) for women; Southern Connecticut State college, founded (1893) as New Haven Normal school; and New Haven (junior) college (1920).

Although much of the area's cultural activities depend upon Yale's art gallery. drama and music schools, and its famed Peabody Museum of Natural History, New Haven has its own symphony orchestra, and in 1958 it instituted a community-wide festival of arts. For years Broadway plays and musicals have used the old Shubert theatre for public try-outs before opening in New York.

Pop. (1960) 152.048; standard metropolitan statistical area (New Haven, Branford, East Haven, Guiliord, Hamden, North Haven, Orange, West Haven and Woodbridge towns) 311,681. (R. A. DL.)

NEW HEBRIDES, an island group in the western Pacific, about 500 mi. W. of Fiji and 250 mi. N.E. of New Caledonia. Area 5,700 sq.mi., pop. (1958 est.) 55,713. The islands are under a condominium, or joint British and French administration.

Administration.—The islands were placed under joint Anglo-French administration, as provided by the Anglo-French convention of Feb. 1906, which was ratified in Oct. 1906, and the Anglo-French protocol; signed in London in 1914 and ratified only in March 1922. Great Britain and France are represented in the islands by high commissioners, who delegate their powers to resident commissioners stationed in the group. The British resident commissioner is responsible to the British high commissioner for the western Pacific, who resides at Honiara in the British Solomon Islands protectorate. The French resident commissioner is responsible to the French high commissioner who is usually also the governor of New Caledonia. There are British and French courts, together with a mixed court with a judge who is a national neither of Great Britain nor of France. The New Hebrides are south and west of the farthest points reached by the Japanese in their southward advance in 1942 and were therefore not directly drawn into the Pacific hostilities.

History.—The islands were sighted by the Portuguese navigator Pedro Fernandez de Quiros in 1606. Believing he had discovered a great southern continent, he named it Australia del Espiritu Santo. The isiands were visited by the French explorer Louis de Bougainville in 1768, and received their present name from the British navigator Capt. James Cook in 1774. Their rugged outline suggested the Hebrides Islands off the northern coast of Scotland.

The islands were found to be rich in sandalwood and were opened up to communication with the outside world by the visits of traders and missionaries during the 19th century. Great Britain and France declared the New Hebrides neutral in 1878. Both Great Britain and France found occasion to intervene in protection of the lives of their nationals in clashes with the natives. The islands were placed under the surveillance of a mixed Anglo-

French commission of naval officers in 1887.

A more detailed scheme of joint administration went into effect as a result of the convention of 1906. This provided that British and French nationals should have equal rights in all respects and that each power should retain jurisdiction over its own subjects or citizens. It was agreed that there should be no penal settlement and no fortifications on the islands.

The second protocol, ratified on March 18, 1922, regulated British, French and native interests, fixed conditions of land tenure and provided regulations for the recruiting of native labour. The sale of drink and firearms to natives and the practice of forced labour are illegal.

Topography and **Climate.**—Espiritu Santo, with an area of 1,500 sq.mi., is the largest of the islands. Efaté, with the two excellent harbours of Vila and Havannah, is the seat of the administration, located in Vila. Port Sandwich, largest port in the islands after Vila, is on the island of Malekula (Mallicolo). The islands are of volcanic, not coral, formation and some active volcanoes still exist. Because of their volcanic origin, the islands reach a considerable elevation, Mount Lopevi reaching a height of 4,755 ft. A height of 6,169 ft. has been recorded in Espiritu Santo. The climate is generally hot and damp, especially in the months between November and April. Natural vegetation is luxuriant and abundant.

Ethnology and Education. — The natives are Melanesians of mixed blood, with a minority of Polynesians in some places. As is usually the case in Melanesian lands, the natives are divided into small tribal units, no one of which acknowledges the authority of another. Cannibalism is still found in Espiritu Santo, Malekula and the Pentecost Islands. Education is largely in the hands of Catholic and Presbyterian missions. There are hospitals with foreign doctors and nurses and there are one government school and two Catholic mission schools for the white population. Malaria and various fevers are prevalent in the islands. Infectious diseases like influenza and whooping cough are sometimes brought into the islands by foreigners and take a high toll of the natives whose sanitary standards are low.

Economics and Finance. — The islands produce bananas, sugar cane; oranges, tropical fruits, corn, vanilla and coconuts. There are several British and French trading companies. New Hebrides trade is mostly with Australia and New Caledonia. Principal imports are food, clothing, metal wares and furniture. Exports include copra, cocoa, coffee, cotton and kauri logs. Imports of wine and spirits, arms and ammunition are forbidden, except under special permit. (W. H. CH.)

NEW IRELAND, an island of the Bismarck archipelago, situated to the north of New Britain, from which it is separated by St. George's channel, in latitude 3° 0' S., longitude 151° 30' E. With the adjacent islands it forms an administrative district of the Trust Territory of New Guinea (*q.v.*). Area (including adjacent islands) 3,800 sq.mi. Pop. (1954) 34,584, of whom a small number are European or Chinese. The island is nearly 200 mi. long but very narrow. The southern portion attains a breadth of 30 mi. but the prolongation which extends northeastward for almost 130 mi. is nowhere wider than 15 mi. and in places narrows to about 5 mi, across. Unlike New Britain (*q.v.*) the island contains no active volcanoes, but it is rugged and mountainous, especially in the south where the Rossel mountains rise to almost 6,500 ft. Limestone mountains and plateaus occupy much of the long northwest peninsula, but there is generally a fringe of coastal plain, of raised coral or alluvium, and at the constrictions the coasts are separated only by low saddles.

Commercial development is practically confined to copra production, especially on the east coast. In addition to the plantations, which occupied about 55,000 ac. in the mid-1950s, there is an increasing production from native groves. Most of the inhabitants live in the north of the island. The administrative centre and chief port is Kavieng in the northwest, connected by a motor road along the east coast to Samo. The southern portion of the island is administered from Namatanai, on the east coast.

First visited by Abel Tasman in 1642, the island was unexplored until 1884 when, as Neu Mecklenburg, it became part of a German protectorate. After World War I it was mandated to Australia. It was invaded by the Japanese in Jan 1942. (D. W. F.)

NEW JERSEY, usually referred to as the "Garden state" because of its many truck farms, is located along the eastern seaboard of the United States about 38° N. of the equator. It is bounded on the north by New York, on the west by Pennsylvania, on the south by the Delaware river bay which separates it from Delanare. and on the east by the Atlantic ocean and the Hudson river. New Jersey ranks 46th in size among the states and measures 166 mi. in length from the northernmost to the southernmost extremities, 57 mi. in width at its greatest girth and 32 mi. at its narrowest. It has a total area of 7.836 sq.mi., of which 315 sq.mi. consist of lakes and other inland water areas. New Jersey, one of the 13 original Colonies, became the third state of the union on Dec. 18. 1787; its state capital is Trenton The red oak has been adopted as the state's official tree, the purple violet as the official flower and the eastern goldfinch as the official bird. The state's flag is buff-coloured with the blue seal of the state in its centre.

PHYSICAL GEOGRAPHY

Physical Features. — Though New Jersey is small in area, it is geologically interesting. Viewed from above it looks like a series of descending steps from the mountains in the northwest to the tidal marshes along the eastern and southeastern seacoasts. It has been estimated that the state's land masses are more than 1,000,000,000 years old and record the whole geological cycle of rock formation and decay through the phases of mountain building, erosion, flooding, re-emergence, the Ice Age and the subsequent breakdown after the glaciers receded. The Appalachian mountains cut across the northwest corner of the state. These mountains vary from 1,200 to 1,500 ft. above sea level and contain High Point (1,803 ft.), the state's highest point of elevation. Alongside this mountain range, but just south and east of it, is a small belt of highlands about 400 ft. lower in average elevation, which covers about one-seventh of the state's area. The remainder of the northeastern and north-central portions of the state are a lowland area that varies between 200 and 800 ft. in elevation. The rest of the state, that is, somewhat more than half of it (4,400 sq.mi.), consists of a flat coastal plain mostly less than 100 ft. above sea level, of which about one-eighth is tidal marshland, usually flooded at high tides, lying between the barrier beaches of the coastline and the actual mainland. The average mean elevation of the state is only 250 ft. above sea level.

The four "steps" or belts correspond closely to the major geological epochs of land formation. The great glaciers of the Ice Age covered a little more than one-third of the state and left large deposits of debris in an irregular line roughly from just west of Staten Island southwestward to Pennsylvania.

The Delaware river, from its junction with the Neversink river to the capes, flows along the western and southern borders of the state for 245 mi. The Hudson river drains only a small part of the state, but has contributed materially to its economic development. The principal stream of the highlands and Triassic lowland, the Passaic, rising in Morris county, passes through a gap in the traprock at Little Falls, descends 40 ft. and at Paterson drops 70 ft. as the Great falls of the Passaic and, bending southward, empties into Newark bay. The Hackensack river enters the state about 5 mi. W. of the Hudson, flows almost parallel with it and empties into Newark bay, having a length of 34 mi. The Raritan, the largest stream lying wholly within New Jersey, flows eastward through the centre of the state. Among the highlands are numerous lakes of which the largest are Lake Hopatcong, in Morris and Sussex counties, and Greenwood lake, partly in New York and partly in New Jersey.

Soil. — The soils of New Jersey generally follow the "steps" of elevation that descend from the mountains in the northwest to the coastal plain in the southern and eastern parts of the state. In the northwestern mountains the soil is regarded as heavy; that is, containing large amounts of sandstone and limestone. The soil of the northern highlands area is also heavy, but includes granite loams and gneiss in addition to limestone, while the southern highlands soil has large quantities of shale and red sandstone as well as traprock. The lowlands tend to be a mixture of loams, sand loams and greensand marl. The coastal plain is composed mostly of sand soils with pockets of loam.

Climate.—New Jersey's climate varies greatly between the northern and southern parts of the state. largely because of the higher elevation in the north and the dominating effect of the Atlantic ocean over the southern coastal plain and lowlands. The average annual temperature is about 50° F. in the extreme north and about 55° in the extreme south, less than 200 mi. away. In the north the winter temperatures average about 28" F. while the summer averages 70°. In southern New Jersey the winter temperatures average about 35° and the average summer temperature is 71°. For the state as a whole the winter temperatures average just above the freezing point (33°) and in the summer generally tend to be reasonably comfortable (average of 74°) though high humidity prevails almost all year round.

The length of the growing season in the state is about 155 days in the northwest and about 203 days along the southeastern coast. The annual average rainfall is about 46 in. for the state as a whole, though southern New Jersey averages only 36 in. while northern New Jersey usually exceeds 50 in.

Vegetation. — The vegetation of northern New Jersey does not vary much from that of the surrounding states, and in the south, especially in the pine forests, there are many examples of plant life common to North America. Plants commonly found in the state include the honeysuckle, beach plum, mild azalea, wintergreen and cardinal flower. Slightly over 30% of the state consists of wasteland, much of which is in scrub forests, and approximately 40% of the state is devoted to farm lands. which are concentrated in the extreme northwestern, western and southern parts of the state.

About two-fifths of the state's area is in forest growths of various kinds. The largest forest region is the pine barrens. which covers more than 1.200.000 ac. and includes a very large part of the southern half of the state. The pine barrens is composed of many varieties of pine, including areas of badly stunted growth and white cedar in the swamps. The next largest forest area comprises about 500,000 ac. in the major river valleys. The principal growth is oak, but there are also birch. maple, ash, elm, walnut and chestnut. Finally, in the mountains of the northwest and highlands of the north central part of the state, there are about 300,000 additional acres of forest lands in which almost all trees common to North America may be found. Throughout all of these forests are ferns, many herbaceous plants, holly and the usual wild flowers native to the eastern United States.

Animal Life. — In the pine forest and the mountains deer, bear and wildcat are common. Other animals often seen in New Jersey are squirrels, chipmunks, rabbits, opossums, raccoons, foxes, muskrats and woodchucks. Snakes also are commonly found, most especially in the south. Many migratory birds pass over the state as do the shore and land birds which populate the southern forests.

State Parks, Forests and Historic Sites. — New Jersey has established 23 state parks with an area totaling approximately 27,000 ac. In the parks are preserved sites of historic significance, native plants and animals and sanctuaries for wildlife. Hunting is not allowed although fishing is permitted under state regulations. Some of the parks are Allaire (1,277 ac.) in Monmouth county, Cheesequake (975 ac.) in Middlesex county, High Point (10,935 ac.) in Sussex county, Parvin (1,025 ac.) in Salem county, Ringwood Manor (579 ac.) in Passaic county and Washington Crossing (372 ac.) in Mercer county.

Eleven state forests, with a total area of more than 150,000 ac., occupy the least-developed sections, such as the mountain area in the north and the lowlands in the pine barrens. These forests provide facilities for camping, picnicking, bathing and water sports, and serve as laboratories for the study of wildlife and also forest plantings. The Wharton tract, covering more than 90.000 ac., was acquired by the state in 1954 as a state forest. Other forests are Bass River forest (9,270 ac.) in Burlington and Ocean counties, Lebanon forest (22,216 ac.) in Rurlington and Ocean counties and Stokes forest (12.429 ac.) in Sussex county. The state parks and forests are under the supervision of the department of conservation and economic development.

The state's historic sites serve as reminders of New Jersey's stirring past. A monument at Freehold commemorates a battle of the Revolutionary War fought on June 28, 1778, in which Molly Pitcher (*q.v.*) figured. Other signs of the Revolutionary period include the Old Barracks at Trenton, built in 1758 to quarter British troops and later occupied by the Continental army; the Wallace house at Somerville, which served as General Washington's headquarters during the minter of 1778–79; and the Morristown National Historical park. which includes Fort Nonsense and Jockey Hollow nith replicas of the quarters occupied by the Continental army during two winters Another famous landmark is the Berrien house at Rocky Hill, where Washington wrote in 1783 the farewell address to his troops. The Continental congress met for a time in Nassau hall (built in 1756) at Princeton university. Another important colonial landmark was the home of Col. William Richards, restored in 1874 by Joseph Wharton. The Edison research laboratory, established in 1887 by Thomas A. Edison at West Orange, became a national monument in 1956.

HISTORY

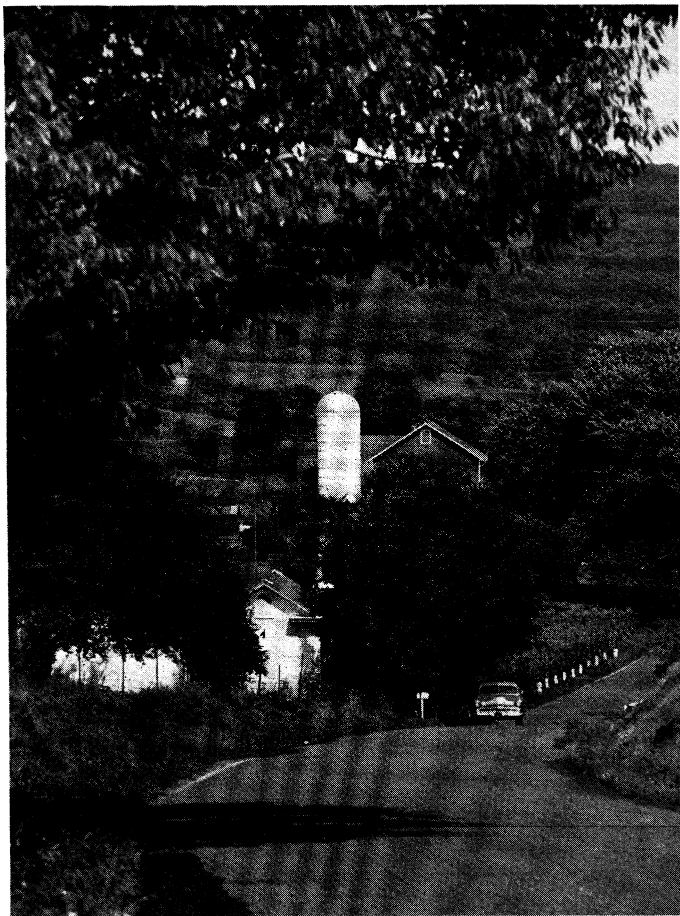
Exploration and Settlement. — The Lenni Lenape Indians (called Delawares by the first settlers), a tribe of the Algonkin group, early inhabited the region now known as New Jersey. In 1758 the dwindling tribe moved to a reservation at Brotherton, now called Indian Mills, in Burlington county.

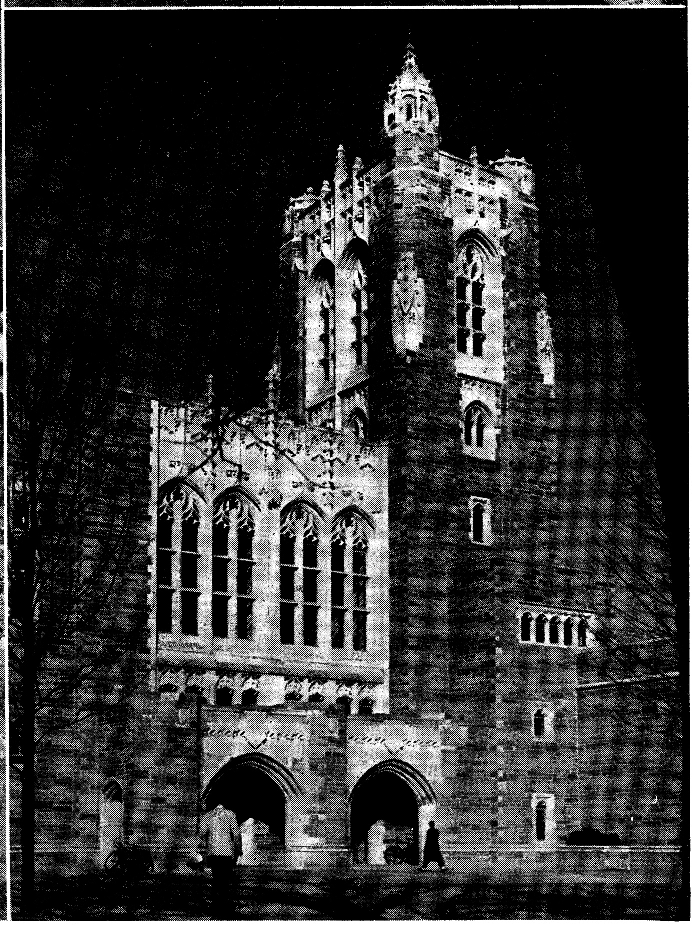
In 1524 Giovanni da Verrazano, a Florentine explorer who sailed for France, touched the New Jersey shore, but it was not until 1609 that Henry Hudson, employed by the Dutch East India company, dispatched a party to explore Newark bay. He then sailed his ship the "Half Moon" up the river now known as the Hudson and established Dutch claims. Nine years later a Dutch trading post was located at Bergen. Cornelius Jacobsen Mey in 1614, and later Cornelius Hendricksen, explored the Delaware river. By 1623 New Netherland (that part of North America between New France, or Canada. and Virginia) was established as a province, and soon Fort Nassau was built at the present site of Gloucester. Fifteen years later Swedish settlers were trading at Fort Christina on the west bank of the Delaware near the present site of Wilmington.

Colonial Rule. — In 1664 King Charles II of England granted to his brother James, duke of York, the vast Dutch holdings that included the present state of New Jersey. The region between the Hudson and Delaware rivers was soon transferred by the duke to John, Lord Berkeley, and Sir George Carteret. By this grant the duke of York created the colony of New Jersey or New Caesarea, named in honour of Carteret, a Royalist, who as its governor had defended the Isle of Jersey for the crown during the English Civil War.

To attract immigrants the proprietors in Feb. 1665 published their "Concessions and Agreements" by which they provided for a governor, a governor's council and an assembly chosen by the freemen and empowered to levy taxes. Meanwhile Gov. Richard Nicolls of New York, ignorant of the grant to Berkeley and Carteret. had confirmed sales to settlers of sites which later became Elizabethtown, Middletown and Shrewsbury. In 1669 trouble between the proprietary gpvernor and the inhabitants of the last two towns over quitrents caused the nullification of the grants made by Nicolls. Four years later the Dutch fleet brought New Jersey under Dutch control. but England reacquired it by the treaty of Westminster, Feb. 9, 1674. The eastern half of the state was restored to Carteret's proprietorship. Berkeley had sold to John Fenwicke and Edward Byllynge, Quakers, his lands which subsequently were acquired by William Penn, Gawen Lawrie and Nicholas Lucas.

By the "quintipartite deed" of July 1676, the province east of a line from Little Egg harbour to a point on the Delaware river in 41° 40' N. (East Jersey) was assigned to Carteret, and that west of this line (West Jersey). about five-eighths of the whole, to the Quaker associates (first Quaker colony in America). In





BY COURTESY OF (TOP LEFT) NEW JERSEY DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT, (TOP RIGHT) CAMDEN CHAMBER OF COMMERCE; PHOTOGRAPHS, (BOTTOM LEFT) CRANE FROM BLACK STAR, (BOTTOM RIGHT) WARD ALLAN HOWE FROM EWING GALLOWAY

VIEWS OF NEW JERSEY

Top left: Scene in Hunterdon county, northwest New Jersey, a dairying and vegetable-farming area
Top *right:* Marine terminal and rail yards, Camden
Bottom left: Loading tomatoes on a farm near Camden where fertile, loamy soil is suited to truck gardening
Bottom *right:* Harvey S. Firestone Memorial library, erected at Princeton university in 1948

PHOTOGRAPHS, FAIRCHILD AERIAL SURVEYS, INC.

AERIAL VIEWS OF TWO NEW JERSEY CITIES

Top: Jersey City, with the Hudson river in the foreground and the Pulaski Skyway leading to the Holland tunnel on the extreme right

Bottom: Atlantic City, showing the famous boardwalk and resort hotels

1677 230 Quakers from London and Yorkshire founded a settlement which became Burlington. West Jersey was never actually governed under the liberal "Concessions and Agreements," presumably drafted by Penn, because Byllynge's title to the land conveyed to him alone the right to govern. Byllynge commissioned Samuel Jennings as deputy governor with the consent of the other proprietors. Jennings called the first assembly which passed fundamental laws providing for a governor and council. In 1680, after Philip Carteret, the governor of East Jersey, had been forcibly carried to New York and imprisoned, Andros appeared before the East Jersey assembly as governor, hut the deputies refused to pass the measures he recommended. A New York jury freed Carteret of charges of illegal exercise of authority and the duke of York recalled Andros from New York. In 1682 the prov-, ince, which Sir George Carteret had bequeathed to eight trustees to administer for the benefit of his creditors. was purchased at public auction by Penn and 11 associates for £3,400. Each sold one-half of his share, thus making 24 proprietors whom the duke of York authorized to govern the province. They directed the appointment of the American Board of Proprietors (1684) who with the deputy governor cared for such proprietary interests as approval of legislation and grant of lands. In 1686 Perth Amboy, the newly created port of East Jersey, became its seat of government. After becoming king in 1685. James 11—determined to unite New York, New Jersey and the New England colonies—extended accordingly the authority of Andros, now viceroy of New England.

In April 1702 the proprietors transferred to the crown all of their rights of jurisdiction but retained their rights to the soil. The provinces of East and West Jersey were then united and governed as a royal province. Until 1738 New York and New Jersey had the same governor; thereafter each had its own. The legislature met alternately at Burlington and Perth Amboy until 1790 when Trenton became the capital.

The diverse population of the colony grew steadily and at the time of the Revolutionary War it was estimated at 138.000. Those settlers who previously had acquired land grants were in constant conflict with the proprietors. A continuous discord prevailed between the royal governors and the assemblies, which, coupled with British commercial restriction, became a factor favouring the Revolution.

The **Revolution.**—New Jersey was active during the Revolutionary War period. In 1774, following the action of the other Colonies, a committee of correspondence and local committees were organized to disseminate information, and on July 21 a provincial congress met at New Brunswick and selected delegates to the first Continental congress at Philadelphia. In June 1776 Gov. William Franklin was arrested by the provincial congress, thus ending the royal authority. A constitution was adopted on July 2. 1776. New Jersey's people were divided. The loyalists, or Tories, had early organized six battalions. while other groups supported the patriots. British sympathizers in the Revolution engaged in guerrilla action, and their "pine barren robbers" conducted raids in southern New Jersey.

Important battles of the war were fought in New Jersey. Late in 1776 General Washington, commander in chief of the Continental forces, unable any longer to hold the lower Hudson, retreated to the Delaware near Trenton and, by commandeering all available boats, won for his dispirited troops the river as defense against their pursuers. Recrossing with 2,500 men on Dec. 25, he surprised three Hessian regiments next morning and took 1,000 prisoners and 1.000 stands of arms. Outmaneuvering Lord Cornwallis, the British commander, Washington defeated a detachment of Cornwallis' army at Princeton on Jan. 3, 1777. As the British army was retreating from Philadelphia to New York. Washington's forces engaged it in the indecisive battle of Monmouth on June 28, 1778. During the war the Continental army crossed the state four times, and Washington twice had his winter quarters at Morristown.

Delegates from the state attended both the Annapolis convention (*q.v.*) in 1786 and the Constitutional Convention at Philadelphia in 1787. At the latter, New Jersey leadership sponsored the small states' position (New Jersey plan) in opposition to the Virginia or large states' plan The New Jersey plan left its imprint in the provision of the federal constitution for equal representation for large and small states in the national senate and for the supremacy of federal law. On Dec. 18, 1787, New Jersey became the third state to ratify the federal constitution.

19th Century. — On Aug. 22, 1787. John Fitch demonstrated on the Delaware the first steamboat. and 31 years later the Vail works near Morristown built the machinery for the "Savannah." the first steamboat to cross the Atlantic. In 1794. under the auspices of Alexander Hamilton's Society for the Establishment of Useful Manufacturers, chartered by the legislature in 1791, a calico-printing factory inaugurated at the Great falls of the Passaic the first factory town in the U.S., now Paterson. In 1806 the first interstate railroad bridge was opened at Trenton. This material progress was interrupted by the War of 1812. which in the beginning was very unpopular. especially among the Quakers. After the war the construction of the Morris (1824–38) and the Delaware and Raritan (1826–38) canals and the completion of New Jersey's first railway, the Camden and Amboy (1834), provided facilities for a widespread industrial development.

Agitation for democratic reform culminated in a constitutional convention at Trenton (Slap 14–June 27, 1844), which drafted a new frame of government by which New Jersey abolished property qualifications for suffrage. modified the basis of representation in the assembly, separated the legislative, executive and judicial powers and provided for the direct election of the governor.

Opinion in New Jersey was divided on the question of slavery. The underground railroad transported fugitives to freedom, but when the American Civil War broke out. 18 people in New Jersey were legally still slaves In 1860 three of the state's electoral votes went to Democrat Stephen Douglas and four to Abraham Lincoln, and New Jersey was one of the three states nhich voted for Lincoln's opponent in 1861. The state furnished 88,305 men for the Union cause and incurred extraordinary expenditures to the amount of $2,894,385. Ratifications of the 13th and 15th amendments were each first refused by the respective legislatures before being voted by their successors in nhich the Republican party had gained a majority; in 1868 the Democratic legislature sought in vain to withdraw the ratification of the 14th amendment voted by its Republican-controlled predecessor

A bitter railway war folloned the Civil War. The Pennsylvania railroad was charged with virtually monopolizing the route between New York city and Philadelphia as a result of a 999-year lease through which it had gained control of the properties of companies previously granted monopolistic privileges. In 1873 the state opened the route to other railroads. This same period was marked by great cultural, scientific and industrial development.

Modern **Times.**—With no limit fixed either to capitalization or to bonded indebtedness, and with a policy of encouraging the holding company structure, coupled with a tax rate lower for large than for small corporations. New Jersey by 1904 had chartered 3 of the 7 largest trusts and had "mothered" 150 of the 298 next largest business organizations in the U.S. A growing concern over the effects oi industrialism led to direct primaries (1907. 1911), a new ballot form (1911), the election of Woodrow Wilson as governor (1911–13) and the passage in 1913 of the "Seven Sisters" acts for eliminating the power of trusts to create monopoly, limit production. fix prices and restrain trade. New laws limited public service franchises to 20 years. subject to municipal referendum.

Political power in New Jersey has usually been shared by the two major parties. but between 1914 and 1961 the Democrats never gained control of the senate and only five times had control of the house. In presidential elections since 1900 the state voted for Democratic candidates only in 1912 (Woodrow Wilson), 1932. 1936 and 1940 (F. D. Roosevelt) and 1960 (J. F. Kennedy).

An intensely industrial state, New Jersey produced great quantities of war matériel during World R'ar II. Important embarkation points for soldiers going to the European theatre of war were at Fort Dix and Camp Kilmer. The U.S. signal corps had its headquarters during the war at Fort Monmouth.

A constitutional convention, delegates to which had been popularly elected in 1947, assembled in h'ew Brunswick and prepared a new constitution which the voters approved and which on Jan. 1, 1948, replaced the 103-year-old constitution. For the first time in more than 100 years the electorate beginning in Nov. 1949 could re-elect a governor and for the first time in 40 years the Republicans held the governorship for two successive terms. Legislative sessions in 1948–51 enacted the basic measures for effecting the structural changes required under the new constitution.

New Jersey had the lowest per capita state taxes of any state in the union at mid-20th century. In the decade between 1950 and 1960, construction, both industrial and residential, boomed. Gov. Robert B. Meyner became the first Democratic governor to succeed himself when he was re-elected in 1957.

GOVERNMENT

After New Jersey joined with the other Colonies in 1776 in declaring its independence, it set up a new form of government that established almost absolute legislative supremacy. This in a modified form was continued in the second constitution of 1844 and lasted till pressures generated by dynamic changes in 1947 forced the adoption of a third constitution.

Executive. — The 1947 constitution created a powerful governor, elected at large by the people, who serves a four-year term and is eligible for immediate re-election once and may serve additional terms after a lapse of one administration. The governor appoints all the state's executive officers, all the judicial officers whose jurisdictions extend farther than one community, the county prosecutors (district attorneys) and certain other county officials. The governor also prepares the annual budget, and may call special sessions of the legislature at will or of the senate separately. He has the right to veto acts of the legislature and specific terms in appropriation bills but only within 10 days of their submission to him while the legislature is in session or within 45 days after it adjourns sine die. He is empowered to supersede a county prosecutor as well as specifically order local police to move against specific offenses or offenders, and he has full powers of investigation concerning state and local administration. He is commander in chief of the state's national guard and chairman ex officio of the state board of canvassers, which certifies all elections. Finally, he is empowered to make temporary appointments to the U.S. senate. In the event of his death, resignation or removal from office, he is succeeded by the president of the senate.

The constitution requires that all state administrative units be organized into not more than 20 departments whose heads are appointed by the governor and who serve at his pleasure. The only exceptions are the attorney general and the secretary of state, whose terms must coincide with that of the governor.

Legislature. — The state has a bicameral legislature composed of a general assembly and a senate. The general assembly comprises 60 members apportioned among the counties every ten years on the basis of population, although each county has at least one seat in the chamber. The senate is made up of 21 members, one from each county. The term of office for assemblymen is two years, that for senators four years with half the membership elected every two years.

The once extensive powers of the legislature were considerably reduced by the 1947 constitution. Gnder that constitution, the legislature enacts all state lams; adopts, approves or revises the state budget; enacts all appropriation bills; fixes all taxes; appoints the state auditor; may remove any executive or judicial officer by the impeachment process; and may override a governor's veto by a two-thirds majority of both houses. The senate, acting alone, confirms or rejects the executive and judicial appointments of the governor.

The legislature meets annually, usually from January until late spring, and then reassembles 45 days after its adjournment for a "veto session"; *i.e.*, to consider all bills the governor has vetoed.

Judiciary. — The New Jersey court system has been hailed by judiciary experts as the best and most flexible in the United States. At the head of the system is the supreme court, composed of a powerful chief justice and six associate justices. The supreme court is the final court of appeal in New Jersey and must finally decide all constitutional questions. Its members are appointed by the governor for an initial seven-year probationary term, after which they may be reappointed on a permanent basis, during their good behaviour, until the compulsory retirement age of 70.

Immediately below the supreme court is the superior court, composed of three divisions: law, appeals and chancery. The law division hears civil and criminal cases; the chancery division equity cases; the appeals division hears appeals from the law and chancery divisions and also from the lower courts. The qualifications, method of appointment and reappointment and terms for justice of the superior court are the same as those for the supreme court.

The lesser courts in the state are the county courts and the district courts, the judges of which are appointed by the governor; municipal courts appointed by local mayors; and the county surrogates are elected at large in each county. The county courts handle all types of cases and review the actions of the district and municipal courts. The district courts, covering only parts of counties, handle only those civil cases in which the amount of damages claimed is less than $3,000 or the crime is a misdemeanor. The municipal courts judge motor vehicle code violations and other lesser offenses.

Local Government. — County government in New Jersey is a hybrid of past and present customs of government in that it is composed of the old and large board of chosen freeholders (37 in Atlantic county, for example) in some areas and small boards (as few as 3) in others. The freeholders nominally operate and direct county government, but as many officials are either elected at large or appointed by the state the freeholders control little more than the county welfare institutions and some lesser clerical functions.

Since the 1947 constitution was adopted, municipal home rule has been the practice in New Jersey, whose more than 500 communities choose between 16 different combinations of the mayor-council, mayor-commission or council-manager types of municipal government. The most prevalent type is the mayor-commission form first advocated by Gov. Woodrow Wilson in 1911.

Finance and Taxation. — In the second half of the 20th century, the state's general treasury fund receipts amounted to more than $675,000,000 annually. Of this sum, about 10% was derived from the federal government and about 50% from state tax sources. Motor fuels, motor vehicle and operators licences, tobacco products, alcoholic beverages and property were the chief sources of tax revenues. The state's annual disbursements totaled slightly more than the general fund receipts and the state had a bonded debt of a little more than $100,000,000. In the latter part of the 1950s, approximately 29% of the state's revenues was being spent on highnays, about 26% on education, slightly more than 10% on health and hospitals and about 8% on public welfare. The state's income in the 1950s was more than four times as great as it had been prior to World War II, but expenditures had multiplied at an even greater pace. New Jersey's per capita income had long been among the highest in the nation, and in 1960 it mas about $2,200, well above the national average.

POPULATION

The population of h'ew Jersey in the first federal census, 1790, was 184,139. This made it ninth among the 18 states and territories that then composed the union, and the population was classified as 100% rural. In 1850 the population of the state was 489,555, making it 19th in size among a total of 37; the state was still classified as rural in character — 82.4% of its inhabitants were considered nonurban dwellers. The next decade was the period of the most rapid growth in the state's history — the population increased 37.3% between 1850 and 1860. At the beginning of the 20th century the state had advanced to 16th in rank of population with a total of 1,883,669 persons according to the 1900 census. The complexion of the state had been completely altered since 1850—in 1900 New Jersey was classified as 70.6% urban in character. The economically depressed decade between 1930 and 1940 was the slowest in population growth in New Jersey — in 1940 the population was only 2.9% greater than it had been in 1930. The 1950 population showed a total of 4,835,329 persons living within the state, making New Jersey eighth in size of population

*New Jersey: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	6,066,782	4,835,329	4,160,165	3,155,900	1,883,669
Asbury Park	17,366	17,094	14,617	12,400	4,148
Atlantic City	59,544	61,657	64,094	50,707	27,838
Audubon	10,440	9,531	8,906	4,740	—
Barrington	7,943	2,651	2,329	1,333	—
Bayonne	74,215	77,203	79,198	76,754	32,722
Belleville	35,005	32,019	28,167	15,660	5,907
Bellmawr	11,853	5,213	1,250	—	—
Belmar	5,190	4,636	3,435	1,987	902
Bergenfield	27,203	17,647	10,275	3,667	729
Bernardsville	5,515	3,956	3,405	—	—
Bloomfield	51,867	49,307	41,623	22,019	9,668
Bloomingdale	5,293	3,251	2,606	2,193	—
Bogota	7,965	7,662	7,346	3,906	337
Boonton	7,981	7,163	6,739	5,372	3,901
Bound Brook	10,263	8,374	7,616	5,906	2,622
Bridgeton	20,966	18,378	15,992	14,323	13,913
Burlington	12,687	12,051	10,905	9,049	7,392
Butler	5,414	4,050	3,351	2,886	—
Caldwell	6,942	6,270	4,932	3,993	1,367
Camden	117,159	124,555	117,536	116,309	75,935
Carlstadt	6,042	5,591	5,644	4,472	2,574
Carteret	20,502	13,030	11,976	—	—
Cedar Grove	14,603†	8,022†	5,208†	3,181†	—
Chatham	9,517	7,391	4,888	2,421	1,361
Clark	12,195†	4,352†	2,083†	794†	374†
Cliffside Park	17,642	17,116	16,892	5,709	968
Clifton	82,084	64,511	48,827	26,470	—
Closter	7,767	3,376	2,603	1,840	—
Collingswood	17,370	15,800	12,723	8,714	1,633
Cranford	26,424†	18,602†	12,860†	6,001†	2,854†
Cresskill	7,290	3,534	2,246	942	486
Delaware	31,522†	10,358†	5,811†	2,331†	1,679†
Dover	13,034	11,174	10,491	9,803	5,938
Dumont	18,882	13,013	7,556	2,537	643
Dunellen	6,840	6,291	5,360	3,394	1,239
East Orange	77,259	79,340	68,945	50,710	21,506
East Paterson	19,344	15,386	4,937	2,441	—
East Rutherford	7,769	7,438	7,268	5,463	2,640
Eatontown	10,334	3,044	1,758	—	—
Edison‡	44,799†	16,348†	11,470†	5,419†	2,801†
Elizabeth	107,698	112,817	109,912	95,783	52,130
Emerson	6,849	1,744	1,487	973	—
Englewood	26,057	23,145	18,966	11,627	6,253
Ewing	26,628†	16,840†	10,146†	3,475†	1,333†
Fair Haven	5,678	3,560	2,491	1,295	—
Fair Lawn	36,421	23,885	9,017	—	—
Fairview	9,399	8,661	8,770	4,882	1,003
Fanwood	7,963	3,228	2,310	724	399
Florham Park	7,222	2,385	1,609	787	752
Fort Lee	21,815	11,648	9,468	5,761	—
Freehold	9,140	7,550	6,952	4,768	2,934
Garfield	29,253	27,550	28,044	19,381	3,504
Garwood	5,426	4,622	3,622	2,084	—
Glassboro	10,253	5,867	4,925	3,073	2,677
Glen Ridge	8,322	7,620	7,331	4,620	1,960
Glen Rock	12,896	7,145	5,177	2,181	613
Gloucester City	15,511	14,357	13,692	12,162	6,840
Guttenberg	5,118	5,566	6,200	6,726	3,825
Hackensack	30,521	29,219	26,279	17,667	9,443
Hackettstown	5,276	3,894	3,289	2,936	2,474
Haddon	17,099†	12,379†	9,708†	2,708†	2,012†
Haddonfield	13,201	10,495	9,742	5,646	2,776
Haddon Heights	9,260	7,287	5,555	2,950	—
Haledon	6,161	6,204	5,303	3,435	—
Hamilton	65,035†	41,156†	30,219†	14,580†	4,164†
Hammonton	9,854	8,411	7,668	6,417	3,481
Harrison	11,743	13,490	14,171	15,721	10,596
Hasbrouck Heights	13,046	9,181	6,716	2,895	1,255
Hawthorne	17,735	14,816	12,610	5,135	2,096
Highland Park	11,049	9,721	9,002	4,866	—
Hillsdale	8,734	4,127	3,438	1,720	891
Hillside	22,304†	21,007†	18,556†	5,267†	—
Hoboken	48,441	50,676	50,115	68,166	59,364
Irvington	59,379	59,201	55,328	25,480	5,255
Jersey City	276,101	299,017	301,173	298,103	206,433
Keansburg	6,854	5,559	2,904	1,321	—
Kearny	37,472	39,952	39,467	26,724	10,896
Kenilworth	8,379	4,922	2,451	1,312	—
Keyport	6,440	5,888	5,147	4,415	3,413
Lakewood	13,004	9,970	8,502	6,110	3,094
Leonia	8,384	7,378	5,763	2,979	804
Levittown	11,861	—	—	—	—
Lincoln Park	6,048	3,376	2,186	—	—
Linden	39,931	30,644	24,115	1,756	402
Lindenwold	7,335	3,479	2,552	—	—
Little Falls	9,730†	6,405†	5,368†	3,310†	2,908†
Little Ferry	6,175	4,955	4,545	2,715	1,240
Little Silver	5,202	2,595	1,461	—	—
Livingston	23,124†	9,932†	5,972†	1,126†	1,412†
Lodi	23,502	15,392	11,552	8,175	1,917
Long Branch	26,228	23,090	17,408	13,571	8,872
Lyndhurst	21,867†	19,980†	17,454†	9,515†	1,590†
Madison	15,122	10,417	7,944	5,523	3,754
Manville	10,995	8,597	6,065	—	—
Maple Shade§	12,947†	6,560†	5,535†	7,273†	4,420†
Maplewood‖	23,977†	25,201†	23,139†	5,283†	1,630†
Margate City	9,474	4,715	3,266	249	—
Matawan	5,097	3,739	2,758	1,910	1,511
Maywood	11,460	8,667	4,052	1,618	536
Metuchen	14,041	9,879	6,557	3,334	1,786
Middlesex	10,520	5,943	3,763	1,852	—
Middletown	39,675†	16,203†	11,018†	5,917†	5,479†
Midland Park	7,543	5,164	4,525	2,243	1,348

Place	Population				
	1960	1950	1940	1920	1900
Millburn	18,799†	14,560†	11,652†	4,633†	2,837†
Milltown	5,435	3,786	3,515	2,573	561
Millville	19,096	16,041	14,806	14,691	10,583
Montclair	43,129	43,927	39,807	28,810	13,962
Morristown	17,712	17,124	15,270	12,548	11,267
Mountainside	6,325	2,046	1,148	493	367
Mount Ephraim	5,447	4,449	2,282	—	—
Mount Holly	13,271†	8,206†	—	—	—
Neptune	21,487†	13,613†	10,207†	6,470†	7,943†
Newark	405,220	438,776	429,760	414,524	246,070
New Brunswick	40,139	38,811	33,180	32,779	20,006
New Hanover	28,528†	18,168†	983†	586†	1,827†
New Milford	18,810	6,006	3,215	—	—
New Providence	10,243	3,380	2,374	1,203	565
New Shrewsbury	7,313	—	—	—	—
Newton	6,563	5,781	5,533	4,125	4,376
North Arlington	17,477	15,970	9,904	1,767	290
North Bergen	42,387†	41,560†	39,714†	23,344†	9,213†
Northfield	5,849	3,498	2,848	1,127	—
North Haledon	6,026	3,550	2,761	887	—
North Plainfield	16,993	12,766	10,586	6,916	5,009
Nutley	29,513	26,992	21,954	9,421	—
Oakland	9,446	1,817	932	497	—
Ocean City	7,618	6,040	4,672	2,512	1,307
Oradell	7,487	3,665	2,802	—	—
Orange	35,789	38,037	35,717	33,268	24,141
Palisades Park	11,943	9,635	8,141	2,633	644
Palmyra	7,036	5,802	5,178	3,834	2,300
Paramus	23,238	6,268	3,688	—	—
Park Ridge	6,389	3,189	2,519	1,481	870
Parsippany-Troy Hills	25,557†	15,290†	10,976†	—	—
Passaic	53,963	57,702	61,394	63,841	27,777
Paterson	143,663	139,336	131,656	135,875	105,171
Paulsboro	8,121	7,842	7,011	4,352	—
Pennsauken	33,771†	22,767†	17,745†	6,474†	3,145†
Penns Grove	6,176	6,669	6,488	6,060	1,826
Perth Amboy	38,007	41,330	41,242	41,707	17,699
Phillipsburg	18,502	18,919	18,314	16,923	10,052
Pitman	8,644	6,960	5,507	3,385	—
Plainfield	45,330	42,366	37,469	27,700	15,369
Pleasantville	15,172	11,938	11,050	5,887	2,182
Point Pleasant	10,182	4,009	2,059	1,575	746
Pompton Lakes	9,445	4,654	3,189	2,008	847
Princeton	11,890	12,230	7,719	5,917	3,899
Prospect Park	5,201	5,242	5,714	4,292	—
Rahway	27,699	21,290	17,498	11,042	7,935
Ramsey	9,527	4,670	3,566	2,090	—
Raritan (Monmouth)	15,334†	2,763†	1,662†	1,659†	1,524†
Raritan (Somerset)	6,137	5,131	4,839	4,457	3,244
Red Bank	12,482	12,743	10,974	9,251	5,428
Ridgefield	10,788	8,312	5,271	1,560	584
Ridgefield Park	12,701	11,993	11,277	8,575	—
Ridgewood	25,391	17,481	14,948	7,580	2,685
River Edge¶	13,264	9,204	3,287	1,077	561
Riverside	8,474†	7,199†	7,072†	6,018†	2,581†
Rochelle Parkδ	6,119†	4,483†	2,511†	2,203†	1,298†
Rockaway	5,413	3,812	3,514	2,655	1,483
Roselle	21,032	17,681	13,597	5,737	1,652
Roselle Park	12,546	11,537	9,661	5,438	—
Rumson	6,405	4,044	2,926	1,658	—
Runnemede	8,396	4,217	2,835	—	—
Rutherford	20,473	17,411	15,466	9,497	4,411
Saddle Brook	13,834†	7,955†	3,169†	2,845†	1,954†
Salem	8,941	9,050	8,618	7,435	5,811
Sayreville	22,553	10,338	8,186	7,181	4,155
Scotch Plains	18,491†	9,069†	4,993†	2,343†	1,200†
Secaucus	12,154	9,750	9,754	5,423	1,626
Somerville	12,458	11,571	8,720	6,718	4,843
South Amboy	8,422	8,422	7,802	7,897	6,349
South Orange	16,175	15,230	13,742	7,274	4,608
South Plainfield	17,879	8,008	5,379	—	—
South River	13,397	11,308	10,714	6,596	2,792
Spotswood	5,788	2,325	1,201	704	—
Springfield	14,467†	7,214†	4,148†	1,715†	1,073†
Summit	23,677	17,929	16,165	10,174	5,302
Teaneck	42,085†	33,772†	25,275†	4,192†	768†
Tenafly	14,264	9,651	7,413	3,585	1,746
Toms River	6,062	2,517	—	—	—
Totowa	10,897	6,045	5,130	1,864	562
Trenton	114,167	128,009	124,697	119,289	73,307
Union	51,499†	38,004†	24,730†	3,962†	4,315†
Union Beach	5,862	3,636	2,076	—	—
Union City	52,180	55,537	56,173	20,651	15,187
Ventnor City	8,688	8,158	7,905	2,193	—
Verona	13,782	10,921	8,957	3,039	2,139
Vineland	37,685	8,155	7,914	6,799	4,370
Waldwick	10,495	3,963	2,475	1,296	—
Wallington	9,261	8,910	8,981	5,715	1,812
Wanaque	7,126	4,222	3,143	2,916	—
Washington	5,723	4,802	4,643	3,341	3,580
Wayne	29,353†	11,822†	6,868†	2,302†	1,985†
Weehawken	13,504†	14,830†	14,363†	14,485†	5,325†
West Caldwell	8,314	4,666	3,458	1,085	—
Westfield	31,447	21,243	18,458	9,063	4,328
West Long Branch	5,337	2,739	2,030	966	—
West New York	35,547	37,683	39,439	29,926	5,267
West Orange	39,895	28,605	25,662	15,573	6,889
West Paterson	7,602	3,931	3,306	1,858	—
Westwood	9,046	6,766	5,388	2,597	828
Wharton	5,006	3,853	3,854	2,877	2,069
Woodbridge	78,846†	35,758†	27,191†	13,423†	7,631†
Woodbury	12,453	10,931	8,306	5,801	4,087
Wood-Ridge	7,964	6,283	5,739	1,923	582
Wyckoff♀	11,205†	5,590†	3,847†	1,671†	2,139†

*Populations are reported as constituted at date of each census. †Urban town (township). ‡Reported through 1950 as Raritan. §Name changed in 1945 from Chester. ‖Reported until 1940 as South Orange. ¶In Bergen county, name changed from Riverside in 1930. δReported until 1920 as Midland. ♀Reported until 1920 as Franklin.
Note: Dash indicates place did not exist during reported census, or data not available.

among the states. It was then nearly 87% urban in classification. In 1950 there were two complete standard metropolitan areas (Atlantic City and Trenton) and Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset and Union counties were a part of the New York-Northeastern New Jersey standard metropolitan area; they contained nearly three-fourths of the total population. By 1960 the standard metropolitan statistical areas housed 78.9% of the total population. In 1960 New Jersey had a total population of 6,066.782, an increase of 1,231,453 or 25.5% over 1950. It ranked eighth among the states.

The population per square mile in 1960, highest of the states, was 774.2, as compared with 49.6 for the U.S. as a whole. The 1960 urban population was 5,359,035 or 88.3% of the total. Distribution by colour and nativity, according to the 1960 census, was as follows: 81.3% native white; 10.0% foreign-born white; and 8.7% nonwhite. In line with the rest of the U.S. the percentage of persons 65 years old or over was increasing, being 9.1% in 1960. The percentage of the population 14 years old and over that was in the labour force was steadily decreasing, the result of prolonged schooling for that age group.

The population is not uniformly distributed across the state, but is concentrated in the urban belts opposite New York city and Philadelphia, with greater concentration opposite New York. Two-thirds of the population of the state live within 30 air miles of that city. Population density runs from an average of 40.000 persons per square mile in the industrial cities in the northeastern part of the state to sections of the state that have no people at all —in fact. almost one-fourth of the whole state's area is free of human habitation.

The over-all complexion of the state's population has changed slowly so that in 1960 New Jersey families tended to be older on the average and have fewer children than those of several decades previously. Also, the number of women increased more rapidly than that of men.

The basic characteristics of New Jersey's population tend to differ somewhat from the general national tendencies in regard to race, religion and degrees of concentration. In New Jersey there are more Protestants than Roman Catholics, although the ratios are closer than in the nation as a whole. Likewise, New Jersey is one of the 11 major areas in the United States in which the nation's Jewish population is concentrated. There is a reversal in the state of the traditional trend of Negroes and foreign born to concentrate in industrial cities and towns. Agricultural southern New Jersey proportionately has more Negroes than does industrial northern New Jersey, and the coastal portions of the state have proportionately almost as many foreign born as do the industrialized areas. In some sections of the southern part of the state Negroes constitute a virtual majority of the residents. Roman Catholicism tends to be the major religious affiliation of the people in the industrialized cities and towns, while Protestantism usually predominates in the suburban, residential and agricultural portions of the state.

In the northeastern part of New Jersey the populace is largely comprised of persons who were born elsewhere than in New Jersey, but the number of nonnative-born diminishes sharply toward the south and west. In the farm areas of the state the people are almost entirely native born.

EDUCATION

History and Administration. — Public education in New Jersey progressed steadily throughout the 19th and 20th centuries. Early in the state's history the legislature gave consideration to funds for public schools, and in 1846 the post of state superintendent of public schools was established. The state constitution was amended in 1867 to require that "the Legislature shall provide for the maintenance of free public schools for the instruction of all children in the State between the ages of 5 and 18" with the result that a compulsory education law was enacted in 1867. Later, industrial and vocational schools were established, and special facilities were made available for crippled, blind, deaf and subnormal children.

Administration of the New Jersey schools is delegated to a state board of education and a commissioner of education appointed by the governor. A county superintendent of schools, appointed by the state board of education upon the recomtnendation of the state commissioner of education, has supervision over the public schools in each of the 21 counties. However, each city has a superintendent who exercises authority over the schools in the local area. Each municipality is theoretically also a school district, though efforts to provide better facilities have caused some municipal boards to merge and form combined districts.

There are two basic types of school boards in the state, one primarily designed for cities and the other for small municipalities. In the cities the mayor appoints the members of the board. In the small municipalities voters elect the members. The boards direct the finances and general policies of the school districts, select teachers, administrative personnel and materials and prescribe the curriculum. The boards also may expel pupils. The budgets of city boards are approved by a board of school estimates composed of members of the school board and the municipal council, while in the small municipalities the budget is adopted by voter action in a special election. In the late 1950s, New Jersey was spending $382 annually per pupil, the second highest sum in the nation and far above the national average.

Universities and Colleges. — Higher education has its roots in the colonial period. Princeton university, one of the nation's finest liberal arts universities for men, was established as the College of New Jersey at Princeton in 1746 (see PRINCETON UNIVERSITY). Rutgers, the state university, was founded as Queens college at New Brunswick in 1766; in 1825 its name was changed to Rutgers college in honour of Col. Henry Rutgers. The New Jersey legislature in 1864 selected the Rutgers Scientific school to be the land-grant college of the state. In 1880 the legislature established the New Jersey agricultural experiment station which was located on the Rutgers college farm. In 1917 Rutgers became the state university; in 1945 the title was extended to all its divisions. The corporate name was changed to Rutgers–the State university, in 1956. Rutgers now comprises the college of arts and sciences, college of agriculture, the New Jersey agricultural experimental station, college of engineering, Douglass college (founded as New Jersey College for Women), school of education, college of pharmacy, University college, Newark College of Arts and Sciences, school of business administration, school of law, College of South Jersey, college of nursing, graduate school, graduate school of library service, graduate school of social work, university extension division, university library, Rutgers University press, division of Physical education of the colleges for men and the division of military education.

In 1855 the first New Jersey state normal school (now Trenton State college) was established by an act of the legislature at Trenton. Other teachers colleges are at Glassboro (1923), Jersey City (1946), Upper Montclair (1908), Gnion (1855) and Paterson (1855). In 1958 the six were designated as state colleges but continued to train teachers for the elementary and secondary schools.

Among the other institutions of higher learning are Seton Hall university at South Orange, Newark, Jersey City and Paterson (Roman Catholic; 1856); Fairleigh Dickinson university at Rutherford, Teaneck and Madison (nonsectarian; 1941); Drew university at Madison (Methodist; 1867); Stevens Institute of Technology at Hoboken (nonsectarian; 1870); Newark College of Engineering at Newark (state and municipal control; 1881); Caldwell College for Women at Caldwell (Roman Catholic; 1939); College of St. Elizabeth at Convent Station (Roman Catholic; 1899); Georgian Court college at Lakewood (Roman Catholic; 1908); Monmouth college at West Long Branch (nonsectarian; 1933); Rider college at Trenton (nonsectarian; 1865); St. Peter's college at Jersey City (Roman Catholic; 1872); Bloomfield college and seminary at Bloomfield (Presbyterian; 1868); and Upsala college at East Orange (Lutheran; 1893).

HEALTH, WELFARE AND CORRECTIONS

The state department of health is an outgrowth of a sanitary commission set up in 1865 and converted into a board of health in 1877. In 1954 the board became an eight-member public health council, two of whose members must be physicians and another a dentist. The council members, who are appointed by the governor, serve without pay. The council is charged with establishing and enforcing the state sanitary code as well as fixing the qualifications for health and food inspectors. Local health boards may establish higher, but not lower, standards than the state code by local ordinance and with the state's permission.

The state officially approves fluoridation of municipal water supplies, though less than 10% of the communities in the state had done so by 1960. About one-fifth of the state's communities have full- or part-time health officers, but only 13 counties have such an official. A special health problem in New Jersey is that of mosquito control. Fifteen counties maintain extermination commissions.

Public welfare activities in New Jersey are handled by the state department of institutions and agencies or the county boards of chosen freeholders. The state licenses and inspects all hospitals, nursing homes and sanatoria in addition to operating institutions for the insane, mentally deficient, feeble-minded and tubercular. Further, the state maintains diagnostic centres for juvenile and sex offenders and homes for aged public servants and veterans.

The state commission for the blind administers the education of the visually handicapped and assists them financially when necessary. The state board of child welfare cares for neglected and dependent children; the bureau of assistance aids the aged, disabled and indigent.

County governments and often the larger municipal governments aid in the welfare work of the state. Most counties and municipalities support or maintain general hospitals. Several counties of northern New Jersey have special hospitals or asylums for the treatment of chronic illnesses or mental disorders and clinics and welfare stations for the treatment of alcoholism and for child-care and other welfare problems. The counties and the municipalities augment the state's welfare payments to the aged, disabled and destitute. This annually amounts to more than $100,000,000 of which the federal government supplies about $25,000,000 and the counties about $45,000,000.

The state has reformatories near Clinton and at Annandale and Bordentown; reform schools near Jamesburg and at Trenton; a state prison at Trenton and prison farms at Rahway and Leesburg.

THE ECONOMY

Living Conditions. — Living conditions generally are good in New Jersey, though in some northern areas where the population concentration is greatest housing tends to be inadequate and in some places substandard conditions prevail. In the second half of the 20th century urban renewal projects and new local housing and sanitation standards ordinances were rapidly eliminating the substandard areas. Newark, the largest city in the state, located in wholly urban Essex county, proportionately has had more federal housing aid than any other city in the United States (see NEWARK). Vast housing developments sprang up in the northeastern counties of the state as the move to suburbs extended outward from New York city into northern New Jersey. Extensive housing developments exist also all along the Delaware river and bay shore lines southward from Trenton to Gloucester City below Camden.

Industry. — Aside from the thousands of persons who work in the urban areas of New York city and Philadelphia, the state's people are engaged in those activities common to a major industrial state. During the second half of the 20th century more than 50% of the state's workers nere employed by nearly 12 000 different manufacturing concerns. Of the remaining labour force, about 20% were engaged in trade, 8% in services, 6% in construction activities, 5% in transportation operations, 4% in finance and insurance services, 3% in the communications industries and utilities, with the balance divided among all the other classifications except farming.

Industries have concentrated in New Jersey because of its proximity to major markets, easy access to transport facilities and a generally favourable tax climate. The state is well located for servicing a market consisting of more than 12 states, and it is within overnight hauling distance of 30% of the national population. The average weekly wage of a New Jersey resident employed in manufacturing is among the highest in the C.S.

The greater part of the important chemical industry is located in Middlesex, Union and Essex counties; auto and aircraft production are mainly in Bergen county; the electrical supplies industry is in Essex and Hudson counties, and shipbuilding is exclusive to Hudson and Camden counties. Transportation, fabricating. machine, ferrous metal and clothing industries are also of great importance. In the latter half of the 20th century: the factories of the state produced nearly $5,000,000,000 worth of finished goods annually. After World War II, many industrial research centres were established in New Jersey.

Agriculture. — The farms of the state include more than 2,000,000 ac. of land of varying fertility which is concentrated on producing cash crops, chiefly products that may be readily canned or frozen, for the nearby metropolitan centres. In a typical year, the total value of the state's crops exceeds $250,000.000, with a crop volume measured in hundreds of thousands of tons. Principal crops are sweet corn. peppers. tomatoes, asparagus. beets, beans, melons and potatoes. In addition, the state produces large quantities of berries of all kinds, grapes, apples (nearly 4,000,000 bu. a year) and peaches (nearly 2,500,000 bu. a year). Livestock and livestock products are also important to the agricultural economy. Eggs. a major agricultural product, exceed 2,500,000,000 annually. Milk production is more than 1,000,000,000 lb. yearly. Meat production is less spectacular, though chickens and broilers are of major importance. The total value of farm products is frequently more than $700,000,000.

Fisheries. — The commercial aspects of fishing are largely confined to clam digging and hard- and soft-shell mussel trawling off the marshes of the three southernmost counties fronting on Delaware bay. Otherwise, most of the rest of the fishing done is of a sporting nature and is classified as part of the vacation industry.

Mining.—New Jersey is rich in a few mineral resources. Its zinc deposits are among the finest in the world, assaying at more than 20% pure ore: the Ogdensberg zinc mines in Sussex county are especially famous for their richness. Other minerals found in the state are iron ore, building materials, lime. greensand marl, peat and semiprecious stones. Iron has been mined in New Jersey for nearly 300 years, and great quantities of magnetite ore are found throughout the northern two-thirds of the state; the industry declined after the Civil War, and only a few mines were in operation in the second half of the 20th century. Building materials minerals are the most developed and are commercially the most significant minerals. Annual quantities of clay produced for brick, tile and terra cotta mare total many millions of tons, as does stone. sand, gravel and lime production. The average annual value of all mineral products produced in New Jersey is a little less than $100,000,000, which. compared with other phases of the state's economy, makes mining a small operation.

Resorts. — Another important New Jersey industry is vacation recreation. Aside from the smaller (but often year-round) vacation industries found along the state's more than 700 lakes. the vacation industry principally is spread in an ever-widening belt along the Atlantic coast line from the Atlantic Highlands off lower Hudson river bay southward to Cape May, with principal concentrations in Ocean and Atlantic counties. There. several cities and many towns offer fine; wide. safe. sandy beaches and cool, moderate surf in which to swim, boat or fish. This "New Jersey Riviera" has its finest facilities at Atlantic City (*q.v.*), a year-round resort centre with eight miles of boardwalks. large amusement piers and a large convention hall. Off these resorts are some of the finest sport fishing grounds in the world, especially for bluefish. weakfish, bonita. tuna, marlin and striped bass.

Transportation and Communication. — Its many transportation facilities and its geographical location helped make New Jersey a crossroads of the eastern section of the nation. The network of railroads number 23, including eight trunk lines; the trackage per square mile exceeds that of any other state. Eight freight terminals handle cargo bound for all parts of the world.

The state is favourably located for shipping near the port of

New York and with its own port facilities along the Delaware river. Port Newark handles export and import tonnage of major economic significance. There are ports also at Camden and Trenton.

There are approximately 30.000 mi. of modern highways and roads in the state. which pioneered in huilding the clover-leaf circle. the dual highway and the elevated highway. The two principal highways in the state system are the New Jersey turnpike and the Garden State parkway. The turnpike. operated by the New Jersey Turnpike authority, is a 131-mi. toll road extending from the George Washington bridge in the north to the Delaware Memorial bridge to the south and with a spur to the Holland tunnel and a link to the Pennsylvania turnpike. The parkway, also a toll road, is 173 mi. in length and is operated under the direction of the New Jersey Highn-ay authority. It extends from the New York state line in the north to Cape May in the south.

There are approximately 100 commercial airports and private landing fields in the state. Newark anti Teterboro. operating as passenger and air freight terminals, are the largest.

Both television and radio experiments have been conducted in the laboratories of the state. Stations WJZ (later WCBS) and R'OR. initially in Newark. were pioneers in the field of radio. Research in television has been done by the Radio Corporation of America research laboratory in Princeton and the Allen B. Dumont laboratory in Clifton. There are more than 250 newspapers in the state, of which about 25 are daily.

See also references under "New Jersey" in the Index volume.

BIBLIOGRAPHY.—*Geography:* For fuller descriptions consult the United States Geological Survey, *Bulletins 177* and *301* as well as the *Final Report* of the New Jersey Geological Survey and the *Annual Reports* oi the New Jersey State Museum. For a listing of the state parks consult E'itzgerald's *Legislative Manual* (annual) and the individual publications of the parks themselves or the general pamphlet materials obtainable from the state Department of Conscrvation. *History:* For further historical details *see* the *Outline History of New Jersey* (1950) by the New Jersey History Committee; E. J. Fisher, *New Jersey as a Royal Province, 1738–1776* (1911); E. P. Panner, *The Province of New Jersey, 1664–1738* (1908); W. E. Snckett, *Modern Battlas of Trenton* (1895); and the *New Jersey Archives by* the New Jersey Historical Association for specific areas or periods. *Government:* For a thorough study of New Jersey government consult Bennett M. Rich, *The Government and Administration of New Jersey* (1957), which contains a thorough bibliography for the detailed aspects of specific phases oi state government, as well as Fitzgerald's *Legislative Manual* (annual) for administrative details. Other useiul sources are the *Reports* oi state commissions and agencies. *Education:* The *Report* of the Commission to Survey Public Education (1928) is useful as are the *Annual Reports* of the state Department of Education and the somewhat more recent state Hoard of Education study on *Opportunities for Higher Education in New Jersey* (1958). *Health and Welfare:* The best sources are the special reports of the Department of Institutions and Agencies dealing with *Public Health Resources in New Jersey* (1947); the *Report on Mental Deficiency in New Jersey* (1954) by a select commission to study the problem, while Paul T. Staiford generally covers public assistance in his work *Government and the Needy* (1941). *Economy:* The *Reports* of the Department of Conservation and Development generally give the most accurate and current picture oi the state's economy as do the *Reports* and *Studies* of the state Tax Commission. General works such as those hy the Department of Economics and Social Institutions of Princeton University may be very helpful as also might the *Reports* of the state Department of Agriculture, the Commission on Water Supply, the Utilities Commission, the Turnpike Authority, and the publication *New Jersey Business* by the state Department of Conservation and Economic Development in conjunction with the Rutgers School of Business Administration.

Other useful books on New Jersey are the Federal Writers' Project book *New Jersey* (1939), the state's Department of Public Instruction study, *New Jersey, Its History, Resources and Life* (1940), and John T. Cunningham, *This is New Jersey* (1953), among many others. There are numerous specialized works on special areas of the state listed in many of the above.

Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica* ***Book of the Year,*** American edition.

(D. N. A.; M. P. M.)

NEW JERSEY TEA (Ceanothus americanus), a North American shrub of the buckthorn family (Rhamnaceae), called also redroot, native to dry open woods and gravelly banks from Maine to Manitoba and southward to Florida and Texas. Its low, branching stems, one to three feet high, which spring from a dark red root, bear ovate, three-ribbed, somewhat downy, toothed leaves and attractive white flowers in umbellike clusters. During the American Revolutionary War the leaves were used as tea. See CEANOTHUS.

NEW JERUSALEM CHURCH or NEW CHURCH, the community founded by the followers of Emmanuel Swedenborg (*q.v.*). Swedenborg himself took no steps to found a church, but having given a new interpretation of Scripture, it was inevitable that those who accepted his doctrine should separate themselves and organize a society in accordance therewith. Those who received them fully during Swedenborg's lifetime were few and scattered, but courageously undertook the task of dissemination, and gave themselves to translating and distributing their master's writings. Two Anglican clergymen were conspicuous in this work: Thomas Hartley (d. 1784), rector of Winwick, and John Clowes (1743–1831). vicar of St. John's, Manchester, through whose influence Lancashire became the stronghold of the Swedenborgians In 1782 a society for publishing Swedenborg's writings was formed in Manchester, and in Dec. 1783 a little company of sympathizers with similar aims met in London and founded the Theosophical society. In 1785 and 1787 J. W. Salmon and R. Mather conducted an open-air missionary tour in the midlands and the north with some success. Five prominent Wesleyan preachers adopted the new teaching and were cut off from their connection, a step which led, in spite of remonstrance from Clowes and others. to the formal organization of the New Jerusalem Church on May 7, 1787.

The first organized congregation of Swedenborgians met in a church in Great Eastcheap in Jan 1788; and in April 1789 a general conference of British Swedenborgians nas held in Great Eastcheap church. followed by another and by the publication of a journal. the New *Jerusalem Magazine,* in 1790.

In 1815 the conference took up the question of home missionary work, and its agents mere able to found many branches of the church. In 1513 the Manchester and Salford (now the North of England) Missionary society was founded, chiefly to provide preachers for the smaller churches in its area; in 1857 a National Missionary institution was founded and endowed, to which most of the local ones became affiliated. The constitution of the New Church is of the Independent Congregational type; the conference may advise and counsel, but cannot compel the obedience of the societies.

The New Church in *Europe.*—In Sweden the Philanthropic Exegetic society was formed by C. F. Nordenskiold in 1786 to collect documents about Swedenborg and to publish his writings. The introduction of alchemy and mesmerism led to its dissolution in 1789, but its work was continued by the society "Pro fide et charitate," which existed from 1796 to 1820. For many years the works of Swedenborg and his followers were proscribed, and receivers of his writings fined or deprived of office, but in 1866, when religious liberty had made progress, the cause was again taken up; in 1875 the society of "Confessors of the New Church" was formed in Stockholm.

In Germany the great name is that of Immanuel Tafel (d. 1863), librarian of Tübingen, who in 1848 founded a "Union of the New Church in Germany and Switzerland" which held quarterly meetings. In Switzerland there is an organized body of the New Church. In France about 1838 J. F. E. Le Boys de Guays began his masterly translation of all Swedenborg's theological works; and nearly every European country has some known adherents.

In America.—About 1784 James Glen, a London Scot, delivered lectures in Philadelphia and Boston and circulated some of Swedenborg's works. Francis Bailey, state printer of Pennsylvania, was attracted by them and became active in their promulgation. During the next ten years a number of prominent men gave their support to the teaching, which spread inland and southward.

The first society for worship was formed in Baltimore, Md., in 1792 (reorganized 1798), though a short-lived one had preceded it at Halifax, N.S., in 1791. Other churches grew up in Philadelphia, Cincinnati, Boston and New York, and the general convention, which later met annually, was formed at Philadelphia in 1817.

In Australia, *etc.*—The formation of societies in Australia began at Adelaide in 1844. Melbourne and Sydney followed in 1854, Brisbane in 1865. New Zealand has a church at Auckland (1883). Mission churches have been established in Japan, the Philippine Islands and British Guiana; and in 1910 David W. Mooki organized a church for the natives of South Africa.

See L. P. Mercer, *The New Jerusalem in the World's Religious Congresses of 1893; Minutes of the General Conference of the New Church* (annual); *Journal of the Annual Session of the General Convention of the New Jerusalem in the United States of America.*

NEW KENSINGTON, a city of Westmoreland county in western Pennsylvania, U.S., about 18 mi. N.E. of Pittsburgh, is located on the Allegheny river.

Situated in the centre of a coal-mining district, the city has been a leading producer of aluminum since 1892 and is one of the earliest homes of that industry. Manufactures include, besides aluminum products, tubing, conduits, steel castings, shim steel, water heaters, glass and textiles.

New Kensington was laid out in 1891 on the site of Ft. Crawford of the American Revolutionary period by a group of Pittsburgh capitalists interested in the reduction of aluminum. Incorporated as a borough in 1892, it absorbed neighbouring Parnassus in 1931 and became a city in 1933. For comparative population figures see table in PENNSYLVANIA: *Population.* (M. R. Wo.)

NEWLANDS, JOHN ALEXANDER REINA (1838–1899), English chemist whose law of octaves anticipated later discoveries concerning the periodic law (*q.v.*), was born in Southwork in 1838. He studied under August W. von Hofmann in the Royal College of Chemistry. London. Of Italian extraction on his mother's side, he fought as a volunteer in the cause of Italian freedom under Giuseppe Garibaldi in 1860. Later he was employed as an industrial chemist.

Newlands was one of the first to propound the conception of periodicity among the chemical elements, his earliest contribution to the question taking the form of a letter published in the Chemical News in Feb. 1863. In the succeeding year he showed, in the same journal, that if the elements be arranged in the order of their atomic weights, those having consecutive numbers frequently either belong to the same group or occupy similar positions in different groups, and he pointed out that each eighth element starting from a given one is in this arrangement a kind of repetition of the first, like the eighth note of an octave in music. The law of octaves thus enunciated was at first ignored or treated with ridicule as a fantastic notion unworthy of serious consideration, but the idea, subsequently elaborated by D. I. Mendeleyev (*q.v.*) and other investigators of the periodic law, took its place as an important generalization in modern chemical theory. Newlands collected his various papers on the atomicity of the elements in a little volume on the Discovery of the *Periodic* Law (1884). He was awarded the Davy medal of the Royal society in 1887. He died in London on July 29, 1898.

NEW LONDON, a city and port of entry in southeastern Connecticut, U.S., about 50 mi. E. of New Haven, is situated on Long Island sound at the mouth of the Thames river. Originally called Nameaug by the Indians and Pequot by white settlers when founded by John Winthrop the Younger in 1646, its name was changed to New London in 1658. In 1709 the first printing press in Connecticut was established there. During the American Revolution New London's privateers irritated British commanders so much they dispatched a landing force under Benedict Arnold which set fire to the city and nearly wiped it out on Sept. 6, 1781. Soon rebuilt, it was incorporated as a city in 1784. New London has one of the deepest harbours on the Atlantic coast and its early history was decisively influenced by the sea. During the 19th century it was a leading whaling and sealing port and, before being blockaded during the War of 1812, had a large trade with the West Indies and the Mediterranean. In the 20th century the New London area became the site of a U.S. navy submarine base with its school for submariners and underwater sound laboratory. Major industries include shipbuilding and the manufacture of clothing, pharmaceuticals, printing presses, engines, paper products, furniture and metal fabrications. Among the educational facilities of New London are Connecticut college (1911) for women, the U.S. Coast Guard academy (1876) and Mitchell (junior) college (1938). Notable buildings include old Fort Trumbull at the harbour entrance, the old town mill (1650), Hempstead house (1678), Huguenot house (1759), the county courthouse (1784) and the New London lighthouse (1760). The annual Yale-Harvard boat races are held on the Thames in June. For comparative population figures see table in CONNECTICUT: *Population.*

(W. D. Lo.)

NEW MADRID, a small town on the right bank of the Mississippi river is the seat of New Madrid county. Mo. It originated as an Indian trading post about 1783. In 1788 Col. George Morgan of New Jersey received a large land grant from the Spanish minister to the U.S. as part of a plan to attach western settlers to the Spanish province of Louisiana; hence the name. He laid out an elaborate townsite extending for four miles along the river; it has several times been relocated because of floods and changes in the course of the river. The town grew rapidly in farming and trade after the purchase of the Louisiana territory by the U.S. in 1803. but was set back by a series of severe earthquakes in 1811–12.

The city played a minor role in the American Civil War in 1862. When the loss of Forts Henry, and Donelson made their base at Columbus, Ky., untenable, the Confederates withdrew downriver 60 mi. to Island So. 10, a heavily fortified position of great natural strength at a sharp bend in the river. New Madrid, seven miles farther down the river on a reverse bend, was also occupied. The Federals immediately pushed downriver, employing the amphibious tactics that were proving so effective on western waters. Maj. Gen. John Pope worked his way southward through the Missouri swamps with an army of 20.003 while Commodore A. H. Foote headed downstream with his flotilla of ironclads, wooden gunboats, transports and barges. Pope outflanked New Madrid by occupying Point Pleasant eight miles below, and when the Confederates withdrew across the river to safety. he occupied the post. But he could not move farther so long as the Confederates controlled the river below Island No. 10. When naval bombardment failed to reduce the defenses at the Island stronghold, two ironclads, the "Carondelet" and the "Pittsburgh," ran the batteries on April 4 and 7. Meanwhile, the army cut a shallow canal across the peninsula in front of the island and enabled light draft transports and supply barges to avoid the heavy guns and bring supplies and support to Pope. The Confederates, trapped between Federal forces and unable to escape into Tennessee because of the high water in the swamps, had no choice but to surrender.

See Phillips Melville, "The *Carondelet* Runs the Gantlet," *American Heritage,* vol. x, no. 6 (Oct. 1959); Writers' Program, *Missouri* (1941).

(C. W. TE.)

NEWMAN, JOHN HENRY (1801–1890), English cardinal and leader of the Tractarian movement, was born in London on Feb. 21, 1801, the eldest son of John Newman, banker, of the firm of Ramsbottom, Newman and company. At the age of seven Newman was sent to a private school conducted by Dr. Nicholas at Ealing. At the age of 15 he was conscious of an "inward conversion," an incident which throughout life remains "more certain than that he had hands or feet." In 1816 he matriculated at Trinity college, Oxford. After graduation in 1821 he took pupils and read for a fellowship at Oriel, to which he was elected in 1822. Two years later he was ordained in the Anglican ministry and became curate of St. Clement's, Oxford. For a year he was vice-principal of the St. Alban's hall, but in 1826 he became tutor at Oriel. In 1827 he mas appointed vicar of St. Mary's (to which was attached the chapelry of Littlemore) and in 1831–32 was select preacher before the university.

In 1832 a difference with Edward Hawkins, provost of Oriel, on the "substantially religious nature" of a tutorship, led to his resignation from that post. He then went for a tour on the Mediterranean with R. H. Froude. but at that time was still strongly Protestant in his views, as his comments on his stay in Rome show. During this tour he wrote many of the poems in the *Lyra Apostolica,* and "Lead, Kindly Light."

Tractarian Movement.— He was at home again in Oxford on July 9, 1833, and on the 14th John Keble preached at St. Mary's an assize sermon on "National Apostasy," which Newman afterward regarded as the inauguration of the Oxford movement. In the words of Dean Church, it was "Keble who inspired, Froude who gave the impetus and Newman who took up the work"; but the first organization of it mas due to H. J. Rose, editor of the *British Magazine,* who has been styled "the Cambridge originator of the Oxford movement." It was in his rectory at Hadleigh, Suffolk, that a meeting of High Church clergymen was held. July 25–29 (Newman was not present), at which it was resolved to fight for "the apostolical succession and the integrity of the Prayer-Book." A few weeks later, Newman started, apparently on his onn initiative, the *Tracts for the Times,* from which the movement nas subsequently named "Tractarian." Its aim was to secure for the Church of England a definite basis of doctrine and discipline, in case either of disestablishment or of a determination of High Churchmen to quit the establishment. The teaching of the tracts was supplemented by Newman's Sunday afternoon sermons at St. Mary's, the influence of which nas very great during the next eight years. In 1835 Pusey joined the movement, which, so far as concerned ritual observances, was later called "Puseyite"; and in 1836 its supporters secured further coherence by their united opposition to the appointment of Hampden as regius professor of divinity. His Bampton lectures (in the preparation of which Blanco White had assisted him) were suspected of heresy, and this suspicion was accentuated by a pamphlet put forth by Newman, *Elucidations of Dr. Hampden's Theological Statements.*

At this date Neaman became editor of the *British Critic,* and he also gave courses of lectures in a side chapel of St Mary's in defense of the *via media* of the Anglican Church as between "Romanism" and popular Protestantism. His influence in Oxford was supreme about the year 1839, when, however, his study of the monophysite heresy first raised in his mind a doubt as to whether the Anglican position was really tenable on those principles of ecclesiastical authority which he had accepted; and this doubt returned when he read. in Wiseman's article in the *Dublin Review* on "The Anglican Claim," the words of St Augustine against the Donatists, *securus iudicat orbis terrarum,* words which suggested a simpler authoritative rule than that of the teaching of antiquity. He continued his work, however, as a High Anglican controversialist until he had published, in 1841, *Tract 90,* the last of the series, in which he put forth, as a kind of proof charge, to test the tenability of all Catholic doctrine within the Church of England, a detailed examination of the XXXIX Articles, suggesting that their negations were not directed against the authorized creed of Roman Catholics but only against popular errors and exaggeration. This theory, though not altogether new, aroused much indignation in Oxford, and, at the request of the bishop of Oxiord, the publication of the *Tracts* came to an end. At this date Newman also resigned the editorship of the *British Critic,* and was thenceforth, as he himself later described it, "on his deathbed as regards membership with the Anglican Church." He now concluded that the position of Anglicans was similar to that of the semi-Arians in the Arian controversy; and the arrangement made at this time that an Anglican bishopric should be established in Jerusalem, the appointment to lie alternately with the British and Prussian governments, was to him further evidence of the nonapostolical character of the Church of England. In 1842 he withdrew to Littlemore, and lived there under monastic conditions with a small band of followers, their life being one of great physical austerity as well as of intense reflection and prayer. To his disciples there he assigned the task of writing lives of the English saints. while his own time was largely devoted to the completion of an essay on the development of Christian doctrine, by which principle he sought to establish the identity of the teachings of the Christian Church throughout the centuries with those of the Roman Catholic Church. In Feb. 1843 he published, as an advertisement in the *Oxford Conservative Journal,* an anonymous but otherwise formal retractation of all the hard things he had said against Rome; and in September he preached his last Anglican sermon at Littlemore and resigned the living of St. Mary's.

Reception into the Catholic Church.—But still an interval of two years elapsed before he was formally received into the Roman Catholic Church (Oct. 9, 1845) by Father Dominic, an Italian Passionist. In Feb. 1846 he left Oxiord for Oscott, where Bishop Wiseman, then vicar-apostolic of the Midland district, resided; and in October he proceeded to Rome, where he was ordained priest. Four years later, he was given the degree of D D. by the pope, *honoris causa.* At the close of 1847 he returned to England as an Oratorian, and resided first at Maryvale (near Oscott); then at St. Wilfrid's college, Cheadle; then at St. Ann's, Alcester street, Birmingham; and finally at Edgbaston, where spacious premises mere built for the community and where (except for four years in Ireland) he lived a secluded life for nearly 40 years. Before the house at Edgbaston was occupied he had established the London Oratory. nith Father Faber as its superior. In 1850, at the Corn exchange in Birmingham, he delivered a course of lectures on "The Present Position of Catholics in England," in the fifth of nhich he protested against the anti-Catholic utterances of Dr. Achilli, an ex-Dominican friar, nhom he accused in detail of numerous acts of immorality. Popular Protestant feeling ran very high at the time, partly in consequence of the recent establishment of a Roman Catholic diocesan hierarchy by Pius IX, and criminal proceedings against Newman for libel resulted in an acknowledged gross miscarriage of justice He was found guilty, and mas sentenced to pay a fine of £100, while his expenses as defendant amounted to about £14,000, a sum that was at once raised by public subscription, a surplus being spent on the purchase of Rednall, on the Lickey hills, where he is buried.

In 1854, at the request of the Irish bishops, Newman nent to Dublin as rector of the newly established Catholic university there. But conditions were not favourable and complications became so great that after four years he retired, the happy outcome of his stay there being a volume of lectures entitled *Idea of a University.* containing some of his most effective writing. In 1858 he projected a branch house of the Oratory at Oxford; but this mas opposed by Manning and others, as likely to induce Catholics to send their sons to that university. and the scheme was abandoned. In 1859 he established, in connection with the Birmingham Oratory, a school for the education of the sons of gentlemen on lines similar to those of the English public schools. But all this time (since 1841) Newman had been under a cloud. so far as concerned the great mass of cultivated Englishmen, and he was now anaiting an opportunity to vindicate his career. In 1862 he began to prepare memoranda for the purpose.

Works.—The occasion came when, in Jan. 1864, Charles Kingsley, reviewing Froude's *History of England* in *Macmillan's Magazine,* incidentally asserted that "Father Newman informs us that truth for its own sake need not be, and on the whole ought not to be, a virtue of the Roman clergy." After some preliminary sparring between the two, Newman published, in weekly parts, his *Apologia pro vita sua,* a religious autobiography of unsurpassed interest, the simple confidential tone of which "revolutionized the popular estimate of its author."

In 1870 he put forth his *Grammar of Assent,* the most closely reasoned of his works, in which the case for religious belief is maintained by arguments differing somewhat from those commonly used by Catholic theologians; and in 1877, in the republication of his Anglican works, he added to the two volumes containing his defense of the *via media* a long preface and numerous notes in which he criticized and replied to sundry anti-Catholic arguments of his own in the original issues. At the time of the Vatican council (1869–70) he thought the time inopportune for a definition of papal infallibility, and privately denounced the "insolent and aggressive faction" that had pushed the matter forward. But he made no sign of disapproval when the doctrine was defined, and subsequently affirmed that he had always believed the doctrine, and had only feared the deterrent effect of its definition on conversions on account of acknowledged historical difficulties.

In 1878 his old college (Trinity), to his great delight, elected him an honorary fellow, and he revisited Oxford after an interval of 32 years. At the same date Pius IX died. His scholarly successor and illustrious patron of education, Leo XIII, was encouraged by the duke of Norfolk and other distinguished Roman Catholic laymen to make Newman a cardinal, the distinction being a marked one, because he was a simple priest and not resident in Rome. The "creation" took place on May 12, 1879, with the title of St. George in Velabro, Newman taking occasion while in Rome to insist on the lifelong consistency of his opposition to "liberalism in religion." After an illness that excited apprehension he returned to England, and thenceforward resided at the Oratory until his death, Aug. 11, 1890. making occasional visits to London.

Newman's influence as controversialist and preacher was very great. Some hundreds of clergymen, influenced by the Tractarian movement of which for 10 or 12 years he was the acknowledged leader, made their submission to the Church of Rome. And the influence continued to be felt. Practically all English converts since 1845 partly attribute their conversion to Newman. Newman's works were translated into several European languages. The accompanying schools of thought, the "Credo in Newmanum," were especially characteristic of France and Germany before Sept. 1939. The attempts of the "Modernists" to make a protagonist of Newman failed, as is evident from Pius X's letter to Bishop O'Dwyer and from the tribute paid to Newman by Pius XI. Many anthologies from his writings appeared, especially in the United States, where, too, a large number of societies, etc., were named in his honour. Several of his works were edited for collegiate study, and similarly his sermons as homiletical models. Passages from his devotional writings were adapted to the form of petition and published as Newman prayerbooks. A movement was started to promote his being declared "Venerable," the first process toward canonization. Newman had a vivid sense of man's personal relationship with God. As he expressed it ". . . alone with the Alone," two beings in all creation, God and himself. All else was a reflection of the Supreme Being. He mas a man of magnetic personality, with an intense belief in the apostleship of his own career; and his character map be described as strong, with an almost feminine sensitiveness to impressions. As a poet he had inspiration and genuine power. His prose style is fresh and vigorous.

There is at Oxford a bust of Newman by Woolner. His portrait by Ouless is at the Birmingham Oratory, and a replica of his portrait by Millais is at the London Oratory, outside which, facing Brompton road, is a marble statue of Newman as cardinal.

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NEWMARMET, a market town and urban district in the Bury St. Edmunds parliamentary division of West Suffolk, Eng., 13 mi. E.N.E. of Cambridge by road. Pop. (1951) 10,185. Area 8.8 sq.mi. Though the town is in West Suffolk and Suffolk is its postal address, the rural district is in Cambridgeshire. Newmarket, on the Icknield way and on the road from London to the once-famous shrine of Walsingham, has been celebrated for its horse races from the time of James I, and Charles I instituted the first cup race there in 1634. It is the headquarters of the Jockey club, founded in 1750, which administers the rules of racing and which, by 1820, had bought nearly all the Heath, where the training and racing takes place. Besides the breeding and training of race horses there are some small industries.

There are two racecourses on Newmarket Heath, southwest of the town: the Rowley Mile course, used during spring and autumn, and the July course. The Rowley Mile course intersects the Devil's ditch or dyke, an earthwork extending about 7½ mi. from Wood Ditton to Reach, which is thought to have been built by the East Anglians against the Mercians about the 6th century A.D. and later formed part of the boundary of East Anglia. The district contains chalk downland with its peculiar flora and fauna, and Wicken Fen, a nature reserve belonging to the National Trust.

NEW MEXICO, the "Land of Enchantment" or "Sunshine state." one of the states of the United States, is located in the southwestern part of the country. Roughly rectangular in shape, it is bounded north by Colorado, east by Oklahoma and Texas, south by Texas and the republic of Mexico and west by Arizona. Its length north and south is 391 mi., its width east and west 334 mi.; the total area is 121.666 sq.mi. (of which only 156 sq.mi. are water surface): making it fifth in area among the states. New Mexico was admitted to the union in 1912 as the 47th state. The state flag is a field of yellow containing in its centre the ancient Zia sun symbol in red. The state flower is the yucca flower, the bird the road runner (*Geococcyx californianus*), the state song "O, Fair New Mexico." The capital is at Santa Fe (*q.v.*).

PHYSICAL GEOGRAPHY

Physical Features.—The borders of New Mexico (lat. 31° 20' to 37° N.; long. 103° to 109° W.) are high plateaus cut by deep canyons; in the central part faulted mountains surround comparatively level areas formed of alluvial deposits. Between the Rio Grande and the Pecos valleys the mountains form a more continuous range than on the west side of the Rio Grande, where the elevated areas carry the continental divide.

The Sangre de Cristo mass, an extension of the Colorado mountains; lies slightly east of the north-central part of New Mexico east of the Rio Grande. South of this northern mass two series of ranges extend to the southern boundary: nearest the Rio Grande the Sandia, Manzano, San Andrés, Oscura and Organ mountains; farther east the Pedernal, White, Sacramento and Guadalupe mountains.

West of the Rio Grande the San Juan mountains dominate the country north of the Chama river; a somewhat smaller mass, the Jemez mountains, lies between the Chama and the Jemez river. The Puerco river separates the Jemez mountains from the Mt. Taylor mountains, which carry the main divide southwesterly to the Zuni mountains and on into one of the largest mountain masses in the state, with the Black range closest to the Rio Grande and the Mogollons, the San Mateo and the Magdalena as outlying ridges toward the west. In the extreme southwestern part of the state the mountains terminate in several parallel ridges: the Burro, Big Hatchet and Peloncillo mountains.

The major divides, following the tops of the ridges and the high plateaus, run generally north and south. The most important are the divides between the Pecos and the Canadian valleys; between the Pecos and Tularosa valleys; between the Tularosa and the Rio Grande; and between the Rio Grande and the San Juan, Little Colorado and Gila valleys.

The rivers are the only important bodies of water, but the Rio Grande and the Canadian have been dammed to form the Elephant

Butte and Caballo reservoirs on the Rio Grande. and Conchas reservoir on the Canadian; primarily useful for irrigation, these reservoirs also offer fishing and water sports. In the northeastern part of the state, in Union county, the Cimarron and North Canadian rivers. both branches of the Arkansas, rise. A third branch, the Canadian, flows through Colfax, Mora, San Miguel and Quay counties, draining the eastern slope of the Sangre de Cristo range, the southern flank of which drains into the Pecos river; this in turn flows southward across the state.

The Rio Grande, the only important river that does not have its source in the state, enters New Mexico through a deep canyon just east of the 106th meridian and flows south through the centre of the state. On the western side of the continental divide the principal rivers are the San Juan, Little Colorado and Gila, tributaries of the Colorado, which flows into the Gulf of California.

Climate.— The climate of New Mexico is generally sunny and relatively dry (average rainfall 14.3 in.) but with considerable variation depending on altitude. Extremes of temperature range from 110° to —29" F. Winter average temperature is about 39° in the south and 29° in the north; summer averages are about 77° and 68°, respectively. Prevailing summer winds blow from the southeast, bringing the summer rains from the Gulf of Mexico. Occasional winter winds from the northwest bring cold, especially to the northwest quarter of the state. Relative humidity is low; Albuquerque, in the centre of the state, has a winter minimum of 24% and a maximum of 58%.

Soil.—The soils of New Mexico generally contain a large amount of mineral matter and a small amount of organic matter; the alluvial soils are deep and very productive when irrigated.

Vegetation and Animal Life.—Altitude. determining climate, also largely determines the distribution of plants and animals. Six zones are recognized, ranging generally irom southern valleys of less than 3.000 ft. above sea level to above the timber line. where only arctic lichens and grasses grow. The tallest peak. Wheeler peak in the Sangre de Cristo range above Taos, rises to 13.600 ft.

Lower *Sonoran* Zone.—The lowest zone, Lower Sonoran, is characterized by mesquite, creosote bush, yucca, desert willow, cottonwood, many varieties of cactus and Spanish bayonet. There are many species of mice, rats, squirrels, skunks and bats; also the coyote. the New Mexico desert fox and weasel and the Mexican badger. Birds include the scaled quail. Scott's oriole. the sparrow, the western mockingbird and the road runner. This zone covers about 18,000 sq.mi. of the state's most fertile land, which is very productive with irrigation.

Upper Sonoran Zone.—The zone above, the Upper Sonoran, from 3.000 to 7.500 ft. of altitude. is the largest, covering about 92,000 sq.mi., three-quarters of the state. and with irrigation is the most productive. Its natural growth consists of piiion and juniper trees and blue grama, galleta, buffalo and porcupine grasses, which make fine range for cattle. These wide grassy plains extend eastward into Texas as the Staked plains (Llano Estacado). Several species of deer, antelope, coyote, wolves and prairie dogs are common to the area; mountain sheep, which had almost disappeared. are coming back with protection.

Upper Zones.—The three zones above the Upper Sonoran—Transition, Canadian and Hudsonian—bear fine timber. Above 8,000 ft., ponderosa pine is replaced by several varieties of fir and spruce, all varied by scrub oak and quaking aspen which covers burned over areas with its delicate green in summer; its golden yellow in autumn. These forests offer good hunting of deer and, in some places, elk. Black and brown bears are found there, and mountain lions prey on smaller animals and domestic stock. In the Arctic-Alpine zone, above 12,000 ft., only a few grasses, lichens and alpine sedges grow.

Parks, Monuments and **Recreation.**—New Mexico possesses many attractions for tourists, among them the Carlsbad Caverns National park (*q.v.*), at Carlsbad. The state also embraces eight national monuments: Aztec ruins, at Aztec; Bandelier, near Santa Fe; Capulin mountain, near Raton; Chaco canyon. near Bloomfield: El Morro, at El Rlorro; Ft. Union near Watrous; Gila cliff dwellings, near Silver City; and Gran Quivira, at Gran Quivira. State parks are Hyde, at Santa Fe; Bottomless lake, near Roswell; Conchas dam. Tucumcari; Kit Carson memorial, Taos; City of Rocks, near Deming; and Bluemater lake, near Grants. State monuments are Mesilla plaza, Mesilla; El Palacio, Santa Fe; Abo, near Mountainair; Pecos. Pecos; Coronado, near Bernalillo; Quarai, near Mountainair; Jemez. Jemez Springs; Lincoln, Lincoln.

HISTORY

Prehistory.— In New Mexico and other areas of the southwest the peripheries of at least two distinct prehistoric Indian cultures touched: the agrarian, docile early groups, and the later aggressive and nomadic Navahos and Apaches. The Sandia cave and Folsom men of 25.000 years ago represent the earliest evidences of human life discovered on the North American continent. For at least 10,000 years man has inhabited New Mexico. Pre-Pueblo Hohokam and Salado Indians were agriculturalists and irrigators. The Anasazi built cities. Among their more interesting ruins are those in the San Juan valley and Chaco canyon. Approximately 1,000 years ago came the Navahos and then the Apaches.

Exploration.—Recorded history began between 1525 and 1543 when Spanish explorations extending from Florida to California paved the way ior Spain's colonization of Florida and New Mexico in the 16th and 17th centuries, Texas and California in the 18th. The first explorer to cross the continent was Alvar Núñez Cabeza de Vaca, who, with three companions. reached the Gulf of California and went on to Mexico City. capital of the viceroyalty of New Spain. There his reports inspired Viceroy Antonio de Mendoza to undertake explorations to the north. He sent out an expedition headed by a Franciscan friar, Marcos de Niza, which reached the Zuni pueblos in western New Mexico and brought back such dazzling (though untrue) reports of wealth (the myth of the Seven Golden Cities of Cibola) that in 1540 Francisco Coronado, with a well-equipped force of 300 soldiers, marched north over the same trail. Coronado proceeded to the Rio Grande and established winter quarters near Bernalillo. His lieutenants conquered the pueblos as far north as Taos and pushed as far west as the Grand canyon. Coronado himself reached mid-Kansas.

Coronado found no gold, but the friars converted many Pueblo Indians, who iarmed small irrigated plots of land and were generally peaceful. His reports, circulated in Mexico, inspired missionaries, and in 1581 Augustín Rodriguez, a Franciscan friar, led an expedition into New Mexico. Rodriguez' military escort soon returned to Mexico, however, leaving the friars behind, and in 1582 Antonio de Espejo set out to rescue them. In this year the name New Mexico was applied to the Rio Grande pueblos. and it appeared in a contract made in 1595 with Juan de Oiiate for the colonization of the area.

Colonization.—Oñate's expedition entered New Mexico at the pass (present El Paso) and proceeded up the Rio Grande to its confluence with the Chama river. There Oiiate established San Juan de los Caballeros as his capital, and the first mass was said there on Sept. 9. 1598. Santa Fe, the present capital of New Mexico, was founded in 1610. To Oñate may be attributed the permanent settlement of the area. His conquest and settlement were described in Villagrá's Historic2 *del Nuevo Méjico*, an epic poem: the first poem written about any section of the U.S., published at Alcalá de Henares, Spain, in 1610.

New Mexico remained a frontier mission field until the 19th century. Twenty friars were serving there in 1624, there were 33 churches and Christian Indians were counted as 3,400. The total Spanish population was only 2.000. an indication that the colony had not become an important source of wealth. The friars, pressing hard to eradicate the Indians' traditional beliefs, aroused such opposition that in 1650 the Pueblos revolted, killed many Spanish settlers, including priests. and drove the rest south to El Paso.

In 1692 Spanish troops under Diego de Vargas re-entered New Mexico, occupied the whole province and by 1696 had peaceably re-established Spanish rule. Later the Spanish kings confirmed the Pueblos' ownership of their lands by royal grants which are the basis of their present holdings. During the 18th century colonists from Mexico continued to enter New Mexico and were granted lands as groups or as individuals. They iounded such enduring towns as Socorro in the south, Don Fernando de Taos near Taos pueblo, Santa Cruz north of Santa Fe and others less important.

Albuquerque (*q.v.*), founded in 1706, became the centre of southern New Mexico, with a population of 4,020 by 1799. The total population of the province. which extended from Louisiana to California, was then about 30,000, including 20,000 Spanish and 10,000 peaceful Indians. Warlike Indians, especially Navaho, Apache and Comanche (*qq.v.*) nomads, harried Spanish towns and Indian pueblos alike. Spain offered the Indians, the towns and pueblos little protection, as the Spanish empire was breaking up.

Mexican Rule.—By 1821 the old viceroyalty of New Spain had attained its independence as the republic of Mexico. This change was little noted in New Mexico, which was beginning to look eastward. The republic of Mexico legalized trade with the Missouri valley towns, which had been discouraged by Spain, and in 1821 the first annual caravan set out from Missouri for Santa Fe (see SANTA FE TRAIL). Trade over the Santa Fe trail grew in value from $15,000 in 1822 to $43,000 in 1843.

The republic of Texas, established in 1836, claimed the Rio Grande as its western boundary and, tempted by the rich Santa Fe trade, invaded New Mexico in 1843; but its badly organized expedition was easily defeated by New Mexicans under Gov. hfanuel Armijo.

Territorial Period.—War between the United States and Mexico broke out in 1846, and during that year the army of the west entered New Mexico under Stephen Watts Kearny. Kearny took formal possession of New Mexico at Las Vegas on April 15, 1846, promising all inhabitants who would take the oath of allegiance to the United States amnesty and full citizenship, with freedom of religion and property rights. Three days later Kearny occupied Santa Fe, where he established a military government and appointed Charles Bent civil governor. Bent was assassinated in a rebellion in Taos on Jan. 19, 1847. Thereafter peace existed. Congress on Sept. 9, 1850, created the territory of New Mexico, extending from meridian 103° on the east to the territory of California at approximately meridian 114'. Part of the Compromise of 1850, the act included provision for Texan surrender of claims to the New Mexico panhandle or lands of the upper Rio Grande in exchange for federal payment of $10,030,000 to Texas. The state's present boundaries were fixed in 1861, when the line between New Mexico and Colorado was drawn at 37° N. lat.; the territory of Arizona was created in 1863 of the western half of New Mexico.

During the American Civil War a Confederate force under Brig. Gen. H. H. Sibley invaded Ne Mexico, hoping to reach the California gold fields. They advanced up the Rio Grande and took Santa Fe, but Col. E. R. S. Canby's Union troops reinforced by the 1st Colorado volunteers met and decisively defeated them at Apache canyon on March 28, 1862.

The period following the American occupation was marked by the solution of the Indian problem and by the economic development of the territory. The Navahos, defeated in 1865, were established in 1868 on a large reservation that crosses the New Mexico-Arizona boundary. The Apaches, in 1880, were settled on two reservations in Arizona and two in New Mexico, the Mescalero in the southern part of the state, and the Jicarilla in the northwest, lands which these tribes still hold. The United States had confirmed the Spanish and Mexican land grants to the Pueblo Indians, to individuals and to groups of Spanish settlers, but it took years and special courts to settle these complicated claims.

The settlement of the Indian troubles and the building of railways into the west brought increased population, the building of towns, the opening of mines and the introduction of cattle from Texas into eastern New Mexico. Spanish and Mexican ranchers had run sheep, and conflicts between cattle- and sheepmen over the use of water and the open range sometimes led to armed conflict. But the cattle wars common to other parts of the west were few in New Mexico. Most publicized was the Lincoln County War, 1877–80, which caused the U.S. government to dispatch Gen. Lew Wallace (*q.v.*) to Santa Fe as territorial governor in an attempt to restore order.

The Atlantic and Pacific railroad (later the Atchison, Topeka and Santa Fe) reached Albuquerque in 1880, building toward California. Later it connected with the Southern Pacific at Deming and ran a branch line to El Paso. New Mexico now had transcontinental roads. In 1891 a public-school system was established. English, the official language since 1846, was beginning to reach the Spanish-speaking majority of the population.

Statehood.—Constant efforts to secure statehood were finally successful; congress passed an enabling act on June 20, 1910; a constitution was drafted and approved; and on Jan. 6, 1912, New Mexico was formally admitted as a state.

The atomic bomb and related developments have led to great population changes in New Mexico. Establishment of scientific centres at Los Alamos, Albuquerque and Roswell caused an influx of highly trained scientists (Los Alamos is said to have more Ph.D.'s than kindergarten children), technicians and supporting personnel, including military and service industries. These new elements, coming from all the states and from many foreign countries, have radically altered the political colour of the state, and vast government expenditures (such as an annual payroll of $30,000.000 at Los Alamos) have led to a great increase in the state's per capita income.

Part of this economic advance has been due to the discovery of oil, gas and uranium on Indian lands. which has made the Navahos, Lagunas and Jicarilla Apaches wealthy; their wealth is owned tribally and is largely devoted to education and improvement of living conditions.

Two world wars greatly affected the state's Indian and Spanish peoples. English has become more widely and better spoken; the young men have seen the world; many have profited by educational opportunities; in general, they have become fully integrated into the American scene.

New Mexico has voted Democratic in presidential elections except in 1920, 1924, 1928, 1952 and 1956.

GOVERNMENT

The constitution adopted in 1911 remains the basis of the New Mexican State government, though some amendments have been approved by the voters.

The state legislature is composed of a senate and house of representatives having (after 1955) 32 and 66 members, respectively. Regular sessions are held in odd-numbered years, beginning the second Tuesday in January. Representatives are elected for two years and senators for four. The governor may call special sessions, and must do so on request of three-fifths of the legislature. The governor possesses the veto power, which can be overridden by a two-thirds vote of the legislative members present and voting. The people have the right of referendum.

A direct primary was established in 1938 but in 1949 was changed to a preprimary nominating convention. The state has two senators and two representatives in the national congress.

The ten elective executive officials—governor. lieutenant governor, secretary of state, auditor, treasurer, attorney general, commissioner of public lands and three corporation commissioners—are elected for two-year terms. They may serve two consecutive terms and are eligible for re-election after two years.

State boards, departments, agencies and commissions include a department of finance and administration, an advisory board on deposits and investments, and commissions on forest conservation, youth, Indian affairs, alcoholism, fair employment practices, a five-member highway commission, members of which serve overlapping six-year terms, and a five-member board of regents, with six-year overlapping terms, for institutions of higher education.

There are 5 supreme court justices elected one at a time for terms of eight years; 12 district judges, elected in the ten judicial districts for six years, who also serve as juvenile judges; probate judges elected in each county for two-year terms; and justices of the peace elected in each precinct for two-year terms.

The cost of state government rose from $22,300,000 in 1938 to about $250,000,000 annually in the late 1950's. A constitutional amendment limiting property tax to 20 mills necessitated a sales tax in 1933, a severance tax in 1937, a compensating tax in 1939 and a tobacco tax in 1943. The state's revenue comes primarily from the sales tax, gasoline tax and oil and gas rentals and royalties.

POPULATION

The population of New Mexico in 1850 was 61,547; in 1910, 327,301; in 1940, 531,818; in 1950, 681,187; and in 1960, 951,023. This last figure represented an increase of 39.6% over the population in 1950. The population per square mile in 1960 was 7.8 as compared with 4.4 in 1940 and 5.6 in 1950, and with 49.6 for the United States in 1960.

Of the 1960 population, 626,479, or 65.9%, lived in incorporated places of 2,500 or more, as compared with 46.2% in 1950 and with 33.2% in 1940 when these places constituted the urban area. The state has one standard metropolitan statistical area, which is Albuquerque. This area had a total population of 262,199, or 27.6% of the total population of the state in 1960.

The number of households in 1960 was 284,225 as compared with 177,128 in 1950. The average population per household had declined from 4.1 in 1940 to 3.8 in 1950 and to 3.3 in 1960.

Of the total 1950 population, 4.9% was 65 years old or over, and 50.4% of the population 14 years old and over was in the labour force. Of the total number of employed males, 23% was engaged in agriculture, 6.5% in mining, 14.4% in construction, 6.6% in manufacturing, 9.5% in transportation and 16.4% in wholesale and retail trade.

New Mexico's ethnic composition is a fair cross section of the United States except for the fact that the usual mixture is based on Indian and Spanish elements rather than Anglo-Saxon. The state's Indians number around 45,000, and a considerable portion of the population has Spanish names! Since the first census of 1850, immigrants from the states and foreign countries have included a preponderance of Germans, with the addition of Jewish, Italian, eastern European and middle eastern persons and some orientals, mostly from China and Japan. Most of the state's English-speaking people have come from the states. Mexicans have come across the border, especially after World War II.

Both Indian and Spanish cultures have left traces in architecture and the other arts, including household furnishings, speech, dress and foods.

New Mexico's Indian population in 1950 was 41,901 including Navahos, Apaches and Pueblos (living in 19 pueblos). Indians, declared citizens by act of congress in 1924, were granted the vote in New Mexico in 1948. Their economic contribution to the state is considerable as stockmen, farmers, craftsmen and workers in many lines of industry.

Contemporary pueblo villages are Zuni, near Gallup; Acoma and Laguna, near Albuquerque; and the eastern pueblos of the Rio Grande and its tributaries. Mescalero, the chief Mescalero Apache village, is south of Ruidoso. Jicarilla Apache headquarters is at Dulce, in northern New Mexico. The Navaho capital is at Window Rock, on the Arizona-New Mexico border.

*New **Mexico:** Places of 5,000 or More Population (1960 census)**

Place	Census of population				
	1960	1950	1940	1920	1900
Total state	951,023	681,187	531,818	360,350	195,310
Alamogordo	21,723	6,783	3,950	2,363	—
Albuquerque	201,189	96,815	35,449	15,157	6,238
Artesia	12,000	8,244	4,071	1,115	—
Belen	5,031	4,495	3,038	1,306	—
Carlsbad	25,541	17,975	7,116	2,205	—
Clovis	23,713	17,318	10,065	4,904	—
Deming	6,764	5,672	3,608	3,212	—
Farmington	23,786	3,637	2,161	728	—
Gallup	14,089	9,133	7,041	3,920	2,946
Grants	10,274	2,251	—	—	—
Hobbs	26,275	13,875	10,619	—	—
Las Cruces	29,367	12,325	8,385	—	—
Las Vegas (city)	7,790	7,494	5,941	4,304	3,552
Las Vegas (town)	6,028	6,269	6,421	3,902	—
Los Alamos	12,584	9,934	—	—	—
Lovington	9,660	3,134	1,916	411	—
Portales	9,695	8,112	5,104	1,154	—
Raton	8,146	8,241	7,607	5,544	3,540
Roswell	39,593	25,738	13,482	7,033	2,049
Snnta Fe	34,676	27,998	20,325	7,236	5,603
Silver City	6,972	7,022	5,044	2,662	2,735
Socorro	5,271	4,334	3,712	1,256	1,512
Tucumcari	8,143	8,419	6,194	3,117	—

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

EDUCATION

Public Schools.—Until the establishment of the public-school system in 1891 education nas carried on by private and religious mission schools. Progress in public-school education was rapid after New Mexico became a state in 1912.

The public-school system is governed by the state board of education, consisting of the governor the superintendent of public instruction (appointed by the board) and ten members elected from the state's ten judicial districts. This method of choosing superintendent and board members was established by an amendment to the constitution approved at the general election of Nov. 1958. Betneen the late 1940s and the late 1950s enrollment in the public schools more than doubled, as did school expenditures and property valuation. In the second half of the 20th century there were nearly 100 public-school systems. employing approximately 10 000 teachers, principals and supervisors. After July 1956 certification was granted only to teachers holding the bachelor's or higher degree; about one-third of all New Mexico teachers held the master's degree. Free basic textbooks were available to all pupils in grades 1 to 12.

The New Mexico Military institute at Roswell, partly supported by state funds, offers high school and junior college work, as well as military training.

Private and parochial schools enroll about 24,000 pupils Some state control is exercised over courses of study. but the state gives no direct financial support for instruction or buildings.

In 1957 a retirement system for teachers and certain other school employees was inaugurated, with both teachers and the state contributing

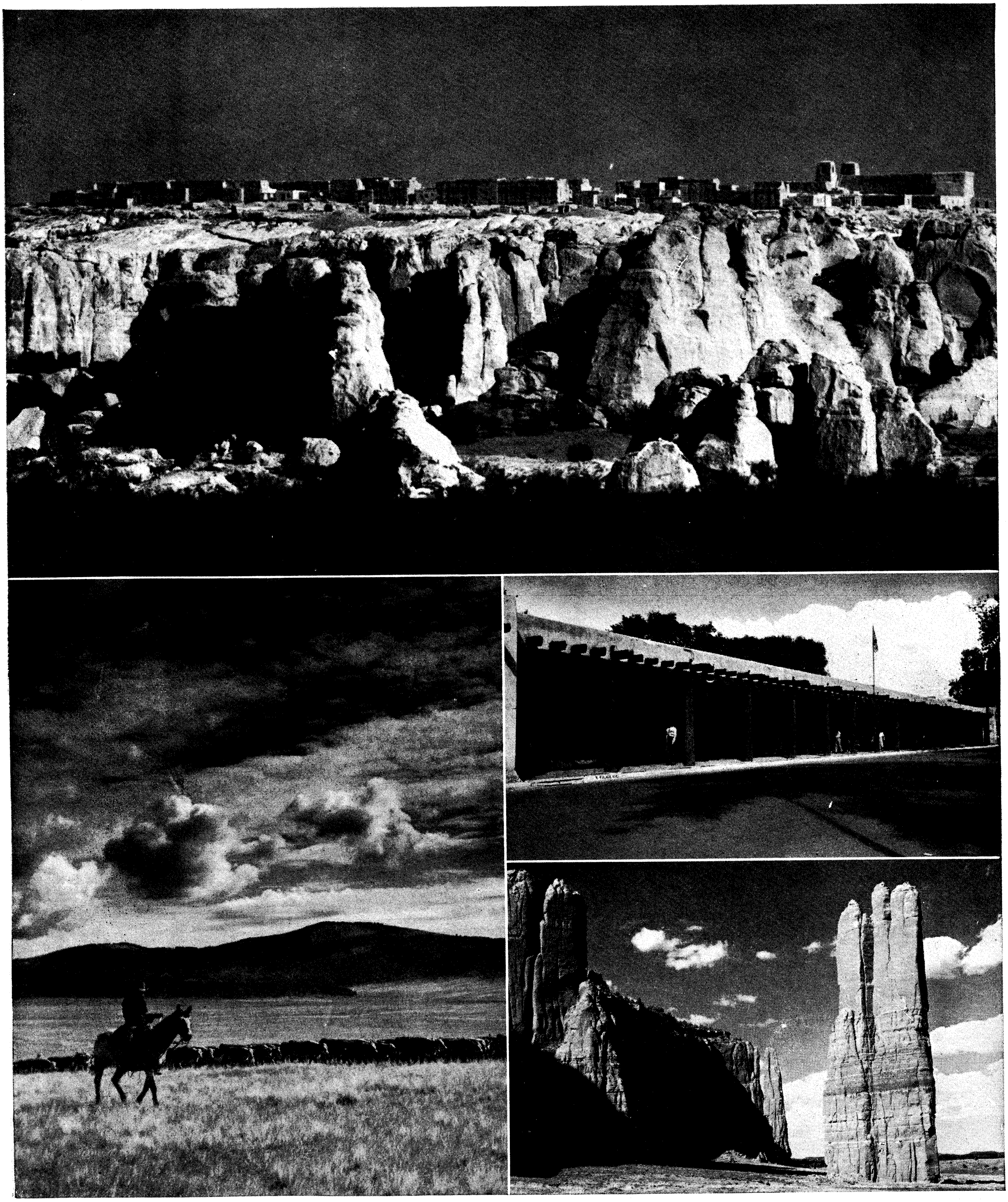
Higher Education.—The Cniversity of New Mexico at Albuquerque, chartered in 1889 and opened in 1892, consists of a graduate school and nine colleges: arts and sciences, business administration. education, engineering, fine arts, law, nursing, pharmacy and university. Regular courses are offered through two semesters. a summer session and extension courses. Other services are offered the state's schools through the college of education Naval and air force reserve training corps units are located on the campus. The university offers the Ph.D. degree in American studies, anthropology. biology, chemistry, education, English, geology, history mathematics physics and Spanish.

New Mexico State university (formerly New Mexico College of Agriculture and Mechanic Arts), established at Las Cruces (State College) in 1889, offets work in schools of arts and sciences, engineering, teacher education and agriculture New Mexico Institute of Mining and Technology in Socorro (established in 1889), includes the college, the bureau of mines and mineral resources and the research and development divisions. New Mexico Highlands university (formerly New Mexico Normal university, chartered in 1893) in Las Vegas offers extension work and grants degrees through the M.A Eastern New Mexico university (established 1934, formerly Eastern New Mexico college), in Portales has schools of liberal arts and sciences, business and economics, music, teacher education and vocations. Sew Mexico Western college (established 1893; formerly New Mexico State Teachers college), at Silver City offers work in liberal arts, teacher education and vocational training.

There are two Catholic colleges in the state: St. Michael's (1947), at Santa Fe, and the College of St. Joseph's on the Rio Grande (1940), at Albuquerque.

Financial support and programs of all state institutions of higher learning are co-ordinated through the board of educational finance, appointed by the governor, which, with its executive secretary, is responsible for screening all college and university budget requirements and for approving all educational programs.

Museums.—The Museum of New Mexico, Hall of Archaeology, and the Museum of New Mexico Art gallery are in Santa Fe, as are the Laboratory of Anthropology the Museum of International Folk Art and the Museum of Navaho Ceremonial Art. The Rosaell Museum and Art centre is at Roswell, the Taos Historical



BY COURTESY OF (CENTRE RIGHT) SANTA FE RAILWAY, (BOTTOM RIGHT) NEW MEXICO STATE TOURIST BUREAU; PHOTOGRAPHS, (TOP) ANDREAS FEININGER FROM "LIFE MAGAZINE," (BOTTOM LEFT) HARVEY CAPLIN

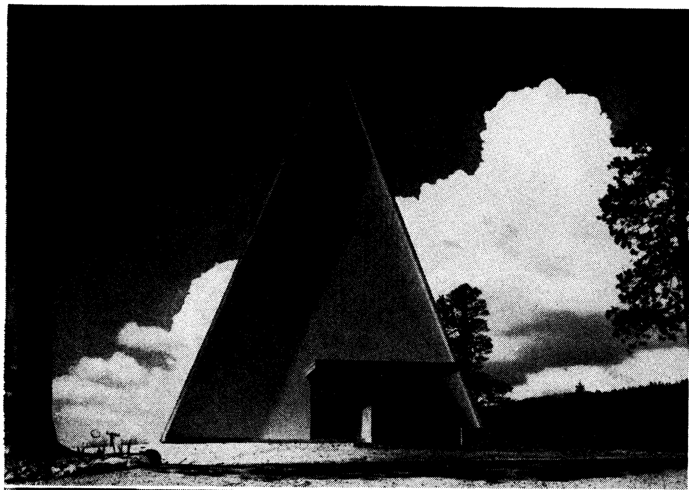
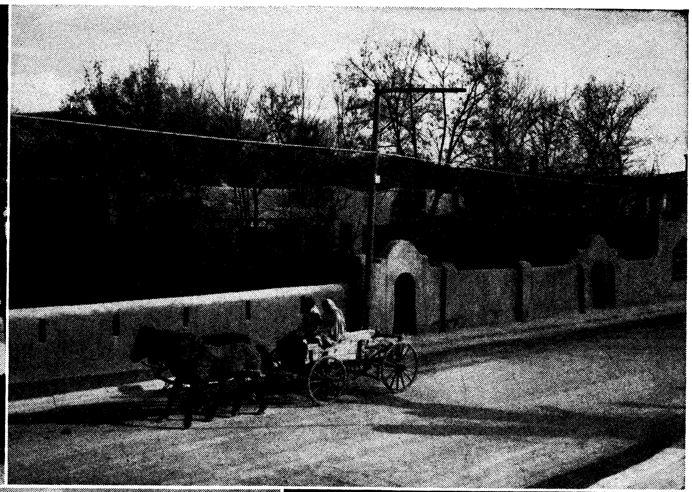
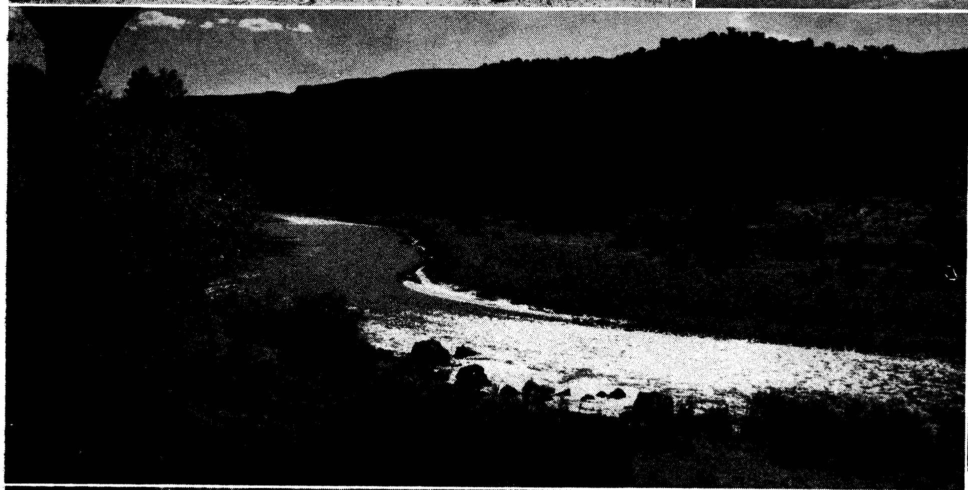
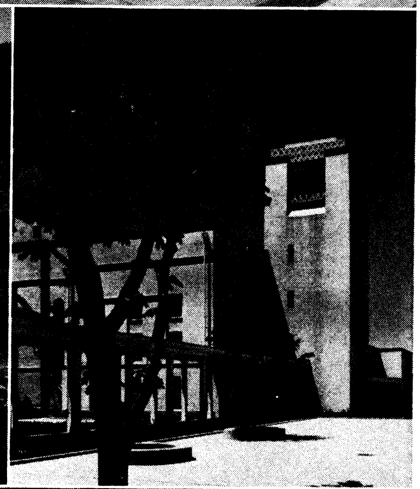
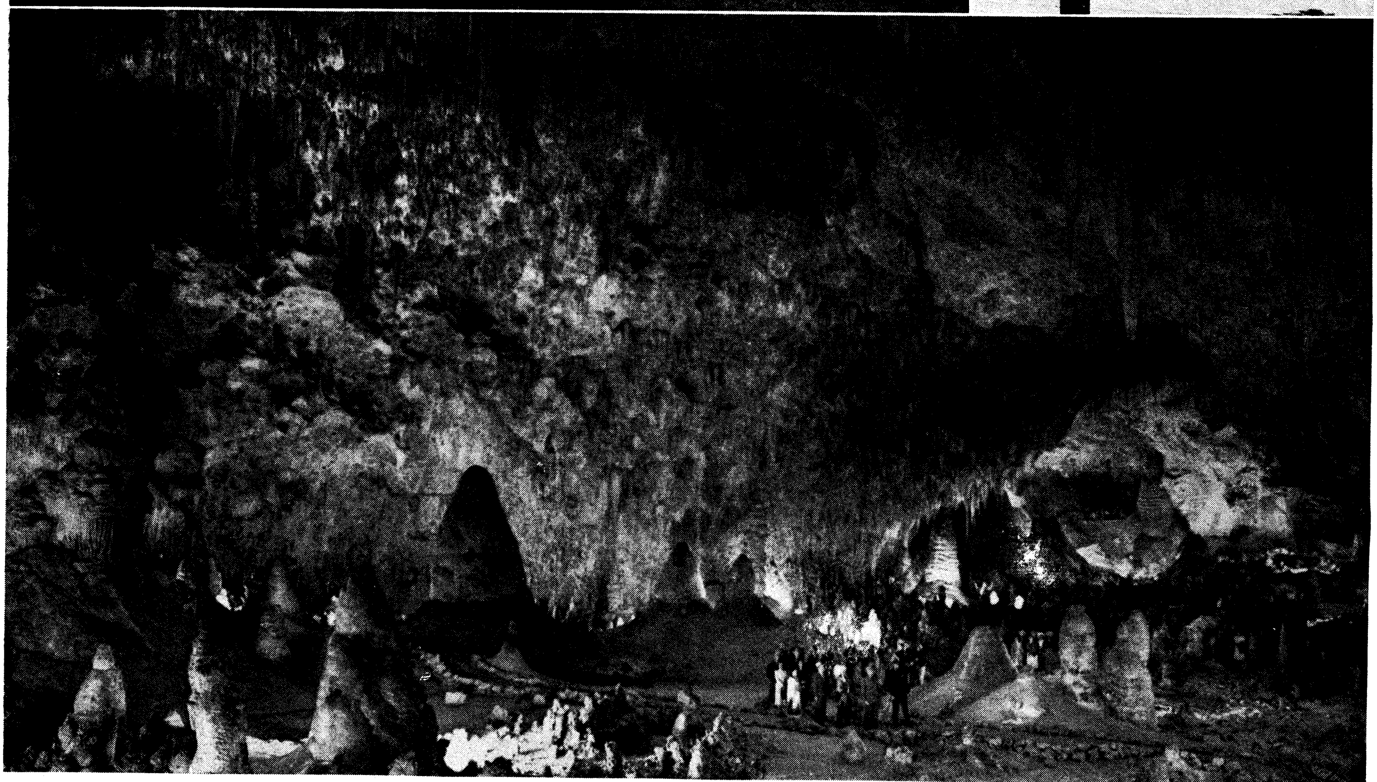
SCENES IN NEW MEXICO

Top: Acoma, Pueblo Indian village on a mesa 357 ft. above the plains. It was an ancient village when Spanish explorers first saw it in 1540

Bottom left: Stock raising along the Chisum trail

Centre right: Palace of the Governors at Santa Fe. It was built in 1609–10 and was the seat of government for 300 years. In 1909 it became an archeological and historical centre operated by the state

Bottom right: Venus' Needle, 207-ft. high sandstone column near Gallup

BY COURTESY OF (TOP LEFT) LOS ALAMOS SCIENTIFIC LABORATORY, (TOP RIGHT) SANTA FE RAILWAY, (CENTRE RIGHT) NEW MEXICO STATE TOURIST BUREAU; PHOTOGRAPHS, (CENTRE LEFT) HARVEY CAPLIN, (BOTTOM) © E. "TEX" HELM

VIEWS OF NEW MEXICO

Top *left:* Church at Los Alamos, nuclear experiment testing area
Top *right:* Street scene in Taos
Centre left: Rio Grande near Taos, north-central New Mexico
Centre right: State capitol at Santa Fe, completed in 1953
Bottom: The Big Room, largest of the numerous underground areas at Carlsbad Caverns National park

Museum and Art gallery at Taos. Albuquerque has the Old Albuquerque museum and the Albuquerque Modern museum. Old Lincoln County Court House museum is in that county seat.

HEALTH, WELFARE AND CORRECTIONS

The state supports a penitentiary (1854) at Santa Fe and a prison farm (1939) at Los Lunas; a hospital for the insane (1889) and a home for the aged (1947), both at Las Vegas; a home for the aged (1952) at Alcalde; a miners' hospital (1903) at Raton; an industrial school for boys (1903) at El Rito, moved to Springer in 1909; a girls' welfare home (1919) at Albuquerque; a school for mental defectives (1925) at Los Lunas; the Carrie Tingley Crippled Children's hospital (1937) at Truth or Consequences; a school for the blind (1903) at Alamogordo; and a school for the deaf (1887) at Santa Fe.

State provision is made for unemployment compensation. There is a joint federal and state program of financial aid to dcpendcnt children, and child welfare services of the state provide both financial and social services to dependent children.

THE ECONOMY

Agriculture. — The area east of the Rio Grande contains about four-fifths of the state's cropland. The Rio Grande valley and the area west of it. principally in Catron county, contain an acreage of about 330,000. In Curry, Roosevelt. Quay, Harding, Union and Colfax counties an average rainfall of about 14.3 in. permits dry farming; over the rest of the state, crops are dependent upon irrigation and hence are confined to the river valleys where irrigation is practicable: the Rio Grande, San Juan, Pecos, Gila, Canadian and their tributaries.

Since prehistoric times man has attempted to bring usable water to New Mexico. Early Pueblo Indians practised limited irrigation. The Anglos used windmills, artesian wells and privately financed irrigation, begun in the 1880s. The Reclamation act of 1902 ultimately resulted in a number of publicly financed dams that make possible irrigation of more than 500.000 ac. Waste and silt are problems.

Value of the major crops of New Mexico approaches $100,000,000 annually; total cropland, including minor crops, is about 1.800.000 ac. The leading cash crop is cotton. followed by hay, winter wheat, grain sorghums. corn and dry beans. The chief farm animals are horses, mules, cattle, sheep and hogs; the number of horses and mules declines steadily. Livestock brings New Mexico farmers and ranchers more than twice as much income as do crops.

Industry.—Manufacturing increased slowly in the first half of the 20th century. In 1899. 174 establishments employed 2.578 persons, paid them $1,290,000 and added $2,062,000 to value by manufacture. Comparable figures reported by the 1954 census of manufactures were: 593; 16,183; $71,966,000; and $291,480,000. The great increase occurred after the census of 1939, when value added by manufacture was only $8,640,000. The chief industries (1954 census) were food and kindred products, lumber and products (except furniture), printing and publishing, chemical and allied products and petroleum products.

Mining.—New Mexico is important as a source of minerals, ranking about eighth (in value of minerals produced) among the states. By the second half of the 20th century its mineral products were valued at more than $550,000,000 annually, chief among them being petroleum, natural gas, potash, uranium and copper. All of these except copper are comparatively new sources of mineral wealth, the state being known in its earlier years as a source of metals, headed by gold, silver, copper, lead and zinc. Gold was discovered in the Fray Cristóbal mountains in 1683 by Pedro de Abalos, and in 1833 the Ortiz mine, the first gold lode discovered and worked west of the Mississippi. was located. Peak gold production was reached in 1915, with 70,681 oz.; production dropped during World War I, reached a new high in 1938 and thereafter declined (to around 3,000 oz. in the late 1950s). Silver mines were worked as early as the 17th century. Production reached a high point of 2.005.531 oz. in 1915 and 1,400,876 oz. in 1939 and then declined to around 150,000 oz. in the late 1950s. Copper remains a leading mineral. Lead ranged above an annual production of 20.000.000 lb. during the depression years 1929–33, then declined to 9,340,000 lb. in 1949, worth $1,470,032; by the early 1960s it was mined in negligible quantities. Zinc reached a production of 119,048,000 lb. in 1943, declined to 58,692,000 lb. in 1949 and by the early 1960s it, too. was of little importance. Coal production showed a similar decline from 14,133,000 tons in 1917 to 1,354,000 tons in 1949 to 117,000 tons in 1958.

The petroleum and natural gas industry did not get under way until the 1930s. but by the second half of the century oil and gas were valued at more than five times as much yearly as the next most valuable mineral product. Principal oil fields are located in Lea, Eddy. Chaves and San Juan counties. Potash mining. also dating from the 1930s, increased ten times in value between the early 1940s and the early 1960s; the state produces about 90% of the potash mined in the United States. It leads the nation in output of perlite.

New Mexico contains more than two-thirds of the United States' known uranium ore reserves, estimated in 1958 at 54,900,000.000 tons averaging 0.26% uranium oxide. Production in the first year of record, 1950, was valued at about $61.000; by the late 1950s it was more than $30.000,000 annually. Chief uranium-producing counties are Valencia. where the spectacular developments near Grants attracted much attention; McKinley, which quintupled its production between 1957 and 1958; San Juan and Socorro.

Transportation and Communications. — In the second half of the 20th century six railroads operated in New Mexico, the most important being the Atchison, Topeka and Santa Fe railway. Commercial air transportation mas provided by transcontinental and regional lines; Albuquerque was the junction airport. Improved surface highways increased from about 2,100 mi. in 1929 to 9,154 mi. in 1948 and to nearly 14.000 in the early 1960s. A motorized state police was established in 1933. The ports of entry, established to collect the commercial mileage tax instituted in 1933, were placed under the state police as registration stations.

New Mexico had 16 daily papers and about 45 weeklies in the second half of the 20th century. In addition, there were many trade, professional. technical and religious publications, most of which had a state-wide circulation. The *New Mexico Historical Review*, published by the New Mexico Historical society; the *New Mexico Quarterly Review*, published by the University of New Mexico; and the *New Mexico Magazine*, a state publication! are well known. *See* also Index references under "New Mexico" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures: together with the current history, are summarized annually in the *Britannica Book of the* ***Year,*** American edition. (E. Fe.)

NEW ORLEANS, a city of Louisiana, U.S., situated on the east bank of the hlississippi river about 107 mi. from its mouth. It is located along a bend in the river, which accounts for its popular name. "Crescent city." The boundaries of the parish (county) of Orleans and the city of New Orleans are the same, with a land area of 198.8 sq.mi. The boundary line is very irregular; approximately Lake Pontchartrain on the north and Lake Borgne on the east, the two being connected by a channel called the Rigolets; the parish of St. Bernard and the Mississippi river on the south; and the river and Jefferson parish on the west. The population of the city in 1960 was 627.525, an increase of 10% from 1950. That of the standard metropolitan statistical area (Jefferson, Orleans and St. Bernard parishes) was 868,380, an increase of 26.7% in the decade. (For comparative population figures for the city *see* table in LOUISIANA: *Population.*)

The soil in the New Orleans area is an alluvial deposit from the river and therefore has its greatest elevation at the river bank, where the ground behind the levees is from 10 to 15 ft. above the mean level of the Gulf of Mexico; but the lower parts of the city are below gulf level. Built on the narrow ridge of land at the river bank, the growing city first expanded along the river front and later, the cypress swamps between the river and Lake Pontchartrain having been cleared and drained, into that area.

The river approaches New Orleans flowing eastward, turns rather abruptly to the south at the upper municipal limits, then eastward as it passes the modern city, and finally northward in one of the sharpest bends to be found in the lower river, near the site of the original city, now called the *vicux carré* or French quarter. The difficulties involved in building a city on such a site as that of New Orleans were great. Drainage, sanitation and a satisfactory water supply were not realized until nearly two centuries after the establishment of the first settlement, and in the interim yellow fever and cholera took frightful tolls. Modern engineering and sanitation finally triumphed and the city overcame these former threats to its existence.

It is noted for its mild and balmy winters; the summers are uniformly warm but extreme heat is unknown. The highest temperature recorded by the weather bureau is 102° F.; a temperature of 100° F. is seldom reached because of the cool breezes from the Gulf of Mexico.

History. — The city of La Nouvelle Orléans was founded by a French governor of Louisiana, Jean Baptiste Le Moyne, sieur de Bienville, and was named in honour of the regent, the duc d'Orléans. The site chosen mas on an elevation along the east bank of the river between the head of Bayou St. John and the river. Among its advantages were the higher land, accessibility by two main waterways (the Mississippi and the lakes), and by Bayou St. John for the small craft of that day. On the other side of the river it was not far to Bayou Barataria, which later was destined to become the rendezvous of the famous pirates, Jean and Pierre Lafitte, and which offered access to the gulf without stemming the current of the Mississippi.

There is some doubt as to the exact date of the founding of New Orleans but it is generally given as 1718. Louisiana at that time was held by a company organized by John Law (*q.v.*), who returned it to the crown in 1731. In the meantime, however, it was proposed that the headquarters of the company should be moved away from the barren coast country and in 1722 New Orleans became the capital of the colony. At this time the city had only about 100 houses and 500 inhabitants. It was laid out in approximately a parallelogram, 4,000 ft. long on the river by 1,800 ft. in depth, divided into regular squares 300 ft. on each side. In 1724 the streets were named. The houses were rude cabins of split cypress boards, roofed with cypress bark. They were separated from one another by willow copses and weed-grown ponds swarming with reptiles. Two squares on the river front near the centre of the city were set apart for military and ecclesiastical uses. The front was the Place d'Armes, now Jackson square; the rear one was early occupied by a church. In 1726 a monastery was erected to the east of the church for the Capuchin monks, who had arrived two years earlier. A company of Ursuline nuns came to New Orleans in 1727. At the same time the Jesuits arrived and received a large tract of land from Bienville. This tract, bounded by what is now Common, Tchoupitoulas, Annunciation and Terpsichore streets, was later added to by donation and purchase and extended to Felicity street. There the Jesuits cultivated myrtle, the wax of which was then a staple article of commerce, and oranges. figs. indigo and probably sugar cane. When the order was suppressed for political reasons in 1763 its great plantation was confiscated by the king of Spain; the Jesuits did not return to Louisiana until 1837.

Many storms and disasters occurred during the early years of the city. In 1719 the river rose to a great height and the site was completely inundated to a depth of a few inches. In 1722 a hurricane destroyed 30 houses and damaged crops. German colonists who had settled on the banks of the Arkansas managed to reach New Orleans and there implored Bienville to send them back to their homes. He persuaded them to establish themselves along the river above the city, and thus was formed the nucleus of the German settlement. which to this day is called the German coast.

There were few women of good character in the colony in the early days; and many of the better class of settlers, missing their home life, desired to return to France. It thus became imperative that if the settlement was to survive, the men must have good wives to make homes for them. When Bienville left the colony in 1724, he promised to send a group of young women as soon as possible. The "casket girls" (*filles à la cassette),* so called because of the small chests of clothes and linens allotted to them by the French government, arrived in 1727 and during the period of courtship were placed under the care of the Crsuline nuns whose convent had been established in the same year. Some of the distinguished families of modern New Orleans claim to be descended from these marriages. The nuns were first domiciled in Bienville's former home but in 1730 their own house on Chartres and Ursuline streets was completed. This is one of the oldest buildings in the United States west of the Alleghenies.

In 1763 the treaty of Paris was concluded between France and England, by which England gained all the territory east of the Mississippi except the Isle of Orleans. By a secret treaty of Nov. 3, 1762, Louis XV had given the Isle of Orleans and all of Louisiana west of the Mississippi to his cousin, Charles III of Spain. It was not until Oct. 1764 that the French king notified the governor of the colony of the transfer and ordered him to surrender Louisiana to accredited Spanish commissioners when they should present themselves. The news was not well received in New Orleans. In 1783 the treaty of Paris confirmed Spain in possession of this territory and granted free and open navigation of the Mississippi river to the subjects of Great Britain and the United States. In 1788 and again in 1794 fires destroyed large portions of the city. By the first, 19 squares were devastated and 856 houses were burned. The second fire destroyed 212 houses and caused a loss estimated at $2,600,000. Rebuilding with brick instead of wood resulted in a more permanent city. During'this period the Spanish merchant, Almonaster y Rojas, was the greatest benefactor of New Orleans; he gave freely of his private fortune for many purposes. He rented in perpetuity the squares flanking the Place d'Armes and erected a row of brick buildings to be used as shops and retail stores. These were replaced in 1845 by the Pontalba buildings, which bear the name of their builder, Baroness Pontalba, Rojas' daughter. He rebuilt the Charity hospital, which had been destroyed by a hurricane, and a chapel for the Ursuline nuns. Through his generosity the cathedral was completed in 1794; it was constructed of bricks and had much the same appearance as today except in details of the belfry and towers. A town hall, or hall of the Cabildo, presented to the city in 1795 was the seat of Spanish rule and is now the state museum.

Before the cultivation of sugar cane the staple crop of Louisiana had been indigo but a caterpillar plague in 1793 and the two years following caused such extensive damage that its cultivation was temporarily abandoned. In 1794 Etienne de Boré, whose plantation is now within the city limits, succeeded in making granulated sugar and thereafter the production of sugar cane increased considerahly. By the treaty of Madrid, signed in Oct. 1795, Spain and the United States agreed that New Orleans should be open to the Americans as a port of deposit for three years; the produce was to be free of duty but a reasonable price for storage was to be paid. The commerce of New Orleans increased greatly and the levee was the scene of noisy, bustling business.

From 1800 to 1803 Louisiana was again a French possession and in 1803 the territory was purchased by the United States (*see* LOUISIANA PURCHASE). This transfer had a further beneficial effect on trade. The first half of that year showed an increase of 37% in tonnage over that of 1802; exports exceeded $2,000,000 and imports $2,500,000. The flatboat trade with the upper valley also increased enormously. Above the *vieux carré* commercial houses were erected and this newer portion of the city gradually became a business centre. Many of the street names are reminders of the first owners or of the first use of the locality. Gravier street bears the name of its original owner, Poydras that of a philanthropist; hlagazine was so named because of the great tobacco warehouses on Magazine and Common, and Camp street because of a slave camp between Poydras and Girod. Along the Bayou St. John road there was an aristocratic suburb.

In 1805 New Orleans mas incorporated as a city and the people exercised their right of suffrage for the first time in electing aldermen. Between 1803 and 1810 the population more than doubled with the arrival of many whites, mulattoes and slaves from Cuba, Santo Domingo and other islands of the West Indies. The population of the city has been cosmopolitan from the beginning, and an unusual characteristic up to the time of the American Civil War was the presence of considerable numbers of *gens de couleur* — "free people of colour,!' many of whom themselves owned slaves. After the war, however, the distinction between "free men of colour" and "freedmen of colour" (the former slaves) was lost and the *gens de couleur* lost the social advantages they had held.

During the War of 1812 New Orleans was not endangered until the autumn of 1811, when a British feet entered the Gulf of Mexico. Gen. Andrew Jackson, commander of the U.S. army in the southwest, reached the city on Dec. 1 and immediately began preparations for its defense. Because of slow communications neither the British nor the Americans had received notice of the conclusion of the war by the treaty of Ghent, signed two weeks previously, when the British attacked on the morning of Jan. 8, 1815. The outcome of the brief battle, a decisive victory for the Americans, had considerable psychological value and greatly advanced the political fortunes of Jackson. (*See* also WAR o~ 1812.)

Commerce on the Mississippi was greatly stimulated by the advent of steam navigation; the first steamboat to descend the river was the "New Orleans," which arrived on Jan. 10, 1812, on its maiden trip from Pittsburgh, Pa. The river trade was carried on in spite of the danger from sandbars on entering the river. In the space of a few weeks, in 1852, 40 ships went aground at the entrance to the river. The terrible yellow fever epidemics of 1853–55 reduced the volume of trade, which was regained, however, and a high-water mark reached in 1857, to be followed by a financial crash which was disastrous to the business houses of New Orleans.

Louisiana seceded from the union on Jan. 26, 1861. Sew Orleans was recognized as a strategic point by the authorities at Washington and two expeditions started to secure the Mississippi for the union: Gen. U. S. Grant was to descend the river and Adm. David Farragut and Gen. Benjamin T. Butler were to ascend it. The city had sent 5.000 soldiers to the defense of the northern line of the Confederacy but the southern government seemed oblivious to the importance of holding New Orleans. While Grant was endeavouring to push his way downstream, Farragut was entering the river from the gulf with a fleet of 43 vessels. The assistance asked by Gen. Mansfield Lovell could not be given by the Confederacy. An attempt was made to obstruct the passage of the Federal fleet by cables put across the river below the city, but New Orleans was captured by Farragut on April 25, 1862, and the city front blazed with the fire from thousands of bales of cotton and hogsheads of sugar and molasses which were burned to prevent their falling into the hands of the Federals.

General Butler with 15,000 soldiers took charge of the city on Nay 1, 1862. The mayor was removed from office and a military commandant appointed in his place; the city council was replaced by the bureau of finance and the bureau of streets and landings. Butler's rule in New Orleans was execrated by the people of the city; his removal before the end of the year curtailed some of the worst excess of the occupation.

The years 1865–77, the period of Reconstruction, were a time of racial and political strife. In the wake of the war came a host of undesirables seeking fortunes by easy means — the "carpetbaggers." who with their southern friends and associates called "scalawags" gained control of the city government through leadership of the voting population, largely composed of the newly enfranchised Negroes. Much of the property of the city disappeared; extravagant expenditures reached $6,961,381 in 1872 and the bonded indebtedness $21,000,000, paying up to 10% interest. The white men of the city, who mere virtually deprived of the ballot by all the restrictions placed upon its exercise, formed the "white league" for the expulsion of the "carpetbag" government and the restoration of white supremacy. Riots broke out frequently and there were armed encounters between the white league and the metropolitan police. The white league made a number of gradual gains and the situation in general aroused northern sympathies, so that in 1877 home rule (which meant in effect white supremacy) was restored in New Orleans by the federal government. These Reconstruction experiences not unnaturally left a bitter aftermath in New Orleans and for many years the Negro was in one way or another almost totally disenfranchised. In the 20th century, however, substantial gains were made, particularly through reform measures that benefitted the economically underprivileged, white or Negro, and in the governor's election of 1959, out of a total registration of 205,000 for the city. 34.000 Negroes were registered voters and an estimated 85%–90% voted. In the early 1960s, however, there was considerable opposition by white-supremacy groups and the state legislature to the racial integration of New Orleans schools.

Municipal improvements made slow progress during restoration times and for many years after; the city undertook the operation of the waterworks in 1869; a drainage system was proposed in 1871 but proved too expensive to be carried out; in 1871 the board of park commissioners bought the Upper City park, now Audubon park. The population in 1860 was 168.755 and had increased by 1870 to 191,418. During this decade many freed Negroes had come to the city from country districts. In 1870 the fifth and sixth districts were added by the annexation of the town of Algiers on the opposite bank of the river and of Jefferson City, a town adjoining the iourth district. In 1874 Carrollton was admitted as the seventh municipal district, and Kew Orleans attained its present limits.

The history of New Orleans in the late 19th and early 20th century is largely its commercial and industrial expansion, and a building program discussed in *Government* below. The channel at the mouth of the river was deepened in the 1870s; by 1883 the city was linked by railroad with the west and north and formed the hub of the state network, as it still does. Although New Orleans was and is primarily a commercial city, there has been increasing development of industry in the 20th century (see *Commerce, Transportation* and *Industry* below).

In the spring of 1927, the city was saved from a great Mississippi river flood by blasting the levee at Poydras, about 15 mi. below the city, on April 29. This operation sacrificed the adjacent parishes of St. Bernard and Plaquemines at a cost to the city of approximately $5,000,000. To avoid similar danger in the future the Bonnet-Carré spillway was constructed about 35 mi.

above the city to remove 250,000 sec.-ft. of water from the river during excessive floods and deliver it into Lake Pontchartrain. Protected by this device and similar safeguards on the lower river, the city survived an even greater flood in 1945 without mishap or any emergency action.

Population Characteristics.—Of the 1960 population of the city 60.9% was native-born white, 2.3% foreign-born white and 39.1% Negroes, including mulattoes and others of mixed blood. Among the foreign-born, almost every nationality is represented; the Italians, who came in considerable numbers after 1900, are the most numerous. The creoles—by current usage the descendants of the original French and Spanish settlers—are perhaps the group for which New Orleans is best known. (Until late in the 19th century, this term as used in New Orleans meant persons born in the city, so that there were "creole" Anglo-Americans, Irish and Germans as well as "creole" Latins.) Although numerically less important than popularly believed (both in the 19th and 20th centuries large numbers of Anglo-Americans from southern and northern states and of immigrants from other European countries settled in the city) the Latin creoles still help give New Orleans a distinctive atmosphere among U.S. cities and the French language continues to be used. When a considerable number of Americans of Anglo-Saxon descent began settling in the city in the early part of the 19th century they built a quarter for themselves upstream from the *vieux carré*, the upper boundary of the American settlement being Canal street. In the 20th century, however, the lines were not nearly so strictly drawn; many creoles have settled in the newer portions of the city and some Americans have moved to the *vieux carré*.

Government and Administration.—The city government was at first carried out by a mayor and administrators, seven in number. In 1912, by act of the legislature, the commission form of government was adopted; the mayor became commissioner of public affairs. Four other commissioners had charge of public finances: public safety, public utilities and public property. In 1950 the legislature restored a mayor-council system, increasing the number of commissioners to seven, each elected by a separate municipal district.

Municipal Works.—During the administrations of de Lesseps Morrison, reform mayor who in 1946 defeated the Old Regular Democratic machine which had long controlled local government, a tremendous physical rehabilitation of the city was effected. Besides major transportation innovations, such as bridges (discussed below), 22 new overpasses eliminating 144 grade crossings were constructed. a central, modern railroad terminal and an extensive new municipal centre, consisting of six major buildings including the city hall, library. state supreme court building and a state office building were erected in the heart of the city on the site of a former slum area; many miles of streets were widened and improved and a program was launched to rehabilitate 45,000 substandard buildings over a ten-year period.

The location of New Orleans presents certain problems in regard to such municipal concerns as water and sewage. The entire city, except for its levees, is below the river high-water mark while a large portion of it is below that of Lake Pontchartrain. Combined with these difficulties New Orleans has heavy rainfall; occasionally more than 3 in. in 1 hour, 7 in. in 5 hours and 9 in. in 12 hours, having been experienced. As a result of the occasional excessive rainfalls, it has been necessary to provide large canal systems to convey the water to and from the pumping plants, and 11 pumping stations for the removal of storm water have been built. 'Ihe average annual rainfall is more than 50 in.; the topography is such that the runoff must be removed by pumping.

The sewage of the city is collected separately from the drainage and is finally discharged into the Mississippi, where the dilution is so great that it is not noticeable farther downstream. Like the drainage, the sewage has to be pumped, much of it through two or more lifts, and this is accomplished by electric pumping stations operating automatically.

Commerce, Transportation and Industry.—Among North American ports New Orleans is second only to New York in most categories. It accommodates more than 80 steamship lines and about 4,000 vessels enter the port annually. Located at the intersection of the Gulf Intracoastal waterway and the Mississippi river, it handles both internal river traffic and foreign trade. The limits of the port include a frontage of 51 mi. on both sides of the river and 11 mi. on the Industrial canal, which connects the river with Lake Pontchartrain; 20 mi. of publicly owned wharves, steel sheds, warehouses, grain elevators and similar facilities are maintained.

By the middle of the 20th century New Orleans had regained the pre-eminence as a port which it enjoyed before the Civil War but the most significant economic development in the post-World War II period was a great increase in industry along the entire lower river south of Baton Rouge. This boom was set off mainly by the discovery of great quantities of oil and sulfur on the Louisiana tidelands, petrochemicals being the most important of the new industries. Other factors responsible, besides the natural advantages of a port, were the accessibility of a cheap fuel, natural gas; free-water supply (300,000,000,000 gal. of water pass New Orleans each day at high river stages, twice as much as is used by the rest of the nation for all purposes); and the apparently successful control of floods on the lower river.

New Orleans is also served by trunk railroads, airlines, barge lines, truck lines, and a public belt railroad 128 mi. in length. It has three airports: the New Orleans airport on the lake, for private planes; the Moisant in Jefferson parish for commercial traffic; and Callender field, across the river below the city for military craft.

In 1928 the first bridge across Lake Pontchartrain, 25.000 ft. long, was completed. Shortly thereafter bridges across Chef Menteur and the Rigolets provided a more direct line to the Gulf coast. In 1935 the Huey P. Long bridge across the Mississippi 5 mi. above the city was opened to traffic, and in 1958 a second river bridge in the heart of the city was completed. In 1957 another bridge across Lake Pontchartrain, 24 mi. long, was put into operation.

Education and Cultural Activities.—The New Orleans public-school system includes kindergarten, elementary and high schools, evening schools and trade schools. In addition there are in the city over 100 nonpublic schools, both private and parochial (mostly Roman Catholic; some Lutheran). Uniform textbooks purchased by the state department of education are supplied to all nonpublic schools and their classes are conducted under a curriculum approved by the department. Largest of the strictly private schools is the Isidore Newman school, founded in 1903, which is coeducational.

Universities and Colleges.—New Orleans has several distinguished colleges and universities. The history of Tulane, a private university, dates from the foundation of a medical college (called the Medical College of Louisiana) in 1834. It was chartered in 1835 and in the following year issued the first degree in medicine conferred in the southwest. Other departments were added and in 1847 the institution took the name University of Louisiana; in 1884 it was renamed in honour of Paul Tulane. who had been a merchant in New Orleans for many years and who had made a very large gift of money to the institution. The university now includes a college of arts and sciences, schools of architecture, business administration, engineering, law, medicine and social work, and H. Sophie Newcomb Memorial College of Tulane university. for women, chartered in 1886.

Loyola university, a Roman Catholic university founded in 1904, is coeducational in its professional departments and for men in other departments. In addition to arts and sciences it has schools of dentistry and law and colleges of pharmacy, music and business administration.

Dillard university, established in 1930 by the merger of two earlier institutions, is affiliated with the Congregational Christian and Methodist churches. It grants the B.A. degree and the B.S. in nursing. Xavier University of Louisiana, a Roman Catholic university, began as a high school in 1915 but became a teachers' college two years later and has since added liberal arts and premedical departments and a graduate school. Originally for Negroes and Indians, it is now open to all races. St. Mary's Domin-

BY COURTESY OF (1) BUTLER AIRPHOTOS, INC., (2) NEW ORLEANS ASSOCIATION OF COMMERCE

VIEWS OF THE NEW AND OLD CITY OF NEW ORLEANS

1. Air view of New Orleans, showing at the left Canal street, the centre of the retail business district, and the sky-scrapers of the modern city. In the distance is the Mississippi river

2. Historic Jackson Sauare, formerly the Place d'Armes, in the old French Quarter. On the left side of the St. Louis Cathedral, built in 1794, is the Spanish Cabildo, now part of the Louisiana State Museum, and on the right is the Presbytere, construction on which was started in 1794. On adjoining sides of this Sauare are the so-called Pontalba apartments built by the Baroness de Pontalba in 1849

ican college is a Roman Catholic liberal arts college for women, established in 1860. Louisiana State university in New Orleans, an integral part of the state university in Baton Rouge (see LOUISIANA: *Education*), opened in 1958 with a freshman class and added an additional class each of the following years until a four-year program was in operation.

Other Institutions.—The Isaac Delgado Museum of Art in City park was established by a gift from Isaac M. Delgado in 1911. The annual exhibition of the Art association is an important event. The Cabildo houses an important historical museum containing much of interest and value pertaining to the history of Louisiana and New Orleans. The Presbytbre, facing Jackson square on the side of the Cathedral of St. Louis, contains a valuable museum of natural history, principally relating to Louisiana. The Confederate Memorial hall, located on Camp street, contains relics of the Civil War. The Tulane university museum occupies the entire third floor of Gibson hall; it contains petrological, paleontological, zoological and anthropological sections. Several galleries exhibiting contemporary art are to be found in the *vieux* carrd. A civic symphony has been established and the Philharmonic society brings the great contemporary musicians and concerts to the city. The Metropolitan Opera comes annually, thus reviving interest in French opera which was originally heard in New Orleans long before it was heard in New York. The Department of Middle-.American research, created in 1924 as a department of Tulane university, has a museum and library, field work and publications as its primary activities. The library of 40,000 items and the museum contain manuscripts, documents and other material relating to Mexico and Central America from expeditions and purchases which are being constantly increased. The institute has a permanent endowment of $300,000. The New Orleans spring fiesta was organized in 1937 and has created tourist interest in art, architecture, gardens and local traditions. The city has more than 12 major hospitals of various types, the largest of which is the Charity.

Journalism.—New Orleans has long been an important newspaper and publishing centre. The *New* Orleans Picayune was founded in 1837, the *Daily* Times in 1863, the Daily *Democrat* in 1875. The two latter formed the Times-Democrat in 1881 and this and the *Picayune* became the Times-Picayune in 1914. The Daily *Item* began publication in 1877, later becoming the New Orleans Item. The Daily States, started in 1880, was purchased by the Times-Picayune company in 1933 as an afternoon and combined Sunday publication. In 1959 the same company bought the *Item* and merged it with the States. This exemplified the tendency, common in the larger U.S. cities, of consolidating ownership of newspapers and thereby eliminating competition; many observers felt that as a result the press in New Orleans in the latter part of the 20th century was characterized mainly by its anemia. .

Among the many writers associated with New Orleans Lafcadio Hearn and George W. Cable are probably the best known. John James Audubon, the artist-naturalist, made his home there for several years.

Recreation and Tourist **Attractions.**—New Orleans is well known as the home of the largest and most colourful Mardi Gras celebration in the United States. The carnival season extends from Twelfth Night (Jan. 6) to Lent and is climaxed by the festivities of Mardi Gras, "fat Tuesday" before Ash Wednesday. Out of the simple idea of masked revelry in the open streets has developed a complex organization of gorgeous torch-lighted parades and balls. The first carnival parade (as distinguished from the Mardi Gras celebration) was held in 1827 by masked students who had recently returned from Paris. In 1837 and 1839 the first processions with "floats" were held in New Orleans. The regular annual pageants, almost uninterrupted except during the Civil War, date from 1857, when the "Mystic Krewe of Comus," the oldest of the carnival organizations, was formed. There are a number of other organizations, secret societies and clubs which assume responsibility for certain portions of the Mardi Gras celebration, which extends for several days. Most of the balls are private but the public parades are a major tourist attraction.

Other tourist attractions are the vieux *carré* and the Garden .district. In the vieux carrd, Spanish and French influences combined to form a unique creole style of architecture; characteristic features of the buildings in the area (many of which are now preserved as historic monuments and are open to the public) are enclosed rear courts, balconies and extensive use of wrought-iron railings and cast-iron "lace." The Garden district, originally a residential district for the American aristocracy who arrived after 1803, is between St. Charles avenue and the river; it is characterized by handsome homes, mostly Greek Revival in style. The city is also famous for its fine restaurants.

Extensive plantings of azaleas and camellias have beautified the city and it is well supplied with parks. Audubon park, with 234 ac. is situated in the upper portion of the city and contains a statue of Audubon. The original area of City park mas about 1.400 ac., later developed and beautified further. The area was added to by hydraulic dredging on the lake shore front between West End and beyond Bayou St. John on the east. A large municipal yacht harbour was constructed at \Vest End. Many miles of boulevards and driveways, with parks and bathing beaches, were also developed as residential areas.

The salubrious climate, the Gulf of Mexico and the hundreds of bayous, rivers and lakes in southern Louisiana make New Orleans a sportsman's paradise. Opportunities for sailing, boating, hunting and fishing, both salt and fresh-water, are excellent. Tarpon are frequently caught within the city limits and numerous fishing rodeos are held annually.

During the Christmas holidays a Mid-Winter Sports carnival is held, ending with the Sugar Bowl football game on New Year's Day. The Fair Grounds race track opens its season each year on Thanksgiving Day; races are held every day except Sunday for three months. As matters of incidental interest it may be mentioned that jazz (*q.v.*) derived most of its original impetus from the Negro musicians of New Orleans and the term Dixie (*q.v.*) is said to have originated there.

See also Index references under "New Orleans" in the Index volume.

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NEW PHILADELPHIA, a city of eastern Ohio, U.S., about 22 mi. S. of Canton; the seat of Tuscarawas county. Located in Ohio's unglaciated hill country in the valley of the Tuscarawas river, the city and its surrounding countryside comprise one of the most scenic and historic areas in Ohio. Just south of the city, the Moravian missionary, David Zeisberger (1721–1808), founded the mission village of Schoenbrunn ("beautiful spring") among the Delaware Indians in 1772. There the first church and schoolhouse in Ohio were built, but in 1777 the settlement had to be abandoned on account of the hostility of neighbouring Indians. The site of Schoenbrunn, discovered in 1923, has been restored. To the north, Ft. Laurens, the only Revolutionary War fort in Ohio, was built in 1778, while nearby, a band of German Separatists in 1817 established the communal village of Zoar which lasted until 1898.

New Philadelphia itself was founded in 1804 by John Knisely on lands set aside by the federal congress in 1796 as the United States military district, tracts within which were to be distributed to veterans of the Revolutionary War. Named in honour of Philadelphia, Pa., the community grew slowly at first, the population reaching but 1.413 by 1850. After the American Civil War, however, growth was more rapid, principally because of the development of large deposits of coal and clay in the immediate area which enabled it to emerge as one of the important small industrial centres of Ohio. Principal industries include the manufacture of mining and road equipment, tapered roller bearings, tools, batteries, spark plugs and ceramics.

Serving as headquarters for the Muskingum Watershed Conservancy district, New Philadelphia is in the heart of one of the nation's most important conservation, flood control and recreational areas. New Philadelphia was incorporated as a village in 1815 and as a city in 1896. For comparative population figures see table in OHIO: *Population.* (P. R. S.)

NEW PLYMOUTH, municipality and seaport on the west coast of the North Island, New Zealand, capital of the provincial district of Taranaki, 251 mi. N.N.W. of Wellington by rail. Pop. (1956) 24,071 (28,292 including urban areas). The town is noted for its parks and gardens, and the district, sometimes called "the garden of New Zealand," produces cereals and fruit and is one of the chief dairy centres of New Zealand. The settlement was founded in 1841 by the Plymouth company under the auspices of the New Zealand company, and chiefly consisted of emigrants from Devonshire and Cornwall. On the seashore are extensive deposits of ironsand. Mt. Egmont (8,260 ft.), 18 mi. from New Plymouth, is well-knomn for its winter sports.

NEWPORT (Welsh, CASNEWYDD), a municipal, county and parliamentary borough, seaport and market town of Monmouthshire, a county of England which for most administrative purposes is still part of Wales. Newport lies on the Usk, 5 mi. from its confluence with the Severn, and is 12 mi. N.E. of Cardiff and 24 mi. S.W. of Monmouth by road. Pop. (1951) 105,547. Area 11.5 sq.mi. It lies chiefly on the right (west) bank of the river, and on the east, north and west it is sheltered by a line of hills.

An ancient mesne borough and castle, it occupied an important position on the Welsh marches. The town, which is not mentioned in Domesday, grew up round the castle built early in the 12th century. Giraldus Cambrensis, writing in 1187, calls it *Novus Burgus*, probably to distinguish it from Caerleon, whose prosperity declined as that of Newport increased. From Robert Fitz Hamon (d. 1107) the lordship passed to the earls of Gloucester and Stafford and the dukes of Buckingham.

The town received its first charter in 1227, and Hugh le Despenser, who held the lordship for a short time, obtained in 1323 a charter of liberties for the burgesses, granting them freedom from toll throughout England, Ireland and Aquitaine. The earl of Stafford granted a further charter in 1385, confirmed by his grandson in 1427, which gave the burgesses the right of self-government and of a merchant guild. On the attainder of the duke of Buckingham in 1483 the lordship lapsed to the crown, of whom it was held in the 16th and 17th centuries by the Pembrokes, and in the 19th by the Beauforts. The town was incorporated by James I in 1624. In 1385 the borough obtained a market lasting 15 days from the vigil of St. Lawrence (Aug. 10). The charter of 1624 granted two fairs. Newport was the scene of a serious Chartist riot in 1839. The town became a county borough in 1891 and returns one member of parliament.

The old parish church of St. Woollos (after 1921 the cathedral church of the Anglican diocese of Monmouth) stands on Stow hill. Originally it consisted only of the present nave, a fine specimen of grand, though unadorned, Norman architecture; but a massive square tower (of the time of Henry III) and a chancel were added later; a large western Early English lady-chapel is interposed between the nave and the tower.

The castle was greatly altered in the late Perpendicular period and was restored in 1929–30. The old Dominican monastery is entirely rebuilt and occupied as a private residence; but there are a few fragments of a house of White Friars. The town has a museum and an art gallery. Kewport increased rapidly in the later part of the 19th century because of its situation on a fine tidal river, which renders it an outlet for the eastern section of the South Wales coal fields.

There are the Alexandra, North and South, docks with a quayage of 7,839 and 17,189 ft. respectively, and the Town (Old) dock with a quayage of 4,853 ft. The Alexandra docks, opened in 1875, enclose a sheet of water $28\frac{3}{4}$ ac. in extent. The average depth of water in both Alexandra docks is 45 ft. at spring tides and 35 ft. at neap tides. In the Old dock, begun in 1842, the depths are 30 ft. and 20 ft. respectively. There are two dry docks connected with the Alexandra docks, one being 523 ft. long and 74 ft. wide and the other 453 ft. long and 64 ft. wide. There are three other dry docks, all of them entered from the river. The town grew rapidly during the first quarter of the 20th century under a town planning scheme, and extensive building was carried out at Somerleyton and St. Julian's.

A transporter bridge, opened in 1906, gives 177 ft. clearance and a road bridge. 60 ft. wide, forms the main gateway for traffic from London to South Wales. There is an impounding reservoir at Talybont. Breconshire, with a capacity of 2,567,000,000 gal. Newport's industries mere greatly diversified in the 1940s. In 1953 the biggest electrical power station in Europe was completed at Uskmouth and plans were approved for a shipbuilding yard at Newport capable of building the largest type of tanker.

NEWPORT, a market town, municipal borough and county town of the Isle of Wight, England. Pop. (1951) 20,430. Area 24.3 sq mi. It is near the centre of the island, at the head of the wide estuary of the Medina river. 5 mi. S. from its mouth at Cowes. Industries include plastics and woodwork, milling, brewing and mineral water manufacture. Newport is the centre of the island's agriculture and its harbour is used for import and export business. The church of St. Thomas of Canterbury was rebuilt in 1854 in the Decorated style; the county hall was built in 1938 and the town hall (1816) was designed by John Nash. The grammar school was founded in 1614. The Albany barracks, Parkhurst prison and Camp Hill Borstal institution, the last two in Parkhurst forest, lie north of the town. Neuport was probably a Roman settlement, then known as Medina; remains of a villa in good preservation were found in 1926. There are no traces of Saxon occupation and no evidence that Newport became a borough before the reign of Henry II. The first charter was granted by Richard de Redvers between 1177 and 1184, and a second, by Isabel de Fortibus, was confirmed by successive kings. The borough was incorporated by James I in 1608 and the final charter, by which Newport was governed until 1835, was granted by Charles II in 1661. It was represented in parliament in 1295, but no other return was made until 1584, when it regularly sent two members. From 1867 to 1885 it sent one but in 1885 its representation was merged in that of the island. The Saturday market dates from 1184, and there is a Tuesday market. Because of its facilities for trade, Nemport early superseded Carisbrooke (*q.v.*) as the capital of the island.

NEWPORT, a city of northern Kentucky, U.S , on the Ohio river, near the mouth of the Licking, opposite Cincinnati, O.; one of the seats of Campbell county and a part of the Cincinnati metropolitan area (see CINCINNATI). Across the Licking is Newport's sister city, Covington

The first settlement, planned in 1790 by Hubbard Taylor, a young soldier, was named in honour of Christopher Newport, commander of the first ship to reach Jamestown in 1607 In 1795 Newport was incorporated as a village and in 1835 as a city. The only antislavery newspaper published in Kentucky during the 1850s was edited in Newport by William Shreve Bailey. It was given various names by its editor, the last being The Free *South.* On Oct. 28, 1859, after a proslavery mob threw his presses and type into the street, Bailey took his paper across the river to Cincinnati.

Newport experienced its greatest growth in the 1880s and 1890s because of the influx of many German settlers and the completion of bridges to Cincinnati, which promoted its development as a residential suburb of that city. A metal fabricating centre, Newport was the scene of a seven-year (1921–28) strike by steelworkers. In 1932 Newport adopted a council-manager form of government. For comparative population figures see table in KENTUCKY: *Population.* (W. F. ST.)

NEWPORT, a city of southeastern Rhode Island, U S , about 30 mi. S.S.E. of Providence, occupying the southern end of the island of Rhode Island (or Aquidneck) in Narragansett bay; a port of entry and the seat of Nenport county. It is a place of historic interest. important formerly as a fashionable summer resort for some of the wealthiest U.S. families and in the second half of the 20th century for its naval installations.

From the harbour on the west, the city rises up a gentle hillside to a plateau at about 250 ft. elevation. Famous for its mild climate the year round. it attracted southerners and West Indian planters in summer as early as the first quarter of the 18th century. The city itself is a community of contrasts. An old section, dating from the colonial period, consists of historic buildings and homes set on narrow streets which climb the slope eastward from the harbour. Along Newport's Bellevue avenue, which runs through the heart of the island. and around the southern coast line can be seen the magnificent mansions of 19th- and early 20th-century millionaires. Some of these have been boarded up while others have been converted for church and school use. A few are still used as summer homes.

Until 1900 Newport was one of Rhode Island's two capital cities, sharing that honour with Providence. The Old State house or Old Colony house (1739), one of the most interesting colonial buildings in the state, still stands at the head of the old Parade, now Washington square. Not far away are such historic structures as Trinity church (1725): Touro synagogue (1763), the oldest in America (designated a national historic site in 1946). famous for the architectural beauty of its interior; and the Redwood library (1750).

The old section known as "the Point." on the harbour front, contains many fine homes of colonial merchant princes. Some of these homes have been restored and opened as museums by the Preservation Society of Newport county. One such is the Hunter house, furnished with outstanding antique furniture, much of it produced by the famous Newport dynasty of colonial cabinetmakers, the Tonnsends and Goddards. Also restored and opened to the public is the pre-Revolutionary White Horse tavern.

In Touro park at the top of the hill is Newport's most enigmatic structure, a stone tower set on stone pillars. Long thought to be a vestige of the Norsemen's visits to America before Columbus, it is now held by most responsible archaeologists and historians to be the remains of a 17th-century windmill built by Benedict Arnold, one of the early settlers and an ancestor of the traitor of the same name.

Other points of interest include the Newport casino, scene of an annual grass-court tennis tournament and the American Lawn Tennis association's tennis "Hall of Fame," and "The Breakers." former summer home of Cornelius Vanderbilt, now open in summer as a museum.

Newport nas founded in 1639 by a group of refugees from the Antinomian controversy (*see* HUTCHINSON, ANNE), in Massachusetts who had first settled the year before at the north end of the island in the present town of Portsmouth. Following a schism in that settlement a group led by William Coddington moved to the south end of the island and established Nenport nhich. because of its excellent harbour and strategic position for water-borne commerce, soon became one of the richest and most flourishing cities in colonial America, surpassed only by Boston, Mass., Philadelphia. Pa.. and New York city.

The British occupation of Newport during the American Revolution, which resulted in a flight of almost all the leading merchants to the mainland, followed within a few decades by the shift of Rhode Island's income from commerce and shipping to textile mills and other manufacturing, brought about the economic decline of the city. But its splendid climate and its charm remained unchanged and right after the American Civil War its rise as a summer resort was spectacular.

In the second half of the 20th century manufactures included electrical instruments and appliances but the largest industry was the complex of naval installations. Comprised of the Naval War college and the several components of the Newport naval base, which includes the naval station (formerly the naval training station), the naval underwater ordnance station (formerly the naval torpedo station), the Melville net and fuel depot in nearby Portsmouth and the naval hospital. The naval station, formerly used to train recruits, now consists of the officerscandidate school and fleet training centre, the legal school. chaplains indoctrination school, WAVES general line school and navy supply school.

Printing in Rhode Island was begun at Newport in 1727 by James Franklin, an older brother of Benjamin, and the colony's first newspaper was published there in 1732. It failed shortly but in 1758 James Franklin. Jr , established the *Newport Mercury,* still published as a weekly.

Newport, beginning in 1954, mas the home of an annual jazz festival, generally held over the Independence day week end. Newport is the seat of Salve Regina college (Roman Catholic, 1947) for women.

Chartered as a city in 1784, Newport resumed the town form of government in 1787, but again became a city in 1853. In 1953 Newport adopted a council-manager form of government. For comparative population figures see table in RHODE ISLAND: *Population.* (B. F. s.)

NEWPORT BEACH, a city of Orange county in southern California, U.S., 35 mi. S.E. of Los Angeles. It includes the communities of Nenport Beach and Balboa on a four-mile-long sandspit between lower Newport bay and the Pacific ocean, Lido Isle and Balboa Island in the bay, and Corona del Mar and Newport Heights on terraces above the northeast shores of the bay. The area is popular as a recreational resort developed around yachting, sportfishing and beach activities, and as a residential community for commuters to Long Beach and Los Angeles. Industries include boatbuilding and repairing, fish canning and packing and the manufacture of electronic components and plastics. The bay itself was a port for Yankee skippers during the Spanish and Mexican periods of California history and from 1872 to 1898 it achieved some local significance as a commercial port. Incorporated in 1906, the city adopted a council-manager form of government in 1946. For comparative population figures *see* table in CALIFORNIA: *Population.* (R. A. R.)

NEWPORT NEWS, a city and port of entry in the tidewater region of southeastern Virginia, U.S., on the north side of the great harbour of Hampton Roads (*q.v.*) and the James river. Its population (1960) was 113,662. The Newport News-Hampton standard metropolitan statistical area, which includes the cities of Newport News and Hampton and the county of York, had a population of 224.503.

Settled by Daniel Gookin, who arrived from Ireland in 1621 with 50 colonists, the area was already known as Newportes Newes. There is no satisfactory explanation of the origin of this unusual name. Newport Nens remained a tiny hamlet until 1880 when it was chosen as the Atlantic deep-water coal shipping port for the Chesapeake & Ohio Railway system. Two years later the town mas laid out and in 1896 it was incorporated as a city. During World War I Newport News was an important port for supplying the Allies and also served as a major supply and embarkation port for U S. forces in 1917–18. In World War II it was headquarters for the Hampton Roads port of embarkation. In 1952 Newport News was made administratively independent of Warwick county in nhich it was located. That same year Warwick county was incorporated as the city of Warwick. and in 1958 Newport News and Warwick merged as the city of Newport News. In 1920 the city adopted a council-manager form of government. Its port facilities. along uith those of Norfolk, Portsmouth (*qq.v.*), Hampton and South Norfolk, are under the jurisdiction of the Virginia State Port authority of Hampton Roads, created in 1926. Modern pier facilities can handle more than 30,000,000 tons of coal per year as well as ore. bulk liquids and general cargo. The Newport Nens Shipbuilding and Dry Dock company, founded in 1886, has one of the largest and most complete shipyards in the world. Among the vessels built there were the luxury liners "America" and "United States," the giant aircraft carriers "Forrestal" and "Enterprise" and the submarine "Robert E. Lee," designed for firing Polaris guided missiles. Both the "Enterprise" and the "Lee" were nuclear powered. In addition to shipbuilding and repairing, Newport News' industries include railroad shops, oil refineries, fish processing plants and the manufacture of textiles, paper products, radar and electronic equipment and mica products. Among points of special interest in the city is the Mariners' museum (1930), containing a collection of ships' figureheads. ship models, anchors, deck and navigation gear, volumes of sea lore, maps, charts and globes. (M. BR.)

NEWQUAY, an urban district and seaside town in the North Cornwall parliamentary division of Cornwall, Eng., 20 mi. W.S.W. of Bodmin by road. Pop. (1951) 9,930. Area 7.2 sq.mi. Newquay, on the tidal Gannel, is almost entirely a modern holiday town, having grown since the mid-19th century from a small fishing village. It stands mostly on bold cliffs overlooking sandy beaches, sheltered on the west from the Atlantic by Towan headland. The climate is equable and tropical plants grow in the Trenance valley. The small harbour, in the shelter of Towan headland, is now used only by local fishing and pleasure boats.

NEW ROCHELLE, a city of Westchester county, N.Y., U.S., on Long Island sound about 14 mi. N.E. of New York city. Founded in 1688 by a group of Huguenots who had fled persecution in France, it became in modern times largely a residential city for those who work in the nearby metropolis. The few local industries produce a variety of light products including surgical instruments, television parts, plumbing supplies and electrical machinery. Many parks lie within the city, while Glen Island nearby on the sound provides 108 ac. of recreational space. There are two colleges, both Roman Catholic, located there. The College of New Rochelle (women) was founded in 1904, while Iona college, a business and liberal arts institution for men, dates from 1940. Named for La Rochelle, the old Huguenot bastion in France, the community has continued since its founding to figure in history. Men and women of prominence who were born or lived there include Peter Faneuil, John Jay, Gen. Philip Schuyler, Thomas Paine and Susan B. Anthony. Points of particular interest are Ft. Slocum, an army post offshore,and a farm cottage given to Thomas Paine by the state of New York, where he spent several of his last years. Incorporated as a village in 1858 and a city in 1899, New Rochelle adopted the council-manager form of government in 1932. Pop. (1960) 76,812; for comparative population figures *see* table in NEW YORK: *Population*. (C. B. F.)

NEW ROMNEY, a municipal borough in the Ashford parliamentary division of Kent, Eng., and one of the Cinque Ports (*q.v.*), 18 mi. S.S.E. of Ashford by road, and more than a mile from the sea. Pop. (1951) 2,356. Area 2.4 sq.mi. Between the town and the sea has grown Littlestone-on-Sea. New Romney lies on Romney marsh, part of a level extending from Winchelsea in the southwest to Hythe in the northeast, which was within historic times in great part covered by an inlet of the sea. The marsh is cordoned off by the Royal Military canal. The river Rother, which now has its mouth at Rye harbour, formerly entered the sea there, but had its course wholly changed during a great storm in 1287, and the gradual accretion of land led to the decay not only of New Romney but of Winchelsea and Rye as seaports. Romney marsh itself is protected by a sea mall, and its guardianship and drainage are in the hands of a special corporation dating from 1462.

Its harbour was the cause of the early importance of Romney, as it was called before 1562–63, and the annual assembly of the Cinque Ports, called the Brodhull, was held there. At the time of Domesday Book the archbishop of Canterbury and the bishop of Bayeux were joint lords. Romney owed the maritime service to the king of supplying five ships to serve for 15 days in the year. A confirmation of liberties was granted by John in 1205. The town was incorporated by Edward III and was represented in the parliament of 1265. It returned two members from 1366 to 1832. After Elizabeth I's charter of 1563, the town was officially New Romney. A large collection of records, maps, etc., relating to the Cinque Ports are in the town hall at New Romney. There is a big sheep fair in August. Of the five churches mentioned in Domesday Book only the Norman church of St. Nicholas remains; there are ruins of a 13th-century priory. The Romney, Hythe and Dymchurch light railway, of 15 in. gauge, incorporated in 1926, is one of the smallest public railways.

NEW ROSS, a town of County Wexford, Ire., on the Barrow, 2 mi. below its junction with the Nore, 87 mi. S.S.W. of Dublin by road. Pop. (1956) 4,643. St. Abban founded the abbey of Rossmactreoin in the 6th century, which gave rise to the ancient city Rossglas or Rossponte. There are remains in Rosbercon, on the Kilkenny side of the Barrow which is there crossed by a swing bridge (1869), of a 13th-century Dominican foundation. In 1269 the town, which stands on a steep hill overlooking the river, was surrounded by walls. The fortresses were dismantled by Oliver Cromwell. Inland water communications reach Dublin by means of the Barrow and the Grand canal. New Ross has breweries and tanyards, a salmon fishery, and exports agricultural produce.

NEWRY, a seaport, urban district and market town in County Down, N.Ire., on the Newry water and Newry canal at the head of Carlingford lough, 38 mi. S. of Belfast by road. Pop. (1951) 13,261. Area 1.1 sq.mi. The site of an abbey founded in 1175, Newry was granted by Edward VI to Sir Nicholas Bagenal, marshal of Ireland. It had an important strategic situation on the route through the "Gap in the North" by which armies attempted to penetrate Ulster from Dublin, Drogheda and Dundalk. In 1689 Newry was set on fire by the duke of Berwick when in retreat before Schomberg. Charters were granted to the town by James I and James II and until 1898 a portion of Newry belonged to County Armagh. The town is picturesquely situated and contains some very attractive Georgian buildings. Spinning and weaving of linen is carried on in Newry and the adjacent village of Bessbrook, and Newry's many industries also include cotton spinning and weaving and the manufacture of waterproofs, dehydrated potato preparations and other food products. Granite is quarried in the vicinity.

NEWS AGENCY, an agency which supplies news to newspapers, periodicals, clubs, associations or private persons, by telegram, in manuscript, proof, by tape machine or duplicated; less frequently by telephone. A news agency does not itself publish news but supplies information privately to its subscribers.

The paramount virtue of the news agency is that, by supplying material to a large number of subscribers, it spreads the cost of collecting such information among all those taking the service and so puts it on an economical basis: no newspaper could, on its own, afford to maintain the kind of coverage which a great news agency provides. All newspapers rely chiefly on the agencies for the receipt of what may be called formal or expected news: *e.g.*, market returns, city quotations, honours lists and election results.

For general news the agencies cover a larger area than any one journal could. An example of agency work is the coverage given in Great Britain by the Press association's representatives of football matches throughout the United Kingdom each Saturday between August and May. and of the like service given by U.S. news agencies during the baseball and football seasons. Interest in the games is widespread, but no single newspaper possesses the resources to enable it to have representatives at each of the matches. (*See* PRESS SYNDICATE.) (K. R. V.; X.)

United States.—The oldest and largest of U.S. news agencies is the Associated Press. Its forerunner was an informal, unincorporated group of New York newspapers which agreed in May 1848 to obtain in one telegraphic dispatch the foreign news brought by ships arriving at Boston, first U.S. port of visit by transatlantic vessels. This co-operation was successful, and the principle was gradually extended. Shortly after an 1856 reorganization, the group came to be called Associated Press of New York; mutual itself, it sold its service to various regional groups. In 1882, however, the Western Associated Press obtained a share in management; ten years later N.Y.A.P. perished in a realignment in which the modern A P., incorporated as Associated Press of Illinois but operating in both the east and the west, was set up in opposition to the United Press (1882–97). An antimonopoly suit by the *Chicago Inter Ocean* in 1900 caused the dissolution of this corporation, which was immediately supplanted by a new one under New York's more lenient laws. A prosecution for violation of the Antitrust act, founded on complaints of the *Chicago Sun,* was successful in 1942–45, thus blackballing of new members by old ones, and practices similar in effect, were no longer possible. By the mid-1950s A.P. had over 1,700 members, as well as more than 1,300 radio and television stations which were associate members, and over 4,000 foreign subscribers. Though a mutual, it pays many local correspondents connected with member papers.

United Press associations was formed in 1907 by E. W. Scripps as a merger of two of his own agencies and one independent.

Under Roy W. Howard's aggressive management (1907–21), the U.P. had obtained more than 1,400 clients before the outbreak of World War II, 130 of them in Latin America and 320 in Europe and Asia. Though not a co-operative, its clients shared its nems efforts. International News service was organized by W. R. Hearst in 1909 for morning papers. After repeated shuffling of Hearst services. INS emerged in 1928 as a round-the-clock service. By the mid-19jos it was said to have in the neighbourhood of 1,000 clients. some in foreign countries. In 1958 U.P. and INS merged to form United Press International (U.P.I.).

Besides these great agencies, there were in the 1950s more than 100 news services, all of which were, in one way or another, more limited in scope. Some were restricted geographically. Some were specialized, as Science service, Religious News Service, Educational Newsfeatures, Daily Sports News service, Associated Negro Press. Several large newspapers syndicated their own correspondence through special agencies such as the Chicago Daily News Foreign service. Chicago Tribune Press service and Chicago Tribune-New York News syndicate, New York Times syndicate, and New York Herald Tribune News service.

Reuters in Great Britain was allied with A.P., exchanging its United Kingdom domestic report for A.P.'s corresponding report from the United States; but each retains the right to market its report in the other's territory as foreign news: and thus Reuters served about 30 U.S. papers with its foreign report at mid-20th century. Canadian Press, founded in 1911 as Canadian Press Ltd., exchanged reports with A.P. from its beginning.

Many of the news agencies mentioned handle features as well; likewise the great feature syndicates handle much straight news, as North American Newspaper alliance (NANA) and Newspaper Enterprise association (SEA). The service of the former includes the report of the Kemsley Foreign News service. McGraw-Hill's World News is an agency established in 1945 to serve magazines.

Pictures are often quite as much news as word reports. By the 1950s there were approximately 75 agencies distributing news pictures located in various G.S. cities, more than one-half of them in New York. Prominent were Wide World Photos, organized by the *New York Times* in 1919 and later taken over by the A.P.; Acme Newspictures, NEA subsidiary, founded 1924; International Photos, Hearst unit begun in 1910 and later a subsidiary of King Features. (F. L. MT.)

Great Britain. — In Great Britain the dominant news agency is the Press association, or the P.A., which is owned co-operatively by the British newspaper press, national and provincial, although its services are available to all. It has special parliamentary and law-court reporting divisions.

The P.A. disseminates home news only. Overseas news is put out by Reuters, with which the P.A. is linked. Although Reuters supplies only overseas coverage to its subscribers in the United Kingdom, it takes the P.A.'s home-news service for dissemination to its subscribers in other countries. There is also a P.A.-Reuters Features and a P.A.-Reuters Photos organization.

Also active in Great Britain are the Exchange Telegraph Co.. Ltd.; the Associated Press. Ltd., London end of the Associated Press (the P.A.'s equivalent in the United States); the British United Press, Ltd., associated with United Press International.

Among the important national news agencies of countries outside the United Kingdom are Agence France-Presse, the U.S.S.R.'s Tass (Telegraphnoie Agenstvo Sovietskavo Soiuza) and the Irish News agency.

The true news agencies must not be confused with the numerous feature agencies which submit general and specialist articles on a free-lance basis. There are also many governmental and "propaganda" agencies which supply news on a broadcast scale for which no fee is charged: thus most commonwealth and foreign countries maintain services in Great Britain to put out regular daily or weekly bulletins carrying items of a "national" character to which they are anxious to give publicity. (K. R. V.)

NEW SIBERIAN ISLANDS are situated off the Arctic coast of Siberia, in Yakut Autonomous S.S.R., Russian S.F.S.R. from 73° to 76° 6′ N., and 135° 30′ to 151°. E. The name is loosely applied, covering either the northern group only of these islands, for which the name of New Siberian or Anjou Islands ought properly to be reserved, or the southern group as well, which ought to retain its name of Lyakhov Islands. Some confusion prevails also as to whether the islands Bennett, Jokhov, Vilkitski. Henrietta and Jeannette, ought to be included in the same archipelago, or described separately as the Jeannette or De Long Islands. The first three of these belong geographically, and probably geologically to the New Siberian group, from which they are less than 100 mi. distant. Henrietta and Jeannette Islands lie 200 mi. northeast of Novaya Sibir Island, in 157° to 159° E. Sannikov Land, reported by J. Sannikov in 1805 to lie north of Kotelni Island, probably does not exist.

The *New Siberian Islands* consist of Kotelni. the largest (116 mi. long, 100 mi. wide), having the small island Byelkovski near its western shore; Thaddeus (Faddeevski), in the middle; and Novaya Sibir, New Siberia, in the east (go mi. long, 40 mi. wide). Kotelni is the largest and reaches an altitude of 1,050 ft. in the volcanic Malakatyn-tas mountain. It is built of Silurian coral limestones (Llandovery division), containing a rich fossil fauna. The same Silurian deposits are widely spread on the mainland as far as the Olenek. Middle Devonian limestones and slates are all faulted north-northwest and south-southeast. Triassic slates appear in the southeast. Diabases pierce to Devonian rocks. The eastern portion of the island! named Bunge's Land, is covered with post-Tertiary deposits. Novaya Sibir Island attains altitudes of 200 to 300 ft. in its western portion. The so-called Wood Mountains, which were supposed to be accumulations of floating wood, are denudations of Miocene deposits containing layers of brown coal with full stems of trees. These Tertiary deposits are characterized by a rich flora and fauna. testifying to a climate once very much warmer. The only representative of tree vegetation now is a dwarf willow 1 in. high.

The *Lyukhov Islands* consist of Bolshoi, or Blizhni, which is separated by Laptev strait, 31 mi. wide, from Svyatoi Nos of Siberia; Mali, or Dalni; and several smaller islands to the west of Mali. Bolshoi too consists of granite protruding from beneath nonfossiliferous deposits. Along its southern coast Baron Toll found immense layers of fossil ice, 70 ft. thick, evidently relics from the Ice Age, covered by an upper layer of post-Tertiary deposits containing numbers of perfectly well-preserved mammoth remains, rhinoceros. *Ovibos,* and bones of the horse, reindeer, American stag, antelope, *saiga,* and even the tiger, associated with relics of forest vegetation. A stem of *Alnus fruticosa,* 90 ft. high, was found with all its roots and even fruit. Similar deposits of ground ice occur in Vasilievski Island. Basalts and Tertiary brown coal deposits enter into the composition of the southern extremity of Bennett Island; Vilkitski Island is low (50 ft.) and basaltic. Bennett and Henrietta Islands have a few small glaciers. Flocks of geese and other birds come to the islands in summer. The lemmings are numerous. Reindeer, followed by wolves, come across the ice from Siberia; the fox and polar bear feed on the lemmings. *See* ARCTIC, THE. (R. N. R.-B.)

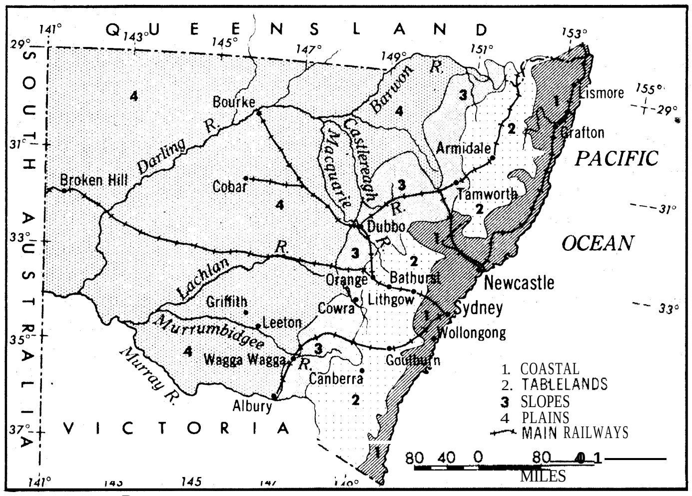
NEW SOUTH WALES, the most populous state of the commonwealth of Australia (3,423,529 of an Australian population of 8,986,529 in 1954), was discovered and named by Capt. James Cook in 1770 and settled by Capt. Arthur Phillip in 1788. It consisted originally of all Australian territory east of longitude 135° E.. but the western boundary was moved to longitude 129° E. in 1825. and thereafter the other eastern states were formed by separating from this area: Tasmania in 1825, South Australia in 1836, Victoria in 1851, Queensland in 1859, the Northern Territory in 1861–63 and the Australian Capital Territory in 1911. Thus the original area of 1,534,389 sq.mi. was reduced to 309,433 sq.mi., about 10.4% of the continent, forming the smallest mainland state after Victoria. The present boundaries are as follows: on the east, the Pacific ocean from Point Danger to Cape Howe; on the west, the 141st meridian of east longitude; on the north. the 29th parallel of south latitude, proceeding east along the Upper Darling and a spur of the Great Dividing range. and thence along the crest of the Macpherson range east to the sea; on the south. the southern bank of the Murray river to its source. and thence a straight line to Cape Howe. The coastal boundary, direct from Point Danger to Cape

Howe, is 683 mi. long: the western boundary is 340 mi.; and the average breadth between these about 650 mi.

PHYSIOGRAPHY

The state consists of four natural geographical divisions running north-south: the coastal lowlands, the tablelands forming part of the Great Dividing range between the coast and the plains, the western slopes of the dividing range and the western plains. The tablelands form a watershed dividing the state: the coastal division is drained by numerous short and rapid rivers which flow eastward from the plateau to the sea; in the west, the one river system, the Murray-Darling, drains the slopes and plains, running finally into the sea in South .Australia. The Murray, rising in the southern highlands, and joined by the Lachlan-Murrumbidgee (watering the southeast slopes) and the Darling and its tributaries (watering the central north and northwest). is the longest and most important river. The coastal rivers are rain-ied and liable to tlood: the western rivers are longer and have larger drainage areas, but their flow is less reliable and, particularly the Darling and its tributaries, are subject to regular droughts. The lack of water is a continual problem west of the dividing range except in the irrigatlon area along the Murrumbidgee and the Murray, where water conservation has completely transformed a low-rainfall area into a rich agricultural district.

The Coastal Lowlands are low-lying, undulating, well-watered (by rain and rivers) and iertile; their average width is jo mi. in the north and 20 mi. in the south, the widest part being the 1 jo mi.



PHYSIOGRAPHIC DIVISIONS OF NEW SOUTH WALES

of the Hunter valley. The climate is mild to hot, and humid: the average annual temperatures are 57°–76° F. in the north and 51°–68° F. in the south; the rainfall averages 30–80 in. a year and is greater in the north. The coast line consists of a succession of rugged promontories alternating with sandy beaches, inlets. river estuaries and, occasionally, marine and estuarine lakes. The river mouths are usually sand obstructed, but in the central coast subsidence has produced some fine drowned valleys. of which Port Jackson (Sydney) is outstanding. Along the rivers lies fertile alluvial land suitable for intensive agriculture (fodder crops) market gardening. fruit growing and, in the north, sugar cane growing) and dairy farming. There are rich coal fields round Newcastle and Wollongong. Almost everywhere the tablelands are separated from the coast by steep and often precipitous escarpments and gorges. Although only 22,287,000 ac. in area, on June 30. 1954, this division contained 2.6j1.851 people (79% of the state's population, of which 376,300 were factory employees). the metropolis and the two largest towns, nearly all the coal and manufacturing areas, all the seaports, the bulk of the dairying and maize growing and the state's financial. governmental and commercial headquarters. The most heavily populated areas are Sydney, the Hunter valley, the Clarence-Richmond-Tneed basins and the Illawarra district. In 1953–54 total cultivation was 311,007 ac. (about 18% of the land suitable for crops). butter production was 61,074 lb (about 85% of total production), the value of mineral production (mainly coal) was £36,523,629 and the value of manufacturing production was £486,473,082 (of a state total of £520,042,549). Wheat and sheep, however, are virtually excluded from this division because of the damp climate.

The Tablelands, an extensive and almost unbroken belt of plateaus running roughly parallel with the coast. vary in width from 30 to 100 mi., and average 2.500 ft. in height. rising to 4,877 ft. in the north (Ben Lomond), 3,400 ft. in the centre (Blackheath) and 7,316 ft. at Mt. Kosciusko (the highest peak in Australia'~in the south; the average height of the northern plateau exceeds that of the southern. The climate is cool or cold. with uniform and reliable rainfall: the average annual temperatures are 45°–70° F. in the north and 38°–63° F. in the south (about 10° F. lower on average than in the corresponding coastal region); the average annual rainfall is 40 in. in the east to 30 in. in the west. The southern tablelands with a mean average temperature of 54° F.. and occasional temperatures in winter below zero. are the coldest part of the state. To the east the tablelands fall steeply to the coast. to the west they slope gradually to the plains. Although there is good agricultural land on the tablelands; much of the country is too rough for anything but grazing sheep and cattle. There are, however. good mineral resources: tin in the north. coal in the centre (round Lithgow), and gold in both north and south. Lithgow is the only large manufacturing town (pop. 1 j.128 in 1954) and most other towns are commercial centres for pastoral, agricultural and mining pursuits. The Blue mountains. due west of Sydney. are a convenient and popular tourist resort. The total area of the tablelands is 25,847,000 ac., of which 548,086 ac. (16% of cultivable land) were under crops in 1953–54; the population was 274,508 (including only 15,513 factory employees) and 'the area contained 13,913,000 sheep (23.4% of the state's total). Agriculture consists mainly of mixed farming. particularly a combination of sheep and/or cattle and crops: the chief crops are oats, maize, wheat, potatoes, vegetables and fruit (apples and stone fruit).

To the west the tablelands slope gradually to the great *Western Plains* which cover nearly two-thirds of the state. The slopes, which vary from 150 to 300 mi. in width, consist of gently rolling country which descends from the plateaus (at elevations above 2,000 ft.) to levels of less than 1,000 it. on the plains. The climate is warm and dry, with a uniform rainfall: the average annual temperatures are 73°–81° F. in summer and 46°–53° F. in winter; the average rainfall varies from 30 in. in the east to 20 in. in the west. This division. with an ample and fairly reliable rainfall and fertile soil, is now devoted mainly to mixed farming, particularly wool-wheat production: the state's best wheat-growing area being the southern slopes. In this area, also, the upper basins of the western rivers and streams and the outcrops of ancient rocks along the slopes in the past yielded rich minerals, particularly gold. In the mid-1950s, of a total area of 28,163,000 ac., 2,770,977 ac. were under crop (about 20% of the cultivable land), producing 34,692,000 bu. of wheat (of a state total of 63,681,000) and 156,146,000 lb. of wool (off 19,427,000 sheep). The population was 262,275, of which only 10,122 were factory employees. Tamworth is the largest town with a population (1954) of 13,641.

The Plains, which extend from the edge of the slopes to the state's western boundary, and which are interrupted only by the elevated country from Orange to Cobar, and the Grey and Barrier ranges in the far west, divide into the central plains and the western plains. The central plains consist of the Riverina district, divided from the western plains by the Lachlan and Murrumbidgee rivers, and the low flat lands stretching east of the Barwon-Bogan rivers. The western plains consist of the area west of Lachlan, Bogan and Upper Darling rivers. Both plains, substantially the large flat basins of the Murray-Darling system, are floored with generally fertile red and black soils, but receive a scanty rainfall, particularly in the western district. However, the northwestern plains fall substantially within the Great Artesian basin, and the southwestern plains in the Murray river artesian basin; moreover, the dams on the upper courses of the Murray, Lachlan and Murrumbidgee have greatly increased the agricultural possibilities of the Riverina by irrigation. The climate is warm to hot, and dry, with a coolish winter; the average annual temperatures are 75°–84° F. in summer and 49°–54° F. in winter; the average annual rainfall varies from 7 in. in the northwest to 10–1j in. along the Darling and 20 in. in the east. In the western plains pastoral and mining activities alone have significance: silver-lead-zinc are mined at Broken Hill (pop. 31,355 in 1954) and opals at Lightning Ridge; pastoral holdings are large, and towns well spaced and, except Broken Hill, small. In the central plains, while wool-wheat predominates throughout. farming is relatively less important in the north and more important, especially in the irrigation area, in the south. The district consists of 121,715,000 ac. (41,394,000 in the central, and 80,321,000 in the western plains) with a population of 215,084 in 1954 (147,377 in the central and 67,707 in the western plains), of which only 6,131 were factory employees. The sheep population was 17,859,000 (29.9% of the state total) in the centre; and 7,238,000 (12.1%) in the west; wheat production was 24,791,000 and 39,000 bu. respectively; the value of mineral production in the west (*i.e.*, Broken Hill) was £21,742,352 (of a state total of £66,937,469).

Climate.— Yew South Wales is situated entirely in the temperate zone and its climate is generally mild, although occasional high temperatures are experienced in the northwest and some extreme cold on the southern tablelands. There is abundant sunshine in all seasons. Average temperatures are higher by 5° to 7° F. in the north than in the south, and the range increases toward the interior, the mean daily range on the coast being about 19° F. and on the western plains about 26° F. Most of the state has frosts for up to five months of the year, but these are severe only on the tablelands and western slopes. Snow has fallen, at various times, over about two-thirds of the state, but it is rare except on the tablelands; perennial snow is found only on the highest peaks of the southern tablelands. The seasons are well defined: autumn beginning in March, winter in June, spring in September and summer in December. The weather is determined chiefly by anticyclones which pass almost continually across the state from west to east, with consequent tropical and antarctic depressions; the state is fairly free from cyclonic disturbances. In summer the prevailing winds on the coast are northeasterly; in the west they are variable, with a marked northerly component in the north and a pronounced southerly component in the south. In winter the prevailing direction of the wind is westerly; due-mest in the southern and southerly in the northern part of the state. In winter New South Wales lies directly in the great high-pressure belt. The amount of rainfall varies from an average 80 in. a year in the northeastern corner to less than 7 in. in the northwest: generally, the east receives more rain. and more uniformly, than the interior. Approximately 39% of the state averages 20 in. a year or more; 17½%, 15 to 20 in.; 23½%, 10 to 15 in.; and 20% of the state averages less than 10 in. Heavy rains cause extensive flooding of the rivers, especially on the coast; and droughts, particularly in the interior, are also common. The minter rain region is bounded on the north by a line from Broken Hill to Wagga Wagga with a curve round to Albury (*i.e.*, the southwest corner of the state); the summer rain region is that part of the state north of a line from the northwestern corner to Newcastle; between those regions the rainfall is fairly evenly distributed, except on a narrow south coastal strip between Nowra and Broken Bay which receives its heaviest rain in autumn. Winter rains arise from antarctic, summer rains from tropical. depressions. Over most of the state the annual rainfall varies on the average between 20% and 35% from the mean. but in the southeast the variation is less and in the northwest it is more. The rate of evaporation increases from about 40 in. a year on the coast to about 100 in, in the northwest. Rainfall has exerted, a powerful influence in determining the character of settlement. the intensity of which varies directly with heaviness and certainty of the rain.

Flora **and** Fauna.— Of the 9,000 botanical specimens found in Australia. about 3.600 are to be found in New South Wales. The natural vegetation. determined mainly by rainfall and temperature, is very varied, from the dense semitropical forest of the north coast to the sparse vegetation of the western plains. Except for the plains, the state is well wooded; about 8% of it being covered with forest and a much larger area with bush and scrub. The forest land is concentrated mainly on the coast and tablelands, giving way on the western slopes to shrub eucalypts, and in the far west to saltbush and spinifex. The predominant tree is the eucalypt which has a great variety of species and which is the main source of the state's hard wood; it grows quickly: is a good timber-yielder and its better varieties (*e.g.*, ironbark and tallowwood) provide excellent timber. The eucalypts are specialized in habitat: the ironbark is found mostly on the coast and warmer parts of the tablelands; the tallowwood on the north coast; the Murray gum, though ubiquitous in Australia, in forests along the western rivers; and less valuable varieties (the box. the stringybark and the turpentine) on the coast and tablelands. The soft woods are found in much smaller quantities on the north coast (the red cedar, the colonial or hoop pine and rosewood) and on the western slopes (the cypress pine), and are used extensively as cabinet timbers. Native grasses, like trees, are well spread, covering most of the state except in the far west and where overstocking has been severe; many varieties are drought-resistant and are good fodder, and partly explain the excellence of the New South Wales pastures for sheep rearing.

The fauna of New South Wales, like that of the rest of Australia. is rich in marsupials and bird life. The dingo, the only indigenous mammalian carnivore of Australia, was once fairly common in western New South Wales! where it preyed on sheep. but fencing and hunting have now made it rare. Of Australian marsupials, New South Wales has three of the four species of native cat, one species of wombat, the native bear or Koala, the common and ring-tailed opossums, the common and long-nosed bandicoots and a variety of kangaroos and wallabies. In addition. the remarkable monotremes unique to Australia, the platypus and echidna, are both found in New South Wales. The state also falls partly into the three main ornithological regions of Australia and thus contains species of most of Australia's bird life: it has the emu in the west; of the mound builders, both the scrub turkey and the mallee hen; the lyrebird on the north coast; a host of parrots and other more common species. Snakes: particularly the black snake. are also found over most of the state. The best-known fish is the Murray cod, an excellent table fish, which is found in all the western rivers.

Both flora and fauna have been considerably modified by white settlement: re-afforestation, particularly with soft woods. is changing the pattern of forests; introduced grasses and intensive agriculture are changing the character of pastures in many areas; and, generally, all animal life is retreating to the less-inhabited regions of the state; some immigrants, *e.g.*, the rabbit and the trout, are completely acclimatized.

HISTORY

The Prison Farm, **1788–1820.**—New South Wales was settled as a convict colony, a place of exile, punishment and reform for British criminals sentenced to transportation. The American Revolution, which deprived Great Britain of its usual place of exile, prompted the British government in 1786 to decide on Botany bay (where James Cook had landed in 1770) as a suitable site for a prison farm. As a consequence of this decision, New South Wales, between 1788 and 1841, received 83,290 convicts. Capt. Arthur Phillip, R.N., was appointed first governor, and the "First Fleet" (of two ships of the royal navy, six transports and three store ships, carrying about 1,000 persons, including 197 marines and 771 convicts) sailed in 1787. Botany bay having been rejected as unsuitable ior settlement, a landing was made at Port Jackson on Jan. 26, 1788. The colony grew slowly, with the arrival of more convicts and, after 1793, oi a trickle of free settlers. For three years there was a shortage of food, but by 1792 there was enough farming to save the settlement from the threat of starvation. The "Second Fleet" of 1790 brought with it the New South Wales corps. especially recruited for service in the colony, to replace the marines as the soldiery to guard the convicts. The officers of this corps completely dominated the political, social and economic life of the colony for 20 years and were influential until the granting of self-government. Their assumption of power mas made easy initially by Phillip's return to England in 1792 because of ill-health and by the acting-governorship from 1792 to 179; of two of the corps's officers, Maj. Francis Grose and Capt. William Paterson.

With power established on extensive land-holding and commerce, this clique of able and unscrupulous men systematically opposed Governors John Hunter and Philip Gidley King, and illegally deposed Gov. William Bligh. Their propensity for trading in spirits earned them the title of the "Rum corps." Finally the corps was recalled and replaced by the 73rd regiment with its commander Lachlan Macquarie as governor. Macquarie's long governorship from 1809 to 1821 was an important one: he pushed economic development by encouraging exploration and the spread of settlement and by building roads and bridges to the interior. He also encouraged the emancipists, the convicts who had served their sentence, to take a full part in the life of the colony; but in so doing he roused the enmity of the free settlers, particularly the former officers of the corps, who wished to exclude (hence their name, "exclusives") the former convict from social and economic advance. The governor's quarrels with the exclusives led eventually to the appointment of J. T. Bigge as commissioner to inquire into the state of the colony. Bigge's reports, though witnessing much of Macquarie's excellent administration, were pro-exclusive and, in balance, anti-Macquarie. Nevertheless, when Macquarie left the colony in 1821, its economic potential had been greatly increased by his work; his administration was the necessary prelude to rapid development.

Pastoral Expansion and Self-Government, 1820–55.—In these years the foundations of modern New South Wales were securely laid: self-government was attained; radicalism emerged; voluntaryism was established as the basis of colonial religion; transportation ceased; trial by jury and a free press were allowed; and the rapid expansion of the pastoral industry made the colony prosperous. New South Wales changed from a prison farm into a self-governing colony with an expanding capitalism. The basis of the expansion was wool: exploration in the 1820s and 1830s opened up the whole of the colony and the increasing demand for wool in Yorkshire enabled the squatter-pastoralist to avail himself of the new land which proved excellent pastures for the fine-woolled merino. Wool was a source of sterling funds and an inducement for capital imports and immigration. The consequent wealth was a solvent of autocracy. The growing body of free settlers was not prepared to suffer autocratic government and transportation, which lowered the moral tone of the colony. But the impetus for colonial reform came also from Britain, where the colonial reformers were transforming the bases of colonial government throughout the empire. Thus, acts of 1823 and 1828 gave New South Wales a nominated legislative council; an 1842 act made it partly representative, and the Australian Constitutions act of 1850 made it completely representative with the powers of writing a constitution. Nevertheless, until 1855 executive control rested entirely with the governor and his executive council, consisting of the leading crown officials of the colony. The legislative council was dominated by the pastoralists, who tried to frame a constitution to thwart the democratic aspirations of the city and labour interests; but the bicameral legislature finally adopted avoided the autocratic excesses of the pastoralists and was the future source of much liberal legislation. The most important social conflict between 1820 and 1855 concerned the status of the former convict, but after transportation was discontinued in 1840, emancipists and exclusives were brought into an alliance to fight for self-government and against the colony's growing radical movement. In religion the privileged status of the Church of England was modified and the various Christian denominations demanded and received legal equality and the impartial patronage of government. In education the attempt by Gov. Sir Richard Bourke to introduce public secular education foundered against the opposition of the churches. But the most important political conflict concerned the alienation of land. The squatters had settled on land beyond "the limits of location," and until 1847 had the most temporary titles to their estates. Gov. Sir George Gipps tried to prevent the complete alienation of the state's pasture lands, but was unable to prevent the 1847 orders-in-council which gave the squatters favourable treatment. The quarrel over land, however, continued throughout the 19th century.

Colonial Liberalism, 1856–85.—In Feb. 1851 gold was discovered at Bathurst, but the main tide of the gold rushes soon swung to the richer fields of Victoria. New South Wales nevertheless gained, with the rest of Australia, in wealth and population from gold. In 1856 the new constitution (drafted 1853, approved by imperial statute 1855) was implemented with a bicameral legislature and responsible cabinet government. One of its early acts in 1858 introduced the ballot and universal adult male suffrage and the new democracy soon moved against the squatters. "Radical" legislation in the next 30 years included the abolition of state aid to religion (1862), the Triennial Parliaments act (1874), the Public Instruction act (1880) and public health legislation (1881). Sir John Robertson's land act of 1861 aimed to facilitate closer settlement by allowing selection before survey; anyone might select 40 to 320 ac. within the "settled" or "intermediate" districts on payment of a quarter of the price, the balance due, with the title, after three years' residence. Much genuine closer settlement resulted, especially on the coast, but the squatters' devices of "peacocking" and "dummying" (*i.e.,* picking the best land and using dummy selectors) left most of the western lands in their hands. The failure of closer settlement meant increasing concentration in the towns, the rapid growth of trade unionism, and radicalism among the growing body of workers. Radicalism before 1870 was reflected in the land legislation and opposition to the British government; between 1870 and 1885 it encouraged state intervention in social and economic life and led to the increasing political aspirations of the unionists. Sir Henry Parkes was the most influential personality in politics and his various ministries between 1872 and 1891 introduced free trade, established nonsectarian public schools and sponsored railway development. He finally lost office in 1891 because he favoured federation before the idea was popular in New South Wales. This was a period of great economic development: by 1890 New South Wales was self-supporting in foodstuffs; valuable minerals were discovered and mined, gold at Lambing Flat in 1861, copper at Cobar in 1869, tin at Inverell in 1871, and silver-lead-zinc at Broken Hill in 1883; 3,281 mi. of railway were completed by 1904, including 1,215 mi. opened between 1875 and 1884; unassisted immigration between 1873 and 1893 was more than 230,000. These developments were much aided by the capital imports of the 1870s and 1880s, much of it by the government for public works.

Labour, Nationalism and Federation, 1885–1914.—The period after 1885 was dominated by a growing feeling of nationalism, the rise of the political labour movement and the federation of the Australian colonies into the commonwealth of Australia. The period began with the collapse of the overseas prices of exports and the great reduction of capital imports consequent on financial difficulties in Britain. This led to wage reductions and industrial unrest and to the great strikes of 1890–91 (in which the trade unions were defeated) and the financial crisis of 1892. Although a time of misfortune, culminating in the great drought of 1902–03, the 1890s were vital in New South Wale's history. The *Sydney Bulletin* encouraged a nationalist literature which produced distinguished contributions from Henry Lawson, Joseph Furphy and many others. The failure of the direct action in the 1890 strike forced the unions into politics with immediate influence on legislation. G. H. Reid, with Labour party support, introduced financial reforms (including income tax), removed the public service from political control, reformed the land law to allow the break-up of large estates and passed the Factories and Shops act (1896). Similarly, after 1900, liberal legislation supported by Labour introduced old age pensions (1900), compulsory industrial arbitration (1901), woman's franchise (1902) and free public education (1906). After federation, Labour gradually increased its power until in 1910 J. S. T. McGowen was able to form the first Labour ministry. Undoubtedly the protection which came with federation favoured the development of New South Wales as the centre of Australian heavy industry and thus of the industrial proletariat and the Labour party. But a similar development also occurred in agriculture where, between 1900 and 1914, the area of cultivation doubled, with a rapid increase in the production of wheat, fruit and dairy products. In 1912, also, the Riverina was opened up for closer settlement.

World Wars I and II and After.—Federation reduced the importance of state politics and most of the important issues of the 20th century were the concern of Australia and thus of the commonwealth government. At the beginning of World War I New South Wales had a Labour ministry under W. A. Holman, but his support of conscription led to his expulsion from the Labour party and his formation of a National ministry in 1916. Labour was returned to office in 1920 and Labour and Nationalist ministries alternated until the depression discredited Labour and put the Nationalists in office for a decade. The failure of Labour after its promising beginning was due mainly to its loss of social purpose and of emphasis on social experimentation, and to internal dissension which began in 1916 over the conscription issue and was continued as a conflict between the centre and radical wings of the party. The 1920s were a period of boom, with considerable immigration and capital imports, and the expansion of public works (for example, railway building, and the Sydney harbour bridge) and private industry. John T. Lang, Labour premier in 1925–27 and 1930–32, is one of the most controversial figures in the history of the Australian Labour movement; he introduced some good social legislation (*e.g.,* widows' pensions), but was dismissed from office by the governor in 1932 when he repudiated overseas debt payments after the New South Wales government had legally committed itself, by agreement with the commonwealth, to pay them. In a landslide victory the Nationalists under B. S. B. Stevens were returned in 1932 and retained office until 1941. By 1941, however, Lang had been expelled from the party and Labour had regained its unity of purpose. Labour governments were returned throughout World War II and up to 1955 with W. J. McKell, J. McGirr and J. J. Cahill as premiers, but they were not distinguished in this period by any remarkable social legislation except the introduction of the 40-hr. week in 1947. After 1940, under the stimulus of war, the postwar boom and a substantial immigration, New South Wales experienced the greatest industrial expansion in its history.

POPULATION

The population of New South Wales increased from 1,024 in 1788 to 3,423,529 in 1954, the population at intervening periods being 33,500 in 1825, 197,265 in 1851, 1,127,137 in 1891, 1,701,736 in 1911, 2,600,847 in 1933 and 2,984,838 in 1947. Until 1860 immigration was more important than natural increase in the growth of population, but after 1861 natural increase became the more important factor. The important periods of immigration have been 1830–40, 1850–60 (the gold rushes), 1861–85, 1911–14, 1924–28 and 1948–52; net immigration in 1949 was 74,143, in 1950, 61,464 and in 1951, 40,597. But from 1861 to 1947 the net immigration of 655,080 was less than 25% of the total population increase. The crude birth rate fell from 1864 to 1903, improved to 1913, declined to a record low in 1934 and has been slowly increasing since then. The net reproduction rate has followed a similar pattern: 1910–12, 1.449; 1920–22, 1.349; 1932–34, .968; 1946–48, 1.306; and in 1955 it was still greater than unity and higher than that oi most European countries. The iniant mortality rate declined irom 124 in 1881–85 to 27 in 1949; the average expectation of life increased from 47 to 68 in the same period. The sex distribution in 1955 was 100.84 males to 100 females (in 1911 the ratio was 109:100); and, like most European populations, the proportion of adults in the total population has grown steadily, since 1881.

There has always been a high urbanization: Sydney increased its population from 95,789 (27.3% of the state total) in 1861. to 481,830 (35.6%) in 1901, to 1,484,004 (49.7%) in 1947; in 1954 Sydney had 1,863,161 persons and the remainder of the state, 1,560,368. The other large centres are Newcastle (134,079 in 1954), Wollongong (90,852) and Broken Hill (31,351), which, with Sydney, contained 67% of the population in less than 1% oi the land of the state, leaving only one-third of the population for rural districts and other towns. The driit toward the central coast has caused concern and some action, but little action has been taken to reverse the trend: between the census years 1911 and 1947 total population increased 81%, urban population 195% (Sydney, 122%) and rural only 4%.

GOVERNMENT AND ADMINISTRATION

New South Wales is a state oi the commonwealth oi Australia within the British Commonwealth of Nations, with its own constitution coniferred by imperial statute in 1855 and its own governor and legislature. Although still nominally subordinate to the imperial parliament, the parliament of New South Wales may for all practical purposes legislate for the peace, welfare and good government of the state in all matters not specifically reserved to the commonwealth. The powers vested in the crown by virtue of its prerogative are exercised by the governor, who is the crown representative in the state and titular head of the go ernment. The state legislature consists of the crown and two houses of parliament, the legislative council and the legislative assembly, and it exercises a general pow-er of legislation, its enactments being restricted only by imperial legislation still applying to New South Wales and by commonwealth legislation validly applicable to the state. The legislative council (a nominee chamber until 1934) consists oi 60 members? 1; of whom are elected triennially, by the two houses sitting together, to serve for 12 years. The legislative assembly, the popular house, consists of 94 members elected triennially by adult suffrage: adult male sufirage was introduced in 1858, iemale suffrage in 1902 and compulsory voting in 1930; payment of members was introduced in 1889 and members now receive £1,875 a year plus allowances. In procedure and conventions the legislative assembly resembles the British house of commons. All money bills must originate in the legislative assembly and by its power over supply it controls the executive. The cabinet consists, by convention, of members of parliament of either house who have been chosen to administer departments of state: they are answerable to parliament and hold office only so long as they command the support of the legislative assembly. In 1953 there were 14 main ministerial departments—of the treasury, education, the attorney general, housing, justice, the chiei secretary, health, agriculture, labour and industry, transport, mines, land, local government, conservation; as well as 2 ministers without portfolio. In addition to ministries, there are various important public services administered by statutory commissions, boards or trusts, of which some of the most important are concerned with fire fighting, main roads, railways, road transport and tramways, police, electricity, iorestry, government insurance, hospitals and housing. These, too, are subject to considerable ministerial control.

In the 19th century the state political parties divided on the issues of land legislation and, particularly aiter 1880, of free trade; but aiter 1890 Labour played an increasing role in politics with the consequence of a party division along Labour-Conservative principles. The first Labour government was formed in 1910, and up to 1953 Labour was in power 2j years (as against 17 ior the Opposition parties), and continuously since 1941, having been returned for another term oi office in 1953.

New South Wales is also represented in the commonwealth parliament by 10 members in the senate (out of a total of 60) and 47 (oi 121) in the house oi representatives; voting for commonwealth elections is universal and compulsory.

ECONOMIC CONDITIONS

Agriculture.— At the foundation of the colony in 1788 all land was vested in the British crown, but alienation was allowed. by grants up to 1830, and thereafter by sale and lease. In the mid-1950s the land of New South Wales occupied in rural pursuits consisted of alienated land (or land in process of alienation), leased crown lands, or a combination of these, and crown reserves. In 1954 the total 198,037,120 ac. of New South Wales mas divided as follows: alienated, 53,522,677: in process of alienation, 13,985,045; leased, 115,038,912 (all except 9,170,119 being long-term or perpetual); and reserved ior the crown. 15,490,486. The nature and pattern of rural settlement has been determined largely by the land, the rainiall and the accessibility to markets. The pastoral industry was the basis of the expansion of the colony aiter 1820 and it is still state-wide; the iar west is devoted entirely to it. In the central west (including the Riverina), where the annual rainiall is 15 in. to 20 in., there is widespread mixed farming. The remainder of the state has large areas of agriculture. The density of settlement and of agriculture increases irom west to east. On the tablelands arid coast intensive farming and dairying on compact holdings. with grazing on rugged back lands, is characteristic. In 1954 there were 73,371 holdings larger than one acre, many oi which were devoted to mixed iarminp; 46,303 holdings grew crops of one acre or more, 16,572 were registered dairies; 18,080 carried 20 or more beef cattle; 34,844 carried 50 or more sheep; 4,233 were commercial poultry farms; and 15,803 carried one pig or more. In 1953–54 there were 5,425,341 ac. under crop: wheat, 3,547,624; maize, 82,216; oats, 1,034,240; rice, 38,859; hay (wheat, oat, lucerne and barley), ,383,655; hay (grass), 66,588; green fodder, 761,552; potatoes, 16,513; other vegetables, 43,926; grapes, 18,128; other iruits, 90,797; and sugar cane, 5,797. Up to 1900 sheep rearing was the main rural industry of New South Wales and agriculture barely sufficed local needs. But wheat growing expanded rapidly aiter 1897, and with new wheats (bred by William Farrer), closer settlement and the irrigation of the southwest, wheat became an important export crop second only to wool. The total area under all crops thus increased irom 1,048,554 ac. in 1891–95 to a record peak of 7,168,068 ac. in 1948. (It has been estimated that, once cleared, 31,822,433 ac. of New South Wales would be suitable for cultivation.) Fluctuations in total acreage are due mainly to variations in the extent of wheat growing, the staple crop which provides 75% of the total. But thr sheep industry is still the most important rural industry and New South Wales is admirably suited to pastoral pursuits. About 156,000,000 ac. in the state are held ior grazing and the pastoral industry provided about 40% oi the total value of primary production in the decade ending in 1950. Although sheep are the most valuable, cattle for slaughter and dairying are important on the coast and tablelands. Sheep are most numerous on the western slopes and central western plains. Of 57,461,000 sheep in 1953, 43,714,000 were merino, 6,064,000 crossbred, 4,142,000 comeback and 3,541,000 other breeds. In 1954 there were 280,063 horses (1861, 233,220), 3,554,016 cattle (1861, 2,271,923), 371,608 pigs (1861, 146,091) and 59,639,000 sheep (1861, 5,615,000); about 34% oi Australia's horses, 23% of the cattle, 31% of the pigs and 47% of the sheep. The total value of rural products increased irom £43,159,000 in 1908 to £249,196,000 in 1948–49 (of which £90,326,000 was the value oi the wool clip), to £355,471,000 in 1953–54 (£171,901,000 wool).

In the period 1918–39 the rural industries of New South Wales were faced with low home prices and uniavourable terms of trade for agricultural produce in the world markets. But World War II and the postwar boom (1946–51) boosted farm income with record prices and, in the case of wheat, record yields. Wheat prices. which in 1938–39 averaged 2s. 2¾*d.* per bushel, increased to 13*s.* 7¼*d.* in 1947–48, while wool prices increased irom 14*d.* per pound in 1935–36 to 145.3*d.* per pound in 1950–51; thereafter. both prices declined somewhat.

Industry and Mining.— The industries oi New South Wales are located mainly in Sydney, where, in 1953–54, 65% of the factories were situated, with 75% of factory employees and 75% of the value of iactory production. The only other important industrial centres are Newcastle, Wollongong and Lithgow (which together have 12% of employees and 13% of production), and Broken Hill. Before 1900 the manuiactures of New South Wales consisted mainly of consumer and durable-consumer goods for local use (food, furniture, bricks, printing, etc.), but iederation brought both the removal of interstate trade barriers and a protective tariii for the whole of Australia. This fostered steady industrial expansion. which, although curtailed by the 1929–33 depression, was greatly stimulated by World Wars I and II. The most remarkable advance was in the manufacture of iron and steel and metal goods, which in 1953–54 employed 177.268 persons, producing a gross output valued at £514,533,527 (of N.S.W. totals of 405,844 factory employees and £1,299,801,000 output value); in the same year the textile and clothing industry employed 69,844 (producing £149,221,-000); the food, drink and tobacco industry. 39,303 (£210,785,000); the chemical and paint industries, 17,241 (£108,089,000); the paper and printing industry. 23,544 (£69,586,000); and the heat, light and power industries, 6,683 (£44,291,000). The period of greatest industrialization in the history of New South Wales was 1938–51, when factory employees increased 178,200 or 78%, of which metals and machinery absorbed more than 50%. This advance showed little sign of abating in 1953. Small iactories were numerous (66% of the factories in 1948–49 employed ten or less workers and totalled only 12% of total factory employees), but 590 factories in 1949 (4% of the total) averaged more than roo employees and employed 52% of all workers. Some concerns, like Broken Hill Proprietory Co., Ltd. (iron and steel)) and Australian Consolidated Industry (glass), dominated whole industries.

New South Wales contains extensive mineral deposits of great value and variety. of which coal is now the most important. Coal was discovered at Newcastle in 1797, gold at Bathurst in 1851 and silver-lead-zinc at Broken Hill in 1883. There has been considerable mining of these five metals and also oi copper and tin. Total mining employment in 1954 was 29,765. The most important coal fields are in the Hunter valley above Newcastle, around Wollongong and at Lithgow. The production of silver, lead and zinc is dominated by Broken Hill (700 mi. K^{T}. of Sydney, on the Barrier range near the western boundary). Most of the Broken Hill ore is exported (as ores or concentrates) for treatment in other parts of the commonwealth (mainly South Australia) or overseas. Gold comes mainly from the Bathurst area where it was first discovered; copper is found mainly near Cohar, in the central and northern tablelands.

Economy. — New South Wales, economically, is the most important state in Australia; of total Australian personal incomes in 1954, New South Wales contributed just under 40%; it contained 39.2% of the people. Statistics ior the period 1948–52 show that New South Wales contained 46.2% of the sheep, 23.6% of the cattle and 29.4% of the pigs of Australia; it produced 44.9% of the wool, 21.6% of the butter, 32.3% of the bacon and ham, 32.3% of the wheat, 24.6% of the oats. 40.4% of the corn. 100% of the rice and 77.3% of the black coal of Australia; it produced 43.9% of the factory production, employed 42.3% of the factory employees and owned 40.2% of the factory machinery and plants oi Australia.

Trade. — New South Wales is a large overseas and interstate trader; it usually accounts for about 40% of Australia's imports and 33% of exports. Sydney is the port of entry for a large quantity of imports destined ultimately for other states. The bulk of the state's trade passes physically through Sydney. Primary produce forms the bulk of exports (78.7% in 1953–54), but the proportion of manufactures and semimanufactures, especially to Asia, has been increasing since 1945. The imports consist mainly of machinery, metals and metal manufacture? (32% in 1953–54); yarn, textiles and clothing (17.5%); petroleum (10.3%); paper (4.1%); tea (2%); and tobacco (3.5%). The direction of trade is still mainly toward Britain, which in 1954 absorbed 26.3% of exports (as compared with 53% before 1939) and supplied 47% of imports (40% pre-World War II).

The interstate trade of New South Wales consists mainly of the import of large quantities of foodstuffs, minerals and timber, and the export of iron, steel. cement, metal goods and coal. At federation (1901) the power to make laws concerning trade and commerce passed to the commonwealth, and, thereafter, tariff policy throughout Australia was uniform, and interstate trade completely iree.

Public Finance. — The revenue oi the state government comes mainly irom the commonwealth under the Financial agreement (1927) and the uniform taxation laws (giving the commonwealth the sole right to income tax); state taxes (the most important being stamp, insurance and probate duties); the state lottery; the sale and leasing of crown lands. Expenditure goes mainly to education, law and order, transport, development and public debt charges. (R. M. Hl.; X.)

NEWSPAPER. Some idea of the magnitude of the modern newspaper industry may be gathered from the fact that when in the 1950s the United Nations Educational, Scientific and Cultural organization conducted an exhaustive investigation it reached the conclusion that not less than 7,520 daily newspapers were produced throughout the world. It stressed the fact that this must be regarded as the lowest rather than the highest figure because there were some parts of the world from which it was not possible to collect full details. There were 53 countries and territories in which no daily journal was published at all. The number of copies printed daily was at least 217,000,000, of which about 96,000,000 were printed in the English language in 2.348 publications. The country. in which the daily press had the largest circulation was the U.S. with 50,000,000 copies or 24% of the world total, and the country with the highest daily ne spaper circulation per 1.000 inhabitants was the United Kingdom with 611 copies compared with the world daily circulation of 88 for every 1,000 inhabitants.

Early Examples. — As early as the jth century B.C. there were writers of newsletters in Rome who furnished news to those who resided at a distance from the capital, and written newsletters continued to be employed to supply intelligence to businessmen and political leaders until long after the invention of printing. Indeed they have their modern counterparts in the "confidential newsletters" supplied to businessmen and others.

When Julius Caesar became Roman consul in 60 B.C. he immediately established the *Acta Diurna,* a daily bulletin posted in the Forum and devoted chiefly to government announcements. Other forerunners of printed newspapers were the town criers (or bellmen), posted proclamations, controversial pamphlets, ballads, broadsides and news pamphlets. Many of the last named appeared in Germany and other European countries in the 16th century and were sold at fairs and in shops; they usually dealt with a battle, a disaster, a marvel or a coronation.

In the first two decades of the 17th century, more or less regular papers printed from movable type sprang up in Germany. Austria, the Netherlands and Italy. (X.)

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I. GERMANY

It appears that not only was the first western printing from movable types done in Germany, but some of the earliest news pamphlets and perhaps the first regularly published newspapers were issued there. At any rate. there is a file of the *Avisa Relation oder Zeitung,* published at Augsburg in 1609, and one copy of the Strasbourg *Relation* of that year.

These papers were folloaed by others, such as the *Frankfurter Journal* of Egenolph Emmel in 161j and the *Frankfurter Oberpostamtszeitung,* begun in 1616 and continued until 1866 under the shortened title of *Postzeitung.* In the course of the 17th century, most German cities supported newspapers; in the 18th century, despite the rigours of local and state censorship, the press multiplied throughout the country Notable for its correspondence from abroad was the *Hamburgischer Correspondent,* founded in 1714 under the title *Holsteinische Zeitungs-Correspondenz.* The outstanding Berlin papers in the 18th century were tno named. for their owners, *Vosszsche Zeitung* (1705) and *Spener'sche Zeitung* (1749); the latter was renamed *Berlinische Nachrichten* and lived until 1827. Under Napoleon censorship merely changed hands: the German press became Gallic and the nenspapers echoes of the Parisian journals. But when Germany was liberated the old censorship reappeared. An 1819 resolution of the diet subjected the press to police supervision.

The greatest German newspaper in the first half of the 19th century nas the *Allgemeine Zeitung.* It was founded at Tiibingen by Johann Friedrich Cotta (later Baron von Cottendorf) in 1798. Censorship and other causes forced it to move successively to Stuttgart. Ulm, Augsburg and Munich. The revolutionary movements of 1830 and 1848 gave impetus to a new German journalism which, though most of the papers were short lived. brought in a new period of press enterprise. Many small papers were established throughout Germany and Austria, nearly all of them consistently partisan. Censorship varied in different states. Those best known throughout the nation, besides the *Allgemeine Zeitung,* were the *Augsburger Zeitung* (1689) and the *Kölnische Zeitung* (1804).

Bismarck had a high respect for the power of the press and kept a firm hand on its control. The press law under which the German newspapers operated 1874–1919 "guaranteed" freedom of the press but actually retained strong government controls. Even during World War I the government controlled a number of important newspapers. Folloning that war, besides owning Wolff's Telegraphic bureau, the leading news-gathering agency. the Prussian government secretly bought the *Deutsche Allgemeine Zeitung,* a Berlin paper founded in 1921 by Hugo Stinnes, and later sold it to the government of the *Reich.*

Under the German Republic.— —Under the Weimar constitution of 1919, German newspapers enjoyed more freedom than they had ever known. In the years 1919–32 the *Gruppenpresse* (newspapers representing political. social and religious groups), though composed of papers of small individual circulations, maintained dominance in the country's journalism. During the 1920s. however, a *Massenpresse,* composed of large-circulation dailies designed for the masses rather than for parties or factions, grew up in Berlin and other large cities; these papers. thoughmore objective in reporting and comment, were commonly partisan in control and thus had notable alignments with the *Gruppenpresse*.

By 1932 there were 4,joo newspapers in Germany. 70% of them dailies. More than roo different parties or group ideologies were represented. The largest paper in this period was the *Berliner Morgenpost*, claiming 600,000 in 1932. It was founded in 1898 by the "house of Ullstein." which consisted of Leopold Cllstein and his five sons. The father had entered the newspaper field by purchasing the *Berliner Zeitung* in 18;; (later called *BZ am Mittag* and credited with 190,000 circulation in 1932). Other Cllstein dailies were the old "quality" *Vossische Zeitung*, acquired in 1913, never a circulation leader; and *Tempo*, an evening paper started in 1930, which had 140,000 by 1932. Other large papers in Berlin were *Der Tag* (1900), claiming 100,000 in 1932; and *Berliner Nachtausgabe* (1924), with 180.000. These. with the *Lokalanzeiger*, were Scherl papers, backed by the Hugenberg *Konzern*. .Alfred Hugenberg, leader of the Nationalist party, controlled the large Scherl dailies. as well as the weeklies and magazines of that chain. Besides the Cllstein and Hugenberg combines. Konzentrations A.G. controlled about 200 Social-Democratic papers and owned a news agency; Rudolph Mosse controlled the *Berliner Tageblatt*, *Volkszeitung* and *Morgenzeitung* in Berlin.

A number of large papers. regarded as belonging to the *Massenpresse* because they each had 100,000 circulation or more, had by 1932 grown up in other large cities besides Berlin. But some of the most influential papers in Germany had only about 60,000 circulation. such as *Frankfurter Zeitung* (1856), *Kölnische Zeitung*, *Nuremberg Fränkische Kurier* (1833) and *Hamburger Suchrichten* (1792). This quartette of famous old papers was long powerful in Europe. Oldest of all German papers, with only a few thousand circulation in 1932, was the *Hartungsche Zeitung* of Konigsherg (1640).

The Hitler-Goebbels Press.—Adolf Hitler's first task in connection with the group which was soon to become the National Socialist party was the direction of a press and news bureau in the district army command at Munich in 1919. After the military *Putsch* of March 1920, sympathizers bought for Hitler the *Völkischer Beobackter*, which had been founded several years before World War I as a weekly gossip sheet. As the Nazi influence expanded in the 1920s, its newspaper effort broadened; but the *Beobachter* remained Hitler's personal organ. and for the elections of 1932 he established a Berlin edition. In connection with those elections. also, Hitler's party established or acquired about 130 other newspapers distributed throughout Germany.

When Hitler became chancellor in Jan. 1933, he immediately caused Pres. Paul von Hindenburg to invoke article 48 of the constitution in order to cancel the guarantee of freedom of the press. Some papers were stopped at once, and the press in general was muzzled. Within three months zoo papers had been suspended. including the venerable *Vossische Zeitung* and *Allgemeine Zeitung;* within a year 600 had been killed, the Deutsche Nachrichtenbüro (DNB) had been set up to supersede Wolff's Telegraphic bureau, and a journalists' registration system had been devised which made newspapermen "semiofficial public functionaries." Max .Amman, publisher of the *Volkischer Beobachter*, became president of the *Reich* press chamber, a division of Josef Goebbels' ministry of public enlightenment and propaganda. Goebbels had founded the newspaper *Der Angriff* in 1927 and two years later became head of Nazi propaganda activities. Amman's duties were largely on the business side, though he shared with Otto Dietrich the veto on new papers. Dietrich was *Reich* press chief and had charge of editorial policies and personnel. Eher Verlag was set up to handle Nazi printing and publishing; operating chiefly in Berlin and Munich, it soon became the largest publishing concern in the world. It published the *Beobachter, Angriff, Schwarze Korps* (SS. organ). *Arbeitsmann, Hitlerjugend* and other official newspapers and periodicals, as well as books and pamphlets.

Jewish newspaper owners—the Ullsteins. Mosse, etc.—were driven out. When Germany seized Austria in 1938 many of the old papers (including *Wiener Zeitung*, founded in 1703) disappeared, and the remainder of the Vienna papers mere combined in one Nazi organ. The number of newspapers in Germany was reduced from 4,700 in 1932 to about 2,000, and the press became, to use Goehbels' famous figure. an organ on which the minister of propaganda could play his on-n tunes.

The Occupation **Press.**—World War II annihilated the German press. New papers were licensed by the occupation powers in their various zones. The Soviet military government established *Tägliche Rundschau* in Berlin; the U.S. military government set up *Die Neue Zeitung* in Munich; the British founded *Die Welt* in Hamburg; the French licensed *Der Kztvier*, an afternoon Berlin paper. By mid-century there were 20 dailies in Berlin, of which the Soviet *Rundschau* had the largest circulation. said to be 800,-000; while the British-licensed *Tclegrnf* and the U.S.-licensed *Tagesspiegel* each had around 500,000. The U.S. semiweekly *Neue Zeitung* was circulating more than 2,300,000 copies of each issue, including Berlin and Frankfurt editions; and the British triweekly *Die Welt*, 700,000. also including a Berlin edition. Most papers outside Berlin were published only two or three times a week.

German Federal Republic and Western Berlin.—There were important developments in the press after the foundation of the German Federal Republic in Sept. 1949. The system of licences was abolished and a return mnde to free competition. Some newspapers founded by the occupation authorities disappeared (*Neue Zeitung*); others continued their existence as wholly independent undertakings (*Die Welt*); new journals were started or old ones reappeared (*Morgenpost* and *BZ am Mittag* launched in western Berlin by the Ullstein group). In the later 1950s there were 1,276 dailies with a circulation of over 16,000,000. The provincial press increased greatly. Several hundred newspapers used the special articles supplied by a small number of centralized agencies (*Maternpresse*). Another characteristic of the postwar daily press was the reduction in number of papers affiliated to political parties (about 20%).

In the later 1950s, in the Federal Republic, the highest circulation was held by *Bild* in Hamburg (*c.* 2,500,000), followed by the *Westdeutsche Allgemeine Zeitung* of Essen (*c.* 350,000). Among the most important papers by reason of their circulation or influence were the *Kölnische Rundschau* (Cologne), *Süddeutsche Zeitung* (Munich), *Die Welt* (Hamburg) and the dailies of Frankfurt. which became the centre of German journalism after World War II: *Allgemeine Zeitung*, *Neue Presse* and *Frankfurter Rundschau.*

In western Berlin the highest circulation record was held by the dailies *Morgenpost* and *BZ am Mittag*, which passed the 200,-000 mark, while quality papers remained notably *Der Tagesspiegel*, *Der Tag* and *Telegraf*.

In 1949 the national agency Deutsche Presse-Agentur (D.P.A.) was started with headquarters in Hamburg. It very soon became one of the largest in Europe.

German Democratic Republic.—After the proclamation of the German Democratic Republic in Oct. 1949, the press underwent a considerable change. Although the system of licensing permitted by the occupying power theoretically disappeared, strict supervision persisted but it was exercised by the *Presseamt* which itself received instructions from the Politburo of the Socialist (Communist) Unity party or S.E.D. Only the *Tägliche Rundschau* continued to be edited by the Soviet military commander, but it stopped publication in 1955.

In 1953 the authorities suspended the big circulation evening paper *Nacht' Express* which had been trying since 1945 to keep its public objectively informed.

In the later 1950s there were 37 dailies in the Democratic Republic: 17 represented non-Communist political groups but their circulation was negligible in comparison with those favoured by the S.E.D. whose main organ. *Neues Deutschland*, reached 500,000 copies. In eastern Berlin nine daily newspapers appeared.

The agency Allgemeiner Deutscher Nachrichtendienst (A.D.N.), founded in 1946 and nationalized in 1953, had a monopoly.

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II. FRANCE

The French newspaper press from the first was characterized by a literary quality generally superior to that of the press of most other countries. by special attention to the arts and by alliances (sometimes amounting to subsidization) with political, social or literary groups. Parisian journalism frequently became a path to fame in both politics and literature.

Beginnings. — The first French newspaper was the *Gazette* (afterward called the *Gazette de France)*, established in 1631 under the patronage and with the active co-operation of Cardinal Richelieu. The first editor and printer was Théophraste Renaudot. The first weekly number apparently appeared in May 1631 So much, at least. may be inferred from the date (July 4, 1631) of the sixth number. which was the first dated publication. Each number of the paper, which cost six centimes, consisted of a single sheet (eight pages) in small quarto, and was divided into two parts — the first simply entitled *Gazette*, the second *Nouvelles ordinaires de divers endroits*. It commonly began with foreign and ended with home news. Much of its earliest foreign news came direct from the minister, and often in his own hand.

In 1672 the *Mercure galant* was established by Donneau de Vizé. Its title was later changed to *Nouveau Mercure*, and in 1728 to *Mercure de France*, a designation retained, with slight modification, until 1853, when the paper finally ceased. It had many prominent contributors. In 1790 its circulation rose very rapidly and reached for a time 13,000 copies.

Under Napoleon the organ of official information was the *Moniteur (Gazette nationale, ou le moniteur universel)*, founded in 1789 under the same general management with the *Mercure*. The *Moniteur* kept step with the majority of the assembly, the *Mercure* with the minority.

The only other newspaper of a date anterior to the Revolution which need be noticed here is the first French daily, the *Journal de Paris*, which was started on New Year's day of 1777 and lived till 1819. Its period of highest prosperity may be dated about 1792, when its circulation is said to have exceeded 20.000. The *Journal des débats* was founded in 1789 by François Jean Baudouin and lasted until the beginning of World War II.

19th Century. — The cheap journalism of Paris began in 1836 with the journal of Émile de Girardin, *La Presse*, and *Le Siècle*, under the management of Dutacq, to whom, it is said—not incredibly — the original idea was really due. The first-named journal attained a circulation of 10.000 copies within three months and soon doubled that number. The *Siècle* prospered even more strikingly, and in a few years had reached a circulation (then without precedent in France) of 38,000 copies.

On July 16, 1850, the assembly passed what is called the *loi Tinguy* (from the name of the otherwise obscure deputy who proposed it), by which the author of every newspaper article on any subject, political, philosophical or religious. was bound to affix his name to it, on penalty of a fine of 500 fr. for the first offense and of 1,000 fr. for its repetition. Every false or feigned signature was to be punished by a fine of 1.000 fr., "together with six months' imprisonment, both for the author and the editor." The practical working of this law lay in the creation of a new functionary in the more important newspaper offices, who was called *secrétaire de la rédaction*, and was. in fact, the scapegoat ex officio. The *loi Tinguy* had a permanent influence on French jour'nalism in the continued prevalence of signed articles, and the consequent prominence of individual writers as compared with the same class of work in other countries.

Moïse Polydore Millaud, creator of the French halfpenny press, made a fortune from *Le Petit Journal* and introduced a new era of cheap papers. In 1878 the paper had a circulation of about 650,000 compared with the circulation of *Le Figaro* (1826) of 70,000. At that period the total number of journals of all kinds in France was 2,200.

The newspapers of Paris, and similarly of France, practically doubled in number between 1880 and 1900. In 1880 there were about 120 Paris newspapers. in 1890 about 160 and in 1900 about 240. The total number of newspapers, as distinguished from periodicals, published in France during 1900 was 2,400, of which about 2,160 appeared in 540 provincial towns.

The French papers, of whatever party, took an increased interest during this period in foreign matters and much improved their organization for collecting news. *L'Eclair* gave less attention to the discussion of political questions from the party point of view than to the collection of news. and was folloued by the *Echo de Paris* (1884) and *Le Matin*, which also dated from 1884, and which by an arrangement with the *Times* of London gave every day a translation of most of the telegrams published in that newspaper. The *journal d'information*, as these papers were called, took its place beside the *journal d'opinion*, more perhaps as a rival than as a complement. The natural result followed, and the more old-fashioned newspapers took steps to provide their readers with news as well as with leading articles, current and literary topics, society gossip, dramatic criticism and law reports. Nothing perhaps was so striking after 1890 as the demand of the French public for foreign and colonial news, or the readiness of the papers to supply it by means of special representatives independent of the news agencies.

In home matters the French press made greater progress still in the rapid and accurate collection of news, and in this respect the provincial press showed more enterprise and more ability than that of Paris. All the best provincial papers had Paris staffs reporting parliamentary proceedings and law cases. Being perfectly independent of purely Parisian opinion or even bias, the decentralization of the French provincial press became complete; it became also more independent politically than the Paris press. Several journals had national reputations: *La Dépêche* of Toulouse, with its 12 editions daily, *Le Progrès* of Lyons, *Le Petit Marseillais* and *La Petite Gironde* of Bordeaux.

20th Century. — During World War I French newspapers were under severe censorship. becoming more than ever servants of the government. Many disappeared for a time because of shortage of paper or manpower. Changes in the French press as a whole were temporary, and prosperity returned after the war.

In 1930 Paris had 23 morning dailies of general circulation, and ten afternoons. while there were 140 dailies in the provinces. Circulation of *Le Petit Parisien* (1876) reached 1,000,000 in 1904; stimulated by its use of U.S. news methods, it distributed 1,700,000 copies daily by 1930. Next was *Le Journal* (1892) with 1~200,000, and third was *Le Matin*, just at the 1,000,000 mark. Characteristic of the popular press were two serial stories, or *feuilletons*, in each issue; front-page opinion articles, signed by well-known contributing editors; and modest sizes of four to ten pages. Every phase of politics was represented. The better-known political papers were *Le Temps* (1861), the venerable *Journal des débats, La Liberte'* (1864), *L'Oeuvre* (1893) and *L'Humanité*, founded in 1904 by Jean Jaurès as the Socialist organ but which became Communist in 1920.

It was clear that when Germany overwhelmed France in June 1940 the press bore no small part of the responsibility for the debacle. Misrepresentation of foreign affairs and of national preparedness was largely the result of government censorship, but submission to government policy and active propaganda for Nazi and Fascist doctrines were sometimes the result of bribery. The 25 Paris dailies of general circulation were reduced during the German occupation to half a dozen: *Le Matin, L'Oeuvre, Le Petit Parisien, Le Temps* (renamed *Les Nouveaux Temps* by the Germans), the *Paris-Midi* and *Le Cri du peuple*. They were not all published during the entire period of the occupation and were supplemented by several short-lived newcomers.

Meantime, an irregular underground press opposing both the Germans and their collaborationists grew up. Among leading underground papers were *Franc-Tireur, Combat, Résistance, Libération* and *De'fense de la France*. Editorial and mechanical staffs were sometimes caught and executed; *Résistance* ended after about a year because its staff was shot by the Germans.

When France was liberated in 1944, the only prearmistice papers allowed to resume were four which had refused collaboration—*L'Humanité, Le Populaire* (Socialist). *Le Figaro* and *L'Aube* (Christian Democratic). The various resistance groups which had published outlaw papers during the occupation now had dailies to represent them in the Paris press, and all those named in the preceding paragraph became competitors for popular favour. Despite the paper shortage that limited each paper to two pages and kept circulations down to prescribed quotas, there was a great demand among French readers, resulting in a boom in the newspaper business and the establishment of more than a score of new dailies in Paris during the first year following the liberation. In July 1946 the size of the Paris papers increased to four pages. But two years later circulations had dropped, advertising had fallen off and costs had advanced alarmingly.

In the later 1950s there were 132 general daily papers with a circulation of 10,300,000 copies. Paris had 12 papers against 34 after the liberation. But their circulation was 3,650,000 copies. Thus. with one-tenth of the total number of papers. Paris accounted for one-third of the total circulation. France-soir had the highest circulation (about 1,500,000) and used U.S. techniques in headlines, objective news, accent on crime and fresh feature material. France-soir was closely followed from the point of view of circulation by Le Parisien *libéré*, *L'Aurore* and Le *Figaro*. Although its circulation moved around 160,000 copies, Le *Monde* enjoyed. from 1945, a considerable reputation, as much in France as overseas, for its news and reporting. but it was also criticized for its political bias favouring '.neutrality."

The provincial press after the war rose to heights it had never experienced before. The number of weeklies and periodicals (about 5,000 at the middle of the century) increased by 1956 to 7,36j. Many of the weeklies. particularly the women's magazines, had circulations of several million copies.

The Havas News agency, founded by Charles Havas in 1835, achieved a virtual monopoly of foreign news by furnishing the most economical method for newspapers of the period to obtain such news and by cultivating close relations with government. Auguste Havas. Charles's son, took over the Agence Havas in 1850 and six years later added an advertising agency. exchanging his news for advertising space. The agency gained in power during the ensuing 50 years, and in the 1920s absorbed several others.

For three-quarters of a century preceding World War II. Havas handled a very large proportion of French advertising, including *publicité d'influence* for government and finance. It handled large sums for the French government and also for certain foreign powers; thus it became, with its dominant news service, the hub of French press corruption. In 1940 the Vichy government, having taken over the entire Havas business. divided the news and advertising services. The former was called Office Français d'Information; the latter, under the old name, became solely an advertising agency and continued after the liberation.

During the German occupation (1940–44) the Free French set up the Xgence Française Indépendante, with headquarters in London, supported by Allied funds. After the liberation this became Agence France-Presse. In 1956 it had more than 50 overseas offices and distributed about 110,000 words a day.

English-language journalism in Paris began with Sampson Perry's *Argus* (1809), a Xapoleonic organ. This was followed by the more important *Galignani's Messenger* (1814–1904). In 1887 James Gordon Bennett, Jr., founded in Paris the European edition of his *New York* Herald, which. became the leading English-language paper on the continent. The Herald absorbed the European edition of the Chicago Tribune (1917–35) and in 1935 changed its name to Herald Tribune to conform with the title of the parent paper in New York.

The continental edition of the London Daily *Mail,* founded in 1905. was stopped in 1953.

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III. UNITED KINGDOM

Certain pamphlets may be taken as predecessors of the English newsbooks *Newes* Concernynge *the General Councell Holden* at *Trydent* (Thomas Raynalde, London, 1549), a translation from the German, was one of the earliest. They dealt with political matters. murders. wonders, etc., and were commonly published some time after the events they chronicled. They were not so much budgets of news as "relations" of a single event and matters connected with such an event. As a type they were modeled upon continental (especially German and Dutch) newsbooks. of which they were sometimes translations or adaptations. The German compilations of a half-year's events. called *Messrelationen* because they were sold at the fairs, influenced later periodical development and were significant for England. Such a compilation in Latin by Micael ab Isselt, entitled *Mercurius Gallobelgicus,* continued 1594–1635, was widely popular in England, and brought the name "mercury" into use for newsbooks; some of the later issues were translated into English.

Doubtless under the influence of the Messrelationen, briefer compilations. many of which were translated or adapted for English readers, appeared from 1590 onward. When English editors took over the idea of the news budget in 1621, the publications were commonly called "corantos" to indicate running news. The first English-language corantos were, however, small single-sheet (two-page) publications. and they were published in the Xetherlands from Dec. 1620 to Sept. 1621. George Veseler published 1; of them and Broer Jonson 6 or 8 in Amsterdam; others were issued in Xlkmaar and The Hague. Apparently the next step was the publication of the same type of coranto in London in Sept. 1621. under the title *Corante,* or, *Weekely Newes From* Italy, *Germany, Hungarie, Spaine and France.* Six of these were issued "for N. B." with slight variations in title through September and October. The title is nearly enough identical. and the weekly periodicity (though actually irregular) clear enough in intention. to support the claim for this series as the first English newspaper. "N. B." was probably Xicholas Bourne. The sheets were translations of Dutch or German corantos.

The next year the single-sheet corantos gave place to those in pamphlet form; and comparative regularity in periodicity, if not in title. came with the *Weekly Newes,* issued by Nicholas Bourne and Thomas Archer beginning in May 1622. This series was generally referred to as composing the "first English newspaper" before the discovery in 1912 of the single-sheet corantos by "N. B." Continuity was by dates rather than identical title; for several years most coranto publishers depended upon changing headlines to sell their product and avoided identical titles. On Aug. 2, 1622. Nathaniel Butter began a *Newes,* "all of which do carry a like title . . . and have dependence upon one another" (Xug. 23). Butter. the son of a bookseller, became the most famous of the coranto publishers who flourished in the 1620s. In Oct. 1622. with Bourne and William Sheffard. Butter began A *Coranto,* with the introduction of serial numbering. In 1625 Archer founded *Mercurius Britannicus,* which probably lasted till the end of 162;. Butter and Bourne remained principal publishers of the corantos of various series until 1632. when all were suppressed because the Spanish ambassador had been offended by news they had published regarding the royal house of Austria. For six years thereafter there were no newsbooks in England, but in 1638 Butter and Bourne were given exclusive patent for publication of foreign news.

Freedom and Censorship.— The next step in the evolution oi the newspaper was due to the abolition of the Star Chamber in 1641. and the consequent freeing of the press: and at last the English periodical with domestic news arrived. In Nov. 1641 began The Head of *Severall Proceedings* in the Present *Parliament* (outside title) or *Diurnal Occurrences* (inside title). the latter being the title under which it was soon known as a weekly; and on Jan. 31, 1642, appeared A Perfect *Diurnal* of the Passages in *Parliament.* These were printed for William Cooke. and were written apparently by Samuel Pecke. "the first of the patriarchs of English domestic journalism" (J. B. Williams). The weekly *Diurnals* were on the side of the parliament until in Jan. 1643 appeared at Oxford the first royalist diurnal. named *Mercurius Aulicus, a Diurnal Communicating* the *Intelligence and Affaires* of *the Court* to the Rest of *the Kingdome* (continued till Sept.

1645, and soon succeeded by *Mercurius Academicus),* which struck a higher literary note. It was conducted by Sir John Berkenhead, a fellow of All Souls, whose style is said to reflect that of the parliamentary oratory of his day. He afterward became master of requests. *Mercurius Civicus,* the first regularly illustrated periodical in London, was started by the parliamentarian Richard Collings on May 11, 1643 (continued to Dec. 1646); Collings had also started earlier in the year the *Kingdome's Weekly Intelligencer,* which lasted till Oct. 1649. In Sept. 1643 appeared another puritan opponent of M. *Aulicus* in the later *Mercurius Britannicus* of Capt. Thomas Audley, which in Sept. 1644 was taken over and continued for nearly two years by Marchamont (or Marchmont) Nedham. Nedham was a master of invective and one of the earliest to change sides when it suited him. From Oct. 1649 to June 1650, by a new act of parliament, the licensed press itself was entirely suppressed, and in 1649 two official journals were issued, *A Brief Relation* (up to Oct. 1650) and *Severall Proceedings in Parliament* (till Sept. 1655), a third licensed periodical, *A Perfect Diurnall* (till Sept. 1655), being added later in the year and a fourth, *Mercurius Politicus* (of which John Milton was the editor for a year or so and Nedham one of the principal writers). starting on June 13, 1650 (continuing till April 12, 1660). After the middle of 1650 there was a revival of some of the older licensed newsbooks; but the *Weekly Intelligence of the Commonwealth* (July 1650 to Sept. 1655) by R. Collings was the only important ne comer up to Sept. 1655, when Oliver Cromwell suppressed all such publications with the exception of *Mercurius Politicus* and the *Publick Intelligencer* (Oct. 1655 to April 1660), both being official and conducted by Nedham.

Till Cromwell's death (Sept. 3, 1658) Nedham reigned alone in the press, but in 1659 a rival appeared in Henry Muddiman (a great writer also of "newsletters"), whose *Parliamentary Intelligencer,* renamed the *Kingdom's Intelligencer* (till Aug. 1663), was supported by Gen. George Monk. Nedham's journalistic career came finally to an end (he died in 1678) at the hand of Monk's council of state in April 1660. His successor, Muddiman, was supplanted in 1663 by Sir Roger L'Estrange, formerly a royalist cavalry officer who narrowly escaped execution during the Commonwealth; he was appointed "surveyor of the press." On him was conferred by royal grant—as it proved, for only a short period—"all the sole privilege of writing, printing and publishing all narratives, advertisements. mercuries, intelligencers. diurnal and other books of public intelligence; . . . with power to search for and seize the unlicensed and treasonable schismatical and scandalous hooks and papers." L'Estrange discontinued *Mercurius Politicus* and *Kingdom's Intelligencer.* and substituted two papers, the *Intelligencer* (Aug. 1) and the *Newes* (Sept. 3), at a halfpenny, the former on Mondays and the latter on Thursdays; they were continued till Jan. 29, 1666.

The London Gazette.—The first number of the biweekly *Oxford Gazette,* licensed by Lord Arlington and written by Muddiman, was published on Nov. 16, 1665. With the publication of the 24th number (Monday, Feb. 5, 1666, old style) the *Oxford Gazette* became the *London Gazette,* which has appeared twice a week, on Tuesdays and Fridays, ever since as an official organ of the government. After the revolution of 1688 the press censorship was relaxed, being finally abandoned in 1693, and a number of newspapers came into being. *Worcester Post Man* (later *Berrow's Worcester Journal*) was the oldest of the provincial papers, having been founded in 1690. In 1699 appeared the *Edinburgh Gazette,* a biweekly. Elizabeth Mallet published the first English daily newspaper March 11, 1702. She abandoned it after a week or two, but it was resumed a month later by Samuel Buckley.

Defoe, Swift and Lloyd.—Daniel Defoe was the first English journalistic writer of national importance. In Feb. 1704 he began his weekly, the *Review,* which eventually was printed three times a week and was a forerunner of the *Tatler* (started by Sir Richard Steele in 1709) and the *Spectator* (started by Steele and Joseph Addison in 1711). Defoe's *Review* came to an end in 1713, and between 1716 and 1720 he published a monthly with an old title, *Mercurius Politicus.*

The *Examiner,* started in 1710 as the chief Tory organ, enjoyed as its most influential contributor Jonathan Swift, the father of the leading article. Swift had control of the journal for 33 numbers between Nov. 1710 and June 1711, but on becoming dean of St. Patrick's he gave up regular journalistic work.

In 1696 Edward Lloyd—the virtual founder of the famous "Lloyd's" of commerce—started a thrice-a-week paper, *Lloyd's News,* which had but a brief existence in its first shape, but was the precursor of the modern *Lloyd's List.* No. 76 of the original paper contained a paragraph referring to the house of lords, for the appearance of which a public apology must, the publisher was told, be made. He preferred to discontinue his publication (Feb. 1697). In 1726 he in part revived it, under the title of *Lloyd's* List—published at first weekly, afterward twice a week. It later became a daily.

Stamp Tax of 1712.—The increasing popularity and influence of the newspapers could not fail to be distasteful to the government of the day. The paper which seems to contain the first germ of the newspaper tax is still preserved among the treasury papers, and probably belongs to the year 1711. The duty eventually imposed (1712) was a halfpenny on papers of half a sheet or less, and a penny on such as ranged from half a sheet to a single sheet.

Swift's doubt, expressed in his *Journal to Stella* (Aug. 7, 1712), as to the ability of the *Spectator* to hold out against the tax was justified by its discontinuance in Dec. 1712, Steele starting the *Guardian* in 1713, which only ran for six months. But some of the worst journals that were already in existence kept their ground, and their number soon increased. Part of this increase may fairly be ascribed to political corruption. Later, toward the middle of the same century, the provisions and the penalties of the Stamp act were made more stringent. Yet the number of newspapers continued to rise. In 1753 the aggregate number of copies of newspapers annually sold in England, on an average of three years. amounted to 7,411,757. In 1760 it had risen to 9,464,790, and in 1767 to 11,300,980. In 1776 the number of newspapers published in London alone had increased to 53.

18th-Century Journalists.—Thus the 18th century saw the gradual development of the purely political journal side by side with those papers which were primarily devoted to news, domestic and foreign, and commerce. It was left to Steele and Addison to develop the social side of journalism in their journals named above. Nor can Samuel Johnson's second biweekly, the *Rambler,* started in 1750, and his weekly. the *Idler* (1758), be omitted. In 1762 the *North Briton* came out and it was largely as a result of John Wilkes's *(see* WILKES, JOHN) determined fight for the liberty of the press that at length the last shackles on free expression of opinion in Britain were cut away, and by 1772 the right to publish parliamentary reports had been established.

The outstanding daily paper in the middle of the 18th century was the *Public Advertiser,* which for about 25 years had been called the *General Advertiser* (and for some time the *London Daily Post).* It was published with notable success by Henry Woodfall and his son Henry Sampson Woodfall, and it was in this paper that the famous letters of Junius (*q.v.*), which have been attributed to Sir Phillip Francis, appeared. These papers led to a marked increase in its circulation, the monthly sale in Dec. 1771 being almost 84,000 as compared with 47,500 seven years previously. But in 1798 it was merged in the *Public Ledger.*

Early 19th Century.—In 1769 William Woodfall started the *Morning Chronicle,* whose daily circulation in 1819 reached 4.000, and in 1843, at a time when Charles Dickens was a contributor, 6,000. But in another six years the circulation had fallen to 3,000. For about five years it became the property of the duke of Newcastle, William Gladstone and others, but finally ended insolvent: after a life of more than 90 years. Another long-lived daily paper, whose top circulation was about 6,000, was the *Morning Herald* (1781–1869). It was William Cobbett who first attempted to reach the masses by his pen, and reduced the price of his *Weekly Political Register* from 1*s.* ½*d.* to twopence in his endeavour to appeal to the working classes for support of those principles of parliamentary reform dear to his heart. In 1808 Leigh Hunt brought out the *Examiner,* whose frank criticism of the prince regent landed him and a brother in prison.

Abolition of "Taxes on Knowledge." — The development of the press was enormously assisted by the gradual abolition of the "taxes on knowledge," and also by the introduction of a cheap postal system. In 1756 an additional halfpenny was added to the tax of 1712. In 1765 and in 1773 various restrictive regulations were imposed. In 1789 the three halfpence was increased to twopence. in 1798 to twopence-halfpenny, in 1804 to threepence-halfpenny and in 1815 to fourpence, less a discount of 20%. As prosecutions multiplied, and the penalties became more serious, revolutionary tendencies increased in a still greater ratio. Blasphemy was added to sedition. Penny and halfpenny journals were established which dealt exclusively with narratives of gross vice and crime. Between 1831 and 1835 hundreds of unstamped newspapers made their appearance. The political tone of most of them was fiercely revolutionary. Prosecution followed prosecution, but all failed to suppress the obnoxious publications.

To Lord Lytton. the novelist and politician, and subsequently to Milner Gibson and Richard Cobden, is chiefly due the credit of grappling with this question in parliament to secure first the reduction of the tax to a penny in 1836, and then its total abolition in 1855. The number of newspapers established from the early part of 1855, when the repeal of the duty had become a certainty, and continuing in existence at the beginning of 1857, amounted to 107; 26 were metropolitan and 81 provincial. The duties on paper itself were finally abolished in 1861.

The abolition of the stamp taxes brought about such reductions in the prices of newspapers that they speedily began to reach the many instead of the few. Some idea of the extent of the tax on knowledge imposed in the early 19th century may be gathered from the fact that the number of stamps issued in 1820 was nearly 29,400,000, and the incidence of the advertisement tax, fixed at 3*s.* 6*d.* in 1804. made it impossible for the newspaper owner to pass on the stamp tax to the advertiser. In 1828 the proprietors of the *Times* had to pay the state more than £68,000 in stamp and advertisement taxes and paper duty. But after the reduction of the stamp tax in 1836 from fourpence to one penny, the circulation of English newspapers, based on the stamp returns, rose from 39,000,000 to 122,000,000 in 1854.

London Morning Papers. — The *Times* was started by John Walter on Jan. 1, 1785, under the name of the *Daily Universal Register.* The founder promised the readers of the new journal that it would contain nothing to wound anyone's delicacy or corrupt the mind, that it would abstain from uniair partisanship and scandalous scurrility. On Jan. 1. 1788, its title was changed to the *Times,* and this great newspaper has ever since been the preeminent national journal and daily historical record. It came into existence when free expression of opinion in the press was still a thing of the future, and within a few years of the establishment of his paper Walter had several sojourns in Newgate and had to pay several fines for criticisms of the authorities. One of his offenses was the statement that the then prince of Wales and other royal princes had by their misconduct incurred the disapprobation of George III.

John Walter II practically took over the reins in 1803, and he also had to encounter the active opposition of governments which he had occasion to criticize, including that of William Pitt. He introduced a better system of news transmission and steam printing (1814), with the result that he was able to make the proud announcement that 1,100 sheets had been impressed in one hour. In view of the newspaper and advertisement tax and other disabilities, it was a considerable achievement when in 1815, the year of Waterloo, the daily circulation reached 5,000. In 20 years this was doubled, in 1851 it had reached 40.000 and three years later it was more than 50,000, when its most circulated rival, the *Morning Advertiser,* had a sale of fewer than 8,000 copies. When John Walter II assumed control the *Times* was a small four-page sheet. When he gave up control in 1847 it consisted of 12 large pages. Sir John Stoddart, later governor of Malta, was the editor for several years up to 1816. He was succeeded by Thomas Barnes, and when the latter's health began to fail much of the editorial work devolved upon Capt. Edward Sterling, whose pontifical and sometimes explosive style caused Thomas Carlyle to say: "He more than any other man was *The Times,* and thundered through it to the shaking of the spheres." Carlyle also called him "Captain Whirlwind," and the popular title of the "Thunderer" often given to the *Times* dated from his time.

In 1841, on the death of Barnes, the editorial chair was taken by John Thaddeus Delane. In 1877 he was succeeded by Thomas Chenery, who died in 1884 and was followed by George Earle Buckle. Meanwhile, from 1848, John Walter III had been in command. He died in 1894, and was succeeded by Arthur Walter.

About the beginning of the 20th century the *Times* had begun to feel the influence of the more go-ahead methods of the popular press, and there was a loss of circulation and revenue which became a grave source of anxiety to its owners. It was a period when another great London daily paper, the *Standard,* was dying. Finally, in 1908, Lord Northcliffe realized his ambition and acquired the chief control of the "Thunderer." It cannot be said that Lord Northcliffe's administration was consistently successful but he thoroughly remodeled the organization and increased its efficiency in all departments. On his retirement Buckle was succeeded as editor by George Geoffrey Dawson. In 1919 he retired from the editorship because of a difference of opinion with Lord Northcliffe and his place was taken by Henry Wickham Steed. who died in 1956. In 1923 when, following the death of Lord Northcliffe, Maj. J. J. Astor, M.P. (later Lord Astor of Hever), became its chairman and chief proprietor, Dawson again became editor. Major Astor secured the future independence of the paper by a deed establishing a body of trustees consisting of holders of various public offices whose consent would be required to validate any future transfer of ownership. In 1941 Dawson retired from the editorship in favour of R. M. Barrington Ward who died seven years later and was succeeded by W. F. Casey. On his retirement in 1952 Sir William Haley, the then director-general of the British Broadcasting corporation, became the editor. Although its circulation of about 250,000 in the later 1950s was far below that of its competitors, the *Times* continued to enjoy all its old prestige. Its reputation for independence continued unimpaired.

The *Times* has always excelled in its home and foreign news departments and in mechanical production. On the editorial side it has at its command experts on every conceivable subject. It makes a special feature of its reports from overseas and from its earliest days it has maintained an able staff of correspondents in all the capitals of the world. Among the other publications issued from Printing House square, the home of the *Times,* are the *Literary Supplement,* the *Educational Supplement,* the *Weekly Review,* first published in 1877 as the *Weekly Edition,* and the *Review of Industry,* published monthly. The *Times Index,* an invaluable record of the news in the daily issues of the paper, is published once every two months.

The *Duily Telegraph and Morning Post* stood, by the middle of the 20th century, second in the list of the great national dailies and. having kept its price down to 2*d.* (as did the other London morning papers with the exception of the *Times* [4*d.*]), achieved a daily sale of more than 1,000,000 copies.

First published as the *Daily Telegraph and Courier* on June 29, 1855, it was owned by Col. Arthur B. Sleigh. who transferred it to Joseph Moses Levy in the following September. Levy produced it as the first penny newspaper in London. the name *Courier* being subsequently dropped. His son Edward Lawson (later the 1st Lord Burnham) soon became editor. which post he continued to hold till 1885. A long list of distinguished members of the staff included Sir Edwin .Arnold. George Augustus Sala. Edward Dicey, Sir J. M. Le Sage. Bennet Burleigh, the war correspondent, J. L. Garvin and H. D. Traill; and among dramatic and literary critics Clement Scott. W. L. Courtney and W. A. Darlington. After 1890 Harry Lawson (later Viscount Burnham), eldest son of the owner, assisted in the general control. The *Daily Telegraph* became the especial organ of the middle classes and shortly before the advent of the halfpenny daily newspaper could claim the largest circulation in the world. It was consistently Liberal up to 1878 when it opposed Gladstone's foreign policy. and at the Irish Home Rule split in 1886 it became Unionist. Circulation by 1927, however, had declined to 84,000; and in 1928 Viscount Burnham sold the paper to Sir William Ewert Berry and Sir James Gomer Berry (later Viscount Camrose and Viscount Kemsley) and Sir Edward (later Lord) Iliffe. Circulation increased. doubling in 1930, when the price was reduced to a penny. The *Morning Post* was absorbed in 1937, and the *Daily Telegraph and Morning Post* was in the later 19jos a well-balanced morning newspaper, independent Conservative in politics, with more than 1,076,000 circulation.

The *Morning Post* had been founded in 1772 as the *Morning Post and Daily Advertising Pamphlet,* mostly an advertising sheet including state lotteries, then legal and popular. It developed into a national newspaper under the ownership of Peter and Daniel Stuart after 1795, and attracted a wonderful galaxy of writers. including Sir James Mackintosh, Samuel Taylor Coleridge, Robert Southey, Arthur Young, the poet Thomas Moore, William Wordsworth and Charles Lamb. The *Morning Post* maintained a tradition of vigorous and unblenching criticism, and Nicholas Byrne, editor-owner who succeeded Daniel Stuart: was murdered in his office as the result of an article which had given offense. In 1850 the paper came under the control of Peter Borthwick, and on his death in 1852 he was succeeded by his son Algernon (later Lord Glenesk). Among the editors of the *Morning Post* were Sir William Hardman, J. Nicol Dunn. Sir Fabian Ware and H. A. Guynne. In 1937 the paper, as noted above, was consolidated with the *Daily Telegraph.*

The *News Chronicle* resulted from the amalgamation of several papers, notably the *Daily News* and the *Daily Chronicle,* both of which will be discussed separately. The *Daily News* was founded in 1'846 under the editorship of Charles Dickens, who was succeeded by John Forster. The original staff included Mark Lemon, afterward editor of *Punch,* and Douglas Jerrold. The *Daily News* became a champion of Liberalism; it led British public opinion in sympathizing with the North in the U.S. Civil War, in supporting the war of freedom in Italy and the emancipation of Bulgaria and the Armenians. Under Sir John Robinson it attained a high reputation for its foreign correspondence, beginning with the celebrated Archibald Forbes in the Franco-German War of 1870–71. The *Daily News* absorbed the *Morning Leader* and acquired the *Star* in 1909, absorbed the *Westminster Gazette* in 1928 and was amalgamated with the *Daily Chronicle* in 1930. The *Daily Chronicle* was established in 1877. It consisted almost entirely of small advertisements, and Edward Lloyd, the founder of *Lloyd's News,* turned it into a general morning London newspaper. During the Home Rule controversies in the 1880s it was Liberal Unionist, but under the editorship of A. E. Fletcher (1895) it became Gladstonian Liberal. Fletcher was succeeded by Henry W. Massingham, who made the paper a more robust political organ. Massingham was a Radical; he lost his position on the *Chronicle* because of his opposition to the South African War. He was succeeded by W. J. Fisher and the paper pursued a humdrum career and was a declining property when in 1904 Robert Donald was appointed editor. The paper then entered upon a new era of prosperity and prestige which reached its height during World War I. The paper was sold to David Lloyd George and his friends in the autumn of 1918, when Sir Robert Donald retired from his position as editor. After several other changes in ownership and management, the *Daily Chronicle* was amalgamated with the *Daily News* in 1930 to form the *News Chronicle.* In 195j it absorbed the *Daily Dispatch* of Manchester. At mid-century it had a circulation of more than 1,500,000, with simultaneous publication in London and Manchester. An independent progressive paper, it emphasized features and sports.

The *Daily Mail,* started by Alfred and Harold Harmsworth in 1890 as a halfpenny daily newspaper. was a phenomenal success from the first number. By 1900 it had already reached the 1,000,000 mark in circulation and by 1929 it had 2,000,000. In 1905 Sir Alfred Harmsworth started in Paris the *Continental Daily Mail,* later the property of Lord Rothermere. The *Daily Mail* also established editions in Manchester and Edinburgh. Sir Alfred Harmsworth (later Viscount Northcliffe) was not only a brilliant organizer but a keen journalist; he was a pioneer in many enterprises of journalism and national interests: and gave invaluable help to aviation. On the death of Lord Northcliffe in 1922, the paper came under the control of his brother, Lord Rothermere. On his retirement in 1937 the management passed to his son. In the late 1920s and early 1930s the *Daily Mail* had the largest daily circulation in the world. By mid-century it had a distribution of more than 2,000,000, but at that time its sales had been greatly exceeded by both the *Daily Express* and the *Daily Mirror* with circulations of more than 4,000,000.

The *Daily Express,* which was founded as a halfpenny newspaper in 1900 by C. Arthur Pearson, passed the *Daily Mail* in circulation in the 1930s, partly through the use of free-gift inducements. Following the lead of U.S. newspapers, the *Daily Express* struck a new note of publishing its principal news on the front page. In 1904 R. D. Blumenfeld became editor and in 1912 he formed a syndicate which acquired control. Lord Beaverbrook began to take an interest in the paper while it was financially in low water, and in 1922 he obtained complete control. He spent prodigious sums in developing the paper, which by the later 1950s had more than 4,000,000 circulation and was being printed simultaneously in London, Manchester and Glasgow.

The *Daily Herald* was founded in 1912 as a Labour organ, but was not taken over officially by the Labour party until 1923. In 1929 Lord Southwood, head of Odhams Press Ltd., arranged to take a 51% interest, while the party retained 49%. It was agreed that the paper should support the policy of the Trades Cnion congress. With the aid of free insurance and other inducements, the *Daily Herald* gradually built up a large circulation and in the later 1950s the audited circulation was 1,865,000.

The *Daily Sketch* was founded in 1909 as a halfpenny illustrated tabloid, absorbed the older and higher-priced *Daily Graphic* in the 1920s and was called for several years the *Daily Sketch and Graphic.* Coming into the hands of Lord Rothermere it was later sold by him to Lord Kemsley. The name of the *Graphic* was then dropped but in 1946 the *Daily Sketch* became the *Daily Graphic.* When, later on, it again passed into the control of Lord Rothermere, the title of the *Daily Sketch* was restored. In the later 1950s it had a circulation of 825,000.

The *Daily Mirror* was originally issued in 1903 by Alfred Harmsworth as a women's paper to be edited by women. When it did not succeed in this field, its owner soon made it over into the first halfpenny illustrated tabloid. It retained a family flavour, however, with attention to women's interests. At mid-century it was second only to the *Daily Express* in circulation, selling 4,750,000 copies daily.

Founded in 1932 as a Communist organ, the *Daily Worker* was suppressed in Jan. 1941 for opposing the national war effort and did not appear again until Sept. 1942 when the U.S.S.R. had joined the war against Germany. Its circulation in the later 1950s was about 83,000.

London Evening Papers.—There are three evening papers published in London, the *Evening* ***News,*** the *Star* and the ***Evening*** *Standard.*

The *Evening News* was founded in 1881 and, after many vicissitudes, when in difficulty was acquired in 1895 by Alfred and Harold Harmsworth and Kennedy Jones. It was the Harmsworths' first incursion into daily journalism, and made a rich experimental field for the *Daily Mail.* One of the Associated Newspaper group, it had the largest circulation of any of the evening papers in the country in the later 1550s—approximately 1,500,000.

The *Star,* the only Liberal evening paper in London, was started by T. P. O'Connor in 1888 as a halfpenny journal in support of Gladstone.. In 1909 it was acquired by the *Daily News* and had a circulation of more than 1,000,000 in the later 1950s.

The *Evening Standard* was begun in the 1870s as the afternoon edition of the *Standard (see* below) and was devoted largely to commercial news. In 1923 it became the property of Lord Beaverbrook, and later it absorbed the famous old *Pall Mall Gazette (see* below). Often called a "quality" evening newspaper, it had a circulation of nearly 800,000 at mid-century.

Great Papers of the Past.—Fleet street is peopled with the ghosts of journals which in their time filled important places in the life of the country. There was the *Morning Chronicle,* which began its career in 1769 and had among its leading contributors R. B. Sheridan. Sir J. Mackintosh, John Campbell (afterward lord chancellor), the poet Thomas Campbell, Thomas Moore, Lord Brougham, Byron, William Hazlitt, J. S. Mill, Charles Lamb and W. M. Thackeray. John Black was its most famous editor. After a notable career the *Morning Chronicle* died in 1862.

The *Standard* was established as an evening paper in the Tory interest in 1827. In the 1850s it was purchased by James Johnstone, who brought out the *Standard* as a morning paper (1857). One of its contributors in the 1860s was Lord Robert Cecil, later Lord Salisbury. Johnstone, to whose energy and perspicacity the paper owed so much, died in 1878, and under his will William H. Mudford was appointed editor and manager for life, or until resignation. In Mudford's hands the *Standard* entered upon a successful period. It had many famous war correspondents, foremost among whom were G. A. Henty, John A. Cameron and William Maxwell. In Jan. 1900 Mudford was succeeded by G. Byron Curtis (d. 1907). In Nov. 1904 the *Standard* was sold to Sir Arthur Pearson. In 1910 it passed into the control of Davison (later Lord) Dalziel and disappeared during World War I.

A disastrous experiment in newspaper production was the *Tribune,* founded by Franklin Thomasson in 1906 as a solid penny daily. After gathering a brilliant staff and expending very large sums he discontinued the paper in 1908. The unhappy enterprise was described in Sir Philip Gibbs's novel *The Street of Adventure.*

The first number of the *Pall Mall Gazette* (the name being borrowed from the incident in which Thackeray describes Captain Shandon in the Marshalsea prison drafting the prospectus of the *Pall Mall Gazette* as a paper "written by gentlemen for gentlemen") appeared in Feb. 1865. Its first editor was Frederick Greenwood, who gathered round him a brilliant array of talent in Sir Henry Maine, Sir J. Fitzjames Stephen, Anthony Trollope, Charles Reade, George Henry Lewes, George Eliot, Matthew Arnold and Richard Jefferies. In 1875 Greenwood was able to convey to Disraeli news of the French bid to secure control of the Suez canal, thereby enabling Britain to get in first. It had been a consistent supporter of Disraeli, and when on changing hands it became Liberal, John Morley (later Viscount Morley of Blackburn) became editor, with William T. Stead (*q.v.*) as assistant editor. When Morley exchanged journalism for politics in 1883, he was succeeded by Stead. Stead was succeeded by E. T. Cook in 1889. The *Pall Mall Gazette* was now steadily Liberal and a strong advocate of Irish Home Rule. Two distinguished editors at a later date were Sir Douglas Straight and J. L. Garvin. It was consolidated with the *Evening Standard* in 1925.

Founded in 1880 by H. Hucks Gibbs (later Lord Aldenham) for Frederick Greenwood to edit when he had left the *Pull Mull Gazette,* the *St. James's Gazette* represented the more intellectual and literary side of Tory journalism in opposition to the new liberalism of Greenwood's former organ. In 1888, the paper having been sold, Greenwood retired and was succeeded as editor (1888–97j by Sir Sidney Low, who in his turn was succeeded by Hugh Chisholm (1897–99). Among the contributors were Rudyard Kipling, Sir James Barrie and G. S. Street. Toward the end of the 19th century it assumed a more popular style and shape, and for a year or two before its acquisition by Pearson in 1903 and its final merging in the *Evening Standard* it was edited by Ronald McNeill (later Lord Cushendun).

When the *Pall Mall Gazette* was sold to Lord Astor in 1892 and converted into a Conservative organ, E. T. Cook, the editor. and most of his staff resigned; in 1893 they came together again on the *Westminster Gazette,* newly started for the purpose by Sir G. Newnes as a penny Liberal evening paper. The paper was conducted on the lines of the old *Pall Mall Gazette,* and it had the advantage of a brilliant political cartoonist in Sir Carruthers Gould. In 1896 Cook was appointed editor of the *Daily News,* and his place was ably filled by J. A. Spender. The *Westminster Gazette* became conspicuous for its high standard of political and literary criticism, and gradually became the chief organ of Liberal thought in London. In 1908 it was sold to a group of Liberal capitalists. After World War I it was replaced by a daily newspaper of the same name which was merged in the *Daily News* in 1928.

Provincial Press.—The first provincial paper in England was the weekly *Worcester Post Man* (1690), later the modern *Berrow's Worcester Journal.* In the first 20 years of the 18th century a number of other, mainly weekly, journals sprang up in country towns, among them the *Stamford Mercury* begun in 1713 and the *Northampton Mercury* begun in 1720. At the start of the 19th century the provincial press consisted of fewer than 100 journals, practically without influence. Benjamin Flower, printer of the *Cambridge Intelligencer,* was the first to introduce the leading article in the provincial press. The *Leeds Mercury,* founded in 1717, under the control of Ed ard Baines (1801) became the most important and influential of the north country papers in the first half of the 19th century. After the Reform act of 1830, the spread of self-education and the establishment of reading circles and newspaper clubs, the country newspapers developed in importance and usefulness. It was not, however, till the final removal of the taxes on knowledge that the provincial press came into its own.

Within ten years of the abolition of the paper duty, penny morning newspapers had taken up commanding positions in many cities in England, Scotland and Ireland. But any real importance as organs of opinion was still confined to only a few of the great penny provincial dailies, notably the *Yorkshire Post, Manchester Guardian, Birmingham Post* (1857), *Sheffield Telegraph* (associated with Sir W. Leng), *Liverpool Daily Post, Leeds Mercury* and *Western Morning News;* others were at the same time cradling journalists who were to become famous, such as the *Darlington Northern Echo,* on which W. T. Stead made his debut.

The first syndicate to send out war correspondents was formed by the *Glasgow News, Liverpool Daily Post, Manchester Courier, Birmingham Gazette* and *Western Morning News,* which dispatched two correspondents to Egypt. The Central News also sent out war correspondents to Egypt and the Sudan. During the South African War (1899–1902) the leading provincial newspapers, however, all formed syndicates to secure war telegrams.

In the middle of the 20th century the leading English provincial daily papers were:

The *Manchester Guardian* was founded in 1821 as a weekly Whig organ and later became the chief exponent of Liberalism outside London. From 1872 to 1929 it was edited by C. P. Scott (*q.v.*) and gained a world-wide reputation. Apart from its vigorous politics it enjoyed an unrivaled literary prestige. It became a penny paper in 1857, two years after it had been turned into a daily.

Prominent names associated with it were C. P. Scott's son-in-law C. E. Montague, Leonard T. Hobhouse, Andrew Lang, Richard Jefferies, Richard Whiteing, Sir Claude Phillips, George Saintsbury, Laurence Housman, G. W. E. Russell and Spenser Wilkinson. In its book reviewing, its dramatic criticism and its foreign correspondence the *Manchester Guardian* exercised an unparalleled influence in provincial journalism. and came to be regarded as a national organ. The *Manchester Evening News,* founded 1868, came under the same ownership as the *Guardian* in 1924. Its prosperity (circulation more than 268,000 at mid-century) helped the *Guardian.*

The *Yorkrhire Post* began in 1754 and became the principal Conservative newspaper outside London, enjoying national prestige extending far beyond the borders of Yorkshire. In its early years it devoted especial attention to racing, which was neglected by most local papers in the country in those days, and under the control of the Beckett family it rapidly attained a solid prosperity. It had talented editors in H. J. Palmer, J. S. R. Phillips, Arthur H. Mann and Sir Linton Andrews.

The *Yorkshire Evening Post,* founded 1890, became the popular evening paper for all Yorkshire, with a circulation of 250,000.

The *Birmingham Daily Post* was founded in 1857 by J. F. Feeney and John Jaffray and later was controlled by Sir Charles Hyde. It came to hold a position in the midlands analogous to that of the *Yorkshire Post* in the north. It was purchased by Lord Iliffe after Hyde's death in 1942. Its evening associate, the *Mail,* had a circulation of nearly 300.000 at mid-century. In 1956 it absorbed the *Birmingham Gazette.*

The *Liverpool Daily Post* was founded in 1855 as a Liberal paper. In 1904 it absorbed the *Liverpool Mercury* (founded in 1811), and it assumed a pre-eminent place in the life of the great seaport. It was far exceeded in circulation by its afternoon associate, the *Evening Echo,* with a sale of more than 380,000.

Scotland, Wales and Ireland. — In Scotland the leading newspapers in 1956 were still the *Scotsman* and the *Glasgow Herald.* The former was started as a biweekly in 1817 and became a daily in 1855. It was Liberal until the Home Rule split in 1886 when it adopted the Unionist cause. Alexander Russel was its most famous editor in the 19th century (1848–76) and worthy successors included Sir George Waters and J. Murray Watson. For many years it has been the only Edinburgh morning newspaper.

The *Glasgow Herald* dates from 1783, when it first came out with the extra name *and Advertiser.* It acquired a great literary reputation under an illustrious line of editors, including Samuel Hunter, George Outram, Sir Robert Bruce and Sir William Robieson.

The largest circulations in Scotland in'the later 1950s were those of the *Glasgow Daily Record,* founded 1895, a Conservative morning paper under Kemsley ownership, 350,000; and the *Glasgow Evening Times,* founded 1876, 250,000.

In Wales the four Cardiff papers in 1929 were amalgamated into two, the *South Wales Echo and Evening Express* and the *Western Mail and South Wales News,* both Kemsley newspapers; at mid-century the former had the largest of Welsh circulations — about 170,000. In 1929 also the two Swansea papers were consolidated by the Northcliffe newspaper group as the *South Wales Evening Post.*

In Northern Ireland Belfast had three morning papers and one evening in 1956. The morning papers were the *News-Letter* (1737), the *Northern Whig* (1824) and the *Irish News* (1855). The evening paper was the *Belfast Telegraph* (1870). In Ireland there were three morning and three evening papers published at Dublin and one of each at Cork. Of these, the oldest and largest were the *Dublin Evening Mail* (1823) and the *Cork Examiner* (1840, morning).

British Illustrated Newspapers. — English papers carried news pictures as early as 1731, when the *Grub Street Journal* printed a woodcut depicting the lord mayor's show, but not until 1842 did England have a fully illustrated newspaper.

Herbert Ingram brought out the first number of the weekly *Illustrated London News* on May 14, 1842. It contained 16 printed pages and 32 woodcuts. The chief engravings, by Sir John Gilbert, illustrated the first *bal masque'* given by Queen Victoria at Buckingham palace. Control of the paper passed in 1860 to Ingram's son, later Sir William Ingram. Its editors included Charles Mackay (1848–59), John Lash Latey (1859–90) and Clement K. Shorter (1890–99). In 1861 the first penny popular paper was started by the same proprietor, the *Penny Illustrated Paper,* edited by John Latey, Jr., who afterward was editor of the *Illustrated London News.* In 1869 the first serious rival of the *Illustrated London News* was published, the *Graphic,* produced by W. L. Thomas. *Black and White,* a paper of the same class as the *Illustrated London News,* followed in 1891; and in 1892 the *Sketch* was started by Sir William Ingram, under the editorship of Shorter, as a social and theatrical illustrated weekly.

From this time forward, many illustrated weeklies were started in the fields of the theatre, sports, fashion and society. In 1926 William Harrison brought all the leading illustrated papers under the management of Illustrated Newspapers Ltd. In 1937 this concern was purchased by Sir John Ellerman and Lord Southwood, the former taking a controlling interest.

Sunday Newspapers. — The *Observer,* most powerful political organ among the Sunday newspapers, was founded in 1791. The *Observer* kept on its respectable but somewhat sombre career until it was acquired by Lord Astor and edited by J. L. Garvin, when it assumed a distinctive character — a virile independence in its political outlook while making a strong feature of foreign correspondence. literature, the drama, etc. On Garvin's resignation in 1942 he was succeeded by David Astor.

The *Sunday Times* was founded in 1822. Its course was similar to that of the *Observer* until 1915, when it was acquired by William and James Berry. The former was editor in chief of the *Sunday Times,* 1915–37. Its circulation in 1956 was about 600,000.

The best-selling Sunday newspaper in the later 1950s was the *News of the World* (founded 1843), which devoted considerable space to sport and crime. Sir Emsley Carr was editor for half a century from 1891 until his death in 1941. The paper passed the 1,000,000 mark shortly after the turn of the century and after the mid-1950s it passed the 8,000,000 mark, a larger sale than that of any other newspaper in the world.

The *People,* with a circulation in the later 1950s of 5,000,000, was printed in London and Manchester, as was the *News of the World.* Founded in 1881, it was owned by Odhams Press Ltd., which also controlled the *Daily Herald.* The *Sunday Express,* founded in 1918 as the Sunday edition of the *Daily Express,* sold about 3,250,000 copies. The *Sunday Dispatch,* founded in 1801 as the *Weekly Dispatch* and later affiliated with the *Daily Mail,* had a circulation of more than 2,500,000; the *Sunday Graphic,* established in 1915, over 1,000,000; *Reynolds News,* founded in 1850 and the organ of the co-operative movement, 625,000. The *Sunday Pictorial* (1915) had a circulation of more than 5,000,000 and the *Empire News,* founded in Manchester in 1884, 2,000,000.

Competition for Mass Circulation. — The competition for circulation reached its height between World Wars I and II and the popular newspapers resorted to many unusual expedients. Free insurance policies were offered to readers and their families and, in return for a subscription to the newspaper, the citizen could obtain free gifts which ranged from complete sets of books by well-known authors to washing machines. Crossword and other competitions for which substantial prizes were awarded were introduced. The result was that for a time circulations were artificially inflated and it is to be doubted whether the public read all the newspapers for which it paid subscriptions. The newspapers realized that a disaster, if it caused the deaths of many policyholders, might have a crippling effect on their finances and a mutual arrangement was agreed upon to limit this form of artificial circulation. In World War II canvassing for circulation was forbidden and circulations were frozen at 1939 levels. There was, however, a renewal of some of this competition during the 1950s when inducements to purchase newspapers included gifts ranging from a race horse to a public house. The coming of broadcasting and television stimulated interest in news and circulations of daily papers continued to mount steadily. The weekly illustrated papers, however, found the competition of television more serious because of the time factor and this was given as one of the reasons for closing down *Picture Post* in June 1957.

Censorship. — With the outbreak of World War II the newspapers were brought under a system of voluntary censorship which had been worked out in advance by a committee representing the services and other government departments and the press. On the whole the system worked well, although in the early months there were some irritating delays and restrictions which were gradually smoothed out. No newspaper was compelled to submit its copy to the censorship department unless a definite embargo had been imposed upon a particular item of news. Comment was not restricted. The newspapers loyally accepted the system and any news which it was felt might give information to the enemy was submitted, for the newspapers realized that the fact that the copy had been passed by the censorship department would be a great help to them if, by any chance, proceedings were brought under the Official Secrets act. Contact between the government and the press was maintained by a system of defense notices and at the end of the war it was agreed that this machinery should be kept in being in case it might be needed again. During the war there were suggestions that the government was contemplating compulsory censorship but the idea was resisted vigorously by the newspapers.

The Royal Commission on the Press. — In the years that followed the end of World War II controversy about the growing power of the newspaper chains and criticism about the alleged bad behaviour of a few individual journalists led to the setting up in 1947 of a royal commission which was charged "in order to further the free expression of opinion through the Press and the greatest practical accuracy in the presentation of news to inquire into the control, management and ownership of the newspaper and periodical Press and news agencies, including the financial structure and the monopolistic tendencies in control." The commission presented its report two years later and decided that there "was nothing approaching monopoly in the press as a whole" but added that it would deplore any tendency on the part of the larger chains to expand. It felt that "the gap between the best of the quality papers and the general run of the popular Press is too wide." It recommended the establishment of a general council of the press to safeguard the freedom of the press; to encourage the growth of the sense of public responsibility among all engaged in the profession of journalism and to further the efficiency of the profession and the well-being of those who practise it. Seven organizations representing the proprietors, editors and working journalists agreed to set up and to finance a voluntary press council which came into being in July 1953.

See also NEWS AGENCY; PRESS SYNDICATE.

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IV. OTHER WESTERN EUROPEAN COUNTRIES

Norway.—The Norwegian press apparently began with the founding of the *Norske intelligenssedler* in Oslo in 1763, and two years later the *Efterretninger fra Addressecontoiret* in Bergen. The latter was a mercantile and labour bulletin which preceded the partisan political press that eventually came to be characteristic of Norway. Shortly after the union with Sweden in 1814, a number of political papers were begun in Oslo, of which the *Morgenbladet,* still published at mid-20th century as a Conservative daily, became one of the best known. In the later 1950s there were 96 daily papers with a total sale of 1,300,000 copies. The *Aftenposten* of Oslo had the largest circulation—about 150,000 copies.

Sweden.—Though a newssheet called *Hermes gothicus* is known to have been published as early as 1624 in Strangnas, and similar corantos were published in other Swedish towns. the first paper published with regularity appears to have been the *Ordinari post tijdender,* begun in 164j and, at mid-20th century, the oldest continuously published newspaper in the world, though little more than an official bulletin, under the title *Post och inrikes tidningar.* Its founder was Johan Beijer, Sweden's second postmaster general. It became a daily in 1820.

The oldest independent newspaper in Sweden in the later 1950s was the *Tidningar,* founded at Norrkoping in 1758. The *Handels- och sjöfarts-tidning* ("Trade and Shipping News"; 1832) of Göteborg maintained a liberal and democratic tradition.

In the later 1950s there were 160 daily papers with a total circulation of 3,630,000. This represented a sale of jo6 copies for every 1,000 inhabitants, one of the largest ratios in the world. The largest circulations in 1957 were those of three Stockholm newspapers: the *Dagens Nyheter* (1864) with more than 250,000, the *Stockholms-Tidningen* (1824) and its afternoon associate *Aftonbladet* (1930). The first-named paper also owned the evening *Expressen* (1944). The *Svenska Dagbladet* had a high reputation in and out of Sweden.

Denmark.—Though various Danish newspaper efforts followed the "king's law" of 1665, government controls were stern until the more liberal "June constitution" of 1849.

In 1739 Ernst Heinrich Berling, German-born book publisher, began publication of the *Kobenhavske Post-Tidener* ("Copenhagen Post-News"). The name was changed several times, finaily becoming *Berlingske Tidende.* It became a daily in 1841; three years later a morning edition was established. to become the major Berling paper, with *Aftenavis* as the evening edition. The paper lost its position as government organ in 1901, but the Berling concern was enlarged by the addition of *B.T.,* a tabloid daily established in 1916, weekly and monthly magazines, etc. *Berlingske Tidende* was the largest Danish paper in 19j6 with about 200.000 circulation.

Another daily founded in the 18th century and still published in 1950 was the *Stiftstidende* (1794) of Xarhus. Second largest Danish paper was the leftist Liberal *Politiken* (1884); *Ekstrabladet* was its evening associate. *Information* grew out of the Danish underground press during the German occupation.

In 1957 there were 131 dailies with a sale of 1,650,000 copies. The news agency Ritzaus, created in 1866. was, in the later 1950s, directed by a council in which the whole Danish press was represented.

Iceland.—Iceland had monthly periodicals as early as 1773. A weekly! *Thjodolfur,* was begun in 1848; and the first daily was *Dagskra* (1896). The oldest and largest paper at mid-20th century was the Conservative *Visir* (1910). The *Althjdubladid,* the organ of the Social Democratic party, was next in importance.

Finland.—The first newspaper in Finland was published in the Swedish language in 1771, and the first in Finnish appeared in 1776. The oldest paper still published at mid-20th century was the *Åbo Underrättelser* (1824) of Turku, while the oldest in Helsinki. the capital, was *Uusi Suomi* (1847). Largest of the dailies was the *Helsingin Sanomat* (1889), with 250,000 circulation. There were 70 daily papers in the mid-1950s of which 12% were printed in Swedish, the most important among the latter being *Hufvudstadsbladet.*

Belgium.—Some of the earliest ne ssheets in Europe were printed in Belgium. It has been claimed that Abraham Verhoeven's newssheets. authorized for publication as *Nieuwe Tydingen* in Antwerp in 1605, constitute the first occidental newspaper, though the earliest extant copy is one for 1621. Newspapers were, of course, under the control of the various national authorities which ruled what is now Belgium over the long period before the constitution of 1831 declared for freedom of the press. Under the liberal provisions of that document Belgium developed vigorous newspapers despite the competition afforded by the French press and the hardships suffered in two world wars.

In 1831 the 10 dailies in the country were all printed in French, and as late as 1848 there were 38 dailies, all in that language. But by 1860 there were 9 Flemish dailies, and by mid-20th century nearly one-third of the 60 dailies were published in that tongue. Most of the large Belgian papers had Sunday editions, and some published weekly illustrated supplements.

The largest papers were issued in Brussels: *Le Soir* (1887). with more than 300.000: *Het Laatste Nieuws* (1886), with almost the same circulation; *La Dernikre heure* (1906) and *La Libre Belgique,* founded in 1885 as *Le Patriote,* but taking the latter name when it went underground during the German occupation in World War I, with 140,000. The largest Antwerp paper was the *Gazet van Antwerpen* (1891). with 130,000. In the mid-1950s there were 38 dailies (27 in French. 11 in Flemish) with a sale of about 3,300,000 copies. The national news agency was Belga.

The Netherlands.—Dutch printers were among the first Europeans to exercise the art, and such early printers as George Veseler. Broer Jonson and Adrian Clarke issued some of the corantos which were the forerunners of regularly published newspapers. Some such papers appeared in Xmsterdam before 1620. In 1656 was founded what by mid-20th century was the oldest paper published in the Netherlands. the *Oprechte Haarlemsche Courant,* which became a daily in 1847.

The *Algemeen Handelsblad,* founded in 1828 as *Nieuwe Amsterdamse Courant,* was the first daily in the country. The largest circulation by 1957 was the 320.000 of *Het Vrije Volk,* a Socialist paper with editions in Amsterdam. Rotterdam, Groningen and Arnhem. The independent *Het Parool,* the Catholic *De Volkskrant* and the antirevolutionary *Trouw,* which began as underground sheets during the German occupation, came next, with more than 150,000 circulation each. As in France, collaborationist papers were suspended at the liberation. *De Telegraaf,* founded in 1893 by H. M. C. Holdert, was suspended but allowed to resume in 1949.

Most famous paper outside Amsterdam was the *Nieuwe Rotterdamse Courant* (1843), founded and conducted by the Nijgh family. In the later 1950s there were 13 national dailies and in all 162 newspapers with a circulation of 2,700,000.

The news agency, Algemeen Nederlandsch Persbureau, was founded in 1934.

Switzerland. — Newssheets known as *Ordinari Wochenzeitung,* published at Basel in 1610, have been cited as constituting a newspaper and thus the beginning of the history of the Swiss press. Political and religious struggles, however, allowed little opportunity for the development of a regular journalism until the "period of regeneration," which began about 1830 and was followed by the federation of 1848. The federal constitution provided for liberty of the press which, except for short periods during World Wars I and II, was free of administrative control.

Of the 127 daily papers at mid-20th century, 68.5% were printed in German, 26% in French, 4.5% in Italian and 1% in Romansh. The largest circulation was that of the *Tages-Anzeiger* (1893) in Zurich, with 120,000 daily; all other papers had less than 100,000. However, some of them are well known outside Switzerland, including the *Neue Zürcher Zeitung* in Zurich (1780), the *Gazette de Lausanne* (1798) and the *Journal de Genève* (1826).

Austria. — At least three weekly newssheets are known to have existed in Vienna before 1620. Though limited in its development by the usual censorships of the 17th and 18th centuries, the Viennese press gained a wide reputation for good writing and criticism. The reign of Joseph II (1780–90) brought a helpful liberality in newspaper licensing, but the following reign and the rule of Metternich were less favourable. The revolutionary disturbances of 1848 brought a new severity into censorship and reduced the 200 papers then published in Austria-Hungary (90 of them dailies) by about half. Not until 1867 was there a relatively free press. Two newspapers which had been founded in Vienna within the first three years of the 18th century — *Posttagliche Mercurii Zeitung* and *Wiener Diarium*—were in 1780 combined as the *Wiener Zeitung,* long the government organ and serving in that capacity at mid-20th century.

Nearly all the existing Austrian papers had been founded since World War II. The chief exception besides the *Wiener Zeitung* was the *Arbeiter Zeitung* (1895), official Socialist organ, which with the *Oesterreichische Neue Tageszeitzing* (1947), chief organ of the majority People's party, led the Vienna press. *Das Kleine Volksblatt* (1929), a tabloid, also represented the People's party. One of the leading Austrian papers in the 1950s was the independent daily *Die Presse.* The provincial press increased in number and influence in the postwar period, partly because of the development of the .party press. Many papers were owned by political groups. In the later 1950s there were 35 dailies with a total circulation of 1,200,000.

Spain. — The history of the Spanish press is chiefly a history of censorship, with intermittent eras of relative freedom. The first authorized papers appeared only after the declaration for liberty of printing by the *Cortes* of Cadiz on Nov. 10, 1810; this was withdrawn in 1814, re-established in 1820 and then annulled 1823–34. The periods of authorized publication were too short to permit the development of important newspapers. Exceptions to the short-lived nature of newspapers before the constitution of 1869 were the government bulletin *La Guceta de Madrid* (1661), begun as a monthly, later published weekly and made a daily in 1890; and *Diario de Barcelona* (1792), which, as the leading and semiofficial paper of Catalonia, was independent of Spanish censorship. Spanish papers were generally political, often in revolt against censorship and inadequately financed.

The civil war of 1936–39 reduced daily papers in Spain from about 250 to fewer than 100. In the mid-1950s there were 117 dailies with a total of 2,500,000 copies. Control of the press at mid-century was somewhat less strict than during the war, though the old system of the *editores responsables* approved by government, first set up in 1833 at the outbreak of the Carlist uprisings, was again in use, and the ministry of information and tourism exerted a precensorship and a control over newsprint.

The largest paper in Madrid in 1957 was *A.B.C.,* founded in 1904 by Torcuato de Tena as a monarchist journal. By the use of pictures and shrewd management, the paper became the most prosperous in the history of Spanish journalism, occupying a new printing establishment and obtaining a circulation of 100,000 in the later 1950s. During the civil war it was in republican hands, but the founder's son, Juan Ignacio Luca de Tena, published a monarchist *A.B.C.* in Seville. After the peace it was forced into line by a refusal of paper quota and temporary suspension.

In the later 1950s there were eight dailies in Madrid, among them the Catholic *Ya* (circulation about 90,000) and *Arribe,* the official mouthpiece of the Falange party (circulation about 20,000). In 1956 in Barcelona seven dailies were published. Only one of them reached 100,000—*La Vanguardia Española.* No periodicals in the Catalan language were authorized.

Agencia Telegráfica Fabra, the Spanish news service, was founded by Nilo Fabra in 1865 as Centro de Correspondencia. There were several news agencies, the most important being the official Agencia Efe.

Portugal. — Successive governments of Portugal allowed scant and temporary liberty of the press. The constitutional provisions of 1911, separating church and state. provided for press freedom, but the dictatorship which developed under the constitution of 1933 was unfriendly to independence of the press. Thus no great newspapers have developed in this country.

In 1957 there were ten dailies in Lisbon, three in Oporto, two each in Braga and Evora and one each in Beja and Coimbra. About 30 weeklies, semiweeklies and triweeklies were published in the country. Largest of Portuguese papers were *Diurio de noticias* (1864) and *O Seculo* (1880), Lisbon morning papers each claiming 100,000 circulation.

Italy. — The name "gazette," which was for so long a more common generic designation of printed sheets or pamphlets of news than "newspaper," is believed to have been derived from *gazzetta,* a small coin used in Venice in the 16th century, which may have been the price of early *fogli d'avvisi* or the admission to a group which listened to the reading of such newssheets. Venice was a chief centre for the written newsletters of the middle ages, and weekly printed newssheets appeared in Florence as early as 1636, the work of Amador Massi and Lorenz Landi. The first Italian paper with a continuous title appears to have been *Sincero,* published in Genoa in 1645.

The press of Italy, always subject to more or less severe government controls, lent itself to reform and even revolutionary movements. Giuseppe Mazzini was an active journalist; and Count Cavour's *Il Risorgimento,* which he founded with Count Cesare Balbo in 1847, was the great organ of the national movement. The constitution of 1848 declared for freedom of the press, yet "special laws," it stated, would "punish abuses." Accordingly, a set of press edicts was issued which retained effective political controls and remained in use until the sterner censorship of the Fascist regime.

In 1920 there were 157 daily papers and 843 weeklies in Italy. Following Benito Mussolini's march on Rome in 1922, the national press regulations were adapted to the pattern of a totalitarian state. with very definite editorial policies prescribed for them almost day by day. Opposition papers were suppressed and their editors disposed of. Mussolini himself had been a journalist, editing the Socialist *Avanti* of Milan in 1912–14, and resigning that position to found his own *Il Popolo d'Italia,* which he edited until 1922. Under his dictatorship, Italian dailies were reduced to 50 or 60. Much the oldest of the survivors was the *Gazzetta di Venezia* (1787). *L'Osservatore romano* was founded as the papal organ in Rome in 1861.

The Agenzia Stefani was set up by Count Cavour in 1853 under the management of Wilhelm Stefani. It functioned as a government news agency in Rome under all changes and through the Fascist era. In 1945 a new national news agency was created under the name *Agenzia Nazionale Stampa Associata* (A.N.S.A.).

World War II put an end to many of the older newspapers but with peace came many new ventures and in 1957, 109 dailies and about 300 weeklies were being published with a total circulation of more than 5,000,000. The *Corriere della séra* ("Evening Courier"; 1876) of Milan had in the later 1950s a circulation of 460,000, the largest in Italy. Despite its name it continued to be a morning paper; its evening associate *Corriere d'informazione* had a sale of 250,000 copies. Other leading dailies were the Communist *Unità* (Rome, 1945) with a circulation of 450,000; *La Nuova Stampa* (Turin, 1868) as *La Stampa* with a circulation of about 250,000; and in Rome *Il Messaggero* and *Il Tempo*. Half a dozen other papers claimed about 200,000 but only 20 Italian dailies had as many as 100,000 and 4 of them were in Milan.

Two foreign-language dailies were published, the *Rome Daily American* and the German *Dolomifen* at Bolzano.

A particular feature of Italian journalism was the *terza pagina* ("third page"), traditionally devoted to culture, book or theatre reviews and scientific discoveries.

Greece.—The first Greek papers were published in foreign capitals by refugees from Turkish rule and propagandists for Greek freedom. These appeared in Vienna. Paris and London from 1790 to 1820. The first Greek paper in the homeland appeared immediately after the beginning of the Greek war for independence—the *Salpinx Helleniki,* founded at Nauplia in 1821. An especially interesting journal was the *Hellenika Chronika,* edited 1824–26 at Missolonghi by a Swiss doctor, Jacques Mayer.

In the later 1950s the oldest Athenian daily was the *Akropolis* founded in 1881. The most authoritative daily was the *Kathimerini* (1919) with a sale of about 70,000. The *Makedonia* (1908) of Salonika had the country's largest circulation (about 100,000). There were 66 daily papers of which 20 appeared in Athens and their total circulation was about 550,000.

Turkey.—The earliest papers in Turkey were French journals published in the last decade of the 18th century. The first Turkish paper was *Takvime Vekayi* ("Calendar of Events"), a translation of a French journal, *Moniteur Ottoman,* begun in the same year oi 1831 by Xlexandre Blac. This was a part of the westernization program of Mahmud II. No considerable development in Turkish journalism took place, however, until after the establishment of the republic in 1920 and the change from Arabic to Roman characters in printing.

The development of the Turkish press was hindered by somewhat restrictive press laws. In the later 1950s 116 newspapers were published in the country with a total sale of 700,000 copies. *Hürriyet,* published in Istanbul, claimed the largest circulation in Turkey (about 100,000). In the later 1950s there were 43 dailies in Istanbul (including 5 printed in Greek, 2 in French and 1 in Armenian) and 10 dailies in Ankara (including one newssheet in English). In the capital the most important dailies were *Zafer* (Democratic) and *Ulus* (1919, Republican).

V. EASTERN EUROPEAN COUNTRIES

U.S.S.R.—The first Russian journal is said to have appeared in 1 jog, but the severe censorship imposed upon the press by the government prevented the development of a press adequate to the extent and population of the country. As newspapers developed in the 19th century, they came to emphasize literature and art and the political policies of government. Nicholas I permitted only 6 newspapers to be published at mid-19th century, but Alexander II allowed more than 60 to be started in the first decade of his reign, 1855–65. These papers soon developed a radical individualism (known as nihilism) which brought back strong repressive measures against the press, and these remained in effect past the end of the century. By 1913 there were 859 papers in all of Russia, approximately 50 of them dailies. A quarter of the daily papers were published in St. Petersburg. Among the latter were such famous papers as *Novoye Vremya* and *Ryech.*

Meantime. the revolutionary press, now regarded as the forerunner of the modern Soviet Union press, began with *Kolokol* ("Bell"), founded first as a monthly by the refugee A. I. Herzen in London in 1857; it was soon made a fortnightly and lived for ten years, exerting a considerable influence on reforms in Russia. Similar revolutionary journals were set up by refugees in other capitals, such as Geneva and New York, and in the 1880s and 1890s there were many illegal sheets in St. Petersburg. The first legal bolshevist paper was *Novaya Zhizn* ("New Life"), founded under Lenin's leadership in 1905. In 1910 *Zvezda* ("Star") was founded in St. Petersburg to combat other leftist groups, and two years later its place was taken by *Pravda* ("Truth"), which after the Revolution of 1917 became the leading Soviet organ and was published at Moscow.

In 1922 the periodical publications of the U.S.S.R. were placed in a carefully devised system which was enlarged to great proportions. Propaganda for the economic, political and social building and maintenance of the U.S.S.R. became the dominant function of the Soviet press.

The Soviet publication scheme provided for a pattern in Moscow which was followed more or less closely in the other republics and to some extent in smaller units. This pattern placed at the top two daily newspapers. one representing the party and the other the government; at Moscow these were *Pravda* and *Izvestia* (1917), respectively. Then under the party bracket were the papers designed for the political and economic indoctrination of special groups—one for the armed forces, one for the peasants, another for industrial workers, special periodicals for youth and for younger children and an increasing number of cultural periodicals. Under the government bracket were the organs of the commissariats of industry, economics, agriculture, etc., and the papers for trade unions and co-operatives. This pattern was repeated in the capitals of all the union republics and, with variations, in each regional and district centre.

Under this system, there were. in May 1957, 7,537 papers in the U.S.S.R., with an aggregate circulation of 53,500,000. Since it was impossible to draw a line between newspapers and other periodicals in this great outpouring of Soviet publications, it was presumed that the above totals were inclusive. The Soviet authorities did not break their totals down in terms of daily, weekly and monthly papers, but it seemed likely that about 500 were dailies. Papers published three or four times a week were common.

Newspapers in the Soviet Union at mid-20th century were published in 60 languages, including 20 which did not exist as written languages before the Revolution. More than 800 papers were published in the Ukrainian Soviet Socialist Republic. Thousands of papers were being published on the state farms, at army installations, in schools and scientific institutions and in factories and mills. During the earlier development of the Soviet press there were many mimeographed and written papers, and "wall newspapers" in factories! on farms and in barracks were common.

Pravda in 1956 had one of the world's largest circulations, reported at one time as high as 3,000,000 but reduced to 2,000,000 during World War II. In 1956 the editors claimed to publish 5,500,000 copies daily. Mats were sent by airmail to 17 towns in different parts of the U.S.S.R. where regional editions were printed. It was a collection of official news. comment on foreign affairs and domestic operations. features and an occasional picture or cartoon, filling Tour pages and sometimes six. From time to time it ran a patriotic fiction serial. It was always sold at 20 kopeks, and its circulation was limited only by available paper supply and official decisions. Leading party papers outside Moscow in the later 1950s included *Leningradskaya Pravda, Radyanska Ukraina* (Kiev), *Zvyazda* (Minsk), *Moldova Socialiste* (Kishinev), *Kommunisti* (Tiflis), *Sovietakan Hayastan* (Yerevan), *Sotsialistik Kazakhstan* (Alma-Ata), *Kzyl Uzbekistan* (Tashkent), *Soviettik Kyrghyzstan* (Frunze) and *Tajikistani Sovieti* (Stalinabad).

Izvestia featured official documents and government statements as well as foreign news. Its circulation was probably about half that of *Pravda*. *Krasnaya Zvezda,* daily organ of the ministry of the armed forces, was designed chiefly for officers and noncommissioned officers, but set the pattern for local and regional army papers for the rank and file. Other leading Moscow newspapers were *Trud,* organ of the central council of trade unions, *Gudok,* of the ministry of railways, and *Stroitelny Rabochy,* of the construction workers. The youth daily was *Komsomolskaya Pravda.*

Among cultural papers published in Moscow were *Literaturnaya Gazeta, Kultura i Zhizn* and *Sovietskoye Iskusstvo.* The official news agency, Telegrafnoye Agentstvo Sovietskogo Soyuza (Tass), was founded in 1925 to collect foreign as well as domestic news for distribution to Soviet papers.

The Baltic States.—There were Estonian newssheets as early as the 17th century, but the modern press of Estonia began with the foundation of the *Postimees* in 1857, which in 1939 had a circulation of 25,000. The *Päewaleht* (1905) and *Uus Eesti* (1934) had the largest circulations, each of about 50,000. In 1939 the country had 15 dailies, 12 of them in Estonian. The leading Communist dailies after 1945 were *Rahva Hääl* in Estonian and *Sovietskaya Estonia* in Russian.

The earliest Latvian newspaper, the *Latweeschu Awihses,* was founded at Jelgava (Mitau) in 1822. The first daily, the *Rigas Lapa,* was founded at Riga in 1877. The *Jaunakas Zinas,* founded in 1911, had a circulation of 125,000 in 1939. In that year there were 133 periodicals in Latvia, including 22 dailies (11 of them in Latvian). After 1945 the leading Communist dailies were *Cina* in Latvian and *Sovietskaya Latvia* in Russian.

The first Lithuanian newspaper, the *Kurjer Litewski,* was founded at Vilnius (Wilno) in 1759 and mas printed in Polish. The first paper in Lithuanian was *Aušra,* founded in 1883. which in 1889 was replaced by *Varpas,* both being published at Tilsit in what was then East Prussia. In 1905 the daily *Vilniaus Žinios* was founded at Vilnius. The *Lietuvos Aidas,* founded at Vilnius in 1917, was later transferred to Kaunas and in 1939 had a circulation of 17,000. There were more than 100 periodicals in Lithuania before 1940. After 1945 the two leading Communist dailies were *Tiesa* in Lithuanian and *Sovietskaya Litva* in Russian.

Poland.—The origins of the Polish press go back to 1661 when Jan Aleksander Gorczyn started to publish his *Merkuriusz Polski,* first in Cracow and later in Warsaw. The first newspaper in Warsaw was the *Gazeta Warszawska,* which started in 1774. The *Kurjer Warszawski* was founded in 1821. Before World War I there were important newspapers in all the three parts of Poland, Russian. German and Austrian, but only in the last named was the press free. After the restoration of Polish independence the press remained regional; with a few exceptions, none of the dailies had a national circulation. In 1937 there were 2,692 periodical publications, including 184 dailies. Among newspapers published in Warsaw the Roman Catholic *Mały Dziennik* had the largest circulation (125,000), followed by the *Kurjer Warszawski* (60,000) and the *Gazeta Polska* (30,000). The *Illustrowany Kuryer Codzienny,* founded in Cracow in 1906, in 1937 had a circulation of 80,000. In Poznan the largest circulation was that of *Kurjer Poznański* (40,000), founded in 1906. The Socialist daily *Robofnik* had a circulation of only 15,000 but it was famous for having been published from 1894 to 1918, clandestinely or abroad. Its first editor was Joseph Pilsudski.

The entire Polish press was closed down by the Germans in 1939. None of the pre-1939 newspapers was allowed by the Russians to reappear after 1945. By 1948 the press was under complete Communist control. In Warsaw there were six dailies. the party newspaper *Trybuna Ludu* (410,000 copies in the later 1950s) having the largest circulation. In 16 provincial chief towns there were two and sometimes three dailies. In the later 1950s the total circulation of the daily newspapers was nearly 1,400,000.

From 1956 the Polish press fought for more objective reporting, better information and the suppression of censorship. Compared with that of other Communist countries, the Polish press was readable, vivid and independent. Among the illustrated weeklies *Przekrój* (Cracow) had in the later 1950s a circulation of 450,000 and *Świat* (Warsaw), 320,000. Two literary weeklies, the *Nowa Kultura* and *Przegląd Kulturalny,* both in Warsaw, had a circulation of about 70,000 each.

Since 1945 there was only one official news agency, PAP (Polska Agencja Prasowa).

Czechoslovakia.—The oldest Czech daily newspaper was the *Narodni Listý* founded in Prague in 1860. It was followed by the *Narodni Politiku* in 1883, by the *Lidove' Noviny* (Brno) in 1893, the Social Democratic *Právo Lidu* in 1397, the *České Slovo* in 1909 and the Agrarian *Venkov* in 1917. After the creation of the republic the Communist *Rude' Právo* appeared in 1920. In 1937 the total number of periodical publications was about 3,500, including 1,200 in Prague alone. The largest circulations in 1937 were those of *Poledni List* (120,000), *Narodni Politika* (145,000) and *Prdvo Lidu* (118,000). In Slovakia the largest newspapers were the *Slovak* (45,000) and the *Slovenski Dennik* (40,000), both in Bratislava. There were also German, Magyar, Polish and Ukrainian newspapers. The *Deutsche Zeitung Bohemia,* founded in Prague in 1828, was the oldest daily newspaper published on Czech territory.

The Czechoslovak press was of high standard, both technically and in the manner of news reporting. It disappeared with the annexation by Germany ih 1939. After 1945, of the pre-World War II newspapers only *Rude' Pravo* (circulation [1955] 750,000) continued to appear—as the organ of the Communist party. In 1955 there were nine dailies in the Czech lands and five in Slovakia. Other dailies were: *Lidovci Demokracie* (government), *Prdce* (trade unions) and *Mladá Fronta* (Youth league). There was only one official news agency, ČTK (Ceskoslovenska Tisková Kancelař).

Hungary.—A Latin weekly sheet, *Nova Posoniensia,* founded in Pozsony (now Bratislava, Slovakia) by Matyas Bel in 1721, was the first Hungarian journal. The first periodical in Magyar was the weekly *Magyar Kurir,* founded by Samuel Decsy in Vienna in 1789. The first Magyar journal, circulated privately in Budapest under the title *Országyülési Tudositdsok,* consisted of the parliamentary reports of Lajos Kossuth (1832–36). In 1841 Kossuth became editor of the Liberal daily *Pesti Hirlap,* while Counts Aurel and Emil Dessewffy started the Conservative *Vildg.* There was a remarkable development of the Hungarian press after 1867, with great latitude for free expression. The number of periodical publications increased from 80 in that year to about 2,000 in 1914. After World War I the Hungarian press was reduced in numbers; in 1937 it comprised about 1,200 publications, including 74 dailies. The *Függetlenség,* a daily newspaper founded in 1933 by Gyula Gombos, had the largest circulation (160.000). It was followed by the *Pesti Hirlap* (100,000), the Social Democratic *Népszava* (founded 1872; circulation 80,000) and *Az Est* (founded 1909; circulation 60,000). After 1945 the Hungarian press recovered much freedom, but by 1949 the press had become Communist controlled. *Szabad Nep,* the principal party organ, changed its name to *Nepszabadság* after the rising of Oct.–Nov. 1956.

Rumania.—The first Rumanian political periodical was the *Curierul Românesc,* founded in Bucharest in 1828 by I. Eliade Radulescu, while the first daily in Rumanian, the *Gazeta Transilvaniei,* appeared in 1838 in Brasov (Kronstadt), then in Hungary. The press developed after the union of the principalities (1859) and more so after the country's unification (1918). By 1937 there were 2,253 periodicals including 104 dailies. *Universul,* founded in 1882, had the largest circulation (140,000); it ceased publication in 1953. Other important newspapers were *Adeverul* (100,000), *Dimineaţa* (90,000), *România* (80,000) and *Argus* (30,000). The restored freedom of the press after World War II was quickly stifled and by 1948 strict Communist censorship prevailed. *Scînteia* was the main Communist party daily organ, *Rominia Liberă* being the government's organ and *Munca* that of the trade unions.

Bulgaria.—'The first political newspaper published in Bulgarian, the *Bulgarski Orel,* was founded in 1846 in Leipzig, Ger., by Ivan Bogorov. Two years later the Turkish government authorized the publication in Istanbul of the *Tsarigradski Vestnik.* The first daily published on Bulgarian soil was the *Balkanska Zora* founded in 1690 at Plovdiv. The first daily in Sofia was the *Vecherna Poshta,* founded in 1900. By 1914 there were 310 periodical publications. In 1937 there were 2j dailies in Sofia alone with *Utro* and *Zora* having the largest circulations (85,000 and 73,000 respectively). After World War II the number of dailies was reduced to five in Sofia and five in other chief towns. The leading dailies were the *Rabotnichesko Delo* (Communist party), *Otechestven Front* (Fatherland frontj and *Zemedelsko Zname*

(Peasant union).

Albania. — The first daily newspaper, the *Ora,* was founded at Tirana in 1930. From 1945 there were two newspapers: *Zëri i Popullit* ("The Voice of the People"), the Communist party organ, and *Bashkimi* ("Union"), the organ of the People's front.

Yugoslavia. — The first newspaper in Serbian, *Srpskija Novini,* was founded in 1791 in Vienna; later Serbian journals appeared in Budapest and Venice. The first newspaper published in Serbia was *Srbske Novine* (Kragujevac, 1834), the first in Croatia *Narodne Novine* (Zagreb, 1835), the first in Slovenia *Ljubljanske Novize* (Ljubljana, 1797). After the creation of independent Yugoslavia in 1918 the Serbian, Croatian and Slovene press developed considerably in numbers and quality. In 1937 there were 1,231 periodicals including 50 dailies; *i.e.,* 13 Serbian (mainly in Belgrade), 21 Croatian (mainly in Zagreb)! 6 Slovene (mainly in Ljubljana) and 10 dailies published by the national minorities. In 1939, among the Serbian newspapers the *Politika* (1904) had a circulation of 100,000, the *Vreme* (1921) 65,000 and the *Pravda* (1904) 38,000; in Croatia the *Novosti* (1906) and in Slovenia the *Slovenec* (1871) had circulations of 30,000 each. The Croatian *Obzor,* the oldest existing Yugoslav daily (founded in 1860), in 1939 had a circulation of 7,000.

After World War II the press came under Communist control. The chief party organ was *Borba,* published in two editions. in Cyrillic for Serbia. Montenegro and Macedonia and in Latin characters for Croatia and Slovenia. Other important papers were *Politika* (Belgrade), *Vijesnik* (Zagreb), *Slovenski poročevalec* (Ljubljana), *Oslobodjenje* (Sarajevo), *Nova Makedonia* (Skoplje) and *Pobjeda* (Titograd). The official news agency, Tanyug, provided uniformity in all except regional and occupational news.

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VI. UNITED STATES

Although printing presses were established at Cambridge, Massachusetts Bay Colony, in 1633, at nearby Boston in 1674 and at Philadelphia in 1685, nothing that could properly be called a newspaper was published in the American colonies until Benjamin Harris issued his *Publick Occurrences Both Forreign and Domestick* in 1690. Free speech and free printing had no legal standing in the colonies in the 17th century. Royal charters commonly contained provisions for licensing the press, but the governors regarded printing as dangerous. Packets of newspapers were brought over from England, and at least two issues of the *London Gazette* were reprinted in the colonies. A few professional newsletter writers did some business. and private letters of news were passed from hand to hand. Ballads, proclamations and pamphlets contained some news. In 1689 Massachusetts leaders compiled and published a news broadside entitled *The Present State of New-English Affairs* in order "to Prevent False Reports" and to tell of Increase Mather's efforts in behalf of a new charter following the overthrow of Gov. Sir Edmund Andros.

First Newspapers. — The next year Benjamin Harris, London bookseller and publisher who had fled England after imprisonment fer printing a seditious pamphlet, issued in Boston no. 1 of *Publick Occurrences Both Forreign and Domestick,* to be "furnished once a moneth (or if any Glut of Occurrences happen, oftener)." on Sept. 25, 1690. Four days later the governor and council suppressed it. This first American newspaper, which was thus ended summarily with its first number, was a very newsy three-page paper (the fourth page being left blank for private correspondence), measuring 6 in. by $9\frac{1}{2}$ in. when folded.

Fourteen years passed before the next venture in American newspaper publishing. In 1704 John Campbell, newsletter writer, bookseller and postmaster, established the *Boston News-Letter,* the first continuously published American newspaper, and issued it "By Authority" for 15 years. Thereafter it was published until the Revolution; then a Tory paper, it suspended shortly before the British evacuation of Boston. In 1719 William Brooker was appointed postmaster at Boston, and since Campbell refused to turn over the *News-Letter* to him. he founded the *Boston Gazette.* This paper had a long and influential career; during the struggle for independence it was edited by Benjamin Edes and John Gill, called "trumpeters of sedition" by their Tory enemies. It survived the Revolution but perished in 1798.

First printer of the *Gazette* was James Franklin, who had as apprentice his 13-year-old brother Benjamin. When Brooker lost both post office and newspaper in 1721, and the new proprietor took the printing of the *Gazette* to another shop, Franklin started a new paper called the *New-England Courant.* During its five and one-half lively years, the *Courant* was a spectacular sheet, first as an opposition organ critical of the Mather regime, and later, after the council had banned James Franklin as publisher, as a repository of periodical essays. To evade the council's order, James put his brother Benjamin in as nominal publisher. The latter had already written his first satirical essays, the early "Dogood Papers," for the *Courant;* but his brother treated him badly, and he soon ran away to Philadelphia.

Early Papers in Philadelphia and New York.—The *American Weekly Mercury* narrowly missed being the third American newspaper; its first issue, Dec. 22, 1719, was only one day later than that of the *Boston Gazette.* It was founded by Andrew Bradford, son of the William Bradford who introduced printing into Pennsylvania but who by this time had moved his press to New York. The second Philadelphia newspaper was begun by Samuel Keimer with the extraordinary title, *The Universal Instructor in All Arts and Sciences, and Pennsylvania Gazette,* in 1728. The first part of the title was due to the project of Keimer, a scientific deist and an eccentric, to print Ephraim Chambers' *Cyclopaedia* serially in his paper. Benjamin Franklin, now established as a printer in Philadelphia, helped to give the rival *Mercury* a competitive advantage in the town by writing his "Busy-Body Papers" for it, and in 1729 bought Keimer out. He abandoned the cyclopaedic serial? cut off the grandiloquent prefix of the paper's title and made such a success of the *Pennsylvania Gazette* that he was able to retire with a competency at 42. He completely disposed of the *Gazette* in 1766 to his partner David Hall who, with his sons and grandsons and various partners, conducted it until its end in 1815.

Meantime, William Bradford had founded the first New York newspaper in 1725 under the title *New-York Gazette.* It was definitely an organ of government in that colony, and when the bitter contest between Gov. William Cosby and the popular party developed in 1733, John Peter Zenger was induced to start an opposition paper. His paper was supported by the contributions of James Alexander and other leaders of the popular party, much as James Franklin's crusading paper in Boston had been aided by a group of dissident writers there. When Zenger was jailed in 1734, Cosby disbarred the attorneys who were defending him. and Andrew Hamilton, a famous Philadelphia lawyer. was brought in to plead his case. Hamilton's masterly argument brought acquittal. was later reprinted as a. pamphlet and did much for the cause of liberty in both England and America.

Other Colonial Beginnings. — The initial papers in other colonies were *Maryland Gazette,* Annapolis, 1727, and *Virginia Gazette,* Williamsburg. 1736, both founded by William Parks, one of the best of the colonial printers; *Rhode-Island Gazette,* Newport, 1732, founded by James Franklin. who had moved his press there from Boston but was able to maintain the paper for only eight months; *South-Carolina Gazette,* Charleston. 1732, founded by one of Benjamin Franklin's printers, and carried on by another Franklin protégé, the talented Lewis Timothy; *North-Carolina Gazette,* New Bern. 1755, founded by James Davis; *Connecticut Guzette,* New Haven, 1755, founded by Timothy

Green; *New-Hampshire Gazette,* Portsmouth, 1756, founded by Daniel Fowle, a paper which lived for 190 years; *Georgia Gazette and Weekly Mercury,* Savannah, 1763, founded by James Johnston; *New-York Gazette,* 1776, by chance New Jersey's first paper, since Hugh Gaine moved this sheet to Newark when the British occupied New York. John Adams, a Wilmington printer, is reported to have published a paper called the *Courier* in that town for a few months in 1762, but the earliest Delaware paper of which there is definite knowledge is the *Delaware Gazette,* begun at R'ilmington in 1785 by Jacob A. Killen. The *East-Florida Gazette,* published at St. Augustine in 1783–84 by the Tory editor John Wells, was the first paper in what was later the state of Florida. Timothy Green, fourth of that name in a long line of printers, established the first Vermont paper in collaboration with J. P. Spooner; it was the *Vermont Gazette and Green Mountain Post-Boy,* of Westminster. The first paper in what is now Maine was the *Falmouth* (Portland) *Gazette,* founded in 1785 by Benjamin Titcomb, Jr., and Thomas B. Wait.

Patriots and Tories.—Leading patriot newspapers during the period extending from the enactment in 1765 of the Stamp act, which taxed the newspapers and aroused them to bitter opposition and noncompliance, to the end of the American Revolution were: the *Boston Gazette,* to which Samuel Adams and his group contributed; the *Massachusetts Spy,* founded in 1770 by Isaiah Thomas, who was later a successful book publisher as well as journalist and the founder of the American Antiquarian society; the *Connecticut Courant* of Hartford, founded in 1764 by Thomas Green; the *New-York Journal,* founded in 1767 by John Holt; the *New-York Packet,* founded by Samuel Loudon in 1775; the *Pennsylvania Journal,* founded in 1742 by William Bradford, grandson of the pioneer printer of the same name, himself an able editor and the outstanding soldier-editor of the Revolution; the *Pennsylvania Gazette,* conducted at this time by David Hall; the *Pennsylvania Packet,* founded in 1771 by John Dunlap, another soldier-editor, who later joined with David C. Claypool to make this paper one of the most successful in America during the years immediately after the war; and the *South-Carolina Gazette,* whose war editor was Peter Timothy. These papers had many bitter experiences during the war. While the British occupied Boston, the *Gazette* found a temporary home at Waterton, while the *Spy* moved permanently to Worcester. The New York papers had to find temporary homes in towns up the Hudson river when the city was lost to the patriots, and the patriot papers of Philadelphia were refugees during the shorter British occupation of their city. When Newport was taken, Solomon Southwick buried his press and type; later he exhumed them to continue the long career of his *Mercury.*

Leading royalist papers were: the *New York Gazetteer,* founded in 1773 by James Rivington; the *New-York Weekly Gazette and Mercury,* founded in 1753 by Hugh Gaine; the *Royal American Gazette* of New York; the *Royal Pennsylvania Gazette* of Philadelphia, published briefly by James Robertson; and the *Pennsylvania Evening Post,* founded in 1775 by Benjamin Towne, who was later to make his paper the first American daily.

Characteristics of Colonial Papers.—American newspapers in the colonial period were modeled on those of the mother country. The common size was four pages, each about 10 in. by 1 j in. Extra pages were sometimes issued to accommodate heavy advertising. Headings of news stories were little more than date lines. The successful papers had good advertising patronage; advertisements were set single-column with little display, so that a page of them resembled modern classified make-up. Paper was obtained chiefly from England until the tax on that staple stimulated American manufacture. The collection of rags from which paper was made was regarded as a patriotic duty during the Revolution. Manufacture of ink, type and presses was also built up in America when importation was Interrupted.

Chief news sources were the English newspapers, since interest in events in the homeland was paramount among the colonists. The second important source was "exchanges"—papers published in other Xmerican towns. The rule was for an editor to cover any news of first-rate importance in his own neighbourhood for his own paper, and for other papers to clip it; thus all colonial papers were members of an informal co-operative news-gathering system. Local news coverage was not intended to be thorough, and small happenings were usually disregarded; there were no local reporters, and the editors were commonly imbued with the concept of news as historical record. Other sources than those mentioned were letters from other cities or from England brought in by friends of the editor; word-of-mouth reports by ship captains, postriders and travelers; and official documents and cbmmunications. With the coming of the war, English papers were cut off almost entirely, and military operations interfered with colonial communications; but patriot committees were active in sending news bulletins from one town to another.

There were no editorial pages, but editorial comment was interspersed with the news. Political and economic dissertations, satirical essays on social customs and poetry were common.

The Daily Newspaper.—A few semiweeklies and triweeklies had been published in the colonies. For example, Benjamin Towne's *Pennsylvania Evening Post* had been established as a triweekly; in 1783 Towne made it the first American daily. Generally it consisted of only two pages, and was a rather shabby sheet. Towne was indicted for treason a few months after he made his paper a daily, and its 17-month existence in that status was shadowed by its editor's disrepute. John Dunlap and David C. Claypool's *Pennsylvania Packet and Daily Advertiser* began daily publication in 1784. It was very successful, as was the *New York Duily Advertiser,* founded in 1785 by Francis Childs; the latter was the first Xmerican paper to be founded as a daily.

Dailies came into the picture less for the purpose of giving timely news than because publishers wished to compete with the coffee-shop bulletins in giving reports to merchants of the offerings of importers just as soon as ships arrived in the harbours of Philadelphia and New York. The political papers of the cities also adopted daily publication rather generally by the end of the 18th century, leaving the weeklies to the smaller towns.

The Party Press.—As national issues developed, newspapers took up the cudgels of partisan strife. From the second administration of George Washington until after the Civil War, ardent partisanship in journalism was the rule. The mercantile papers, as well as those confessedly established as political organs, took sides; and when the penny papers appeared in the 1830s, with their emphasis on local news and human-interest features, they, too, were soon involved in party controversy. At its height during the first two decades of the 19th century, this partisanship resulted not only in slanting and distorting news but in personal abuse and vilification of political figures, duels and assaults among editors and much prostitution of the newspaper's chief duty of disseminating the news accurately, fairly and fully. The situation improved in the 1840s and 1850s, but it was not until the doctrine of partisan independence made its great gains in the 1870s that biased reporting of public affairs was largely abated.

First national political organ was John Fenno's *Gazette of the United States* (1789–1818), Federalist, established at New York when the capital was situated there and later moved with the government offices to Philadelphia. Its great rival in the latter city was Philip Freneau's *National Gazette* (1791–93), Republican (Democratic). Alexander Hamilton and Thomas Jefferson, rivals in Washington's cabinet, were the respective sponsors of Fenno and Freneau in their editorial efforts. Supplanting the *National Gazette* as spokesman for the Jeffersonian Republicans was the *Philadelphia Aurora,* founded by Benjamin Franklin Bache, grandson of Benjamin Franklin, in 1790. Another notable political paper in that city was *Porcupine's Gazette* (1797–99), edited in vitriolic fashion by William Cobbett, at the time a refugee from England. In Boston Benjamin Russell's *Columbian Centinel* became a nationally recognized Federalist organ; founded in 1784, it was in many respects an excellent newspaper. Noah Webster, later famous as a lexicographer, founded the *American Minerva* in New York in 1793 as a Federalist organ; four years later this paper adopted the name *Commercial Advertiser,* which it kept for more than a century.

One cause of the Alien and Sedition acts (1798–1801) is to be found in the prevailing scurrility of attacks on public officers, but the immediate occasion was the threat of war with France and the consequent need to guard against disloyalty. There were about 25 arrests under the Sedition act and 11 trials resulting in 10 convictions. Actions under the common law brought total convictions to 15, of which 8 related to newspapers. But the censorship involved was greater than these figures indicate. The acts expired with the John Adams administration. Two years later Alexander Hamilton: in an argument for a new trial in the case of Harry Croswell, editor of the *Hudson* (N.Y.) *Wasp,* advanced the "Hamiltonian doctrine," later made a part of most state constitutions. to the effect that evidence of the truth of statements published with good intentions may be introduced by the defense in a criminal libel suit.

The *National Intelligencer,* established in Washington in 1800 as the organ of the Jefferson administration by Samuel Harrison Smith, proved to be mild in partisanship and reliable in news. Conducted after 1810 by Joseph Gales, Jr., and W. W. Seaton, the *Intelligencer* was considered by other papers for many years as the authority on Washington news. It was displaced as the government organ, however, when Andrew Jackson became president. Duff Green's *United States Telegraph* (1825) was Jackson's first Washington paper; it was supplanted in 1830 by the *Washington Globe,* edited by Francis P. Blair. Associated with the *Globe* also were Amos Kendall, editorial writer, and John C. Rivers, business manager, who, with Blair, were members of Jackson's "kitchen cabinet" of political advisers.

Meantime, in New York, James Cheetham's *American Citizen* was the vituperative organ of the George Clinton faction of the Democratic party during the first decade of the 19th century. Established largely in order to combat Cheetham's sheet was the *New York Evening Post,* founded in 1801 by Alexander Hamilton and friends associated in a joint-stock company. William Coleman was its first editor; he was followed in 1829 by William Cullen Bryant, who edited the paper until his death in 1878.

The Penny Press.—The chief characteristics of the penny press of the 1830s were smaller size, a one-cent price in comparison with the six cents charged by the larger papers, and adaptation to lower economic and social levels of readership. The penny papers featured local and human-interest matter, preferred news above support of a party or mercantile class, exposed abuses of banks and churches and tended to give a realistic picture of the news scene despite taboos.

The first successful penny daily was the *New York Sun,* founded in 1833 by Benjamin H. Day. Most important of its rivals in this field was the *New York Herald,* begun two years later by James Gordon Bennett. Three New York printers, William M. Swain, A. S. Abell and A. H. Simmons, founded the *Philadelphia Public Ledger* in 1836 and the *Baltimore Sun* in 1837; Swain was chiefly responsible for the former and Abell for the latter over many years. In 1841 Horace Greeley founded the *New York Tribune* as a penny paper; and ten years later the *New York Times* was started by Henry J. Raymond. George Jones and Edward B. Wesley at the same price. All these New York papers except the *Sun* soon went to the two-cent price, enlarging their size and scope. The penny papers initiated what may be called modern journalism by their emphasis on local news and timeliness. They were leaders in the use of expresses and the telegraph for quick transmission of news, and their large circulation and advertising receipts enabled them to improve their news services and install fast cylinder presses.

Bennett and Greeley, rival editors through three decades (both died in 1872), were leading figures in a period of personal journalism. Bennett was one of the most original of editors, initiating financial and society departments and playing a part in many other innovations. Greeley was the great idealist, a crusader against slavery and intemperance and in favour of westward expansion. His hospitality to new ideas brought Fourierism, spiritualism, women's rights, Grahamism and many other reforms and fads into the columns of the *Tribune.* His alliance with Thurlow Weed, the political boss who was editor of the *Albany Journal,* 1830–63, and William H. Seward was dissolved in 1854 by a letter in which he showed his resentment because he had not been given political office; later he had much to do with the defeat of Seward for the Republican presidential nomination. The *Tribune* did not always support Lincoln during his administration, however.

In Springfield, Mass., the *Republican* was begun as a two-cent daily in 1844. Its weekly edition had been founded by Samuel Bowles 20 years earlier, but the daily was the project of a son, also called Samuel, aged 18. It became one of the most famous of small-city dailies, and exerted a wide influence, largely through its weekly edition, for many years. Following a printers' strike in 1947, it was reduced to the status of a Sunday paper.

In New Orleans, George W. Kendall and Francis Lumsden started the *Picayune* in 1836, and it soon gained a wide reputation not only as a good newspaper but as a repository for amusing sketches and witty paragraphs. During the Mexican War Kendall became the first important and regular reporter of military actions from the field.

The war with Mexico was a great stimulant to speed in news transmission. The expense of efforts in this direction led to the first important effort in co-operative news gathering—the New York Associated Press, founded in 1848, forerunner of the present Associated Press. This group consisted of the *Sun, Herald, Tribune, Express, Courier and Enquirer* and *Journal of Contmerce*—the leading papers of the metropolis. When the *Times* was begun, it was taken in. The *Express* (1836–81), conducted by James and Erastus Brooks, was a strong mercantile paper. The *Courier* and *Enquirer* was the result of a merger in 1829 of Mordecai M. Noah's *Enquirer* and James Watson Webb's *Morning Courier.* Under Webb's aggressive editorship it was bright, bellicose and enterprising. The *Journal of Commerce* was founded in 1827 by Arthur Tappan as a commercial paper with a strong religious bent; it soon became the property of Gerard Hallock and David Hale.

The Westward Movement.—The first newspaper west of the Appalachians was the *Pittsburgh Gazette (Gazette Times,* 1906; *Post-Gazette,* 1927), founded by John Scull and Joseph Hall in 1786. The following year the *Kentucky Gazette* was founded at Lexington by John Bradford. First paper in what is now West Virginia was the *Potowmac Guardian,* begun by Nathaniel Willis in 1790. Tennessee's first paper was the *Knoxville Gazette,* 1791, George Roulstone founder. Benjamin M. Stokes started the first Mississippi paper, the *Mississippi Gazette* (1799–1801) at Natchez. The first New Orleans paper was *Moniteur de la Louisiane,* 1794, by Louis Duclot, a sheet of four small pages in French. The earliest paper in what is now Alabama was the *Mobile Centinel* (1811–12) by Samuel Miller and John B. Hood.

First newspaper to be established in what is now Ohio was the *Centinel of the North-Western Territory,* founded at Cincinnati by William Maxwell in 1793. First in Indiana was Elihu Stout's *Indiana Gazette,* later *Western Sun,* at Vincennes in 1804. Joseph Charless founded the *Missouri Gazette* in 1808; it was the first paper printed wholly in English west of the Mississippi. Its name was later changed to *Missouri Republican* and in 1888 to *Republic;* it was merged with the *St. Louis Globe-Dentocrat* in 1919.

First Michigan paper was the *Michigan Essay,* produced briefly under the patronage of Gabriel Richard, a Catholic missionary; the first Michigan paper of longer life was the *Detroit Gazette* (1817–30). In 1814 Matthew Duncan brought his press up from Kentucky and founded Illinois' first paper at Kaskaskia, the *Illinois Herald,* which he later moved to the new capital at Vandalia and renamed the *Illinois Intelligencer.* The first Chicago. paper was the *Democrat,* founded in 1833 by John Calhoun, later mayor of the city; it was merged with the *Tribune* in 1861. In 1819 the *Arkansas Gazette* was begun by William E. Woodruff at Arkansas Post; it was moved to Little Rock when that settlement was chosen as the capital.

First newspaper in Wisconsin territory was the *Green Bay Intelligencer* (1833–36). First in Iowa was John King's *Dubuque Visitor* of 1836, and first in Minnesota James M. Goodhue's *Minnesota Pioneer* of 1849, later famous as the *St. Paul Pioneer*

Press. In 1854 the *Nebraska Palladium,* which had been begun in Iowa, was moved across the river to Belleview and published for several months in the new territory. First Kansas paper was a missionary sheet in an Indian language called in English *Shawnee Sun,* published in 1835 at the Baptist mission; first English-language paper in that territory was the *Kansas Weekly Herald* (1854–61) of Leavenworth. The pioneer Kansas papers were embroiled in the free-state war of 1856. The *Lawrence Herald of Freedom* office was destroyed by the proslavery faction, but it gave its type to be molded into balls used for the attack on Fort Titus, so that the discharges of the antislavery cannon were called "new editions" of the *Herald.*

The *Sioux Falls Democrat* was first of South Dakota papers in 1858; its name was soon changed to *Northwestern Independent.* The *Fort Union Frontier Scout* of 1864 was North Dakota's first paper.

In the southwest Oklahoma's first paper was a Baptist missionary organ) the *Cherokee Messenger,* printed in an Indian language, near the present site of Westville, in 1844–46. Pioneer Texas paper was the organ of the provisional revolutionary government at San Felipe called *Telegraph and Texas Register,* 1835; it had an adventurous career before it became the first Houston newspaper. A small campaign sheet called *El Crepusculo,* published in Santa Fe by Antonio Barreiro, was apparently the first publication in New Mexico, but the first real newspaper was the *Santa Fe Republican* (1847–49), with two pages in English and two in Spanish. The *Weekly Arizonian,* Tubac, 1859, was the first paper in Arizona.

California's first paper was founded in 1846. It was a small sheet printed on one side only at Monterey. and was called the *Californian.* It was soon moved to what is now San Francisco, where the *California Star* had been established in 1847. Both were absorbed into the *Alta California* when that famous paper was set up in 1849. The first paper printed in Nevada was the *Territorial Enterprise,* begun in 1858 at Genoa, but more famous as the Comstock lode organ at Virginia City, where Mark Twain and Dan De Quille worked on it. Another gold rush brought Colorado's first paper, the *Rocky Mountain News,* founded in Denver by William N. Byers in 1859; it became a Scripps paper in 1926. Other western "firsts" were the *Oregon Spectator,* Oregon City, *1846;* the *Columbian,* Olympia, Wash., 1852; the *Deseret News,* famous Mormon paper in Salt Lake City, Utah, 1850; the *Golden Age,* Lewiston, Ida., 1862; the *Montana Post,* begun in 1864 at the Virginia City gold camp and moved to Helena in 1868; and the *Fort Bridger Daily Telegram* of 1863, first Wyoming and first state paper to begin as a daily.

The first paper in what is now Alaska was *Esquimaux,* printed monthly at Port Clarence, Russian America, by John J. Harrington for the Western Union Telegraph expedition in 1866–67. The *Klondike Nugget* was published at Dawson (1898–99) by Eugene C. Allen and was later established as a weekly at Nome. Anchorage, Juneau, Fairbanks and Ketchikan acquired small dailies, and by mid-20th century there were a dozen weeklies.

The first Hawaiian newspaper was the weekly *Sandwich Island Gazette and Journal of Commerce* (1836–39), by Samuel D. Mackintosh and Nelson Hall, which was continued monthly (1839–40) as the *Sandwich Island Mirror and Commercial Gazette.* Of longer life was James Jackson Jarves' *Polynesian* (1840–64). The first daily was the *Hawaiian Herald* (1866). The chief papers in Honolulu at mid-20th century were the *Star-Bulletin* and the *Advertiser.* The *Hawaiian Star* was begun in 1893 and the *Evening Bulletin* in 1882; they were merged in 1912 by Wallace R. Farrington, later governor of the territory. The *Advertiser* was founded as a weekly by Henry M. Whitney in 1856. The *Hawaii Times* was founded in 1885 and published in both English and Japanese. In Hilo the daily *Tribune-Herald* was founded in 1895.

The Civil War and Reconstruction.— The Civil War was well covered by special correspondents in the field, more than 150 of whom served northern papers during the war. Military restrictions, government control of telegraph lines and mob violence—all sporadic—curbed press activity; but there was no regular and consistent censorship. A number of papers were forced to suspend publication by military commands or the post-officedepartment.

Among these were the *New York Daily News* and the *Chicago Times.* The *News,* founded in 1855, was a penny paper, organ of the Tammany Democracy; it had come into the hands of Benjamin Wood, brother of Fernando Wood, New York's mayor. The Woods were strongly proslavery. and a combined military and postal blockade forced the *News* to close down for 18 months in 1861–62. After the war this paper won a very large circulation in the tenement-house districts as a penny sensation-monger. Wood lived until 1900, and the next year Frank A. Munsey bought the *News* from his widow for $34,000 in $1,000 bills. Munsey improved it so much that it lost its public, and it perished in 1906. The *Chicago Times,* founded in 1854, had been bought by Wilbur F. Storey in 1861. Its editorial attacks on the Union cause led Gen. A. E. Burnside to seize and suspend the paper, but after three days President Lincoln requested that the order be rescinded. The *Times* became a successful sensation paper after the war, receding only as the *Tribune* came to control the Chicago morning field and absorbed the *Times* in 1895.

The *Chicago Daily Tribune* was founded in 1847; it had a difficult time until Joseph Medill and five partners (including Charles H. Ray and Alfred Cowles) took it over in 1855. After Medill gained control of the paper in 1874, he directed its destinies until his death 25 years later, making it a strong and successful paper.

A leading newspaper development of the 1870s was the rise of the *New York Sun* in prestige and influence. Purchased in 1868 by Charles A. Dana and associates, it soon became one of the best-written and edited papers in the country, independent in politics, bright and saucy, its human-interest stories of the great city one of its chief attractions. The *Evening Sun* was launched in 1887.

Notable in the 1870s also was the growing independence of the press from party control. Dating from the secession of Republican papers from the Ulysses S. Grant forces in 1872, what was sometimes called the "mugwump" movement gained in strength and caused the defeat of James G. Blaine in 1884. By 1880 one-fourth of American newspapers were listed in the directories as independent; by 1890 the proportion had reached one-third. By the 1950s one-half of the daily papers listed themselves as "independent" and another one-fourth as "independent Republican" or "independent Democratic."

The "New Journalism."— Joseph Pulitzer, Hungarian-born immigrant who had made a success of the *St. Louis Post-Dispatch,* which he had formed in 1878 of the unimportant *Dispatch* (founded 1864) and John A. Dillon's *Post* (founded 1875), upset the New York newspaper situation in the 1880s and did more than anyone else to set the pattern of modern journalism. In 1883 he bought the *New York World* and soon made it the country's most successful newspaper.

The *World* had been founded in 1860 by Alexander Cummings as a religious daily, but it did not flourish and soon came into the hands of Democratic politicians and financiers. In 1869 Manton Marble purchased majority control, and under his editorship the paper was influential and moderately successful. When he retired in 1876 the *World* came under the control of Thomas A. Scott of the Pennsylvania railroad, who unloaded it on Jay Gould in connection with a railroad deal. The paper had been losing $40,000 a year when Pulitzer bought it. The *Evening World* was established in 1887. The *Sunday World,* with a record-breaking circulation of 250,000, consisted of 26 to 44 pages, half advertising. The combined circulation of the dailies (374,000 by 1892) exceeded those of any two competitors. The *World* had become the most profitable paper published.

Other important New York papers in the 1870s and 1880s besides the *World, Sun* and *Daily News* were the *Herald,* under the control of James Gordon Bennett, Jr., 1872–1918, during which time he lived chiefly in Paris; the *Tribune,* under Whitelaw Reid. 1872–1905, which combined with the *Herald* to become the *Herald Tribune* in 1924; the *Evening Post,* under Edwin Lawrence Godkin, 1883–99; the *Times,* under George Jones, 1869–91; the

Commercial Advertiser, descended from Noah Webster's *American Minerva,* under Hugh J. Hastings, 1868–83; and the *Mail and Express,* a consolidation formed by Cyrus W. Field in 1882 and edited and published in the 1880s by Elliott F Shepard.

In Philadelphia a leading paper was the *Public Ledger,* published 1864–94 by George W. Childs. Later it came into the hands of Adolph S. Ochs, who sold it to Cyrus H. K. Curtis, the magazine publisher; Curtis made a great but unprofitable paper of it, and it perished in 1942. The *Record* was founded by William J. Swain in 1870 and published by William M. Singerly, 1877–98. It was published by Thomas B. Wanamaker, 1902–28, and by J. David Stern until it was sold to the *Bulletin* in 1947. The *Press* was founded in 1857 by John W. Forney, conducted in the 1880s by Charles Emory Smith and merged in the *Public Ledger* in 1920 The *Inquirer,* founded in 1829, was long conducted by Jesper Harding and his son William W., and later by the Elverson family; it was bought in 1936 by M. L. Annenberg. The *Times* was founded in 1875 by Alexander K. McClure, to become a great crusading paper. The *Evening Item,* founded in 1847 by Thomas Fitzgerald and conducted by him and his sons for nearly half a century, gained a large circulation. The *Evening Bulletin,* founded on the basis of the *American Centinel* (1816–46) by Alexander Cummings, was Philadelphia's first afternoon paper. In the 20th century, under William L. McLean and his sons, it gained the largest circulation in the city. At the end of 1957, with the purchase of the *Daily News* by the *Inquirer,* Philadelphia had morning and evening newspapers under one ownership.

In Washington. D.C., the *National Republican* (1860–88) was edited by W. J. Murtagh. The *Evening Star,* established in 1852, was purchased in 1867 by a group headed by Crosby S. Noyes and later conducted by his sons Frank B. and Theodore W. Noyes. The *Post,* founded by Stilson Hutchins in 1877. was edited by him until 1889. After a varied career, the *Post* was bought at auction in 1933 by Eugene Meyer, who made it again a successful newspaper.

In Boston the *Herald,* founded in 1844, was a leader under the editorship, 1862–87, of E. B. Haskell. In 1912 it bought the *Traveller,* founded in 1845, as its evening associate. The *Daily Advertiser,* founded in 1813. and made by Nathan Hale the first successful daily in New England, seemed moribund in the 1880s; but it lived to be made a tabloid by William Randolph Hearst in 1938, and later to become the *Sunday Advertiser.* The *Post,* founded by Charles G. Greene in 1831, also declined in the 1880s, but had a rebirth under Edwin A. Grozier in 1891. The *Journal* (1833–1917) was edited by W. W. Clapp in the 1880s in the sensational manner of the "new journalism." The *Transcript* (1830) was edited in this decade by Edward H. Clement; for many years it was the great newspaper organ of Boston culture, but it died in 1941. The *Globe* (1872) was highly successful under Gen. Charles H. Taylor and his son William O.

In Atlanta. Ga., Henry W. Grady in 1880 bought a quarter interest in the *Constitution* (1868) and as its managing editor made it a great newspaper; he died in 1889 and was succeeded by Clark Howell. In Louisville, Ky., Walter N. Haldeman consolidated the *Courier* and *Journal* in 1868, and put in charge Henry Watterson, who made the *Cozirier-Journal* famous and remained in service until 1919. In Cincinnati, Murat Halstead became editor of the *Commercial* (1843) in 1865; it became the *Commercial Gazette* when it was consolidated with the *Gazette* (1815) and Halstead sold it in 1890. John R. McLean took over the management of the *Cincinnati Enquirer* (1842) in 1870, and bought it from his father in 1881; in 1895 he bought also the *New York Journal* and in 1905 the *Washington Post.* Cincinnati's evening papers. the *Times* (1840) and the *Star* (1872), were merged in 1880 by Charles P. Taft and in 1958 was purchased by the Scripps-Howard chain. The great San Francisco paper of the period 1870–90 was the *Chronicle,* founded in 1865 by two brothers in their teens, Charles and Michel H. de Young; it was a lively, fighting paper, and Charles de Young was shot and killed in 1880 in connection with a political fight. The *Call* (1856) and the *Bulletin* (1855) were under the same management; much later (1928) they were consolidated by Hearst. The *San Francisco Examiner* (1865) was bought by George Hearst in 1880 to further his political ambitions. The best-known editor in the Pacific northwest for many years was Harvey W. Scott, who edited the *Portland Oregonian* 1865–1910.

The great event in Chicago journalism in the post-Civil War period was the founding of the *Daily News* as a penny paper by Melville E. Stone in 1875. When the paper was on the verge of failure after a few months, Victor F. Lawson came in as partner. bringing needed capital. A liberal, crusading paper, the *Daily News* made a great success. In 1888 Stone sold out to Lawson. later becoming the first general manager of the reorganized Associated Press. John S. Knight bought the paper in 1944, and it was sold to the *Chicago Sun-Times* in 1959. The *Herald* mas founded in 1881 by James W. Scott; who combined it with the *Times* in 1895. The *Times-Herald* became the *Record-Herald* when Herman Kohlsaat, its owner since the consolidation, bought the *Record,* morning edition of the *Daily News,* in 1901 and made a new combination; after Kohlsaat's *Inter Ocean* (1872) was merged in the *Record-Herald* in 1914, it became the *Herald* again. but four years later Hearst bought it and merged it with his *Examiner* as the *Herald-Examiner,* later the *Herald-American* and still later as the *American.* In 1956 it was purchased by the *Chicago Tribune.*

In Kansas City, Mo., William Rockhill Nelson and Samuel E. Morss began the *Star* in 1880 as a small two-cent daily. Morss dropped out on account of ill-health after a year or two. but Nelson made the *Star* a strong, crusading local newspaper, adding a Sunday edition in 1894, buying the *Times* (1868) for its morning edition in 1901 and starting the *Weekly Star* as a farm paper in 1890. Nelson died in 191j and staff members bought the paper for $11,000,000. Henry J. Haskell was editor 1928–52.

Yellow Journalism. — William Randolph Hearst's first paper was the *San Francisco Examiner,* which his father, George Hearst, turned over to him. Successful in his management of that paper, he went to New Tork in 1895 and bought the *Journal.* With this paper he challenged the supremacy of Pulitzer's *World* in New York. Some of his staff he brought from San Francisco and some he hired away from the *World.* He outdid his rival in sensationalism, crusades and Sunday features. A comic picture series called "The Yellow Kid" was drawn by Richard F. Outcault for the *Sunday World* and later for the *Sunday Journal,* but after the departure of the originator to the rival paper it was drawn by George B. Luks for the *World;* these picture series excited so much attention that the competition between the two newspapers came to be called "yellow journalism." This all-out rivalry and its accompanying promotion developed large circulations for both papers and affected U.S. journalism in many cities. The "yellow journalism" formula, as it developed, was distinguished by (1) "scare heads" in large type, printed in black or red; (2) lavish use of pictures; (3) pseudoscientific articles; (4) the Sunday supplement, with coloured comics and sensational features; (j) ostentatious crusading for popular causes. The era of "yellow journalism" may be said to have ended shortly after the turn of the century, with the *World's* gradual retirement from the competition in sensationalism and the rise of the *Times.*

One of the phenomena of the era was the promotion of the war with Spain through hysterical propaganda against that nation based on exposures of Spanish atrocities in Cuba. This jingoism was not limited to the *Journal* and *World,* though they were leaders in it. Some techniques of the "yellow journalism" period became more or less permanent and widespread, as banner headlines, coloured comics and copious illustration.

Adolph S. Ochs, publisher of the *Chattanooga* (Tenn.) *Times,* took over management of the failing *New York Times* in 1896. In 1898 Ochs reduced the price of the paper to one cent. Instead of getting into the "yellow" competition, the *Times* adopted the slogans "All the news that's fit to print" and "It does not soil the breakfast cloth." Ochs, who had actually put in only $75,000 in 1896, had a controlling interest by 1900. The *Times*'s success as a clean. conservative newspaper was one of the most striking phenomena of the new century.

"Chains" and Consolidations.—If we define a newspaper "chain" loosely enough to include affiliations formed by an uncertain degree of co-operation rather than common ownership. the groups of colonial papers of which Benjamin Franklin and Isaiah Thomas were patrons and sometimes part owners might be said to be the first American chains. But modem chains began with the Scripps papers in 1878. By 1900 eight such groups could be listed, and ten years later there were a dozen and the number of papers in them had doubled. In the next decade the number of chain papers doubled again; and in the boom decade of the 1920s the number of chains reached more than 50, and the number of papers owned or affiliated in them about 300. Those statistics still held at the mid-century mark.

The first paper on which E. W. Scripps worked was the *Detroit Tribune,* founded by his half brother James E. Scripps in 1873. The first paper he founded (with assistance from his half brothers James E. Scripps and George Scripps) was the *Cleveland Press,* begun in 1878 as a penny paper. Successful there, he persuaded his half brothers to buy the *St. Louis Chronicle* (1880–1905), with which 'he failed to overcome the dominant competition of the *Post-Dispatch* and *Globe-Democrat. A* little later he bought a controlling interest in the *Cincinnati Post* (purchase of the *Times-Star* and merging of it with the *Post* in 1958 gave the Scripps-Howard chain control of all daily papers), and founded the *Kentucky Post* at Covington. By this time he had developed his formula, which was to establish papers in medium-sized cities with cheap equipment. put young men from his organization in charge with working partnerships, sell for a penny a copy and campaign for causes popular among the common people (often for organized labour). With Milton A. McRae as partner in the Scripps-McRae league, he bought or founded many papers in the midwest in the years 1897–1911. McRae dropped out in 1914, and in 1917 Scripps placed management in the hands of two sons, James G. and Robert P. Scripps. Three years later, a quarrel with James resulted in his being supplanted by Roy W. Howard, who had been general manager of the United Press Associations, founded in 1907 as the Scripps news-gathering agency. In 1922 E. W. Scripps retired completely, turning over his newspaper properties to his son Robert, who formed the organization known as Scripps-Howard. Chief Scripps-Howard additions to the chain in the 1920s were the *Pittsburgh Press* (1884) in 1923 and *New York Telegram* (1868) in 1927.

Most important of all was the purchase of the *New York World* in 1931, and its merger with the *Telegram.* To this combination the *Sun* was added in 1950.

The Hearst chain began with the *Sun Francisco Examiner* arid the *New York Journal* and *Evening Journal.* In 1900 Hearst founded the *Chicago American* as an evening paper, and in 1902 the morning *Examiner.* In 1904 he started the *Boston American.* Beginning in 1917, he added many more papers to his list, buying as many as seven in one year (1922). He bought or established altogether more than 40 daily papers, 16 of which he owned at the time of his death in 1951.

Though the Scripps and Hea'rst chains were the largest of such systems, there were many other groups. such as the Booth Newspapers in Michigan, founded by George C. Booth; the Brush-Moore Newspapers in Ohio. founded by Louis H. Brush and Roy D. Moore; the Lee Syndicate in the upper Mississippi valley. founded by Alfred W. Lee; the Copley Press in Illinois and California, founded by Ira C. Copley; the Speidel Newspapers, founded by Merritt C. Speidel and strung across the country from New York to California; the Frank E. Gannett Newspapers, chiefly in New York; the James M. Cox Newspapers in Dayton and Springfield, O., Miami, Fla., and Atlanta. Ga.; Central Newspapers, founded by E. C. Pulliam, chiefly in Indiana; the H. C. Ogden Newspapers in West Virginia; the John H. Perry Newspapers, chiefly in Florida; Stauffer Publications. Oscar Stauffer president, in Kansas. Missouri and Oklahoma; Ridder Publications. built up by the sons of Herman Ridder in New York. Minnesota and on the west coast; the Knight Newspapers, owned by John S. Knight, comprising the *Chicago Daily News* (sold in 1959 to the Field Enterprises, publisher of the *Chicago Sun-Times).* the *Detroit Free Press,* the *Miami* (Fla.) *Herald,* the *Akron* (O.) *Beacon-Journal* and the *Charlotte* (N.C.) *Observer;* and the group rising in the 1950s under the direction of S. I. Newhouse, including the *St. Louis Globe-Democrat,* the *Portland Oregonian,* the *Syracuse* (N.Y.) *Post-Standard* and the *Birmingham* (Ala.) *News.*

Consolidations, like chains, were not new in modem journalism. Ever since the consolidation of the *New-England Weekly Journal* with the *Boston Gazette* in 1741, weak papers had been absorbed by strong ones. But the large newspaper capital investments which. beginning in the 1890s, came to characterize the newspaper business of the 20th century made the merger a recognized technique for "cleaning up" a ruinous competitive situation. Especially dangerous, it seemed to critics of the modem communications system. was the increasing number of large cities with only one newspaper ownership; by 1940 this was the case in more than one-fourth of American cities of more than 100,000 population. Moreover, the number of daily newspapers in the United States declined from a peak of 2,519 in 1916 to 1,850 in 1945. Slight increases marked the latter half of the 1940s, but in 1955 the total was 1,841. (These figures are from N. W. Ayer and Son's *Directory of Newspapers and Periodicals;* see *Bibliography.)*

Newspaper consolidation was dramatized about 1920 by Frank A. Munsey's activities. In 1916 Munsey bought the *New York Sun, Evening Sun* and *Press* and merged the *Press* in the *Sun.* Four years later he bought the *Herald* and its evening associate, the *Telegram,* and merged the *Sun* in the *Herald,* changing the name of the *Evening Sun* to *Sun.* His next move was to sell the *Herald* to the *Tribune* for another merger in 1924. Then he bought the *Globe,* which had been merged with the *Commercial Advertiser* in 1905, and merged it with the *Sun.* His last consolidation was that of the *Mail and Express* and the *Telegram* in 1924.

Varied Newspapers.—The *St. Louis Globe-Democrat* had been formed when J. B. McCullagh in 1875 bought the *Missouri Democrat* (founded 1852) and merged it with his *Globe* (founded 1872). The *St. Louis Star-Times* was formed in 1935 by the consolidation of the *Star* (founded 1878), which had absorbed the *Chronicle* (1905), and the *Times* (founded 1895). It was merged with the *Post-Dispatch* in 1951.

The Denver *Post,* founded in 1892. was purchased three years later by Fred G. Bonfils and Harry H. Tammen and made an outstanding exemplar of the "yellow journalism" of the period. Tammen died in 1924 and Bonfils in 1933; in 1946 Palmer Hoyt became publisher, modifying the policy of the paper. Edgar Watson Howe founded the *Atchison* (Kan.) *Globe* in 1877, and made it a widely quoted paper. Another famous editor in a small Kansas city was William Allen White, who bought the *Emporia Guzette* when it was five years old in 1895 and soon achieved national fame through his editorial writings.

The *Christian Science Monitor* was established in Boston by Mrs. Mary Baker Eddy in 1908. A handsome and high-minded general newspaper. it fought "yellow journalism" and emphasized international news. The *Des Moines Register* was begun in 1856 as the *Iowa Citizen,* a Free Soil paper. From 1870 to the end of the century the *Register* was published by Coker F. Clarkson, followed by his two sons; in 1902 it absorbed the *Leader,* which had been begun as the *Iowa Star,* Des Moines's first newspaper, in 1849. The next year the combined paper was bought by Gardner Cowles, who in 1908 gave it the two-year-old *Tribune* as an evening associate. Following the retirement. of Cowles, the *Register* and *Tribune* were conducted by his sons John Cowles and Gardner Cowles, Jr.. who in 1935 purchased the *Minneapolis Star* and later the *Journal* and *Tribune* of that city. In 1949 the Minneapolis papers were reduced to two—the *Tribune* for morning and the *Star* for afternoon.

The *New Orleans Times-Picayune* was a combination of the two papers of that city which survived the Civil War period—the famous old *Picayune* and the *Times-Democrat* (founded 1863, 1875; merged 1881). The *States* became its evening associate in 1933. The *Item* (1877) and *Tribune* (1924) were sold in 1949 to David Stern, son of the former publisher of the *Philadelphia Record.* In 1958 the *Item* was merged with the *States,* the merger being jointly owned by the *Times-Picayune.* The *Washing-*

ton (D.C.) *Times-Herald* was formed in 1939 when Mrs. Eleanor Patterson, granddaughter of Joseph Medill, bought the two papers from Hearst. The *Herald* had been founded in 1906 by Scott C. Bone, who had been managing editor of the *Washington Post;* the *Times* (1894) had been under Munsey ownership 1901–17. Mrs. Patterson left the *Times-Herald* to seven executives of the paper on her death in 1948; but the next year they sold it to Robert R. McCormick, publisher of the *Chicago Tribune.* It was merged with the *Post* in 1954.

The Tabloid. — The earliest American newspapers were all tabloids, if by that term only the small size of the pages is meant. The experimental Jan. 1, 1900, issue of the *New York World,* designed and edited by Alfred Harmsworth (later Viscount Northcliffe) and called by him a "tabloid newspaper" and "the newspaper of the 20th century," had the small page size and an emphasis on condensation. Tabloid journalism had come to stand for three techniques by the 1940s: (1) the folded-in-half page size, as compared with that of the normal eight-column paper; (2) the devotion of a large proportion of the paper's space to pictures; and (3) a terse, condensed and lively presentation of the news.

Two grandsons of Joseph Medill, Robert R. McCormick and Joseph Medill Patterson, took over jointly the management of the *Chicago Tribune* in 1914. Five years later they formed a subsidiary of the Tribune company to publish the *New York Daily News* as a new morning tabloid. In 192j, when the paper had reached nearly 1,000,000 circulation — largest in the U.S.— Patterson left his executive position on the *Tribune* and until his death in 1946 devoted himself to the management of the *Daily News.*

The sensationalism of the *Daily News* in the 1920s brought it into competition with Hearst's morning *American,* and Hearst first tried out the form in Boston by "tabbing" the *Daily Advertiser,* and then founded the tabloid *Daily Mirror* in New Tork in 1924. Three months later Bernarr Macfadden began the *Daily Graphic* in the same form. Thus began the "war of the tabs" in New York, in which the three competitors tried to outdo each other in sensationalism. The *Graphic* perished in 1932, to be revived in 195j; the *Daily News* cleaned up its columns and prospered, and Hearst sold the *Mirror* in 1928. Later Hearst had to take the *Mirror* back and it went on to a 1,000,000 circulation by 1950—second only (among American dailies) to the 2,250,000 of the *Daily News.* Both these circulations declined somewhat in the later 1950s. Meanwhile, the success of the leaders among the tabloids had tempted publishers of dailies in other cities to try that form; there were about a dozen C.S. tabloids in 1930, 50 in 1940 and 70 in 1950. Most important, besides those mentioned above, were the *Washington News* (1921), the *Philadelphia News* (1925), the *Chicago Times* (1929; later the *Sun-Times*), the Denver *Rocky Mountain News* ("tabbed" 1948), the *Los Angeles Mirror* (begun in 1908 as a tabloid, to become the standard-size morning edition of the *Times* in 1954) and the *New York Post* (the old *Evening Post,* "tabbed" in 1942).

World Wars. — There were comparatively few U.S. correspondents abroad when World War I broke out in Xug. 1914, and those who were rushed across found themselves hampered on all fronts by censorship. After the arrival of the American expeditionary force in 1918, several hundred U.S. newspaper, magazine and agency men covered the war in various foreign centres and on the several military fronts.

Censorship at the fronts, though often severe arid stupid in the early years of the war, was somewhat more tenable after the arrival oi the A.E.F. Maj. Frederick Palmer, Associated Press and magazine correspondent, wrote the section of the U.S. field service regulations dealing with war correspondents and nas himself chief American censor for six months. Within the United States more than 75 papers had their mailing privileges withdrawn under the terms of the Espionage act. The German-language press declined about one-half. The Committee on Public Information, George Creel, chairman, participated in both propaganda and censorship, and presented to U.S. papers a "voluntary censorship" code.

Most famous of the many camp and field newspapers published by and for U.S. soldiers during World War I was *Stars and Stripes,* continued for 16 months from Feb. 1918.

When the United States entered World War II in Dec. 1941, there were more than 200 U.S. reporters gathering news abroad, mostly in belligerent countries. By the spring of 1943 the number had risen to 435. The U.S. war department accredited during the entire war, for longer or shorter periods, 1.186 American correspondents and news officials, representing all mediums, and rhe navy department 460 more. Besides the press associations; 30 individual newspapers and 12 magazines had their own correspondents at the war fronts. Photographers played a far larger part in war reporting than ever before. Most famous of war pictures was that of the flag raising at Iwo Jima in Feb. 1945, taken by Joseph Rosenthal of the Associated Press. Most famous of war correspondents was Ernest Taylor ("Ernie") Pyle, who wrote from England, north Africa, Sicily, Italy, France and the Pacific; he was killed on Ie Shima in the Okinawa campaign. Casualties among writers, photographers and radiomen covering the war numbered 37 killed and 112 wounded, exclusive of combat correspondents. Among the best-known writers who perished were Raymond Clapper of Scripps-Howard Newspaper alliance and Webb Miller of the United Press.

The U.S. Office of Censorship, with Byron Price as director, was created Dec. 19, 1941, and lasted throughout the war. It promulgated the "Code of Wartime Practices for the American Press," which formed the basis for a remarkable co-operative self-censorship. Field censorship on the war fronts varied greatly in efficiency and reasonableness. A number of home periodicals were suppressed, chiefly after convictions of publishers and editors under the Foreign Agents' Registration act. The Office of War Information, with Elmer Davis as director, was set up on June 13, 1942, and handled an immense amount of news and propaganda at home and abroad.

Thousands of army unit, camp and installation, ordnance plant and combat ship papers served the American soldiers in World War II. Of this "G.I. journalism," *Stars and Stripes* was the chief daily newspaper and *Yank* the chief magazine. The former was reborn in London in April 194: and was later printed in many editions on various fronts. *Yank* was begun about the same time in New York, and came to have 22 editions and a circulation of about 2,500,000. Altogether there were said to be about 600 army unit papers and twice that many camp papers in the United States.

The war of 1950–53 in Korea was thoroughly covered by correspondents of American newspapers and news services. In the first year 320 newsmen, serving all communication agencies, were at the front for varying periods, Nine correspondents were killed and many wounded and taken prisoner.

Marshall Field's Newspapers. — The New York tabloid *PM* was founded in 1940 by Ralph Ingersoll and associates as an adless daily of liberal opinions. Marshall Field III had sorne money in it at the start and later increased his holdings to a controlling interest. Sold in 1948, its name was changed to the *Star,* but it perished the next year. Ted O. Thackrey, former editor of the *Post,* founded the *Daily Compass* in 1949 with the financial backing of Mrs. Anita McCormick Blaine, publishing from the *Star's* former plant.

Marshall Field III founded the *Chicago Sun* in 1941 as a competitor for the *Tribune* in the morning field. Six years later he bought the *Times,* evening tabloid, and "tabbed" the *Sun;* in 1948 the two papers were combined as the *Sun-Times* with round-the-clock publication. In its competition with the *Tribune,* the *Sun* felt the lack of an Associated Press membership, which it did not obtain until the government had brought suit against the X.P. for violation of the Sherman Anti-Trust act. This suit, instituted in 1942, was decided in favour of the government in 1945 and caused the X.P. to amend its rules to forbid the "blackballing" of competitors. In 1959 Field Enterprises bought the *Chicago Daily News.*

American Newspaper Guild. — The American Newspaper guild was organized in 1933 "to preserve the vocational interests of its members and to improve the conditions under which they work by collective bargaining. and to raise the standards of journalism." First contract negotiated was with the *Philadelphia Record*. In 1936 the guild affiliated with the American Federation of Labor, and the next year with the Committee for Industrial Organization. By mid-century it had 23.000 members and had contracts in force on about 175 dailies and several independent newspapers, as well as on other periodicals and with the news-gathering agencies. There were many strikes, some of which forced suspension of newspapers. One of the strikes, called by the International Typographical union (organized 18jo) against the Chicago papers on Nov. 24, 1947, lasted 22 months. The papers resorted to "cold type" production methods, printing from plates made directly from typewritten ("varityped") copy.

Circulations and Profits.—In the 1950s the aggregate circulation of English-language dailies increased steadily, passing the 55,000,000 mark in 1954. Advertising business also increased, especially in the mid-1950s. It was estimated that in the years 1947–54 daily newspaper income increased over 100%. At the same time, however, costs rose more than 133%, thus greatly diminishing the margin of profit. Most dailies increased the price per copy to five cents, some to seven and a few to ten.

Weekly Newspapers.—Though the urban shift which began after the Civil War tended to highlight the metropolitan daily with its large circulation and fast service, the weekly newspaper of the small towns remained a powerful influence on the lives and thinking of a large part of the population of the U.S. The number of these community papers increased 1870–90 from fewer than 4,000 to about 12.000; the peak was reached in 1914 at 14,500, but consolidations reduced the number to about 10.000 shortly after mid-20th century.

From the handwork of 1900, with much dependence on ready-printed sheets, the community weekly developed into a machine-set, power-driven operation, with strong emphasis on community service. In 1953 the Western Newspaper Union, which had furnished "ready prints" to weeklies since 1880, discontinued that service.

Suburban Shift.—Nearly half the population increase of the 1940s took place in the suburbs of the metropolitan areas. This residential movement caused a shift in types of newspapers serving the newly populous centres. Two types grew up rapidly: the "middle-size" dailies, which served sizable suburbs or groups of suburbs (typical of these was *Newsday*, Garden City, Long Island); and the neighbourhood weeklies, often associated in groups. The latter type was by no means limited to suburban centres; it was found singly in small cities and made its most spectacular showing in groups in residential areas of Chicago and Philadelphia.

Foreign-Language Newspapers.—Benjamin Franklin was publisher of the first foreign-language newspaper in what is now the United States. It bore the title *Philadelphische Zeitung*, but it published only two issues, in 1732. Most notable of this class in the 18th century was Christopher Sauer's paper published 1739–78 under various titles but most prominently as the *Germantowner Zeitung*. The first daily in a foreign language was *Courrier Français* of Philadelphia, which supported the French cause in America in 1794–98. The phenomenal growth of the foreign-language press, however, waited upon the great waves of immigration, especially those from Germany. In 1830–60 German papers were founded in nearly all the states; and French, Italian, Spanish, Dutch, Swedish, Norwegian and Welsh languages were represented. By 1860 nearly 10% of the country's papers were in foreign languages, and two-thirds of these were in German. *New Yorker Staats-Zeitung*, foremost of them, was founded by Jacob Uhl in 1834 and was later conducted through successive periods by Oswald Ottendorfer and Herman Ridder. Though the foreign-language press reached its peak in the first decade of the 20th century, it declined relative to the growth of English-language papers in the United States after about 1880. Two world wars served to destroy the major prosperity of the foreign-language press in America. There were 140 dailies (about one-third German) in 1914; a decade after the end of World War II there were 76 (4 of them German, 12 Chinese). At the latter date 35 languages were represented.

The Negro Press.—The first Negro newspaper was *Freedom's Journal*, conducted in New York in 1827 by Samuel Cornish and John B. Russwurm. Like all Negro journals published before the Civil War (about 24 in number), this paper devoted a short life to the antislavery cause. Most important paper conducted by a Negro in the years after the war was the *New York Age*, founded in 1879 by the poet and essayist T. T. Fortune under the name of the *Globe*. At mid-20th century it was the oldest of Negro newspapers, and was edited by Dan Burley.

In 195j there were 110 weeklies (excluding religious and other special interest papers) and one daily, the *Atlanta World*, being conducted by Negroes. The leaders were: *Pittsburgh Courier* (1910), *New York Amsterdam News* (1909) and *Norfolk* (Va.) *Journal and Guide* (1901). The *Chicago Defender*, published since 1905 as a weekly, began daily publication in 1956.

Appraisals of the Press.—Since the hostile criticism of the first American newspaper, *Publick Occurrences*, there has been a fairly steady stream of criticism of newspapers in books, magazines, public speeches and the newspapers themselves. These criticisms, by such men as Charles Dickens, James Fenimore Cooper, Lambert A. Wilmer, David G. Croly, Edwin Lawrence Godkin, Oswald Garrison Villard, George Seldes, Silas Bent, Harold L. Ickes and Herbert Brucker, have ranged from angry invective to sober appraisal, from personal or partisan motivation to the scholarly and sociological attitude. Perhaps the most important investigation was undertaken by the Commission on Freedom of the Press headed by Robert M. Hutchins, then chancellor of The University of Chicago. The report of the commission, entitled *A Free and Responsible Press* (1947), restated the principles of press freedom, emphasized dangers of mass publication and monopolistic control and made a series of recommendations, some of which met with general acceptance.

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VII. CENTRAL AND SOUTH AMERICA

Mexico.—A Mexican newssheet published in 1541 constituted the earliest printed news in the western hemisphere. It was published by Juan Pablos and was an account of the Guatemalan earthquake of the preceding year, entitled *Relacidn del terremoto de Guatemala*. The first regular newspaper came nearly two centuries later, *Gaceta de México* (1722). The first dailies were *Diario de México* and *Diario de Veracruz*, both begun in 1805. Arbitrary censorship was the rule and tradition in Mexico. The constitution of 1857 was liberal in language, but did not in practice afford any considerable freedom of the press. In the long presidency of Porfirio Diaz, however, economic stability was favourable to the development of the newspaper industry. The "insurgent press," beginning with *El Despertador americano* (1810–11), from time to time played an important part in national affairs. Papers in Indian languages were established in the 1880s, as *Purepe* of Quiroga, in Tarascan; *Mor* of Tepoztlán, in Aztec; and others in Maya and Zapotecan in Yucatan and Oaxaca.

Daily newspapers in Mexico in 1955 numbered about 108, of which 18 were published in the federal district. Nearly all had been founded after 1920 and many after 1940. The only important daily dating back to the 1880s was *El Correo de la tarde* (1885) of Mazatlán. The largest papers in Mexico City were: the established and respected *El Universal* (1916), with its evening tabloid edition, *El Universal gráfico* (1922); *Excelsior* (1917); *Novedades* (1932); and *La Prensa* (1928). These journals had large Sunday editions and affiliated radio stations. There was one paper owned and operated by the government. *El Nacional* (1929). Guadalajar and hlonterrey, the next largest cities, had three and four dailies respectively.

The circulation of Mexican dailies. regional rather than national, virtually doubled in the decade 1940–50 and continued to increase in the next decade.

Central America. — The earliest printing in Central America was at Antigua, in the colony of Guatemala; but it was in the town of Guatemala that a monthly *Gaceta* was established in 1729. The country's oldest daily in 1955 was *Diario de Centro-America,* founded the year after the adoption of the constitution of 1879 as *El Guatemalteco.* There were ten Guatemalan dailies in 1955 (eight in Spanish, one in English, one in Chinese). *El Imparcial* (1922) had the largest circulation.

In Honduras the first paper was the *Gaceta de Honduras* (1830), in Comayagua; the first daily was *El Diario* (1897), in Tegucigalpa, the capital. In 1955 Honduras had 6 dailies in the capital and 24 weeklies and semiweeklies.

British Honduras had the *Belize Daily Clarion* (1897) and the *Belize Billboard* (1946).

Nicaragua's first paper was *El Telégrafo nicaragüenese* (1835) of Leon, and its first daily was the *Diario de Nicaragua* (1884) of Granada. In 19jj there were six dailies in Managua (including the government's *Gaceta),* two in León and one in Granada.

El Salvador had a paper at San Sebastian called *Liberal guipuzcoano* in 1820. In 1955 there were six dailies in the capital. San Salvador. of which *Diario oficial* (1847). the government gazette, was the oldest, and *La Prensa gráfica* (191j) and *El Diario de hoy* (1936) foremost in circulation and influence. Sonsonate and Santa Ana each had one daily.

El Noticioso universal, established by Joaquin Bernardo Calvo at San José in 1832, was Costa Rica's first newspaper. There were four dailies in that city in 195j. each claiming 12,000 to 24,000 circulation. *Diario de Costa Rica* (1919) was the oldest paper and the only one of standard size.

In what is now Panama. *Miscelánea del Istmo* was established in 1822. and short-lived political papers appeared from time to time; but modern Panaman journalism began with the founding of the *Panama Star* by a group of American forty-niners bound for California but temporarily detained awaiting ship. Their main purpose appears to have been to publish an account of their celebration of Washington's birthday, and the paper was begun Feb. 24, 1849. The paper soon came into other hands, and when Panama seceded from the Colombian federation in 1853 it was made a daily and given a Spanish section, which eventually became a separate edition called *Estrella de Panamá.* The *Panama Herald* (1851) was absorbed in 1854. and the English edition became *Panama Star & Herald.* The *Panama American* and its associate *El Panamá-América* began in 192j, and the *Nation* and *La Nación* in 1944. Panama had ten dailies in 19jj, eight in the city of Panamá and two in David.

West Indies. — In 1764 the printer Olivos was ordered by the captain general of Cuba to issue a monthly *Mercurio,* and other official gazettes were published later, but the first general newspaper in the island was *Papel periddico de la Habana* (1790). Strict censorship was the rule under the Spanish government, and even after independence there mas occasional interference with the press, especially during the Gerardo Machado regime, 1925–33. The chief paper with a national circulation in 1955 was *Diario de* la *marina* (1832), much the oldest of Cuban papers. There were 48 dailies in the island, 19 of them published in Havana. El *País* (1921) and *Prensa libre* (1941) had the largest circulations. There was one daily in English. the *Havana Post* (189j), and three in Chinese.

The *Gazette du Cap,* of uncertain history. is said to have been Haiti's first paper. The *Gazette politique et comnzerciale d'Haiti* (1804) was the first government organ of the new republic. In 1955 Haiti had six daily papers, all published at Port-au-Prince.

Somewhat larger in circulation were the two dailies at Ciudad Trujillo in the Dominican Republic, *La Nación* (1940) and *El Caribe* (1947).

La Gaceta was founded as the official organ of the Spanish government of Puerto Rico in 1807 and continued until the occupation of the island by United States forces in 1898. In 195j there were two dailies in San Juan: *El Imparcial* (1917) and *El Mundo* (1919) claimed more than 50,000 circulation each. There was one daily each in Ponce and Arecibo.

Robert Baldwin began the *Weekly Jamaica Courant* in 1718 at Sant' Jago de la Vega. the capital of Jamaica until 1872. In 1955 the morning *Daily Gleaner* (1834) was the chief paper of Kingston, and the evening paper was the *Star* (1951).

Colombia. — Manuel del Socarro Rodriguez was the publisher of the earliest papers issued in what was then called Santa Fé de Bogota; they were the *Gaceta* (1785) and the *Papel periddico* (1791–95). In 1955 Bogota had 7 dailies and other Colombian cities 34. *El Tiempo* of Bogota. largest paper in the country, suffered under the heavy hand of government censorship in the mid-1950s. Largest paper outside the capital was *El Colombiano* (1912) of Medellín.

Ecuador. — The first known newspaper in Ecuador was the *Gaceta de Santafé* (178j) of Quito. No further paper was printed in the country until alter the revolution of 1809, when the *Gaceta de la corte de Quito* was begun. *El Tclkgrafo* (1884) was Ecuador's oldest daily in 1955, when the country had 25 in all. *El Comercio* (1906) was the most important of Quito's seven dailies; it also owned *Últimas noticias* (1938), the capital's only evening paper.

Venezuela. — The first Venezuelan newspaper was the *Gaceta de Caracas* (1808). The oldest daily in Venezuela in 1955 was *La Religión* (1890) of Caracas. Of the 22 dailies in the country, 9 were published in Caracas, the capital. *El Nacional* (1943) and *Últimas noticias* (1941), both of Caracas, had over 60,000 circulation each.

Peru. — Probably the earliest newssheet printed in South America described the capture of the pirate Richard Hawkins off the Peruvian coast; it was issued by Antonio Ricardo at Lima in 1594. The first titled and numbered paper was *Gaceta de Lima* (1744). Peruvian newspapers, both under Spanish rule and after establishment of the republic in 1822–23, were firmly controlled by the government. Except for the government gazette *El Peruano,* which was founded in 1820, the oldest newspaper in 195j was *El Comercio* (1839) of Lima, which was also the largest, claiming a combined morning and evening circulation of 190,000. Government control was the rule.

Bolivia. — In 1825, the year in which the name of Alto Peru was changed to Bolivia, the *Gaceta de Chuquisaca* and the *Cdndor de Bolivia* were founded in the capital, Chuquisaca, later renamed Sucre. Bolivian newspapers. chiefly owned by political factions, were unstable until some time after the adoption of the press law of 1925. The oldest daily in 1955 was *El Diario* (1905) of La Paz. Under the Paz Estenssoro regime. which came into power in 1952, there was a severe censorship. There were six Bolivian dailies in 1955.

Brazil. — Brazil's first weekly newspaper was the official *Gazeta do Rio de Janeiro* (1808), which in 1823 became *Diário do govêrno.* The country's oldest paper in 19jj was *Dicirio de Pernambuco* (1825) of Recife. Founded in 1827 was *Jornal do comercio* of Rio de Janeiro, which, though its circulation was less than those of most other papers in the capital in 1955, had long enjoyed a high reputation and influence as a conservative journal.

With the fall of the empire in 1889 there was a rapid development of newspapers, and in the next 20 years the number of papers and periodicals increased from about 600 to 1,000. By 195j there were more than 200 dailies, of which 23 were in the capital and 14 in São Paulo.

The largest paper in Brazil in 1955 was *O Globo* (1925) of Rio de Janeiro. which claimed 120,000 circulation. Perhaps the outstanding paper in São Paulo was O *Estado de São Paulo* (1875). *A Noite* (1911) had long been a leading paper in Rio. Diários Associados had become a strong group of 24 daily papers and 14 radio stations spread widely over the country and including such large papers as *Dicirio da noite* (1929) and *O Jornal* (1919) in Rio, *Dicirio da noitc* (1925) in São Paulo and *Diário de Pernambuco* in

Recife.

Argentina.—El *Telkgrafo* (1801–02), the first newspaper published in Argentina, came from the Buenos Aires press of Francisco Cabella y Mesa, a printer who had already engaged in journalism in Lima. Peru. It was followed by a few other papers in the first decade of the century and, after the first national government was established in 1810, by an official *Gaceta* (1810–21). The chaotic period which preceded the Juan Manuel de Rosas regime (1829–52) brought out many small, vituperative political sheets, but Rosas limited the regular Argentine press to a few papers which were forced to confine themselves to commercial news and official documents. Meantime, Argentine journalists took refuge in other South American countries, there to spread their doctrines of liberty and reform. After the fall of Rosas many of these men returned and renewed the conflicts of political journalism.

The modern Argentine press began in the 1860s. *La Nacidn Argentina* was founded in 1862 and became one of the great South American newspapers. In 1869 José Clemente Paz founded *La Prensa,* which was to win even greater fame. The oldest Spanish-language daily, *La Capital,* was begun in Rosario in 1867.

About 175 dailies were published in Argentina in 19jj and more than 80 cities had at least one daily. A considerable foreign-language press existed in Buenos Aires.

La Prensa, long considered one of the world's great newspapers, had the largest circulation (480,000) of any Spanish-language newspaper in the world in 1950. Still owned by the Paz family, it had become famous for its voluminous world-news reports, for its remarkable classified advertising section. for its editorial independence and for its special public services. In 1951, however, *La Prensa* was seized by the government, and was not returned to Alberto Gainza Paz, the publisher. until the fall of the Perón regime in 1955. In his 12 years in power Juan Perón used many devices to control the Argentine press.

La Nación also had strong international news coverage, and gave much attention to technical and transportation problems. Its circulation in 1955 was about 300,000. *Crítica* (1913) also had 300.000. *Democracia* gained first place in the Perón period, with 350.000.

Uruguay. — The publication of Uruguay's first paper was occasioned by the brief British occupation of Montevideo in 1807; it was an English-Spanish sheet called *La Estrella del Sur.* Many papers, chiefly political, appeared during the troubled history of the country; probably the longest life was that enjoyed by El *Telégrafo* (1850–1931). José Batlle y Ordóñez founded El *Día* in 1886. The above-mentioned papers were published in Montevideo. where 15 of the 22 daily papers (with more than nine-tenths of the circulation) in Uruguay were still situated in 1955. Leading morning papers were *El Dia* and *El País* (1919), and the chief evening papers were *El Diario* (1923) and *El Plata* (1915), the latter affiliated with *El Dia.* There was much government control.

Paraguay. — Journalism in Paraguay dates from the middle of the 19th century, though it was irregular until about 1898. There were never more than six dailies in the country at once; there were six in 1955, all published at Asuncion, including *La Tribuna* (1925), *El País* (1923) and *La Unión* (1949).

Chile. — The earliest of Chile's papers was *La Aurora de Chili,* issued in 1810 at Santiago. *El Mercurio* was founded at Valparaiso in 182j and *La Unión,* another important paper, was established in the same city in 1885. In 1902 Augustin Edwards, owner of Valparaiso's *El Mercurio,* founded another morning paper of the same name in Santiago; this chain eventually came to include two evening papers in the capital and one in Valparaiso. The Santiago *Mercurio* had the largest circulation of the 50 Chilean dailies in 1955—110,000. *La Nacidn* (1917) was government owned.

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VIII. ASIA

China.—The first newspaper in China and, if all the claims that have been made for it are accepted, the first newspaper in the world, was a court gazette which began during the T'ang dynasty (A.D. 618–906) and was used as a means of communication between officials. It was continued in the Sung dynasty (960–1279), and early in that period it began appearing at regular intervals and achieved a considerable circulation among Chinese scholars. For title it took the term *Ti-pao,* from *ti,* "palace," and *pao,* "report." a word which had been applied to the earlier bulletins; it was sometimes called *Ti-chan,* or "Court Reading-Matter." In the Ming dynasty (1368–1622) the title of this gazette was changed to *Tungchengsee.* In the last reign of the Ming dynasty, that of Zung Cheng (1628–44), the bulletins, which had hitherto been either handwritten or printed from blocks, began to be printed from movable wood type. During the Ch'ing dynasty (1644–1912) the bulletins were continued under the name *King-pao* ("Peking Gazette"). The series was allowed to perish with the Manchus after 1912.

Similar official gazettes sprang up in the provinces under Manchu rule, and gazettes by the various ministries began in 1906. But newspapers for the general public, as apart from gazettes for officialdom, did not begin in China until the 19th century, and then they were translations or imitations of the English-language press which had been established in that country by commercial and missionary agencies.

James Matheson's *Canton Register* (1827–43) was the first English paper in China; when Hong Kong became British, it was transferred to that city and became the *Hongkong Register* (1843–59). Other papers were published in Canton and Hong Kong, and in 1845 the famous *China Mail* was founded in the latter city, with Andrew Shortrede as editor; it became a daily in 1876. The *North China Herald* was founded in Shanghai in 1850; in 1864 it was made a daily under the new title. *North China Daily News.* The *China Press* was founded in Shanghai in 1915 by a group of Americans, and was edited for a time by John B. Powell.

In 1858 Wu Ting-fang suggested Chinese translations of the *China Mail;* the result was the first Chinese paper for the general public. *Chung Ngoi San Pao.* The most important paper founded for the Chinese before the crisis of 1895 was *Shun Pao,* established at Shanghai in 1872 by Frederic Major, an Englishman. At the time of the Chinese revolution in 1911 it was sold to Sze Liang-zay. who made it prosperous and influential before his assassination in 1934. Sze also owned, after 1929, *Sin Wan Pao* (1893).

A period notable for the founding of many revolutionary journals representing various reform movements began in 1895, after the defeat of China in the Chino-Japanese War. These papers had much to do with bringing about the revolution of 1911. After that, the free speech guaranteed in the provisional constitution was an invitation to hundreds of young Chinese to start journals, many of which were short lived. The severe press laws of 1914 cut off most of the newspapers, but in the years 1918–20 the "literary revolution" and the "student movement" again gave rise to a multitude of journals. In 1921 it was reported that more than 1,000 publications were appearing in China, about half of them daily newspapers.

Sun Yat-sen's regime in Canton was especially favourable to development of the press, and the nationalist revolution of 1927 marked the beginning of another new era in the publication of newspapers in China. By 1948 there were, according to government estimates, about 1,800 newspapers, more than half of them dailies, in the entire country.

Aside from a few well-established and influential papers, most of the dailies were small in size and circulation. Many were party organs, often representing small groups. No little venality and unreliability existed among such papers. The press law of 1914 continued throughout Pres. Chiang Rai-shek's administration to impose a stern censorship; by 1948 it was almost equally severe on English-language and Chinese papers.

During World War II Japanese occupation of the coastal cities drove most of the great Chinese papers inland, but they were quick to recover in 1945–48. *Shun Pao* ("Shanghai Gazette") returned to Shanghai from Hong Kong; and its sister paper, *Sin Wan Pao* (the "News Gazette"), achieved an all-time Chinese circulation record of 350,000, largely through its commercial news. National circulations grew as never before, through the establishment of multiple-city editions. Thus the Kuomintang organ *Chung Yang Jih Pao* ("Central Daily News") was published in Nanking, Shanghai, Chungking and several other cities.

It was estimated that there were 776 dailies published in 1956 under the aegis of the Chinese people's republic. A handful were in Shanghai and four in Peking. The most important was the *Jen Min Jih Pao* ("People's Daily"). The *Ta Kung Pao* ("Impartial Gazette"). founded at Tientsin in 1902, was the only paper which survived the nationalist regime but its independence was very limited. The Hsin Hua or New China News agency. which was a section of the ministry of information, had a monopoly in the collection and distribution of news.

Formosa. — In 1956 there were 28 daily papers appearing at Taipei and other towns in Formosa, *Chung Yang Jih Pao* being the most important. There were two dailies published in English.

India. — Though printing from movable types was done in India in the 16th century. and there were written newsletters during the Mogul dynasty in that century. the first newspaper appeared Jan. 29, 1780. This was the *Bengal Gazette or Calcutta General Advertiser,* better known as "Hickey's Gazette." James Xugustus Hickey's attacks on the government and on private individuals resulted first in barring his paper from the post office and then in his arrest and imprisonment and the seizure of his paper. The second paper was Peter Reed's *Indian Gazette or Calcutta Advertiser,* begun later in the year 1780 and devoted largely to the business of the East India company; it lasted for more than jo years. Bombay journalism began with the *Bombay Herald* in 1789, and the first in Madras was the *Madras Courier* of 1785.

The first periodical in a vernacular language was the monthly *Digdarshan* of 1818, in Bengali, by J. C. Marshman, a Baptist missionary, which soon became a weekly newspaper with the title *Samachur Darpan* ("Mirror of News"). In 1829 it became bilingual, with local and foreign news in both English and Bengali. In the early 1820s many vernacular papers appeared in Gujarati and Bengali; active in this journalism was the religious leader, Rama Mohan Roy, founder of the first Persian weekly, *Mirat-ul-Akhbm,* in Calcutta — papers which were suspended under the John Adam press regulations. Later Roy was associated with *Banga Dutt* ("Bengal Herald"), printed in Bengali. Persian. Hindi and English. Most famous of Bengali papers was *Ananda Bazaar Patrika,* founded in 1878, and enjoying by mid-20th century the third largest circulation of all Indian dailies—50,000. This paper and the other leading daily in Bengali, *Jugantar* (1937), were both published in Calcutta.

The leading English-owned papers in India at mid-20th century were: the *Statesman* of Calcutta (with a New Delhi edition), founded by Robert Knight in 1875, which absorbed the *Englishman* (1821) and *Friend of India;* and the *Pioneer* of Allahabad, founded in 1865, and famous for the service on its editorial staff of Rudyard Kipling for a few years in the latter 1880s.

Half a dozen leading Indian papers in the English language were owned by Indians at mid-century. The *Hindu,* Madras, began as a mimeographed journal of a literary society, became a regular weekly in 1878 and a daily in 1889. The *Times of India,* of Bombay, founded in 1838 as *Bombay Times,* was long regarded as the chief newspaper in India. The *Tribune* of Ambala Cantt, East Punjab, founded in 1881 and made a daily in 1906, became a modern and influential paper. *Amrita Bazaar Pntrika,* founded in 1860 in a village near Calcutta, was in 1871 moved to that city and was made a bilingual paper. After the Vernacular Press act of 1878, it was made an English paper and gained the largest circulation of any newspaper in India. The *Bombay Chronicle* was founded in 1913 by Sir Pherozeshah Mehta. The *Free Press Journal* of Bombay was founded in 1930 by S. Sadanand, the outgrowth of a news agency; the *National Standard,* Bombay, became the nationalist outgrowth of the antinationalist *Morning Standard.* The *Hindustan Times,* founded in 1923, was edited for a number of years by Devadas Gandhi, son of Mohandas K. Gandhi.

The daily press of India in the later 1950s consisted of more than 300 papers with an aggregate circulation of probably 2,500,-000—76 in Hindi, 70 in Urdu, 41 in English, the rest in other languages. About 40 papers might be said to have national circulation, nearly all of them published in Calcutta, Bombay, Madras or New Delhi. About half the papers in these four cities were printed in English.

Indian newspapers in 1948 formed their own co-operative news agency under the name of the Press Trust of India Ltd., taking over the so-year-old Associated Press of India Ltd., which was a Reuters subsidiary. The Indian press at the same time joined those of the United Kingdom, Australia and New Zealand in the general management of Reuters.

Pakistan. — Following the birth of this new state in 1947, a number of new journals were established. Pakistan lost some of its papers by their removal to India, but gained its largest daily, *Dawn,* which moved from Delhi to Karachi. where it continued to publish editions in several languages. Leading English-language papers were the *Civil and Military Gazette* (1870) and *Pakistan Times* at Lahore and *The Times* of *Karachi.* In the later 1950s the country had 81 dailies, including 23 at Karachi. 19 at Lahore and 4 at Chittagong in East Pakistan. In West Pakistan they were printed mainly in Urdu, but some were in Gujarati or Sindhi. Three dailies at Chittagong were printed in Bengali.

Japan.——Newssheets called *yomiuri* appeared in Japan late in the 17th century. They were printed from blocks and were sold by vendors who attracted customers by reading the news aloud; hence the name, which means "selling by reading aloud," and which later became the title of one of the greatest of Japanese newspapers. The first newspaper was the English-language *Shipping List and Advertiser* (1861) of Nagasaki. which was soon moved to Yokohama to become the *Japan Herald.* Several other papers in English were begun in the 1860s. The first periodical in the Japanese language was a series of official translations of foreign ne s! issued monthly, of which the earliest was *Batavia Shimbun* (1862), derived from a Dutch paper in Java. The first Japanese newspaper for general circulation was the *Shimbunshi* (1864), established by Joseph Hikozo. This paper was followed by other Yokohama papers in Japanese, published by Englishmen and Americans.

But it was in 1868, the year of the Meiji restoration, that Japanese journalism really began. In that year 16 papers. in Tokyo. Osaka. Kyoto, Yokohama and other cities. were founded. This development continued despite strict censorship, many imprisonments of editors and occasional forcible suspensions.

The *Tokyo Nichi-Nichi* was founded in 1872, with the famous Genichiro Fukuchi, dramatist and educator, as its editor. In 1906 Hikoichi Motoyama, manager of one of the great industrial syndicates which were growing up in Japan, bought the *Nichi-Nichi* and made it an associate of the *Osaka Mainichi,* which he had owned for many years. The latter paper was founded as *Osaka Nippo* in 1876, but Motoyama rechristened it *Mainichi* when he bought it in 1888. These two papers set a great pace in enterprise. foreign correspondence and a degree of sensationalism. Each paper ran its circulation to more than 1.000,000 before World War II. Provincial papers were founded or purchased. including *Kyushu Mainichi* at Moji. In the war consolidations of 1942–43 these were all lost except the Kyushu paper. From the ordeal, however. the Tokyo and Osaka papers emerged with nearly 1,500,000 circulation each. and the one in Kyushu with more than 500,000.

The *Osnka Asahi* was founded in 1879 by Kyuhei Murayama, one of the greatest journalists of the Meiji era. It flourished.

winning respect for its careful news coverage and progressiveness, and in 1888 the Tokyo *Asahi* was begun. Establishing connections with the Times of London. the *New* York Times and the Associated Press, these papers built up circulations of more than 1,000,000 each. covering the island of Honshu; in 1935 the Asahi company established the *Seibu* (Kokura) *Asahi* on the southern island of Kyushu. In the postwar period the Tokyo and Osaka papers each had about 1,500,000 circulation, and the Kyushu paper more than 500,000.

Founded in 1874, the Yomiuri of Tokyo had made a success in the 1930s by its emphasis on sports, finance and politics. In 1942 it was consolidated with Hochi, founded in 1872 by friends of Marquis Okuma and later owned by Seiji Noma, the "magazine king." In the war years it gained on its competitors, reaching nearly 2,000,000 circulation in 1944.

By 1937 the Japanese press, despite a period of stern repression preceding the constitution of 1889. had reached a very prosperous position. Beginning about 1889, it had largely changed over from the system of party journals to that of more or less independent mass-circulation papers. In 1937 there were 1,200 dailies and 600 weeklies in Japan. In the next two years, as the government tightened its control, there was a small decline; in 1940–41 came a reduction of 36% annually; in 1942, at government "suggestion." wholesale combinations were made which left one daily in each district outside the largest cities. This brought the total down to j3. After the end of the war in 1945, the number soon advanced to about 130, and in the later 1950s there were 179 dailies with a total circulation of 34,500,000.

Many newspapers suffered damage to plants during the war. Under the administration of the supreme commander for the Allied powers (SCAP), newspaper management was "purged," and a precensorship set up which operated until July 1948.

Some papers have reduced the 9,000 ideographs known to the learned to fewer than 2,000 used in their columns, in order to bring their articles and editorials within the reading knowledge of the masses, using the syllable alphabet known as kana as an aid.

Nearly half the daily circulation of Japanese newspapers at mid-century was concentrated in Tokyo and Osaka, with 17 papers in the former city and 10 in the latter. The "big three" in Tokyo — Yomiuri, Asahi and Mainichi — had a circulation of 4,000,000 to 5,000,000 and even more. They sold only about 5% of their copies on the street, while Tokyo *Shimbun* (representing a wartime consolidation of Miyako *Shimbun,* 1884, and *Kokumin Shimbun,* 1890) sold most of its nearly 500,000 circulation from ppvement stands. Two other notable Tokyo papers were *Nippon* Keizai *Shimbun* (1876), the "*Wall* Street Journal of Japan"; and *Nippon* Times, an English-language daily edited by Japanese. The latter paper was a war consolidation of the Japan Times (1897) and the Japan *Advertiser* (1890). There were also English editions of Asahi, Mainichi and Yomiuri.

Osaka: besides its Asahi and *Mainichi* and a few less important papers, had the Osaka *Shimbun.* Papers with circulations of more than 500,000 outside Tokyo and Osaka were: Chubu Nihon Shimbun, Nagoya; Hokkaido *Shimbun,* Sapporo; Mainichi *Shimbun,* Nishinihon *Shimbun* and Asahi *Shimbun,* Fukuoka. Kyoto had four dailies and Nagoya six.

A feature of the Japanese newspaper is the eniployment of a large staff. The Mainichi in 1956 employed more than 5,000 men, about a quarter of them on the editorial side. Employment on a newspaper was generally a lifetime position. Newspaper labour unions had become strong.

The leading news agency at mid-20th century was Kyodo Tsushin Sha (Mutual Wire-Service company), the descendant of the old government-subsidized Domei, founded in 1936.

The Philippines. — The pioneer of the Philippine press was Del *Superior gobierno,* a sheet devoted to European news, published in Manila 1811–12. The first daily was La *Esperanza* (1846–49). The government's official gazette was founded in 1848 as *Diario* de Manila. The leading paper for many years was El *Comercio* (1858–1925). After 1888 a greater liberality in the censorship and the development of political groups, chiefly nationalist in character, resulted in the establishment of a large number of papers. most of which were small and short lived. The first paper in the Tagalog language was *Patnubay Nang* Catolico (1890).

The *Manila* Times, first U.S. daily in the islands. was founded in 1898 and became a leading paper in circulation and influence. La Independencia (1898) became the leading organ of the Emilio Aguinaldo insurrection and was moved from place to place until captured by the U.S. forces.

In World War II all Manila newspaper plants were destroyed by the Japanese. Following the liberation and the establishment of the republic the Manila and provincial press was greatly expanded. In the later 1950s there were 22 dailies, 18 of which were published in Manila. with a total circulation of about 400,000. Ten were in Tagalog, nine in English. two in Spanish and one in English. The *Manila* Times had the largest circulation (80,000).

Ceylon. — In the later 1950s there were eight dailies totaling 300,000 copies, the most important being Dinamina (in Sinhalese) and *Thinakaran* (in Tamil); four dailies were published in English.

Thailand. — In 1956 there were 29 dailies with a circulation of 300,000. All were published in Bangkok; four were in Chinese and two in English.

Burma. — Only about a dozen daily newspapers were published in Burma before World War II. but that number had trebled by 1948. The oldest paper was Hanthawaddy (1889). The Burmese press, stimulated by national independence, became concentrated in Rangoon. Other languages were represented in the provincial press of lower Burma. In the later 1950s there were 32 dailies, in Burmese, Chinese, Hindi, Urdu, Tamil, Telugu and Gujarati.

Singapore. — The crown colony of Singapore had 16 daily papers in 1948. They circulated not only in the city but largely also in the Federation of Malaya. The Straits Times (1845) had a special Malayan edition. There were papers in English, Chinese and the Indian and Malayan languages.

Malaya. — Newspapers in the Federation of Malaya (Feb. 1948) were likewise in English, Chinese and Indian and Malayan languages. After the federation the Malay press tended to increase. A leading paper in the capital was the Malay Mail (1896).

Indonesia. — A newspaper called Batavaise Nouvelles was published in Batavia, Java, as early as 1744–46 as a small two-page weekly. Other government gazettes appeared as the colony passed from the French to the Dutch, and then to the English and back to the Dutch. The *Bataviasche* Courant was begun in 1816, changed to Javasche Courant in 1828, and continued for more than a century. Continuous struggles with censorship marked the development of the press in the Netherlands Indies.

During the first years of independence, the press developed quickly. In the later 1950s there were 89 dailies with a total of 580,000 copies; '63 were in the Indonesian language, among them the leading papers such as Indonesia Raya and *Merdeka,* 16 in Chinese and 1 in Javanese. The Dutch press was represented by only eight papers. New periodicals appeared in English, among them the daily Times of Indonesia in Jakarta.

Iran. — Though there were earlier newssheets concerned with court events, the first regular newspaper in Persia was *Rúznáma,* an official gazette established in Tehran in 1851. With some changes in title, this journal continued for many years. and the modern official daily Iran may be said to be descended from it. The first Persian daily was *Khulásatul-Hawádith* (1898), a two-page paper, printed on one side from type and lithographed on the other. Though typography had been introduced into Persia as early as 1817, it was superseded by lithography during most of the last half of the 19th century.

Many short-lived political papers were published during the chaotic World War II period, some of which continued after the re-establishment of the national sovereignty in 1947. In the later 1950s there were 25 dailies with only 120,000 circulation. Leading papers were *Ettela'at* (1924), with news editions in English and French, and Kayhan, both published in Tehran.

Israel. — First Hebrew daily paper in Palestine was E. B. Yehudah's *Haheruth* (1909–15). With the establishment of Israel in 1948. Tel Aviv became an active newspaper centre. One year later it had seven morning and three evening dailies, all in Hebrew. The largest of these papers (circulation 38,000) was a tabloid called

Ma'ariv (1948). Oldest of them was *Ha'aretz,* founded in Egypt in 1918 and the next year moved to Jerusalem. and later to Tel Aviv. The others were party papers, most important of which was *Davar* (1925), a Socialist organ. In 1937 there were 23 dailies including 20 at Tel Aviv (of which 2 were Yiddish, 2 in German, 1 in Hungarian, 1 in Bulgarian, 1 in French and 1 in Arabic). Seven papers appeared three times a week, five of them being in Rumanian and two in Polish. The *Jerusalem Post* (1930) is the only English language paper.

Lebanon. — Several Lebanese newspapers were established before 1900, but all were small in circulation. In the later 1950s there were 33 dailies published in Beirut, including 24 in Arabic, 4 in French, 3 in Armenian and 2 in English.

Syria.— —There were. in the later 1950s, 30 Arabic dailies in Syria with a total circulation of 150,000; 22 were published at Damascus and 6 at Aleppo.

Iraq. — The first daily newspaper in the country was the *Baghdad Tinzes,* founded in 1914, which in 1920 became the *Iraq Times.* In the later 19jos there were 14 Arabic dailies in Iraq, including 7 in Baghdad, 5 at Basra and 2 at Mosul.

Jordan. — In the later 1950s there were five Arabic dailies, including two at Amman and three in Jerusalem.

Saudi Arabia. — The country's first and only daily newspaper was *El-Bilad el-Saudiyeh,* published at Mecca.

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IX. COMMONWEALTH OF NATIONS

Canada. — The first Canadian newspaper was the *Halifax Gazette,* founded by John Bushel1 as a two-page weekly in 1751. In 1770 Anthony Henry combined this paper uith his *Nova Scotia Gazette* and continued it for many years. First paper in Quebec was the *Quebec Gazette,* founded by William Brown and Thomas Gilmore in 1764 and printed in both English and French; it lasted for more than 100 years and was finally merged in the *Morning Chronicle* (1847) which, after a combination in 1926 with the *Telegraph* (1872), became known as the *Chroizicle-Telegraph.* First in Montreal was *La Gazette Littéraire,* founded in 1778 by Fleury Wesplet (a protégé of Benjamin Franklin) and Charles Berger; the modern *Montreal Gazette* is its descendant. First Ontario paper was Lewis Roy's *Upper Canada Gazette and American Oracle,* established in 1793.

By the middle of the 20th century Canada had more than 100 daily nenspapers and about 900 weeklies. semiweeklies and triweeklies. Leading English-language papers were the *Montreal Star,* founded in 1869 and acquired in its first year by Hugh Graham (later Lord Atholstan) nho conducted it until his death in 1938 when it was purchased by J. W. McConnell; the *Toronto Daily Star,* founded in 1892 and purchased in 1900 by Joseph E. Atkinson, who brought it to the largest circulation in Canada, about 390 000; and the *Toronto Globe and Mail,* the result of a consolidation by C. George McCullagh, nho bought the *Globe* (1844) in 1936 and, a month later, the *Mail and Empire* (1872). adding the *Toronto Evening Telegram* (1876) to his holdings in 1948. With the death of McCullagh in 1952 control of the *Toronto Telegram* passed to John Bassett, Jr., and associates. In 1955 ownership of the *Globe and Mail* passed to Howard R'ebster of Montreal.

'The chief French-language paper, *La Presse* of Montreal, was founded in 1884 and conducted by Trefflé Berthiaume. French-language papers are found chiefly in the province of Quebec, which in 1956 had 11 of them published daily, including *Le Soleil* (1880) and *L'Action catholique* (1907), important papers of the city of Quebec.

Total circulation of daily newspapers in Canada in the later 1950s was about 3,900,000, a gain of 26% since 1946 and 77% from the prewar total. Sunday editions are not published but many papers include coloured supplements with their Saturday editions.

Of the 101 daily newspapers in Canada 97, including all the principal papers, are members of the Canadian Press. the leading national news service. The Canadian Press Ltd. was established in 1911 as a holding company for the Canadian rights to the news services of the Associated Press. until then held by the Canadian Pacific railway. In 1917 the four regional co-operative news associations set up in the previous ten years were merged into the national news co-operative association of daily newspapers which became known as the Canadian Press. It has sole rights to distribute in Canada the news reports of both the Associated Press and Reuters. After 1952 the C.P. news reports were made available in both French and English.

Australia. — There are no national daily newspapers in Australia with circulations and influence extending throughout the commonnealth. This is due chiefly to the immense distances to be covered in delivery, the political division of Australia into six states and the concentration of population on the coastal perimeter of the continent.

In consequence, there are 15 metropolitan daily newspapers published in the six capital cities, all of them enjoying considerable circulation and influence within their own state borders. In important centres outside the capital cities, or where, as in New South Wales and Queensland, distances make prompt delivery impracticable, daily newspapers with regional circulations have been developed. Their circulations are small by capital city standards. They combine a coverage of world and national news with extensive local news. These extrametropolitan dailies number nearly 40, many of them publishing only five days weekly. In addition there are more than 400 country triweeklies, biweeklies and weeklies, local in interest, and almost all operated in conjunction with a commercial printing business. Magazines are published in all the capital cities, but only a few of them have national distribution. The national weekly with the largest circulation is *Australian Women's Weekly,* published in Sydney, with more than 740,000 copies, circulating in all states. *The Bulletin* (Sydney), a weekly founded in 1880 by J. F. Archibald in partnership with John Haynes, still circulated in many parts of Australia, especially in country districts, in the later 1950s.

A feature of the Australian press has been the number of important metropolitan dailies that have been, during a large part of their existence, family-controlled concerns. Australia's first newspaper was the *Sydney Gazette,* a weekly publication of four pages, which appeared in 1803. It was printed by George Howe, a convict, under the direction of P. G. King, then governor of New South Wales. Its policy was dictated by the government and thus the *Gazette* was the first of what has been called the "convict press." Other publications in this class included the *Derwent Star* (1810), the *Van Diemen's Land Gazette* (1814) and the *Hobart Town Gazette* (1816), all published in Tasmania. These publications, subservient to the requirements of official policy, were disliked by the growing number of free citizens in the penal colonies of New South Wales and Tasmania. The remainder of the century, therefore, saw the emergence of family-controlled newspapers, hampered at first by censorship and repression, struggling for freedom of the press and eventually reaching positions of great financial and political power.

In April 1831 three young men, two of them clerks in the *Sydney Gazette* office, combined to publish the *Sydney Herald.* Later it was acquired by Charles Kemp and John Fairfax, the latter a member of a Warwickshire family who had been part proprietor of a paper at Leamington, Eng. In 1853 the paper, which had in the meantime become the *Sydney Morning Herald,* became the sole property of the Fairfax family, and it remained a family concern until 1956, when a public company was formed, which also acquired control of the *Sun,* a Sydney evening newspaper.

In Melbourne: Victoria, the *Argus,* established by William Kerr in 1846, was bought in 1848 by Edward Wilson, a clerk from London who had emigrated to Port Phillip. The *Argus* remained a family-controlled paper, under the proprietorship of Messrs. Wilson and Mackinnon, until 1936, when ownership passed to a public company. Subsequently, a controlling interest was acquired by Daily Mirror Newspapers Ltd., London. Publication of the *Argus* ceased in 1957. Another Melbourne newspaper, the *Age,* which had been started in 1854, was acquired in 1856 by David and Ebenezer Syme, of Scottish origins. For a very long time it continued to be controlled entirely by the Syme family, later becoming a public company. David Syme exercised great political power.

The second quarter of the 20th century saw a decline in the number of papers published, both metropolitan and country. The economic crises of the 1930s caused the closing of some publications. Important metropolitan changes between 1936 and 1956 were the closing of political dailies published by the Labour party in Sydney and Brisbane; the amalgamation, in Sydney, of the *Telegraph* (former broadsheet daily) and the *Daily Guardian* and the publication in tabloid form of the *Daily Telegraph* by Consolidated Press Ltd.; the establishment in Sydney of the *Daily Mirror* in 1941, control of which was later acquired by John Fairfax and Sons, Ltd., thus making it a part of Associated Newspapers, Ltd., publishers of the *Sun* evening newspaper; and publication of the *Herald* and the *Sun* from one building. All Sydney dailies had circulations exceeding 300,000 copies in the later 1950s.

There are no daily newspapers in the capital cities tied to any political party. All are independent in editorial policy. The establishment of daily newspapers directly controlled by the Labour party was not successful. They were closed down for lack of support. The only directly controlled Labour daily paper in the 1950s was the *Barrier Daily Truth* (Broken Hill), owned by the Workers' Industrial union (Barrier district).

With one exception (the *Daily Mirror,* Sydney) all metropolitan and provincial daily newspapers take their basic world news through Australian Associated Press, Ltd.. which is linked with the Reuter organization. The metropolitan newspaper groups, however, maintain their own staffs of correspondents in London, New York and elsewhere as occasion arises and send a substantial amount of news to supplement the basic service.

New Zealand.—Pioneer English and Scottish settlements in New Zealand made haste to establish newspapers, sometimes even before houses were built. The people were highly literate for the times, and weekly journals were begun, not so much to supply news as to give vent to political opinion, intended to exert pressure not only on the New Zealand authorities but on the British parliament as well. Thus the Wakefield expedition got out a paper, the *New Zealand Gazette* (Samuel Revans, editor), in London before it sailed in Sept. 1839, and published the second issue on arrival in April 1840. The paper survived at Wellington under various titles till 1868. In the north of the country, where Gov. W. Hobson arrived in 1840 to annex the country as a British possession, the *New Zealand Advertiser and Bay of Islands Gazette* (G. A. Eagar, editor) began publication on June 20,1840, as a fierce opponent of the governor and his supporters. It ceased at the end of the same year. In Dec. 1840 the first official publication, the *New Zealand Government Gazette,* was printed at Paihia at the Church Missionary society's printing office. Each new settlement had one or more newspapers, many of which had very short lives. Communications were poor—the quickest way of sending news from Dunedin to Auckland was by ship to Sydney, Austr., and thence by ship to Auckland, a matter of 2,500 mi. The Devonshire settlers at New Plymouth founded the evening *Taranaki Herald* in 1852 and the *Taranaki Daily News* in 1857. Both continue as dailies, the former being the oldest paper in New Zealand.

Auckland had its succession of newspapers and in the mid-1950s had the two with the largest circulations in the dominion, the *New Zealand Herald* with 175,000 daily and the *Auckland Star* with 135,000. Wellington's two surviving newspapers were, in the mid-1950s, the *Evening Post* and the *Dominion.* The *Evening Post* was founded in 1865 by Henry Blundell and its circulation in the later 1950s was 80,000. The *Dominion,* Wellington's morning daily, was founded in 1907 by C. E. Earle and edited by him until his death in 1950. Its circulation, in 1956, was the same as that of the *Evening Post.*

Christchurch journalism began with the *Lyttelton Times* which was founded on Jan. 16, 1851, exactly one month from the day the Canterbury association settlers landed at the port. It had been planned in London, and Isaac Ingram, an Oxford printer, was the first publisher. The first editor was J. E. FitzGerald, a member of the committee of the Canterbury association, who, for the two years of his editorship, fought a continuing battle for self-government for the colony. The *Lyttelton Times,* under the editorship of Sam Saunders, became the leading Liberal paper of New Zealand, particularly in the days of the Seddon government (1893–1906). It was opposed by the *Christchurch Press,* founded in 1868 as a Conservative organ. In the same year the *Times* established an evening paper, the *Star.* Just before the outbreak of World War I, E. C. Huie began publishing another evening paper, the *Sun.* The depression years of 1930–35 found the four daily newspapers engaged in a bitter circulation war which ended with New Zealand Newspapers, Ltd., owners of the *Times* and *Star,* closing the *Times* and absorbing the *Sun.* Thus Christchurch was left with two daily newspapers, the morning *Press* with a circulation, in the later 1950s, of 50,000 and the *Star-Sun* with one of 57,000.

Dunedin had a number of newspapers, particularly in the 1860s when the gold discoveries in Otago brought fabulous wealth to the community. Survivors are the *Otago Daily Times,* founded in 1861 (John Moffett, editor), with a circulation in the later 1950s of 35,000, and the *Evening Star,* founded in 1863, with one of 28,000. Both are flourishing and reflect in their policies the high aims of the original Presbyterian Church settlement.

There were, in 1956, 30 dailies in the provinces and 40 biweeklies. All were vigorous. Their circulations ranged from 2,000 to 20,000. Overseas and New Zealand news was handled through the co-operative New Zealand Press association, which secured most of its overseas news through the Australian Associated Press. With A.A.P. it is a partner in Reuters. The weekly newspapers, of which there were a dozen at the beginning of the 20th century, had declined to two by 1956, the *Auckland Weekly News* and the *New Zealand Free Lance.* Both became picture magazines.

Union of South Africa.—The first publication in South Africa to convey news and views was the bilingual *Cape Town Gazette and African Advertiser* or *Kaapsche Stad Courant en Afrikaansche Berigter,* which appeared on Aug. 16, 1800, and bore the imprint of Messrs. Walker and Robertson, Cape Town. This firm, which combined printing with slave dealing, was given a monopoly by the governor to print a weekly journal. From 1800 to 1824 it was the only newspaper in the country. In Dec. 1823 a printer, George Greig, having been denied permission by Lord Charles Somerset, the governor, to publish an independent newspaper, decided to test the matter by issuing the prospectus of the *South African Commercial Advertiser,* the first number of which appeared on Jan. 7, 1824, with Greig as printer, editor and proprietor. The publication was an immediate success, striking a pugnacious and idealistic note which reflected the temper of the colonists at the time. From the third number Greig was joined by Thomas Pringle and John Fairbairn, who were given permission to publish a newspaper alternately in English and Dutch under the titles of the *South African Journal* and *Het Nederduitsche Zuid-Afrikaansche Tydschrift,* the latter under the editorship of Abraham Faure. These publications soon came into conflict with the governor who tried to stifle the free expression of views by rigorous censorship. As a protest Greig decided to suspend publication until redress was obtained from the governor and the British government. The last number of the *Advertiser* was dated May 5, 1824. The *Journal,* too, suspended publication but the *Tydschrift* went on its way unhampered. Greig then obtained the permission of the secretary of state for the colonies to publish without censorship. And about that time Pringle returned to England while in 1825 Fairbairn revived the *Advertiser* and ranged it against the *South African Chronicle,* a government-inspired paper. In 1827 Lord Charles Somerset succeeded, from England, in getting the *Commercial Advertiser* suppressed for the second time. The public at the Cape, however, sent Fairbairn to London and he secured the freedom of the press. Several months later an ordinance was passed allowing for the publication of any newspaper conforming with reasonable regulations and with the law of libel.

The year 1830 saw the founding of the *Zuid Afrikaan* which for many years interpreted the beliefs and outlook of the Afrikaner people as opposed to those of the English settlers as reflected by the *South African Commercial Advertiser*. The following year the *Graham's Town Journal* was published and it was followed by other papers in that area, the most notable being the foundation in Port Elizabeth in 1845 of the *Eastern Province Herald,* in the 1950s still the chief mouthpiece of the eastern Cape. The *Cape Argus* was founded in 1857, and the *Cape Times* in 1876, and they were still, in 1957, the chief papers in the English language in Cape Town.

The first paper in Natal was the *Natalier,* published in 1844. It was followed in 1846 by the *Natal Witness* in Pietermaritzburg, and in Durban by the *Natal Mercury* in 1852 and by the *Natal Advertiser* (later called the *Natal Daily News)* in 1878.

The earliest newspaper in the Orange Free State was the *Friend of the Sovereignty*. Later came the *Friend,* which has survived as the most influential journal in English in that province. An occupant of the editorial chair for a brief period during the South African War was Rudyard Kipling. The first Dutch paper was *De Tyd* (succeeded by *De Express),* which espoused closer co-operation between the northern republics, but both of these later died.

The first paper in the Transvaal was the *Oude Emigrant,* in the Dutch language, founded in 1859 at Potchefstroom. It was followed in 1873 by *De Volkstem,* printed in Pretoria, which became comparable in substance and standing with the best journals in other parts of the country. Both these newspapers have ceased publication. The *Star,* the leading afternoon daily of the Argus group, was originally founded in Grahamstown and was transported by ox wagon to Johannesburg in 1887. Later papers in the English language to make their appearance on the gold fields were the *Transvaal Leader,* the *Sun,* the *Daily Express,* the *Rand Daily Mail,* the *Sunday Times* and the *Sunday Express;* the first three of these later ceased to exist.

The birth and growth of the Afrikaans newspapers in the first half of the 20th century constitute one of the most outstanding phenomena in the history of the South African press. *Die Burger* of Cape Town, *Die Volksblad* of Bloemfontein and *Die Vaderland* of Johannesburg had, by 1956, long become firmly established as mediums of comment for the Afrikaans-speaking community.

The first paper printed in a non-European language was the Xosa *Imvo Zabantsundu,* which was founded in 1884 and still flourished in the 1950s in Kingwilliamstown. In the 1950s the Bantu Press group could point to 12 weeklies, 1 fortnightly, 7 monthlies and 1 quarterly issuing from its presses.

(For the West Indies Federation. see *Central and South America,* above; for India, Pakistan, Singapore and Malaya, see *Asia;* and for Ghana and other African commonwealth members and colonies, see *Africa,* below.)

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X. AFRICA

Egypt.—The first Egyptian paper was *Le Courrier de l'Egypte,* issued by Napoleon's forces at Cairo in 1798. This and the similar *La Décade egyptienne,* of the same year, were temporary; but an official gazette established in 1828 as a part of Mohammed Ali's program of national development. and printed in both Turkish and Arabic, lasted. With the establishment of the Egyptian post office in 1865, and under the encouragement of Ismail's government. a dozen or more papers sprang up in Cairo in the next decade, plus two in Alexandria and one in Port Said. With British rule, the press developed under a licensing system.

The oldest of the daily newspapers in Egypt at mid-20th century was *Al Ahram* ("The Pyramid"), a survivor from the Ismail regime. Founded in Alexandria in 1875, it was moved to Cairo in 1899. Long published by Gabriel Takla Pasha, *Al Ahram* introduced linotypes with Arabic characters and rotary presses into Egypt in 1904, employed correspondents abroad and achieved a circulation which exceeded 100,000 in its best years.

There were 46 daily newspapers in Egypt in the later 1950s and about 200 weekly publications. Twelve dailies were published in Cairo (including four in French, one in Greek, one in Armenian and one in English) and eight in Alexandria (including four in French and one in Greek). Under the republican regime there was strict press control and several dailies stopped publication, among them *Al-Misri,* one of the leading Egyptian papers.

Sudan.—In the later 1950s ten daily newspapers were published at Khartoum, eight in Arabic and two in English.

Ethiopia.—There were only three daily newspapers in the later 1950s, all published at Asmara, two of them in Italian and one in Amharic and Tigrinya. At Addis Ababa there was the *Negarit Cazeta* (official announcements only).

Libya.—In the later 1950s there were four daily newspapers at Tripoli, three in Arabic and one in Italian.

Tunisia.—The press of this country was concentrated in Tunis, where there were in the later 1950s nine daily newspapers, six of them in French and three in Arabic. The oldest was *Ez-Zohra* (1886); next came the largest Tunisian newspaper, *La Dépêche tunisienne* (1888), with 35,000 circulation.

Algeria.—The oldest Algerian daily in the later 1950s was the *Echo d'Oran* (1844) and the largest the *Echo d'Alger* (80,000 copies). Nearly all the Algerian papers were still published in French, though there were three Arabic weeklies. There were ten dailies in the country—four in Algiers, three in Oran, two in Bône and one in Constantine.

Morocco.—The oldest Moroccan daily (founded as a triweekly) was the sultan's organ, *Es Saâda* (1905), of Rabat; the oldest privately operated paper was *La Vigie marocaine* (1907) of Casablanca. The latter paper was the largest evening paper in Morocco at mid-century, with somewhat less than 50,000 circulation, while *Le Petit Marocain* (1921) was the largest morning journal; both were published in Casablanca. In the later 1950s there were seven dailies, including one in Spanish at Tangier.

Ghana.—In this new state, whose independence was proclaimed in March 1957, there were five dailies in English, four at Accra and one at Kumasi.

Federation of Rhodesia and **Nyasaland.**—In the later 1950s there were three dailies, at Salisbnry, Bulawayo and Ndola respectively.

French Colonies.—In the later 1950s there were three French dailies in French West Africa (at Dakar, Abidjan and Lomé) and two in French Equatorial Africa (both at Brazzaville). There were also two dailies at Antananarivo, Madagascar.

British Colonial Territories.—In the later 1950s there were 12 English dailies in Nigeria (4 at Lagos), 4 in Kenya (2 at Nairobi and 2 at Mombasa), 4 in Sierra Leone (all at Freetown), 1 in Uganda (Kampala) and 1 in Tanganyika (Dares Salaam). A daily newspaper in Swahili, the *Mwangaza,* was published at Dar es Salaam. There were three dailies in French in Mauritius and one, also in French, in the Seychelles Islands.

Portuguese Colonies.—In Portuguese East Africa (Mozambique) there were four dailies at Lourenço Marques.

Belgian Congo.—Seven daily newspapers were published in the later 1950s, all in French. They were published at Leopoldville (four), Elisabethville (two) and Stanleyville (one).

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XI. THE NEWSPAPER OFFICE

Newspaper.—Newspaper offices all over the world differ, just as newspapers differ: Spanish newspapers are more literary, French newspapers are more political than are U.S. newspapers. In the U.S. a big metropolitan daily newspaper office may be in a multistoried building; a small-town weekly nenspaper may be in a one-story building nith the combined editorial, advertising and business office in front and a print shop in the rear, and two men doing all the work. What follows here is a generalized account of a newspaper office of a metropolitan newspaper in the United States.

A newspaper is produced and distributed by an organization divided, generally. into three major parts: editorial, business and mechanical. The large newspaper is directed by, in addition to these basic operational divisions, or sides, an administrative group, and is aided by a promotion department. Thus the entire organization may be said to have five divisions.

Editorial Division. — This is the heart of the newspaper. Its function is the gathering and preparation of news, features and comment; indeed! the editorial side includes everything that goes into the paper except advertising.

Housing arrangements differ in the various offices, but the modern news room is big and inclusive. Prominent in it is the city desk, headquarters for local news coverage. There the city editor directs a corps of reporters and rewrite men; the latter prepare copy from news telephoned in, rewrite stories from earlier editions, etc. More or less under the direction of the city desk are a number of reporters and critics in special fields, such as the theatre, motion pictures, music, churches, schools, books, fashions, etc. These men are often called editors in their particular departments; on the largest papers theirs are full-time jobs, but on most papers they perform these special functions in combination or along with other assignments. Also under the supervision of the city desk is the picture editor, with the staff photographers to whom he gives assignments. Some papers have feature editors, whose duty is to select from syndicated material or from pieces obtained from reporters attached to the city desk a supply of entertaining or instructive stories known as features. About-town columnists are often connected with the feature desk.

The sports editor may have a staff of several reporters. and perhaps special photographers and columnists are attached to that desk. The financial editor also has reporters for local news, as well as assistants to handle wire reports. The society editor and her staff of reporters deal with social events, meetings of women's clubs, etc, Most of the large papers also have woman's page editors, who produce, from the syndicates and other sources, matter of special interest to women. An increasing number of science editors write special articles on new developments in the sciences. In agricultural regions, many papers have full-time farm editors; and there are oil editors in districts where that industry is of great importance.

The Sunday editor and his staff have charge of the planning and assembling of features for the Sunday edition. (In England all Sunday newspapers have separate staffs even though they may be owned by organizations possessing a daily.) Attached to his desk are the editors and staffs of any pictorial or feature supplements that originate in the newspaper office.

The editorial page staff is headed by a chief who is usually called editor of the editorial page (or section). The political cartoonist belongs to this staff: and the syndicated public affairs columns pass through their hands.

In the newsroom is located the copy desk, a great U-shaped table at which copy from reporters, feature writers and the teletypes are processed for the printers. This processing includes checking for facts, libelous statements, names: spelling, punctuation, paragraphing, tautology, etc., and the writing of headlines. The copy chief. or slot man, sits inside the "U," whence he can hand out incoming copy to the copyreaders "on the rim." Nearby is the desk of the telegraph editor, who handles the long strips of copy torn from the teletype machines, which receive the reports of the wire news agencies. Through the teletypes pours a stream of reports irom abroad, from Washington, from the state capital and from news centres throughout the country. The telegraph editor has the responsibility of selecting from this mass of material the sections that his paper's readers will find most important and interesting.

It must be understood. however, that copy desk functions, like the organization of the newspaper office throughout, differ considerably irom paper to paper. For example, the copy chief sometimes doubles as telegraph editor, even on large papers. Sports, society and so on may move their copy across a so-called universal copy desk; on the other hand, those departments (and even state news, city and telegraph in a few cases) may have separate copy desks.

Conveniently situated for the use of newsmen, copyreaders and editorial writers are the paper's reference library and morgue. In the latter are filed thousands of clippings, as well as the paper's own back numbers; innumerable photographs, engravings and mats; from which pictures may be reproduced; and other materials that may be drawn upon for the day's stories, whether the reported events are scheduled or unexpected.

Business Division. — The revenue division of the newspaper has two parts: the advertising department and the circulation department. The financial outgo is also considered as belonging to the business side, but in the organizational chart it comes under the administrative division, considered below.

Advertising. — The advertising department headed by the advertising manager, is divided into three subdepartments according to the types of advertising produced: local display, which sells space to local merchants and helps them prepare their copy; national display, which handles advertising from outside the local trading area, much of it obtained from agencies serving various regions or the whole country; and classified, which takes care of the small ads (wanted, for sale! etc.). The local (or retail) advertising manager directs a force of salesmen, who are assisted in providing attractive copy by a corps of copy writers and artists. The national (or general) advertising manager works with special advertising representatives in the large manufacturing centres and with the advertising agencies. The classified advertising manager directs street salesmen: correspondence salesmen and a group of telephone solicitors, as well as the office's own want-ad clerks. Attached to the advertising department in many newspaper offices is a research bureau, whose director is assisted by interviewers and a clerical force.

Circulation. — The circulation department is composed of several units. City distribution by truck and carrier is central in its duties; also there is distribution by truck in outlying districts, towns and cities, and by mail. Sales and collections are important; carrier boys are often useful in these activities. The circulation manager of a large paper may have under him such supervisors or managers of various divisions, as a city circulation manager, country circulation manager, mail circulation manager and Sunday circulation manager. District and branch supervisors oversee delivery to street salesmen, newsstands, local carriers, motor route carriers and outside country dealers. There are also street and telephone solicitors and subscription agents, as well as collectors, etc. The mailing room superintendent directs a force of mailers.

Mechanical Division. — This department has four chief units: (1) the composing room, where copy from the newsroom (or rooms), editorial room and advertising desks is set into type, mainly by Linotype, and made up into page forms; (2) the engraving room. which takes photographs and drawings and makes engravings (cuts) for printing; (3) the stereotyping room, where plates for the presses are cast in molten metal from the page forms; and (4) the pressroom, where the papers are printed, folded, trimmed, counted and delivered to the mailing room for bundling for the trucks and wrapping and addressing for the post office.

A mechanical superintendent usually oversees and co-ordinates this four-part operation. A composing room foreman supervises the force of Linotype operators (or compositors); the machinists who care for the Linotypes; the compositors who assemble the Linotype slugs, hand-set type, cuts, etc., that make up the ads; the proofreaders and correctors of both news galleys and ads; and the make-up men, who put the pages together in forms and who work under the direction of a make-up superintendent. The engraving room has its own foreman, with such assistants as are necessary to process the cuts for news stories, features, advertising and the editorial page. The superintendent of the stereotyping room has a force of stereotypers, who make mats from each form to be placed in the casting mold; the plates from this mold are curved so that they may be locked on the cylinders of the presses. The pressroom foreman directs a group of pressmen. who not only fix the plates on the cylinders but also by accurate mechanical means take care of the necessary ieeding of paper and ink to produce a well-printed paper.

Administrative Division. — An organization as complicated as that which produces a daily newspaper must be efficiently co-ordinated. This requirement is met by an administrative group that varies greatly in its composition and in the terminology of its personnel from one newspaper office to another. In general, however, it includes the president, publisher, executive editor, managing editor, circulation manager, advertising manager, mechanical superintendent and business manager.

At the head of these is the president of the publishing company or the board of directors. He sometimes carries the title of publisher, or there may be both a president and a publisher. These positions represent the ownership, and the men occupying them generally direct the policy of the paper. Ordinarily there is a large degree of autonomy allowed the editors and managers on the lower levels. The term editor in chief is no longer in common use. Editor is a title often given to the chief of the entire editorial division, though a few, papers retain the older custom of calling the editor of the editorial page editor of the paper; indeed, some papers combine the two functions. In a number of instances the publisher also carries the title of editor. Publisher is the title of the active executive head, however, and the man filling that position keeps in constant touch with all the administrative heads named above.

Under the editor are the executive editor, the managing editor and the news editor. Usually a paper does not have all three of these positions. When it has an executive editor, he is chiefly occupied with the management of the personnel of the editorial division, and then the managing editor has general oversight of the flow of news and features. If there is no executive editor, the managing editor usually works mainly with personnel and a news editor with planning the news and feature program of the day. A news editor commonly has a desk adjacent to the copy desk, so he can keep tab on the copy that is coming in. He is in constant consultation with the city and telegraph editors as well; and, with the make-up editor, he is continually planning and replanning the pages of the next edition as events develop.

The business manager is in charge of all financial outgo. He and his staff attend to payroll and to purchases of paper, ink, metal and other supplies With the custodian, he takes care of maintenance of the building; with the mechanical superintendent, he keeps up the equipment of machinery. The accounting department may be headed by the treasurer of the publishing company or by the cashier or controller. Here are the auditor and a staff of bookkeepers and clerks. The business manager himself is sometimes called assistant publisher. and he keeps in close contact with all departments and operations of the newspaper office.

Promotion Division. — The division devoted to promotion and advertising of the paper to the public works closely with the circulation department, but it also serves other departments. It gives support to the paper's community service projects, striving to create good will and understanding. It is headed by a promotion manager, who may be assisted by copy writers, script writers and photographers or, at any rate, by workers who can help in the preparation of newspaper and direct-mail advertising, radio and television shows, exhibits, etc.

The Story of a Story. It may help to clarify the activities of the newspaper office to trace a news story for an afternoon paper throughout its course from assignment to lockup in its page form.

Reporter Jones receives from his city editor in the morning an assignment to cover a bar association meeting at which, it has been rumoured, Judge X may announce his candidacy for the governorship. Jones is back by 11 o'clock. "He's going to run," he tells the city editor, who then instructs him as to how long his story may be. As Jones pounds it out on his typewriter, it is brought by a copy boy to the desk of the city editor, who looks it over and perhaps calls Jones over to consult about some points in it. Then he places it in a box, from which a copy boy soon carries it to the news editor, who glances over it and hands it to the copy chief, with a few words about the position and display he plans to give it in the next edition.

The copy chief then marks Jones's story with an identifying name, "Judge X." and a number indicating the kind of headlines it is to carry, in conformity with the "play" suggested by the news editor, and turns it over to one of his copyreaders for checking and head writing. After the copy has been edited and the head written and attached, it is sent by pneumatic tube down to the composing room. There the copy cutter. because the deadline for the first home edition is approaching, divides the copy into two "takes" for two of the Linotype operators. Soon the slugs, each carrying in relief letters from which a line is to be printed, and now still warm from the machines, are delivered to the galley bank, together with the original copy. The bank man pulls a proof, which he sends, with copy, by tube to the proofroom. After the proofreaders return the marked proof to the composing room, lines in which errors have occurred are reset, and the new slugs are substituted for those that carried the errors, in a process called correcting the galleys.

Meanwhile, in the newsroom upstairs, the first home edition is taking form under the supervision of the news editor, who must decide on space, position and display of news. The ads have already been in place on the make-up tables downstairs for hours; and the sports, society, editorial and stock-market pages are being made up separately by their own departments. The news editor is assisted by his make-up editor, who is working with dummy sheets for pages on which space allotted to various ads is crossed off. They have an earlier mail edition as a starting point from which to lay out the home edition. In conferences around the news and make-up desks, city, state, telegraph and picture editors have pointed out the stories that could be discarded from the earlier edition and those that are in process for later editions, thus keeping the news editor informed on a constantly changing news picture.

Today a European political crisis, an airplane disaster and the proceedings of a congressional committee are the big stories; but the news editor points out a position on page one below the fold for Judge X's announcement, and the picture editor has dug up a single-column cut of the judge from the morgue to go with it.

At one o'clock the completed dummies of the main news pages are taken down to the composing room by the make-up editor. There the make-up men are bending over rows of steel-topped tables on which lie the page forms to which they now transfer from the galleys the slugs carrying the various stories. The news editor himself comes down to oversee the last phases of the make-up of page-one form, shortening a story here and there to make it fit, with the assistance of a Linotype operator. At last everything is exactly in place. and the sound of the planer and mallet on the form marks the end of the editorial work on page one, with Jones's story of Judge X's announcement. The form is ready to be uheeled to the stereotyping room, and in a matter of minutes it will be on the presses. (F. L. Mт)

NEWT, the name applied to the small salamanders of the genus *Triturus,* represented in Europe, temperate Asia and Japan and in North America north of the tropics. All of the species are aquatic during the breeding season and as larvae. After transformation, the adults of some species, like the common crested neat of Europe, take up life on land. while others, like the North American red-spotted newt, live permanently in water. All feed on small insects and other invertebrates.

Newts exhibit considerable differences between the sexes, associated with an elaborate courtship. Fertilization takes place by the deposition of a spermatophore. which is taken up by the female after the courtship stimulation. The male sexual characters are much more pronounced during the breeding season; they consist in ornamentation with brighter coloration and higher crests on back and tail; and the hind limbs are provided with strong horny ridges. Newts in general lay their eggs singly. and these are attached to water plants. They hatch in about two weeks, and the aquatic larval gilled stage lasts for about three months. Under certain conditions some newts may fail to transform, becoming sexually mature as larvae (*see* METAMORPHOSIS). The red-spotted newt of eastern North America (*Triturus viridescens*) is remarkable for a coral-red land stage that lasts for three years after loss of the gills, after which, with transformation of the skin texture from rough to smooth and change of colour to green, the adult permanently aquatic stage is attained.

Three species, the crested. common and palmated newts, are found in Great Britain. The newts of eastern North America include three races of the spotted newt and two less well-known forms.

The newts of the Pacific states have been much studied by embryologists. with the result that their distribution. breeding behaviour and development are exceptionally well known.

The best known of the Asiatic newts is the Japanese fire-bellied newt, *Triturus pyrrhogaster,* which is often to be seen as an aquarium animal in Europe and North America.

See S. C. Bishop, *Handbook of Salamanders* (1943). (K. P. S.)

NEW TESTAMENT: *see* BIBLE.

NEWTON, ALFRED (1829–1907), English zoologist, was born at Geneva, Switz., on June 11, 1829. In 1854 he was elected to the Drury traveling fellowship of Magdalene college, Cambridge. and from then until 1863 he visited Lapland. Iceland, the West Indies, North America and Spitsbergen, studying chiefly ornithology. In 1866 he became the first professor of zoology and comparative anatomy at Cambridge, a position which he retained till his death on June 7, 1907. His services to ornithology and zoogeography were recognized by the Royal society in 1900, when it awarded him a royal medal, having elected him a fellow in 1870. He was also given the gold medal of the Linnaean society in 1900.

His books include *Zoology of Ancient Europe* (1862), *Ootheca Wolleyana* (1864–1902) and a *Dictionary of Birds* (1893–96), an amplification of the numerous articles on birds which he contributed to the ninth edition of the *Encyclopedia Britannica.*

NEWTON, SIR CHARLES THOMAS (1816–1894), British archaeologist, was born on Sept. 16, 1816, at Bredwardine in Herefordshire, and educated at Shrewsbury schools and Christ Church, Oxford. He entered the British museum in 1840 as an assistant in the antiquities department. In 1852 Newton left the museum to become vice-consul at Mitylene, with the object of exploring the coasts and islands of Asia Minor. Aided by funds supplied by Lord Stratford de Redcliffe, then British ambassador at Constantinople, he made in 1852 and 1855 important discoveries of inscriptions at the island of Calymnos, off the coast of Caria; and in 1856–57 achieved the great archaeological exploit of his life by the discovery of the remains of the mausoleum of Halicarnassus, one of the "seven wonders" of the ancient world. He was greatly assisted by Murdoch Smith, afterward celebrated in connection with Persian telegraphs. The results were described by Newton in his *History of Discoveries at Halicarnassus* (1862–63), written in conjunction with R. P. Pullan, and in his *Travels and Discoveries in the Levant* (1865). These works included particulars of other important discoveries, especially at Branchidae, where he disinterred the statues which had anciently lined the Sacred way, and at Cnidus, where R. P. Pullan, acting under his direction. found the colossal lion now in the British museum.

For 25 years, 1860–85, Newton was keeper of Greek and Roman antiquities in the British museum. He was Yates professor of classical archaeology at University college, London (1880–88). His collected *Essays on Art and Archaeology* were published in 1886. Newton died at Margate on Nov. 28, 1894.

NEWTON, SIR ISAAC (1642–1727), English physical scientist and mathematician, one of the greatest figures in the entire history of science, was born at Woolsthorpe, near Grantham in Lincolnshire, on Dec. 25, 1642. His father had died the previous October. In 1645 Newton's mother remarried, moved to her new husband's home and left her son in the care of her mother. Newton was an indifferent scholar until a successful fight with another boy aroused his spirit and led to his becoming the best student of the school.

When Newton was 14 years old (1656), his mother became widowed for the second time, returned to Woolsthorpe and brought the boy home from school to run the farm. He proved to be an absent-minded farmer, occupying himself with mathematics instead of attending to his work. His uncle, William Ayscough, rector of Burton Coggles, was a member of Trinity college, Cambridge, and in 1660 by his advice Newton was sent back to school to prepare for Cambridge. On June 5, 1661, he matriculated as a subsizar at Trinity college. Three years later he was elected as scholar and in Jan. 1665 took the B.A. degree. In 1667 he was elected a fellow of the college. In the autumn of that year the spread of the Great Plague caused the closing of the university. Until its reopening in the spring of 1667 Newton remained at Woolsthorpe. During those 18 months he laid the foundations for his famous discoveries in mathematics and physical science.

Early Basic Discoveries.—During the first of these months at Woolsthorpe, Newton discovered what is now called the binomial theorem (*see* BINOMIAL THEOREM), and soon thereafter the method of "fluxions," later known as the differential calculus, the most important single mathematical innovation made since the time of the ancient Greeks. In May of 1666, he related, "I had entrance into the inverse method of fluxions," or the principle of the integral calculus, the method of calculating areas under curves and the volumes of solid figures.

These discoveries alone would have entitled him to one of the highest places in the history of the sciences. But they were accompanied by two others, each of an equal significance. One was an analysis by experiment of the composition of white light and the nature of colours. The other was the discovery of the gravitational force holding the moon in its orbit, though nothing of this was published for almost 20 years (see *Work on Gravitation and Astronomy,* below). Newton later said that during those two years, "I was in the prime of my age for invention, and minded mathematics and philosophy [*i.e.,* science] more than at any time since."

Newton returned to Cambridge and to Trinity college in 1667, and did not publish his discoveries. But his teacher. Isaac Barrow —a man who distinguished himself in the fields of optics, mathematics and theology—recognized the superiority of his gifted pupil and resigned his chair, the Lucasian professorship of mathematics, so that Newton, at the age of 26, might succeed him. In a book on optics published in that year, Barrow recorded his indebtedness to Newton, calling him a "man of quite exceptional ability."

Work on the Telescope and Optics.—At this time the subject of optics was Newton's chief scientific interest. He worked at the problem of grinding lenses with nonspherical surfaces and continued to experiment with prisms. One result of his research was a new type of telescope, called the reflecting telescope because its principal light-gathering component was a mirror rather than the lens system of the refracting telescope. News of this invention came to the Royal society of London. Newton constructed a telescope and sent it to the society, to which he mas elected a fellow. A week later, he suggested that he would like to present an account of the scientific discovery that had led him to design the new instrument, a discovery, in his words, "being in my judgment the oddest, if not the most considerable detection, which has hitherto been made in the operations of nature."

The main points of Newton's discovery were these. He found that if a narrow beam of "white light," *e.g.,* sunlight, is allowed to pass through a slit into a prism, it will be decomposed into light of many colours, or will produce a spectrum. Separate out any single colour from that spectrum. as by placing a board with a slit in the path of the light leaving the prism, and allow that monochromatic light to pass through a second prism. The result is that that beam is bent but its colour is unchanged. Hence, those were wrong who had argued that the production of a spectrum by a prism arose from a "staining" action of the prism. Rather, as Newton's experiments showed, all light is bent or refracted as it goes from one medium to another (save in a direction perpendicular to the interface between the two mediums). Newton showed that white light is a mixture of light of all colours and that the prism separated the mixture into its component parts because the light of each colour is refracted by the prism by a different amount. But if light of a single colour were to be separated out in the spectrum, its colour would not change as it passed through another prism since it would not be a mixture but would be (to use Newton's own phrase) "homogeneal."

Knowing that white light is a mixture of light of all colours, and the prism separates light into these component colours, Newton could then explain many colour phenomena. For instance, a piece of white paper when illuminated withlight of a single colour (say, red, green or yellow) will no longer appear to be white (but rather red, green or yellow). The colours of objects thus are related to the light by which they are seen, because "natural bodies . . . are variously qualified to reflect one sort of light in greater plenty than another." On this research are founded the science of colour and the technique of spectrum analysis.

In one set of experiments, Newton studied the phenomenon known now as chromatic aberration. Since the prism experiments had shown that each colour has its own index of refraction, Newton concluded that the image of a body illuminated by white light (as sunlight) will not be sharp, there being a different focus for each colour. Thus an ordinary biconvex lens forms an image with an edge coloured like a miniature rainbow. Newton concluded erroneously from experiments that no one could ever make a lens system free of these colour fringes—free of chromatic aberration. He claimed to have shown by experiment that there is such a relation between the bending of light beams (mean deviation) and the spreading out into colours (dispersion) that even a system of two or more lenses could never give an image without these unwanted colour effects. In this he was mistaken; prisms and lenses can be made of different kinds of glass in pairs so that there is no dispersion although there is a net deviation or bending of light rays from their original paths. (See TELESCOPE: *Achromatic* Telescopes.)

In order to prevent chromatic aberration from spoiling the quality of the telescopic image, Newton devised a telescope in which the principle element was a concave or magnifying mirror. Yet, as Christiaan Huygens pointed out, the full potentialities of Xewton's reflecting telescope could not be realized until there was a method of grinding parabolic mirrors. (The most powerful telescopes at Mount Wilson and Palomar observatories are reflecting telescopes.) The telescope Newton made for the Royal society, one of their most prized possessions, is nine inches long and has a two-inch mirror. (See TELESCOPE: Early Reflecting Telescopes.)

When Newton sent his paper on light and colours to the Royal society, a committee was appointed to study the question further. One committee member, Robert Hooke, the originator of a theory of light and colour of considerable merit, had written a book dealing in part with the same type of phenomena Newton had studied, the *Micrographia* (1664). Hooke admitted the accuracy of Newton's experiments, but doubted Newton's conclusions. Huygens also held to his own theory of colour, and as E. N. da Costa Andrade has explained, "he failed to understand . . . that Newton was not arguing about the nature of colour, about matters of doctrine, but describing experiments to show how white light and coloured light behaved, to show what were the measurable properties." Other critics arose; some misunderstood the experiments, but there was chiefly disagreement on Newton's theory. Three of Newton's comments explain his position clearly: ". . . the Theory, which I propounded, was evinced by me, not inferring 'tis thus because not otherwise, that is, not by deducing it only from a confutation of contrary suppositions, but by deriving it from Experiments concluding positively and directly." "For the best and safest method of philosophising seems to be, first to enquire diligently into the properties of things, and of establishing these properties by experiment, and then to proceed more slowly to hypotheses for the explanation of them." As to "certain properties of light, which, now discovered, I think easy to be proved, . . . which if I had not considered them as true, I would rather have them rejected as vain and empty speculation, than acknowledged even as an hypothesis."

Discussions about Newton's paper lasted until well into 1675. In December of that year he wrote, "I was so persecuted with discussions arising out of my theory of light that I blamed my own imprudence for parting with so substantial a blessing as my quiet to run after a shadow."

One effect of the controversy was that Newton was led to investigate other effects of colour, to inquire how light was produced and to develop the emission or corpuscular theory of light, according to which light is caused by the emission by a luminous body of a host of tiny particles traveling in empty space with a speed of about 186,000 mi. per second; the laws of reflection and refraction were developed on mechanical principles, aided only by a supplementary hypothesis as to why, when falling on a transparent surface, some of the particles are reflected—bent back into the medium from which they have come—and others are refracted. along a new path inclined to the old, into the medium toward which they are traveling. It is a consequence of this theory that light travels more slowly in a dense medium such as glass than in air. The theory was also applied to explain the colours seen when light is reflected from a thin film, a soap film or the thin layer of air between a convex lens of large radius and a flat reflecting surface on which it rests; in this case, when viewed in reflected light of a definite colour a series of dark and light rings circling round a central black spot is seen. Newton determined the law connecting the radius of a bright ring and the colour of the light. Since the radius depends on the colour, the bright rings for the various colours, when white light is used, will be different and the observer will see a series of coloured rings surrounding the black central spot. This phenomenon is now known as "Newton's rings." (See LIGHT: The Age of *Newton* and *Huygens*.)

Hooke was again a critic; in his *Micrographia* he had adopted a kind of wave theory of light, according to which light consists of a series of pulses transmitted through a medium pervading space, the universal ether, and had endeavoured to explain rectilinear propagation, reflection and refraction as well as dispersion and the colours of thin plates. Newton, in his explanation of optical phenomena showed how the corpuscles of light might be guided by waves in an ethereal medium; yet he thought little of Hooke's attempts at explanation. From the work of Thomas Young in 1804 and the brilliant work of the French genius Augustin Fresnel a few years later came the explanation on the wave theory of all the phenomena of light as then observed. Young drew on Newton's concepts of waves as much as on the vie s of Christiaan Huygens.

Newton rejected a simple wave theory of light because it could not account for rectilinear propagation or for polarization. As Newton demonstrated, all wave phenomena—for instance, sound—carry the disturbance into the region of shadow, or around obstacles. It never occurred to him that the waves of light might be exceedingly small. Yet in studying the colours of thin plates, Newton provided much of the necessary information for the later wave theorists. Thomas Young showed that Newton's careful measurements led to an accurate determination of the wave length of the several colours. In his early papers, and later on in his Opticks (first edition 1704) Newton advanced an explanation of optical phenomena that was neither a pure corpuscular theory nor a pure wave theory. According to Newton it seemed probable that light consists of a series of corpuscles emanating from luminous bodies. These corpuscles give rise to waves as they travel through the ether and many optical phenomena (such as the colours of thin plates) arise from the interaction of the waves and corpuscles. This explanation fell from favour during the 19th century, when the wave theory of light was universally accepted. But since Einstein's theory of photons of 1905, many writers have called attention to a similarity between Newton's views and those of the 20th century, in which there is a fusion of elements of both wave and corpuscular theories of light.

Work on Gravitation and Astronomy.—Since the early years at Woolsthorpe, Newton had been considering the main problem of motion: what force is it that keeps the planets moving about the sun in the Copernican system? Newton showed that one and the same force of universal gravitation causes the planets to revolve about the sun in elliptical paths according to Kepler's laws. Furthermore, this force, which varies as the inverse square of the distance, keeps the moon in motion about the earth and causes objects to fall to earth.

Newton related that the occasion of this discovery was the fall of an apple. What did he mean? If the moon moves in an orbit around the earth, and does not fly off in a straight line along a tangent to the orbit, there must be a force directed to the earth, a "centripetal" force pulling the moon to the centre at the earth. The situation is similar to that of a ball whirling in a circle at the end of a string; if the string breaks, the centripetal force ceases to be exerted. and the ball flies off along a tangent. Expressed differently: the moon is continually drawn away from its rectilinear tangential path by a force; this force causes the moon to fall continually away from a straight line and to follow its observed orbit. Newton computed the distance the moon must fall in each second. If the force that makes the moon fall varies inversely as the square of the distance, then, since the moon is at a distance of 60 earth radii from the earth's centre, the earth's force on the moon is $\frac{1}{60} \times 60$, or $\frac{1}{3,600}$ of what it would be if the moon were at the earth's surface. Hence, assuming that the force of gravity keeps the moon in its orbit and that this force varies inversely as the distance, Newton could predict the rate of fall of an object to the earth. This proved to be approximately what is observed: as Newton expressed it, the observation agreed "pretty nearly" with the theory. He also was able to show that Kepler's laws implied a central force that varied inversely as the square of the distance. Conversely, by assuming a single force exerted between sun and planets proportional to the masses of the sun and the planet involved and inversely proportional to the square of the distance between them, one could derive Kepler's laws and show that one and the same force acted between the planets and the sun. between any planet and its satellite, between the oceans and sun and moon (so as to produce the tides) and, in general, between any two bits of matter in the universe.

In London, there were great debates about planetary motions and about the orbits that would result from specified types of forces. Discussions went on at the Royal society or in the houses of the members—Sir Christopher Wren, Hooke, Edmund Halley and others who were active in the society, until one Wednesday in Jan. 1684 Halley met Wren and Hooke and the latter declared "that he had demonstrated all the laws of the celestial motions." Halley confessed his ignorance and Sir Christopher "to encourage enquiry said he would give Hooke or me"—the quotation is from a letter of Halley to Newton—"two months to bring him a convincing demonstration." Sir Christopher offered to give "a book of 40 shillings" to the one who first found the solution. So it remained until August, when Halley visited Newton at Cambridge and put the question, what would be the path of a body moving under the action of a central force mhich varied as the inverse square of the distance from the centre. Halley wrote that Newton knew the answer and "had brought this demonstration to perfection." Newton promised to look for the old proof hut could not find it, "and not finding it did it again." Halley returned to Cambridge and persuaded Newton to put his work in form for the Royal society. On Dec. 10. 1684, Halley informed the society that he had lately seen Newton, who had showed him a curious treatise, De *Motu*, which. upon Halley's desire, was sent to the society to be entered on their register.

Newton then attacked and solved a major problem. Hitherto his calculations had proceeded on the assumption that the sun and the planets could each be treated as though they mere points, with all their matter concentrated at their respective centres. But was this true or was it merely an approximation resulting from the fact that the planetary distances were so immense that even a great sphere like the sun could in comparison be treated as a point?

Newton proceeded to work this out, on the assumption that each particle of the sun attracted an external particle with a force proportional to the product of the masses of the two and inversely proportional to the square of the distance between them. Thus he proved that if the sun were of uniform density then the resultant force on the external particle was the same as that which would be exerted by the whole mass of that concentrated at the centre.

Some scholars have held that it was the difficulty of solving this problem that had caused Newton in 1665 to lay aside his astronomical calculations. Others agree with H. Pemberton's remark that a poor value for the earth's radius was responsible for the delay In any event, the calculations were resumed with a more correct knomledge of the moon's distance.

The writing of the *Principia* was begun in March 1686. Entitled *Philosophiae Naturalis Principia Mathematica,* or "Mathematical Principles of Natural Philosophy." the work was first published in the summer of 1687. At that time the Royal society was in difficulties as to funds and Halley took the nhole cost on himself. Hooke. when the first book was presented, claimed that he had forestalled Newton in part of it, and in the correspondence that followed Halley did all he could to smooth over the difficulties and persuade Newton to continue his work.

The *Principia* set the seal to Newton's reputation. It explained for the first time the way in which a single mathematical law could account for phenomena of the heavens, the tides, and the motion of objects on the earth. The nhole development of modern science begins with this great book. For more than 200 years it reigned supreme, and all theories of cosmogony were based on the principles laid down by Newton. His mechanics guided astronomers and men of science in their search for natural knowledge.

Religious Beliefs.—Newton was profoundly interested in religious matters. He studied carefully the writings of the church fathers, the early xriters on Christianity, and sought evidence to bolster his own principles of faith, which were anti-Trinitarian. John Maynard Keynes. who studied Newton's writings on esoteric and theological matters, concluded that Newton was "a Judaic monotheist of the school of Maimonides." Very likely this was the reason that Newton refused Holy Orders and had to be given a special dispensation to hold his professorship. He kept his religious convictions, like his experiments on alchemy, secret. Unfortunately, the amount of time and energy that he devoted to alchemy rivaled that given to physics or to mathematics. So well did Newton keep his secret that his activities in these two realms are not generally and fully known.

Middle and Later Life.—In 1687 James II tried to force the university to admit as a master of arts Father Alban Francis, a Benedictine monk, without taking the oaths of allegiance and supremacy. Newton was one of those who led the resistance to the royal action, and appeared before Lord Jeffreys to argue the case for Cambridge. In the end the deputies were reprimanded and John Peachell, the vice-chancellor, was deprived of his office. Newton's share in the affair led to his being elected member of parliament for the university in 1689, retaining the seat till the dissolution next year. He was elected again in 1701, but he never took any prominent part in politics.

Cpon the dissolution of parliament in 1690 he returned to Cambridge and continued for a time his mathematical work; this was interrupted in 1692–94 by a serious illness. He was suffering from insomnia and nervous trouble. There was a report that he was going out of his mind. In June 1694 Huygens wrote to G. W. Leibniz, "I do not know if you are acquainted with the accident to the good Mr. Newton, namely, that he has had an attack of phrenitis which lasted eighteen months and of which they say his friends have cured him by means of remedies and keeping him shut up." For some time his friends had been anxious to obtain some recognition of his work; this came in 1695. Charles Montague, later earl of Halifax. a former fellow of Trinity who was chancellor of the exchequer, offered him the post of warden of the mint. This he accepted and four years later became master. In the same year he was elected one of the eight foreign associates of the French Academy of Science.

In 1696 John Bernoulli addressed a letter to the mathematicians of Europe, challenging them to solve two problems and giving six months for the solution. On Jan. 29, 1697 Newton received from France two copies of the printed paper containing the problems and the following day sent the solution to the Royal society. They mere transmitted anonymously to Bernoulli, who, as he said, recognized the lion by his talon, "*tanquam* ex *ungue leonem*."

As warden of the mint Newton had retained his Cambridge offices, but soon after his appointment as master he named a deputy, and in 1701 resigned his professorship and the fellowship at Trinity. He had moved to London, where he continued his duties as master with marked efficiency until his death in 1727. In 1703 Newton became president of the Royal society and was re-elected annually until his death. Queen Anne visited Cambridge in 1705 and on this occasion Newton was knighted. About the same time the controversy with Leibniz as to the invention of the differential calculus began. It is now generally recognized that Leibniz invented the calculus independently of Newton and that Newton's claim that Leibniz was a plagiarist had no foundation. Early in 1727 Newton was taken seriously ill; he died on March 20, 1727, and was buried in Westminster abbey on March 28.

Published Works.—Since the first issue of the *Principia* in 1687 (*see* above), there have been many editions. In 1708 Newton consented to have Roger Cotes, a fellow of Trinity, help him prepare a second edition, which was published in 1713; a third edition made with the aid of Henry Pemberton appeared in 1726. This third Latin edition was reprinted in Geneva in 1739–42 with an excellent commentary by two minims, Le Sueur and Jacquier; often reprinted, this is known incorrectly as the "Jesuits! edition." An English translation first published by A. Motte as *Mathematical Principles of Natural Philosophy* (1729) was revised and republished (1803), revised again by Florian Cajori and reprinted together with Newton's *System of the World* (1934).

The *Opticks*, first published in 1704, went through three editions in Newton's lifetime: a modern edition appeared in 1952.

The scientific papers published by Newton in his lifetime are collected in *Isaac Newton's Papers and Letters on Natural Philosophy*, edited by I. Bernard Cohen (1958). The most recent edition of Newton's writings, edited by S. Horsley in five volumes under the title *Opera quae extant omnia* (1779–85), is not complete.

Correspondence of Scientific Men of the 17th Century, etc., From the Originals in the Collection of the Earl of Macclesfield, edited by S. P. Rigaud (1811); and *Correspondence of Sir Isaac Newton and Professor Cotes, Including Letters of Other Eminent Men* (1850), edited by J. Edleston, contain many of Newton's letters, and the latter volume contains a synopsis of his life. A selection of Newton's writings on religion is contained in H. McLachlan (ed.), *Theological Manuscripts* (1950); earlier published religious writings were *Chronology of Ancient Kingdoms Amended* (1728), and the *Apocalypse of St. John* (1733).

The Royal society has undertaken an edition of *The Correspondence of Isaac Newton*, of which the first two volumes (1959, 1960), edited by H. W. Turnbull, cover the years 1661–75, 1676–87.

For information on the impact of Newton's work on scientific thought, *see* SCIENCE: *Determinism and Postdeterminism*. For further information on his major scientific contributions, *see* CELESTIAL MECHANICS; GRAVITATION; LIGHT: *The Age of Newton and Huygerts;* MECHAKICS: *Newtonian mechanics as an abstract science and as a branch of physics;* MOTION, PRINCIPLES AND LAWS OF; TELESCOPE: *Early Reflecting Telescope*. *See* also Index references under "Newton, Sir Isaac" in the Index volume.

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L. T. More, *Isaac Newton* (1934). The most readable account of Newton's life and achievement is E. N. da Costa Andrade, *Sir Isaac Newton* (1954); still useful for the amount of quoted material is *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton, by* Sir David Brewster, 2 vol. (1855; reprinted 1860). Valuable critical commentaries are to be iound in Augustus de Morgan, *Essays on the Life and Work of Newton*, edited with notes and appendices by P. E. Jourdain (1914). A brief 'account of Newton's life and works is given in S. Brodetsky, *Sir Isaac Newton* (1928). Of great value to students oi Newton is the *Catalogue of the Portsmouth Collection of Books and Papers Written by or Belonging to Sir Isaac Newton* (1888), which describes the great mass oi Newton's papers which came at his death into the hands of Conduitt. Among general commentaries may be mentioned: H. Pemberton, *A Virw of Sir Isaac Newton's Philosophy* (1728); Colin Maclaurin, *An Account of Sir Isaac Newton's Philosophical Discoveries* (1748); F. Rosenberger, *Isaac Newton and seine Physikalische Principien* (1895); Léon Bloch, *La Philosophie de Newton* (1908); I. Bernard Cohen. *Franklin and Newton* (1956).

Of great importance for the controversy with Leibniz is the report drawn up by order of the Royal Society, published under the title *Commercium Epistolicum* (1712), of which editions appeared in 1722 and 1725. *See* also S. P. Rigaud, *Historical Essay on the First Publication of Sir I. Newton's Principia* (18.38); *W.* W. R. Ball, *Essay on Newton's Principia* (1893); J. W. L. Glaisher, *Bi-Centenary of Newton's Principia* (1888); *Isaac Newton, 1642–1727,* ed. by W. J. Greenstreet, a memorial volume (1927); History of Science Society, *Sir Isaac Newton, 1727–1927* (1928); *W.* Stukeley, *Memoirs of Sir Isaac Newton's Life, 1752* (1936); H. W. Turnbull, *Mathematical Discoveries of Newton* (1945); Royal Society of London, *Newton Tercentenary Celebrations, 15–19 July, 1946* (1947). (R. T. GL.; I. B. C.)

NEWTON, JOHN (1725–1807), English divine, the friend of William Cowper, was born in London on July 24, 1725 (O.S.). His father, who for a long time was master of a ship in the Mediterranean trade, became in 1748 governor of York Fort, Hudson bay, where he died in 1751. The lad had little education and served on his father's ship from 1737 to 1742; shortly afterward he was impressed on board a man-of-war, the "Harwich," where he was made a midshipman. For an attempt to escape while his ship lay off Plymouth he was degraded, and treated with so much severity that he exchanged into an African trader. He made many voyages as mate and then as master on slave-trading ships, devoting his leisure to the improvement of his education. He left the sea in 1755, when he was appointed tide surveyor at Liverpool. He began to study Greek and Hebrew, and in 1758 applied to the archbishop of York for ordination. This was refused him, but, having had the curacy of Olney offered to him in April 1764 he was ordained by the bishop of Lincoln. In Oct. 1767 William Cowper settled in the parish. An intimate friendship sprang up between the two men, and they published together the *Olney Hymns* (1779). In 1779 Newton left Olney to become rector of St. Mary Woolnoth, London. He died on Dec. 21, 1807.

Like Cowper, Newton held Calvinistic views, although his evangelical fervour allied him closely with the sentiments of Wesley and the Methodists. His fame rests on certain of the *Olney Hymns* (*e.g.*, "Glorious things of Thee are spoken," "How sweet the name of Jesus sounds," "One there is above all others").

His prose works include an *Authentic Narrative of some Interesting and Remarkable Particulars in the Lifr of John Newton* (1764); *Omicron* (a series of letters on religion, 1774); and *Cardiphonia* (1781). His *Letters to a Wife* (1793) and *Letters to Rev. W. Bull* (posthumous, 1847) illustrate the frankness with which he exposed his most intimate personal experiences. *A Life* of Newton by Richard Cecil was prefixed to a collected edition of his works (6 vol., 1808; 1 vol., 1827). *See* also T Wright, *The Town of Cowper*.

NEWTON, JOHN (1823–1895), U.S. general and engineer, was born in Norfolk, Va., on Aug. 24, 1823, and graduated from the U.S. Military academy in 1842. From 1842 to 1861 he was engaged in coast defense constructions and waterway improvements; he was assistant professor of engineering in the Military academy from 1843 to 1846, became a captain in 1856 and was chief engineer in the Utah expedition of 1857–58. He served in the Virginian campaign of 1861, and was promoted brigadier general. U.S. volunteers. He distinguished himself in the Seven Days' battle and at Antietam, and after the battle of Fredericksburg was made major general, U.S. volunteers. In the Chancellorsville campaign Newton took part in the storming of Marye's heights at Fredericksburg, on May 3, 1863, and at the battle of Gettysburg he was for a time in command of the 1st corps. Later in Gen. W. T. Sherman's army, as a division commander under Gen. Oliver O. Howard, he took part in the Atlanta campaign. For gallant conduct at Peach Tree creek he was made brevet brigadier general, and at the close of the war was made brevet major general, U.S. army. In 1884, he became chief of engineers, and held this position until his retirement in 1886. In 1887–88 he was commissioner of public works in New York, and from 1888 until his death on May 1, 1895, was president of the Panama railway.

See Gustavus Smith, *In Memoriam of General John Newton* (1895).

NEWTON, a suburban, residential city of Middlesex county, in eastern Massachusetts, U.S., is located on the south bank of the Charles river, immediately west of Boston (*q.v.*) and Brookline. Settled in 1639 as part of Cambridge, it was separated in 1688 and incorporated as New Towne, changing its name to Newton in 1691. During the 19th century farming was the principal occupation although the upper and lower falls areas of the Charles were busy industrial centres. Newton's growth as a residential suburb was given impetus by the opening of the Boston and Worcester railroad in 1834. Newton was incorporated as a city in 1873.

With a population (1960) of 92.384, Newton is part of the Boston standard metropolitan statistical area. Despite its size, Newton has kept the flavour of a small suburban town, being divided into 14 individual villages, and containing a number of parks, playgrounds and other recreational facilities. Industries. limited by zoning laws, manufacture electronic tubes, electrical signalling systems, textiles, rubber goods and plastics. Situated within the city are Newton Junior college (1936); Boston college (Roman Catholic, 1863); Newton College of the Sacred Heart (Roman Catholic, 1946); and the Andover-Newton Theological school formed by a merger of Andover Theological seminary (Congregational, 1808) and Newton Theological institute (Baptist, 1825). (M. R. M.)

NEWTON ABBOT, a market town in the Totnes parliamentary division of Devon, Eng., 16 mi. S.S.W. of Exeter by road and near the head of the Teign estuary. Pop. (1961) 18.066. It has a Wednesday cattle and general market; it is also a shopping centre and railway junction with various light industries. The two parish churches. St. Mary's in Wolborough and All Saints' in Highweek, are Perpendicular in style. The Jacobean Forde house (1610) was visited by Charles I and William of Orange, who first read his declaration to the people of England at Newton Abbot market cross. The 15th-century manor house of Bradley belongs to the National Trust. The portion of Newton Abbot in the parish of Highweek was formerly a separate town known as Newton Bushel. There is a racecourse on the opposite bank of the Teign.

NEWTOWNARDS, a municipal borough of County Down, Northern Ire., 10 mi. E, of Belfast by road. Pop. (1961) 13,090. The town mas founded by Sir Hugh Montgomery in 1608. at the site of a Dominican friary founded in 1244 by Walter de Burgh (ruins of which survive), and was incorporated in 1613. It is heavily industrialized. and as well as the spinning and weaving of linen its industries include the manufacture of hosiery, aircraft components, sheet metal work and draughtsinen's instruments, fabric printing and rayon weaving. (Hu. S.)

NEW TOWNS. In order to decentralize population and industry from London and other big towns in Great Britain, a New Towns act was passed in 1946. Following this. 12 New Towns were designated in England and Wales and 3 in Scotland, each with its own development corporation financed by the government. Relatively undeveloped sites are usually chosen and the New Towns are self-contained and locally governed. Each has an admixture of population so as to give it a balanced social life. Final population figures range from 30,000 to 50,000 in the built-up areas, and up to 80,000 within a lo-mi. radius, in England and Wales, but these figures may be lower in Scotland. The 12 New Towns designated in England and Wales are Aycliffe and Peterlee in County Durham, Basildon in Essex, Bracknell in Berkshire, Corby in Northamptonshire, Crawlcy in Sussex, Cwmbran in Monmouthshire, Harlow in Essex, and Hatfield, Hemel Hempstead, Stevenage and Welwyn Garden City in Hertfordshire. The three Scottish ones are Glenrothes in Fife, East Kilbride in Lanarkshire and Cumbernauld in Dunbartonshire.

See also HOUSING: *Greut Britain: Town Planning After World War II: New Towns Policy.*

NEW WESTMINSTER, city of Canada, on the north hank of the Fraser river, 17 mi. from the mouth, and British Columbia's largest fresh-water port. Pop. (1961) 33,654. Founded in 1859, it was the capital of British Columbia when the British possessions on the Pacific coast formed two colonies; *i.e.*, British Columbia (the mainland portion) and Vancouver Island. The city has a fine harbour with 30 to 40 ft. of water, modern terminal facilities and a cold storage plant and has a large trade, particularly in timber. It is a manufacturing centre, fish. fruit and vegetable canning, iron founding, oil refining. shingle and lumber mills and shipbuilding being among the industries; fruitgrowing, dairying and mining are carried on in the district. The city is on the Canadian Pacific, Great Northern and Canadian Kational railways, and is connected with Vancouver, 12 mi. distant. by electric railway. St. Ann's academy and St. Louis college are located there.

NEW YEAR'S DAY, the first day of the year. In the Gregorian calendar this date occurs 12 days earlier than in the Julian.

The ancient Egyptians, Phoenicians and Persians began their year at the autumnal equinox (Sept. 21) and the Greeks until the jth century B.C. at the winter solstice (Dec. 21). The ancient Romans once celebrated the beginning of the year on Dec. 21, but Caesar by the adoption of the Julian calendar postponed it to Jan. 1. The Jews have always reckoned their civil year from the first day of the month of Tishri (Sept. 6–Oct. j), but their ecclesiastical year begins at the spring equinox (March 21). March 25 was the usual date among most Christian peoples in early mediaeval days. In Anglo-Saxon England, however, Dec. 25 was New Year's day. William the Conqueror ordered that the year should start on Jan. 1, but later England began its year with the rest of Christendom on March 25. The Gregorian calendar (1582), which restored Jan. 1 to its position as New Year's day, was accepted by all Catholic countries at once; by Germany, Denmark and Sweden about 1700, and by England in 1; 52.

NEW YORK, one of the original 13 states of the United States. ranks 31st in area among the states, but first in population, trade and manufacturing. Its land area is 47,939 sq.mi. and the area of inland waters is 1,637 sq.mi. The state has a triangular outline. with a breadth from east to west of 322 mi. and from north to south, on the line of the Hudson river, of 312 mi. In addition, Long Island thrusts about 118 mi. eastward from New York bay.

New York is bounded on the north by Lake Ontario, the St. Lawrence river and Canada; on the east by Vermont, Massachusetts and Connecticut; on the south by the Atlantic ocean, New Jersey and Pennsylvania; and on the west by Pennsylvania, Lake Erie and the Niagara river.

Because of its great wealth and the concentration of business and industry, New York has come to be known as the "Empire state." The state capital is Albany and the state ratified the federal constitution on July 26, 1788, the 11th of the colonies to do so. The sugar maple has been adopted as the state's official tree and the rose as the official flower. The state flag has a blue field upon which is imprinted the state coat of arms with the motto "Excelsior" inscribed on a white ribbon beneath it.

PHYSICAL GEOGRAPHY

Physical Features. — The most notable topographical feature of the state is the circular Adirondack mountain area in the northeast. This ancient mountain mass of Pre-Cambrian rocks resembles more the Laurentian mountains of Canada than the Appalachians. The highest peak is Mt. Marcy (5,344 ft.). Other peaks range from about 2.000 ft. to about 5,000 ft. Even the highest summits are worn and rounded and are largely forest-covered. The Adirondack area proper, and much of the surrounding ring of younger sedimentary rocks is too rugged and the soil is too thin for agriculture. Because of the beautiful scenery, this is a favourite recreational centre. In summer. visitors hunt, fish, swim and climb; in minter, they skate and ski. Small factories have developed, partly to utilize the products of forest, mine and farm and partly to use the extensive water power.

South of the Mohawk river and west of the Hudson river rises a high level plateau which extends westward to the Pennsylvania border. There the sedimentary strata are essentially horizontal and of the Paleozoic age, mainly Devonian. This plateau area, which comprises more than half of the state, has much variety. The elevation decreases toward the north by means of a series of "steps," the lowest elevation being on the Ontario plain which skirts the southern shore of Lake Ontario for a width of about 35 mi. The fertile and level lands along the shores of Lake Ontario and Lake Erie have attracted many farmers especially fruit growers. The large lakes have a moderating effect on the climate and lengthen the growing season. The plateau surface becomes more rugged toward the south and the east. Elevations of about 1,500 and 2,000 ft. are common from Chautauqua lake to the Catskill mountains. The plateau is cut by many streams which have created deep valleys. The valley walls rise to undulating and often fairly level uplands which provide excellent pasturage for dairy cows. In southeastern New York, near the Appalachians the plateau becomes much higher, reaching its culmination in the Catskills. Summit elevations of from approximately 3.000 to 4.000 ft. are common, the highest point being Slide mountain (4.185 ft.). Like the Adirondacks, this region is largely forest-covered and is famous as a site of summer and winter sports. The Helderberg mountains are really an escarpment facing the lower Mohawk and the Hudson rivers, south of Albany, where there is a downward step in the plateau. The steeply rising face of the plateau is the result of the resistance of a durable layer of limestone, known as the Helderberg limestone. The most notable escarpment in western New York is the Niagara which extends eastward from Canada, forming the Niagara falls, and creating a sharp drop at Lockport.

South of the Catskills there are a number,of different topographical features which are caused by the belts of differing rock structure that cross the state from southwest to northeast. The most pronounced of these upfolded strata form the low Shamangunk mountains, which descend to a lowland region of folded strata of limestone. slate and other rocks in Orange and Dutchess counties. This lowland area is a continuation of the great valley of the Appalachians and extends northeast into Vermont and southwest across New Jersey, Pennsylvania, Maryland and Virginia. It is bounded on its southeast side by the highlands, a belt of crystalline rocks which merge into the Taconic range, or Berkshires. The Hudson river has cut a deep gorge through the highlands. South of the highlands is a belt of Triassic sandstone which, because of its peculiar columnar jointing, has developed the famous Palisades of the lower Hudson. Long Island, a northeast extension of the coastal plain, has few heights of more than 200 ft. High hill, the highest point, is only 410 ft. above sea level.

The continental glacier covered the entire surface of New York with the exception of a very small area in the extreme western part. It broadened and deepened many of the valleys, rounded the hills, turned aside many streams, causing changes in drainage giving rise to innumerable waterfalls and rapids, and formed the thousands of lakes which dot the state. As the ice receded, it halted at various points where it formed moraines and other glacial deposits.

Drainage.—New York is drained by streams running in various directions. The St. Lawrence river system receives most of the runoff: mainly from short streams from the plateau and from the Adirondacks. A small part of the state, in the west, is drained toward the Ohio river. A much larger area drains into the Susquehanna river and into Chesapeake bay. A part of the Catskills, and the region farther south, drains into Delaware bay through the Delaware river. The Hudson is by far the most important river within the state, being navigable for 151 mi. from the sea. It is noted for its remarkable scenery, especially where it crosses the highlands.

There are about 8,000 small, glacial lakes and ponds in the state. The largest lake apart from Lakes Erie and Ontario is Lake Champlain into which Lake George drains. The largest lake entirely within the state is Oneida lake. In the central part of the state is a series of elongated lakes called the Finger lakes; the six largest are Cayuga, Seneca, Keuka, Canandaigua, Owasco and Skaneateles. In the extreme western part of the state is Chautauqua lake. New York has many falls and rapids the largest of which is the cataract of Niagara which is about 1 mi. wide and 167 ft. high. The U.S. fall is entirely within New York, but the Canadian boundary line passes down the centre of the Horseshoe or Canadian fall.

Climate.—New York has a wide variety of climate because of its topography and location between the Atlantic ocean and the Great Lakes. The average mean annual temperature in the state is about 45° F., though it varies from 52.3° in New York city to less than 40° in the Adirondacks. The mountain and plateau regions have heavy snowfalls and extreme changes in temperature. Daytime temperature is often high, but the nights are decidedly cool because of the rapid loss of heat. In contrast. Long Island has light snowfall and fairly constant temperature because of the moderating effect of the ocean. Similarly, the area adjoining the Great Lakes, and to a lesser extent the Finger lakes, has long, mild autumns and winters much less severe than the uplands a few miles away.

There is a wide variation in the annual precipitation, though the greatest amount falls during the growing season. The average annual precipitation in New York city is 42.11 in.; in Syracuse 35.31 in.; in Binghamton 34.41 in. The average annual snowfall ranges from 31.3 in. in New York city to 87.0 in. in Oswego and 126.6 in. at Lake Placid. New York lies within the northeastern cloud belt and therefore receives less sunshine than the central or western states.

Soil.—The soil is mostly glacial drift. with the depth and composition often varying greatly even within small areas. The most widely distributed soil. especially in the eastern half of the state, is clay formed by the glacial pulverizing of limestone and shale. The most fertile soil is found along the shores of the lakes and in the river valleys where alluvium has accumulated.

Plants and Animals.—A dense forest covered the state during the colonial period except for a few natural clearings in the Genesee valley but only in the recesses of the Adirondacks are there tracts of the original forest. There are 149 kinds of trees of which 116 are native. Spruce. pine and hemlock are the commonest trees in the Adirondack and Catskill mountains. The evergreens provide a rich background for the maples, birches and beeches. Oak. short-leaf pine. maple. hickory and gum trees are the principal ones on Long Island. Oak, hickory. chestnut and elm are the most predominant trees in the Hudson–Mohawk valley, the Lake Ontario plain and the deeper valleys of the plateau.

New York also has thousands of varieties of plants and ferns. In the forests there are wild sarsaparilla. Solomon's seal, trillium and many other kinds of wild flowers. Buttercups, clover, violets, wild roses and rushes are common throughout the state.

Both northern and southern animal types are found in New York. The wild turkey. panther, elk, moose. wolverine and timber wolf have been killed off but protective measures have saved the beaver, otter, mink and black bear from extinction. Deer, foxes. muskrats, raccoons, rabbits and squirrels are common in most parts of the state.

About 265 kinds of birds inhabit the state during some portion of the year. In the summer there are the robin, wood thrush, catbird, bluebird, wren. barn swallow. meadow lark, red-headed woodpecker and oriole among others. Year-round types include the English sparrow, crow and various kinds of woodpecker and hawk. The state protects game birds such as partridge, pheasant, ruffed grouse. varieties of wild duck, snipe and woodcock. There are a great many types of fish in New York's waters despite pollution and disturbance of the balance of nature through the stocking of streams. The kinds common in most natersheds are darters, yellow perch, suckers. bullheads, sunfish, small-mouthed bass, rock bass. shiners, dace, brook trout and blunt-nosed minnows. Long Island is noted for its shellfish: lobsters. oysters, clams and scallops. Its fishermen seek out the pollack, flounder, mackerel, bluefish, striped and sea bass in the ocean waters.

Parks and Reservations.—New York has an extensive state park system but no national parks. The conservation department supervises 87 parks which vary in size from 6 ac. (Sackets Harbor) to 59.600 ac. (Allegany state park). The state council of parks which is composed of the chairmen of the various regional park commissions acts as a central advisory agency. The nine park commissions are Niagara frontier nhich preserves the beauties of Xiagara falls and gorge; Palisades interstate; Genesee valley which oversees Letchworth park; Finger lakes nhich includes Watkins glen and Taughannock falls; Thousand Islands; Taconic state which supervises 10 park areas on the east bank of the Hudson; Central New York; Long Island which supervises 17 parks including Jones beach; and Allegany state. In addition, the state owns the Adirondack forest preserve, a virgin wilderness embracing 2,252,970 ac.

Following the colonial practice, New York in 1784 made a treaty with Chief Joseph Brant and the six nations of the Iroquois, and assumed responsibility for the Indians residing within its borders. In 1960 about 7.000 Indians lived on seven reservations. They are the Allegany, Cattaraugus, Tonawanda and Tuscarora in the western part of the state; the St. Regis, the most populous, near Massena; the Shinnecock, on Long Island; and the Onondaga, south of Syracuse. Indian agents are appointed by the state board of social welfare and are directed to provide care and relief for needy Indians.

Historic Sites and Museums. — New York has many museums, notable buildings and historic sites. The New York State Historical association operates two museums at Cooperstown: Fenimore house, its headquarters, with historical and art collections and the Farmers' museum with its 19th-century village. Nearby is the Baseball museum and hall of fame. The Adirondack museum at Blue Mountain lake has exhibits of logging equipment, boats and early resorts. Other important historical museums are the Albany Institute of History and Art, the Buffalo Historical museum, Oneida Historical society in Utica. the Rochester Historical Society museum and the Suffolk County Historical Society museum at Riverhead. New York city has several important museums. Perhaps the most interesting historically are the Museum of the City of New York and that of the New York Historical society. Local societies throughout the state have collected Indian relics, newspapers, diaries, tools, firearms, china and furniture.

The state has acquired more than 20 historic houses and sites. Three Revolutionary War battlefields—Oriskany, Saratoga, Bennington (Walloomsac)—are marked by monuments and parks In Kingston stands the senate house where the first state senate met on Sept. 10, 1777. Three historic places in the Newburgh area are associated with the last two years of the American Revolution. They are Washington's headquarters, Knox's headquarters and Temple hill where General Washington appealed to his rebellious officers to remain patient and loyal. Across the Hudson river are the Clinton house at Poughkeepsie, Philipse manor at Yonkers and the John Jay homestead at Bedford. The national government administers a library at Hyde Park, the home and grave of Franklin D. Roosevelt. The Albany area has three state-administered houses or museums: the Schuyler mansion, Ft. Crailo in Rensselaer and the state museum attached to the state library in Alhany. The state museum specializes in Indian material and collections of the animals, flowers and minerals of the state. Johnson hall in Johnstown, Guy park in Amsterdam and Ft. Johnson in Fort Johnson were built by Sir William Johnson. an early Indian trader and builder. The Schoharie County Historical society has its museum in the Old Stone fort in Schoharie. Near Little Falls stands the Herkimer home where the hero of the battle of Oriskany, Nicholas Herkimer, died in 1777. Three colonial forts have been reconstructed. They are Ft. Ontario at Oswego, Ft. h'iagara at Lewiston and Ft. Ticonderoga. Three memorials commemorate the campaign by Generals John Sullivan and James Clinton against the Iroquois in 1779. They are the Sullivan monument near the south end of Conesus lake, the Boyd-Parker monument near Geneseo, and the Newton battlefield near Elmira. Two outstanding industrial museums are the George Eastman House of Photography in Rochester and the Corning Glass museum in Corning.

HISTORY

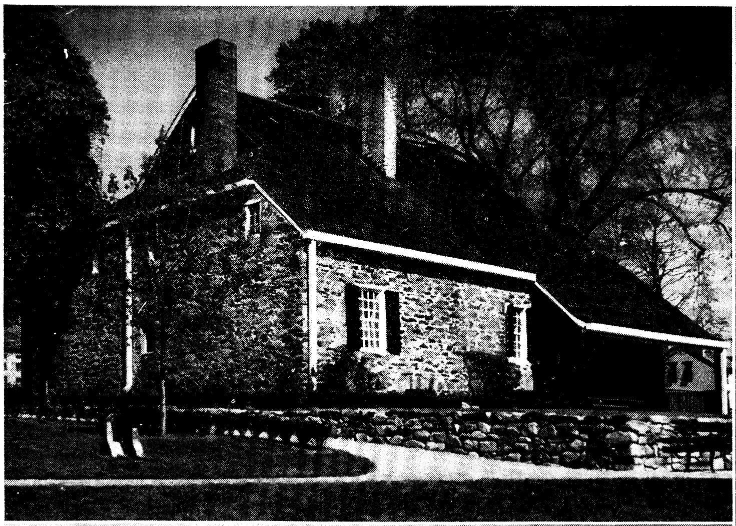
The Indians. — The Iroquois Indians had an important influence in New York not only on provincial development, but also on the imperial struggles between the Dutch, British and French. The five tribes (Mohawk, Oneida, Onondaga, Cayuga and Seneca) of central and western New York formed the confederacy of the Five Nations about 1570. This confederacy or league, which admitted the Tuscarora in 1722, reached the height of its influence about 1700 when it held the balance of power between England and France. The league's power rested on its commanding position on the strategic waterways, its control of the fur trade between the seacoast traders and the tribes of the interior, its unity and its skill in warfare. The various Algonkin tribes in the lower Hudson valley and Long Island were much less important.

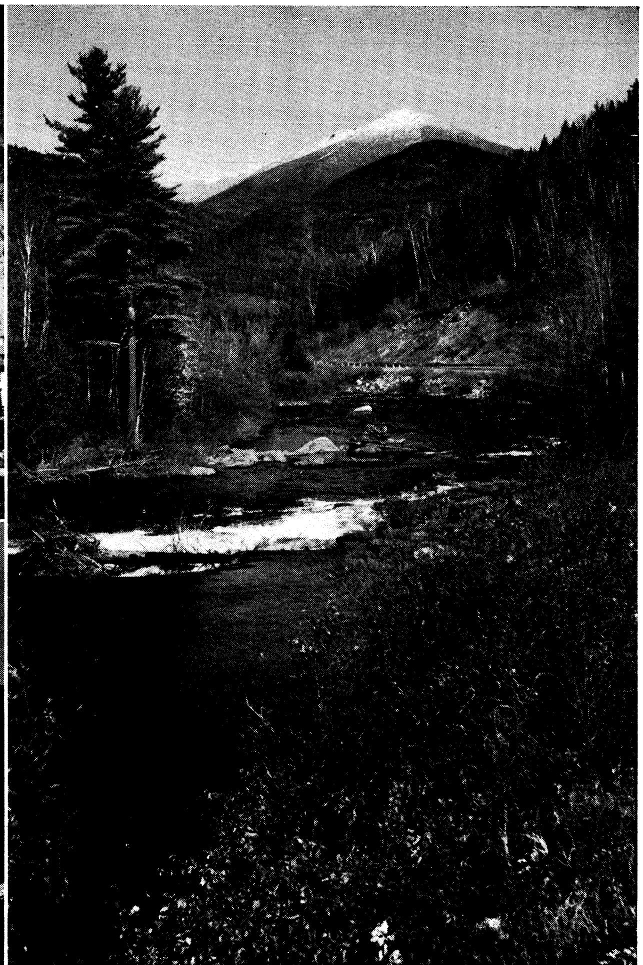
Discovery and **Exploration.**—New York bay and the Hudson river were discovered by Giovanni da Verrazano in 1524. For many years after that, French vessels occasionally ascended the Hudson to trade with the Indians. Henry Hudson and Samuel de Champlain penetrated deep into the heart of New York in 1609. The Dutch East India company employed Hudson. an Englishman, to find a new water route to the far east. After a vain effort to sail around northern Europe, Hudson turned westward and finally entered New Tork harbour. Hudson sailed up the "river of the mountains" to a point near the site of Albany. His reports on the fertile land, furs and friendly Indians aroused much interest among Dutch merchants. The East India company sent out more sea captains to explore and trade. Adriaen Block in 1613–14 explored the shores of Long Island sound from Manhattan Island to the present state of Rhode Island. Late in 1614 or early in 1615 a stockaded trading post called Fort Nassau was erected on Castle Island within the present limits of Albany.

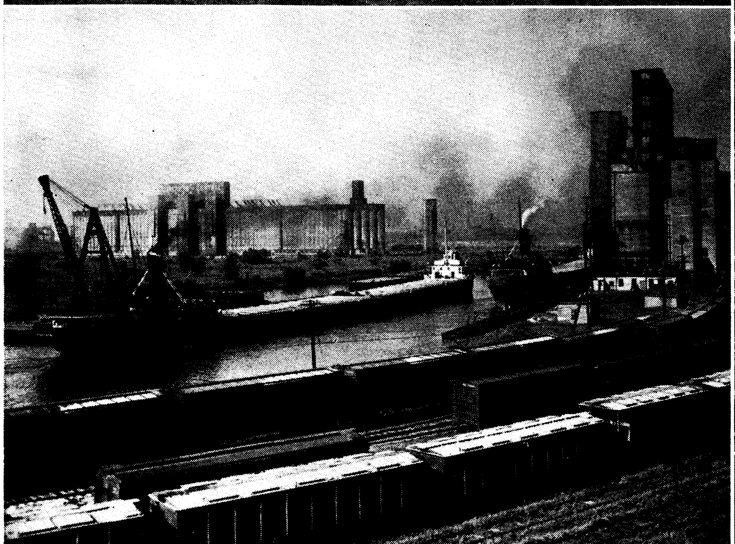
Settlement. — In 1621 the states-general, the ruling council of the Dutch republic, granted a charter to the Dutch West India company which gave it a monopoly of trade for 24 years along the shores of the Americas and in the Atlantic below the Tropic of Cancer. The company's directors drew up in 1624 a provisional order for administering a colony to be established in the recently designated (1623) province of New Netherland. It provided for company control of trade and for a director-general. The same year it sent out about 30 families, mostly Walloons, and 18 of these families founded the first permanent settlement at Fort Orange (Albany). Three more vessels arrived in 1625 and Willem Verhulst replaced Cornelis Jacobsen May as director or governor. In 1626 the company appointed as governor Peter Minuit who purchased Manhattan Island from Indian chiefs for 60 guilders (about $24) in trinkets and built a fort at the lower end of the island. This settlement, known as New Amsterdam, became the seat of government and trade. The village grew slowly having only about 1,000 inhabitants by 1650 and about 1,500 in 1664.

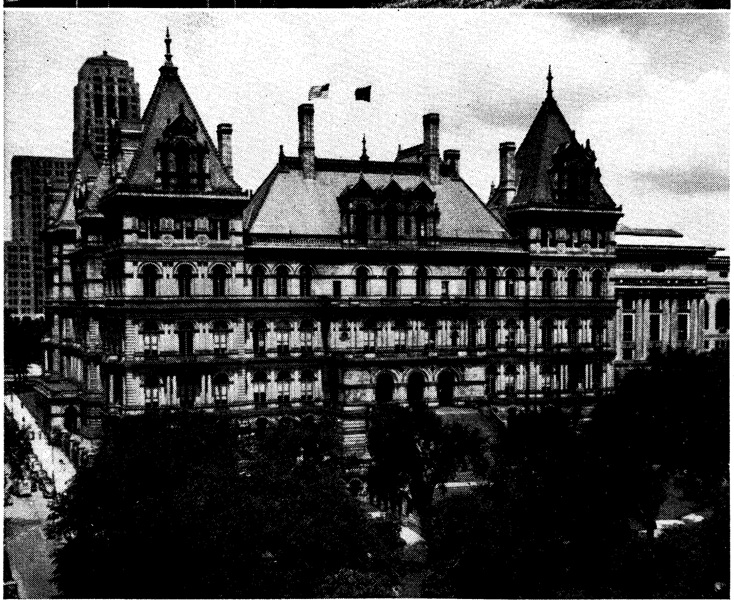
In 1629 the company adopted the charter of freedoms and exemptions in order to spur colonization and agriculture. With company permission individuals could take possession oi as much land as they could cultivate. Thus began the system of individual development and private ownership of land. Members of the company who peopled their tracts with 50 adult settlers in four years could acquire huge estates along navigable rivers. Only one of these patroonships proved successful, however, that of Kiliaen Van Rensselaer, a diamond merchant of Amsterdam, who developed his estate which covered most of modern Albany and Rensselaer counties by sending out colonists, craftsmen and supplies. His practice of leasing his land encouraged the system of farm tenancy which the English landlords later expanded.

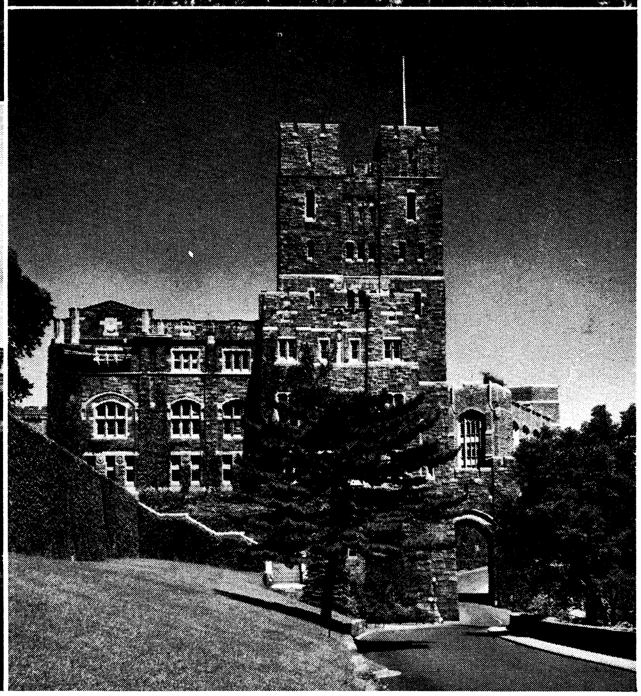
The Dutch Period. — Governor Minuit was recalled in 1631 for granting privileges to the patroons at the expense of the company. His successor, the corrupt Wouter Van Twiller (1633–38) constructed forts on the Connecticut and Delaware rivers in order to protect the fur traders. Willem (William) Kieft began his nine-year rule in 1638 when the company gave up its monopoly of trade. Two years later it permitted those who transported five settlers to the colony to receive 200 ac. and it also began to allow manufacturing. These inducements encouraged immigration from the homeland and from New England and Virginia. The activities of irresponsible traders and the mismanagement of Indian affairs by Governor Kieft, however: provoked the Algonkins to attack the Dutch settlements (1641–45). Out of this warfare arose an organized movement for a government in which the colonists would have a voice, but in 1642 Kieft refused to accept reforms which were recbmmended by an unofficial board of 12 leading colonists. The next year he clashed with another board of eight men over the issue of taxes and this board's request to











BY COURTESY OF (TOP LEFT, TOP RIGHT, BOTTOM LEFT) NEW YORK STATE DEPARTMENT OF COMMERCE; PHOTOGRAPHS, (CENTRE LEFT) H. ARMSTRONG ROBERTS, (BOTTOM RIGHT) EWING GALLOWAY

VIEWS OF NEW YORK STATE

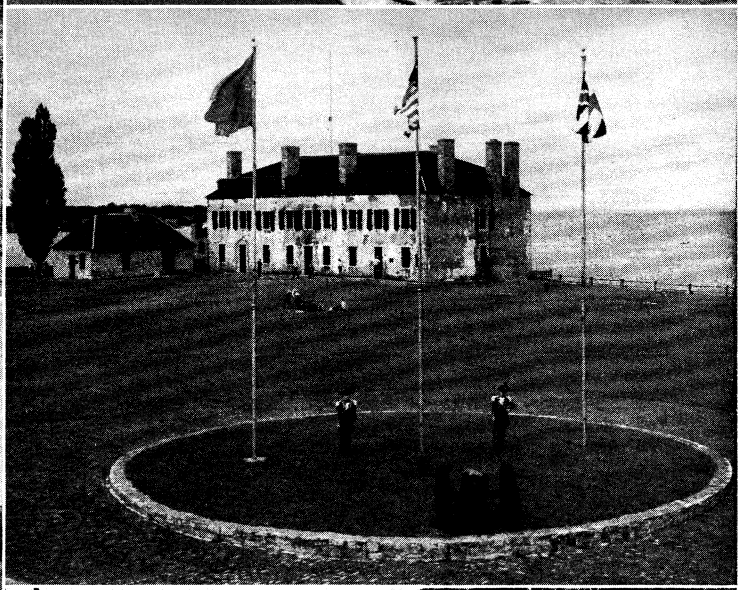
Top left: Dutch farmhouse at Newburgh built in 1750. George Washington used it as his headquarters in 1782–83

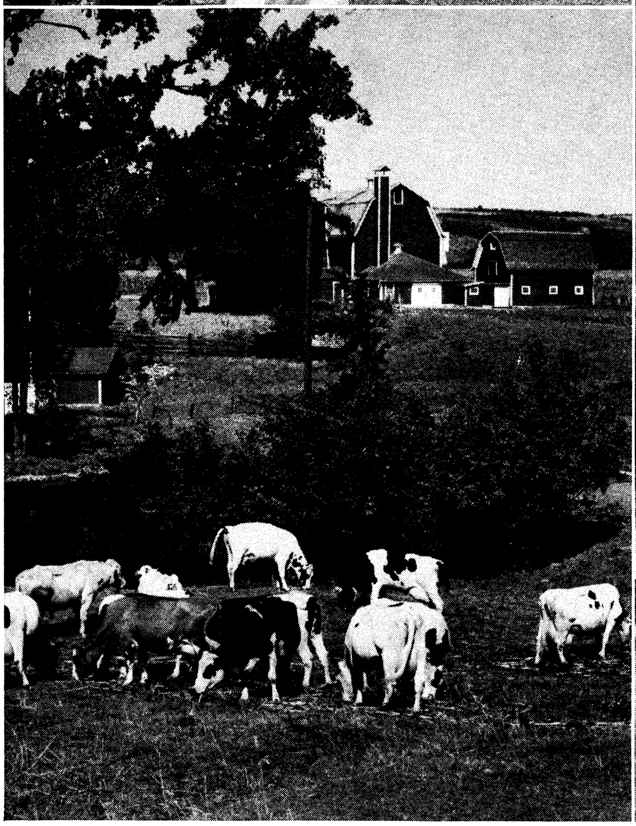
Top right: Whiteface mountain (4,872 ft.), part of the Adirondack range, with the Ausable river in the foreground

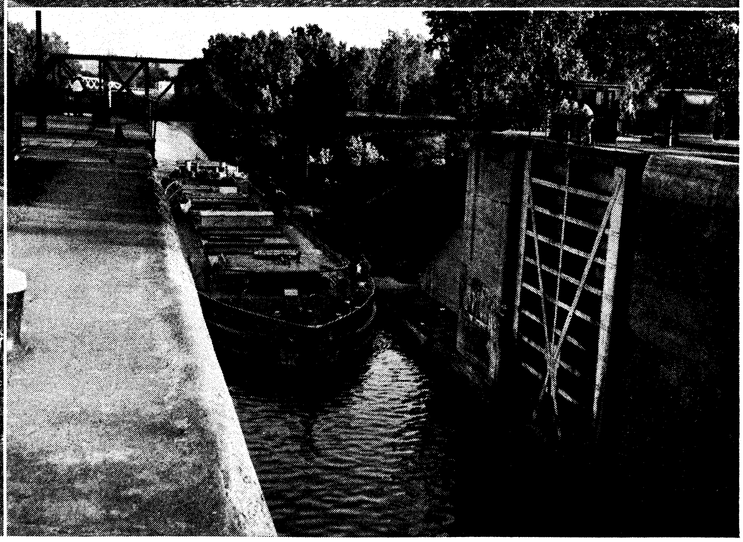
Centre left: Ore and grain boats on Buffalo creek. Buffaio has been a leading port and industrial centre of the United States since the opening of the Erie Canal in 1825

Bottom left: The state capitol at Albany, completed in 1898, which took more than 30 years to build

Bottom right: The Administration building at West Point, the U.S. Military academy







BY COURTESY OF (TOP LEFT) NEW YORK STATE THRUWAY AUTHORITY. (TOP RIGHT, CENTRE RIGHT, BOTTOM LEFT) NEW YORK STATE DEPARTMENT OF COMMERCE, (BOTTOM RIGHT) STANDARD OIL CO. (N.J.)

SCENES IN NEW YORK STATE

Top left: New York State thruway, principal traffic artery between Buffalo in the northwest and New York city in the southeast. The photograph shows the road as it runs parallel to the Mohawk river near Fort Plain

Top right: Surf-casting for striped bass at Hampton Bays on the south shore of Long Island

Centre right: Fort Niagara, overlooking Lake Ontario at the mouth of the Niagara river. The first fort on this site was built by the French in 1678, the present structure in 1725–26

Bottom left: A dairy farm near Syracuse. Milk and dairy products provide more than half of the total annual farm income of New York state

Bottom right: Tanker passing through the Erie canal at Waterford, near the junction of the Champlain and Erie divisions of the New York State Barge canal system which is about 525 mi. long the states-general for the recall of Kieft was granted.

Peter Stuyvesant (*q.v.*), his successor, arrived in May 1637. He agreed to the establishment of a board of nine men, the first permanent board of officials in the colony, but he rejected the board's recommendations. The grant of municipal rights to New Amsterdam in 1653 encouraged the towns on Long Island to demand more self-government. The leading men from the province met in a diet and demanded a share in the enactment of the laws and in the election of officials. Stuyvesant dismissed the meeting but the Long Island towns kept up their demands until in 1663 they secured the right to elect their own magistrates in town meetings. They also won a memorable victory for religious liberty. Stuyvesant, a zealous Calvinist: was especially angry at the rebellious town of Flushing which permitted Quaker meetings. His order forbidding Flushing to harbour Quakers led 26 freeholders to sign a remonstrance in 165i calling for liberty of conscience. The imprisonment of one of the leaders did not stop the Quaker activities in Flushing and in 1662 Stuyvesant arrested John Bowne for allowing meetings in his home. Bomne was jailed and deported but the directors of the company urged Stuyvesant to end his persecution and eventually, Bowne returned to New Netherland a free man.

Stuyvesant had more success in conducting foreign affairs. In 1655 a fleet of seven ships and 650 men which he had dispatched captured the Swedish settlements on the Delaware river founded by the New Sweden company in 1637. The English threat was potentially more dangerous. The English government claimed the whole region held by the Dutch, citing the discoveries of John Cabot (1498), the patent of the London and Plymouth companies (1606) and the patent to the council of New England (1620). Most threatening of all was the invasion of the Connecticut valley, the land along the sound and Long Island by English settlers. Realizing the weakness of New Netherland, Stuyvesant was forced in 1650 to sign the humiliating treaty of Hartford with the New England confederacy by which Long Island was divided. The English obtained the part east of a line drawn south from Oyster bay and also secured the region west of the Connecticut river although they agreed not to settle within 10 mi. of the Hudson river.

Trade regulation, however, led to the final conflict between England and Holland. The Dutch traders constantly interfered with the enforcement of the acts of trade and navigation. Then, on March 22, 1664, Charles II of England granted to his brother James, duke of York and Albany, all of the land from the west side of the Connecticut river to the east side of Delaware bay, including Maine, Long Island, Martha's Vineyard and other islands. Col. Richard Nicolls was appointed commander of a fleet to capture New Netherland. Stuyvesant surrendered in September without fighting and Nicolls replaced him as governor.

English Rule.—The transition from Dutch to English rule and institutions was accomplished smoothly. The duke of York assumed sole power to make laws, regulate trade, grant land and fix taxes. Completely autocratic rule, however, was limited by several factors such as the great distance from England, demands by inhabitants for home rule. the willingness of governors to make concessions in order to secure cooperation and the requirement in the duke's charter of 1664 that all laws must harmonize with those of the homeland. Governor Nicolls began in 1665 by creating an English county named Yorkshire out of Long Island, Staten Island and Westchester and promulgating a code of laws known as the "duke's laws." This code gave the freeholders of each town a voice in town government through the election of a board of eight overseers and a constable. It also guaranteed religious freedom and jury trial. The code soon was extended to the rest of the province. The duke of York had reduced his holdings in 1663 by granting New Jersey to Lord John Berkeley and Sir George Carteret and Governor Nicolls recognized Connecticut's claims to its present borders. Nicolls was succeeded in 1668 by Col. Francis Lovelace who, as governor, continued the policy of conciliation.

In Aug. 1673, Holland and England being at war, a Dutch fleet surprised and captured New York and restored Dutch authority and names. The treaty of Westminster, however, extinguished the Dutch title in Feb. 1673 and in November the English again took possession in the person of Gov. Edmund Xndros. The merchants strenuously resisted Andros' efforts to levy import duties and while he was in England to answer unfounded charges of dishonesty the citizens renewed their demands lor a representative assembly. The unrest led the duke in 1683 to send a new governor, Thomas Dongan, with orders to call the desired assembly. It met in New Work city and passed 15 acts, the most important of which was a charter of liberties and privileges that provided for an assembly elected by the freeholders and freemen. This assembly had the power to approve or reject all taxes. When the duke became king of England as James II in 1685, he withdrew his approval of the charter and instructed Dongan to resume full legislative powers. In 1688 he consolidated New York, New Jersey and the New England colonies into the Dominion of New England under the viceregal authority of Andros as governor general.

The news that the British parliament had dethroned James and that Boston's citizens had jailed Governor Andros led to a popular uprising in New York under the leadership of Jacob Leisler (*q.v.*). Leisler called an assembly which proclaimed James' successors, William and Mary, as monarchs and formed a committee of public safety to rule. Leisler surrendered the colony on March 29, 1691, to Henry Sloughter, the new governor. The landlord-merchant aristocracy hated Leisler for his democratic tendencies and they persuaded Sloughter and his council to bring charges of treason against Leisler who was tried, convicted and hanged. The Leisler rebellion, besides sharpening class cleavages, helped preserve New York's separate existence. It also resulted in a permanent bicameral legislature since Leisler's assembly was made a permanent elected unit and the old council became the upper house.

The rise of the assembly and of provincial home rule were the most striking developments in the political history of New York in the 18th century. The extravagances of Gov. Edward Cornbury (1702–08) caused the assembly in 1i06 to demand and win the right to appoint its own treasurer when it needed to raise "extraordinary supplies" beyond the normal budget. In 1715 Gov. Robert Hunter (1710–20) agreed unofficially to spend the budget according to a system specified by the colony's leaders. Gov. George Clinton (1743–53) clashed repeatedly with the assembly which tried to strip him of his powers even over military affairs. Finally a compromise was arranged whereby Clinton could initiate money bills but he had to accept a one-year appropriation bill which named officials and fixed salaries. The great landlords of the upper Hudson, led by the Livingston family, organized a new faction in the 1750s to challenge Lieut. Gov. James DeLancey, who had agreed to a tax on land in order to raise revenue for the French and Indian War (1754–63). During the next 20 years the Livingston group in alliance with the Presbyterians, lawyers and artisans tended to challenge the royal prerogative and eventually became the patriots of the American Revolution whereas the DeLancey group, supported by the Anglican Church and the most important merchants of the city, tended to oppose radical measures and they became the Tories (Loyalists) in 1775.

The famous libel suit against John Peter Zenger (*q.v.*) who had established the *New York Weekly Journal* in 1733 advanced the freedom of the press and to some extent the independence of the judiciary. Gov. William Cosby arrested Zenger in Nov. 1734 for printing criticisms of his administration. At his trial, the jury released Zenger because it held his statements were true and therefore not libelous. In 1805 New Tork, at the urging of Alexander Hamilton, enlarged the freedom of the press by admitting truth as a defense in libel cases.

The northern frontier of New York was a crucial area in the long conflict between England and France for the domination of North America—thus the colony was often a battleground in the four Anglo-French wars between 1689 and 1763. Between 1713 and 1740 relative calm was maintained on the New York frontier. The French, however, built Ft. Niagara (1726) and Crown Point (1731) on Lake Champiain and Gov. William Burnet countered by building Ft. Oswego in 1727. Gov. George Clinton favoured vigorous action against the French but the assembly would vote him no money. He made William Johnson, a famous Indian trader, the Indian agent for New Uork but Johnson was able to win support only from the Mohawk tribe. The Iroquois complained that the land speculators stole their lands and that the government did not protect them from French attacks. To meet this dissatisfaction the colony's board of trade directed Governor De Lancey to call a colonial congress at Albany in 1754 at which Benjamin Franklin advanced his plan for colonial union. The congress adopted the plan with modifications, but the plan was ultimately disapproved by all of the colonies. The congress was partly successful, however, in placating the Iroquois.

The British plans for 1755 called for attacks on Ft. Niagara and Crown Point. Neither campaign succeeded although at the battle of Lake George the British defeated the French forces of Baron Ludwig Dieskau. In 1756 the French general Montcalm took Oswego and the following year Ft. William Henry on Lake George. Ticonderoga, Crown Point and Niagara were eventually taken from the French and Montreal fell in 1760. The final British victory in 1763 meant the end of the French threat but it also marked the decline of Iroquois power. Furthermore, it set in motion the forces which led the colonists to seek home rule and finally independence.

The Revolutionary Period.—Victory brought perplexing problems to Great Britain. Among them were a large debt, heavy taxes, the administration of new territories and the necessity of reorganizing the imperial trade. In wrestling with these problems cabinet ministers advanced solutions which encroached upon the home rule of the colonists. The Sugar act of 1764 with its provision for vigorous enforcement provoked the merchants who were suffering from the postwar depression and a currency shortage. Irritation became anger when parliament in 1765 passed the Stamp act (*q.v.*) which imposed a tax on legal documents, licences, commercial instruments, newspapers, pamphlets, e t ~ .The New York assembly authorized a committee to correspond with committees in other colonies and to attend a Stamp Act congress which met in Kew York city in 1765. The Sons of Liberty, a radical group of artisans led by lawyers and merchants, rioted. boycotted British imports and threatened stamp officials. The good feeling caused by the repeal of the Stamp act in 1766 turned to dismay when Gov. Henry Moore prorogued the assembly in late 1766 until it should provide for quarters and supplies for British soldiers. The Townshend acts of 1767, designed to raise further revenue, stirred merchants to sign a nonimportation agreement. Finally, in 1770 parliament repealed the duties except the tax on tea.

Tension relaxed until 1773 when the Tea act was passed. This act annoyed most merchants because it gave the British East India company the right to sell tea through its own agents. Following the example of Boston, a band of men disguised as Indians were dispatched to dump tea into New York harbour. When parliament passed the "Intolerable acts" in retaliation, the New York assembly appointed a committee which approved the calling of a continental congress. The first continental congress in Oct. 1774 adopted the "association," an agreement not to import from or export to Britain until American rights were respected. A committee was to be set up in each town, city and county in each of the English colonies in North America to enforce the association by punishing violators. (See CONTINENTAL CONGRESS, THE.) This action disturbed the conservative majority in the assembly who refused to choose delegates to the second continental congress, but the radicals asked county committees to send representatives to a provincial convention which met on April 20, 1775, and appointed the delegates.

News of the battle of Lexington on April 19, 1775, led to the collapse of royal government in New York. The radicals formed a committee of 100 which in effect governed New York until the second provincial congress met on May 22.

There was never a majority of New Yorkers who favoured severing the imperial tie. Loyalist sentiment was perhaps stronger in New York than any other state. Traditional ties of family, church and trade were reinforced by the fear of radicals and the destruction of trade by the association. Real power, however, passed to the third provincial congress which met in May 1776 and called for a new government. This congress refused to permit the New York delegates to the second continental congress to sign the Declaration of Independence on July 4, but the fourth provincial congress, meeting at White Plains, approved the famous document July 9.

Nearly one-third of all the engagements of the Revolutionary War took place in New York. George Washington came to New York city on April 13, 1776, to prepare against an attack. Britain's Sir William Howe landed with 10,000 men on Staten Island on July 2. He ousted the Americans from Brooklyn and occupied New York city on Sept. 15. Gen. John Burgoyne with 7.700 British and German troops took Ft. Ticonderoga on July 6, 1777, but surrendered his forces at old Saratoga (Schuylerville). Meanwhile, the British colonel Barry St. Leger led an auxiliary force from Oswego against Ft. Stanwix (Rome). On Aug. 6 he fought one of the bloodiest battles of the war at Oriskany where the American commander Nicholas Herkimer was killed. Deserted by his Indian allies, St. Leger retreated to Oswego. Sir Henry Clinton. who had been left in charge by Howe, led a small expedition up the Hudson, broke through the highland barrier and burned Kingston. When he learned of Burgoyne's imminent defeat, Clinton decided to withdraw to New York city. The failure of the British campaign not only saved upstate New York and New England, but it persuaded France to enter the war as an American ally. Frontier attacks by Tories and Indians caused much damage in the Mohawk and Schoharie valleys. As a result in 1779, the American generals John Sullivan and James Clinton advanced through the Finger lakes region to the Genesee valley where they burned about 40 Iroquois villages. The closing episode of the war as far as New York was concerned was the discovery of Benedict Arnold's attempt in 1780 to betray West Point and other posts on the Hudson to the British. Washington established his headquarters at Newburgh after the British surrender at Yorktow-n in 1781. The British left New York city on Nov. 25, 1783, but did not give up their posts on Lake Ontario until 1795 after the signing of the Jay treaty in 1794. (For further details, see AMERICAN REVOLUTION. THE.)

Early Years of Statehood.—John Jay was the principal author of New York's first constitution. The structure of government was quite similar to that of colonial New York although the power of the governor was curtailed. Both Jay's appointive and veto power had to be shared with councils which included senators. These councils worked badly and the constitutional convention of 1821 abolished them. In 1777 George Clinton became the state's first governor and held the office for the next 18 years. He was a champion of the patriots against the Tories, of states' rights against central government and of small farmers against the landed aristocrats. The conservatives wanted a strong government and their leader,'Alexander Hamilton, helped call the Constitutional Convention in 1787 and he alone of the New York delegation signed the federal constitution which the convention adopted. Nevertheless, his opponents composed about two-thirds of the delegates to the state convention called to ratify the federal constitution in 1788. A bare majority for ratification was obtained as the result of Hamilton's arguments, the ratification by New Hampshire and Virginia, a promise of a bill of rights and the threat of secession by New York city. All New Yorkers supported Washington for president and were pleased by the choice of New York city as the temporary national capital.

The friends and foes of the federal constitution continued their rivalry under the designations of Federalists and Anti-Federalists (Clintonian Republicans). Most of the aristocracy, except for the Livingston family, backed Hamilton whereas a majority of the farmers supported Clinton. Aaron Burr transformed Tammany hall from a fraternal association into an arm of the Republican (future Democratic) party. The Federalists easily elected Jay as governor in 1795. Jay reformed the criminal code and pushed through a law in 1799 providing for gradual emancipation of slaves. The Federalists, however, lost popular support because of their attempts to prosecute Jedediah Peck and other critics of Pres. John Adams under the federal Sedition act.

The return of Clinton as governor in 1801 inaugurated a period of factional strife among his Republican followers. His nephew, De Witt Clinton, challenged Aaron Burr's political control of New York city and became mayor in 1803. Burr in 1804 ran for governor as an independent with Federalist backing. Hamilton's advice to his friends not to vote for Burr added to Burr's hatred of Hamilton and this enmity led to a duel between the two men in which Hamilton was killed. Thereafter, the Federalists declined although the party experienced a temporary revival when the Embargo act and the War of 1812 injured trade and shipping.

Gov. Daniel D. Tompkins (1807–17) proved an exceptional war leader during the War of 1812. Tompkins surmounted such difficulties as the poorly trained militia, obstructive tactics by the Federalist majority in the assembly and incursions by the British. Many of the war's battles were fought along the state's borders. The American plan for an attack on Niagara and Montreal ended ingloriously largely because the state's militia refused to advance beyond the state's borders. British raids on Plattsburgh and Buffalo and the American burning of York (Toronto) occurred in 1813. The next year Capt. Thomas McDonough defeated a larger British fleet on Lake Champlain and prevented an invasion.

De Witt Clinton's speech in 1815 demanding canals between the Hudson river and Lakes Erie and Champlain met such an enthusiastic response the legislature was forced to make Clinton the head of a canal commission.

Power Politics.—In 1817 Clinton became governor by an almost unanimous vote and, largely through his efforts, the Erie canal was built. About this time, Martin Van Buren and other Republicans such as William L. Marcy and Silas Wright organized a powerful political machine known as the Albany Regency. This group favoured low taxes. fiscal economy and no government interference n-ith business. At the constitutional convention of 1821, Van Buren reflected the democratic spirit of the day by extending the vote to all nhite males over 21, but his group refused to give Negroes the vote unless they could meet high property qualifications. The Regency elected Joseph C. Tates in 1822 and ousted Clinton from the canal commission in 1824. This blunder enraged public opinion and Clinton was swept back into the governor's office in 1824 just in time to open the Erie canal in 1825.

New York politics was especially complicated in the period from 1825 to 1865. The two-party system tended to break down because of the almost continuous splits within the major parties and the emergence of several new parties. The principal issues were the role of government toward canals and railroads, the extension of slavery to the territories, prohibition of liquor, immigrants and the chartering of banks. Thurlow Weed and William Seward used the Antimasonic party (*q.v.*) to attack the Albany Regency which had granted many bank charters to its friends. Reed finally cemented an alliance between the Antimasons and most of the followers of De Witt Clinton. This alliance became known as the Whig party and was the main opposition to the Democratic party between 1834 and 1855.

Seward became the first Whig governor in 1838. The Whig program called for the enlargement of the Erie canal and more aid for education. A piece of significant legislation was the Free Banking act of 1838 under which individuals or associations could engage in banking without any special charter provided they had a paid-up capital of $100,000. The Democratic party was split between the "Hunkers" or conservatives and the "Barnburners" or radicals. The conservatives urged the use of canal revenues to complete the canals while the radicals wanted to pay off the state debt. The Earnburners opposed the extension of slavery into the territories, but the Hunkers co-operated with the southern Democrats m-ho often controlled the presidency and the national congress. In 1848 the Barnburners created the Free Soil party and chose Martin Van Buren to run for president. The Democratic split guaranteed a Whig victory for Hamilton Fish as governor and Zachary Taylor as president. But the slavery issue also split the Whigs and the factional fight within the party led to its collapse by 1855. The mortal blow came with the Kansas-Nebraska act of 1854 which led to the formation of the Republican party. Weed, William Seward and Horace Greeley were three of the prominent Whigs who joined the Republicans along with several Barnburners and Free Soilers. The Republican party attracted upstate farmers and small businessmen and in 1856 elected John King as governor.

The national crisis of 1860–61 bewildered New Workers, but under the able direction of Republican Gov. Edwin Morgan the state provided supplies, money and almost 500,000 soldiers for the ensuing Civil War. The unfair provisions of the draft act and its clumsy administration were the causes of the draft riots of July 1863 in New York city.

New York citizens took the leadership in the humanitarian movement mhich characterized the period between 1830 and 1860. The state supplied several leading reformers—Thomas Eddy, Gerrit Smith, Susan B. Anthony, Theodore Weld—in such fields as penology, mental care, temperance. women's rights and antislavery agitation. Washington Irving and James Fenimore Cooper established the state's literary reputation before 1825 after which New England authors marched to the fore. Walt Whitman and Herman Melville after 1850 re-established the leadership of New York in literary affairs. In music, art and the theatre, New York city became pacesetter for the nation.

New York became the "Empire state" by 1830 when it was first in population, agriculture, foreign trade, manufacturing and transportation facilities. The influx of hundreds of thousands of Yankees meant the rapid clearing of forests, stimulation of trade and the growth of factories. The most significant developments in the land history of the state were: the treaty of Hartford of 1786 by which Massachusetts gave up its claims to western New York in return for the land west of Seneca lake plus ten townships near Binghamton; the purchase of land titles from the Indians by Massachusetts and New York agents; the sale of huge tracts to such speculators as Robert Morris, the Holland Land company and the London associates; the rapid distribution of land into the hands of small farmers; the collapse of the old leasehold system; and the rise of speculation in urban real estate from New York city to Buffalo.

"Boss" Rule and Corruption.—During the decade following the Civil War, "boss" rule and corruption characterized government operations on the state, county and city levels. Postwar demoralization, the antiquated government structure, the pressure of business interests for franchises and contracts, the strengthening of political machines such as that of Boss William Tneed were the major causes of corruption. The Democratic party generally controlled the governorship between 1875 and 1895 under such important leaders as Samuel Tilden (1875–76) who broke up the "canal ring," (see TILDEN. SAMUEL JOKES), Grover Cleveland (1883–84) and David Hill (1885–91). During these years the Republican party was divided by factional strife with the leader Roscoe Conkling quarreling with Republican presidents, Rutherford Hayes, James Garfield and Chester Arthur, for control of patronage especially in the New York custom house. The governorship passed to Republicans between 1895 and 1910 because the public charged the Democrats with corruption and responsibility for the depression of 1893 and because the Republicans were ably led by Theodore Roosevelt and Gov. Charles Evans Hughes. Hughes (1907–10) brought about the regulation of insurance and utility companies, introduced many labour reforms including the first workmen's compensation law and took steps to conserve forest and water resources. The split between the progressive followers of Theodore Roosevelt and the conservative Republicans gave the state to the Democrats in 1910 and 1912. An intraparty fight between Democratic Gov. William Sulzer and Boss Charles Murphy of Tammany hall led to the impeachment of Sulzer in 1913. He was found technically guilty of perjury, misrepresentation of campaign expenditures and concealment of evidence. More important than these quarrels were the labour laws passed after the diastrous Triangle shirtwaist factory fire in New Tork city in 1911. Robert Wagner, with the aid of Alfred E. Smith, made a thorough examination of labour conditions and their recommendations were enacted into legislation. Among the laws passed was the Widowed Mothers Pension act.

Modern Times.—The Democratic party usually controlled the governor's office from 1918 to 1942 because of the ability of its able leaders such as Smith. Wagner, Franklin D. Roosevelt, and Herbert H. Lehman to attract the votes of the foreign-born and their children in the cities. Most immigrants preferred the Democratic party because of its traditional hospitality to immigrants as opposed to the nativistic tendencies of the Federalist-Whig-Republican group; its opposition to prohibition; its sympathy toward labour; and its willingness to use government agencies to combat the depression of 1930.

The structure and scope of New York's government has been transformed especially since 1922. Governor Smith (1919–20; 1923–28) left an impressive record despite the obstructive tactics of the Republican-controlled legislature. Smith aroused public opinion to force through his program including the consolidation of 187 bureaus into 18 departments; the executive budget; "home rule" for cities; more state aid to localities for roads, health and education; the expansion of the park system; the eight-hour day; the retention of public power sites; and the expansion of the mental hygiene program. Gov. Franklin D. Roosevelt (1929–33) continued Smith's policies despite the onset of the economic depression in 1930. He arranged for work relief for the unemployed and started a system of old-age pensions. In 1932 Roosevelt succeeded in removing James Walker, colourful mayor of New York city, whose administration was tainted with corruption. The Smith-Roosevelt experiments in social legislation anticipated much of the federal New Deal legislation of the 1930s.

Among the policies of Governor Lehman (1933–42) were more stringent regulation of public utilities, low-cost housing projects, minimum wages for women, close regulation of the dairy industry, the extension of the merit system to practically all government departments, a liberal welfare program and a balanced budget. In 1942 Thomas E. De ey, a Republican lawyer who had made a reputation prosecuting rackets in New York city, became governor, a position which he held until Jan. 1, 1955. Dewey continued Lehman's efforts to expand agricultural and industrial production for defense during World War II. The state division of commerce sought and secured many government contracts for New York firms. More than 1,000,000 workers mere trained and the state and federal labour boards were successful in settling almost all labour disputes. A special war council co-ordinated efforts to solve such problems as the shortage of farm labour, feed and gasoline, civilian defense, vocational training and food conservation. The Ives-Quinn act of 1945, the first state law of its kind, forbade discrimination in employment. Its chief purpose was to educate employers to hire the best qualified candidates. The five-man commission established by the act was given authority, however, to issue cease and desist orders against violators of its orders. Another achievement was the creation of the State university in 1948 which consolidated the existing state institutions of higher learning and also encouraged the establishment of new two-year community colleges. Under Dewey the health services were greatly expanded and in 1948 the thruway was begun. His administrations won for Dewey national attention, but he failed in his two campaigns for the presidency.

Averell E. Harriman, a Democrat, barely defeated Republican senator Irving Ives in 1954. Harriman's administration continued the policies begun by Smith, Roosevelt and Lehman and continued by Dewey. Harriman lost his bid for re-election in 1958 to Nelson Rockefeller, who won office by more than 500,000 votes. His program for 1959–60 continued the enlargement of social services and tax reforms.

GOVERNMENT

New York has been governed under five constitutions which were adopted in 1777, 1821, 1846, 1894 and 1938 respectively. The constitution of 1938 has 20 articles, including a bill of rights. It grants the vote to all citizens of 21 years or over who have resided within the state for 1 year, in the county for 4 months and in the election district for 30 days. Voters must also be able to read and write English. The constitution provides for revision in two ways. Every 20 years the voters are given the opportunity to approve or reject the convening of a constitutional convention. Any changes by a convention must receive the approval of the voters in the next election. The more frequently used method of revision, however, is passage of legislation by two consecutive sessions of the legislature after which the proposed changes are submitted to popular referendum.

The governor of New York is a strong executive whose prominent position often makes him a presidential possibility. He is elected for a four-year term along with a lieutenant governor, comptroller, and attorney general. Among the duties and powers of the governor are the construction of the budget, the appointment and removal of many officials, law enforcement, the approval or veto of legislation and the command of the state militia and police. In the event of the death, impeachment, resignation or absence of the governor, the lieutenant governor becomes the chief executive.

A constitutional amendment of 1944 added a department of commerce to the state's organization; an amendment in 1959 added the department of motor vehicles. The other state departments are those of audit and control, taxation and finance, law, state, public works, conservation, agriculture and markets, labour, education, health, mental hygiene, social welfare, correction, public service, banking, insurance and civil service. In addition there is an executive department directly under the control of the governor.

The legislative power is vested in a senate of 58 members and an assembly of 150 members, each chamber elected biennially. Both senators and assemblymen are elected from single districts. Republican control of the legislature and the constitutional conventions of 1894 and 1938 has led to the apportionment of seats in such a way as to favour upstate and rural counties over New York city. The legislature meets each year on the first Wednesday after the first Monday in January. Most of the work is done by committees whose chairmen have a great deal of power in determining what bills will receive approval. Bills approved by both houses are sent to the governor for his signature or veto. All bills sent within the last ten days of a legislative session are subject to the "30-day rule." The governor has 30 days to study these bills, but a bill must have his signature to become law.

The court structure is an unwieldy system which defied systematic reorganization from 1846 until 1959 when the legislature approved a constitutional amendment revising the court system within New York city. Most judges are elected, usually for a 14-year term. The court of appeals, the highest court in the state, consists of a chief justice and six associate justices who are elected from the state at large This court reviews only questions of law except in cases in which the death penalty is involved.

The state is divided into ten judicial districts each of which has several supreme court justices. The supreme court has general jurisdiction in law and equity, including both civil and criminal actions. There are four judicial departments in which appellate divisions of the supreme court are established. These courts review cases from the supreme and inferior courts. The governor selects the justices who sit on the appellate division. The court of claims consists of six judges appointed by the governor and approved by the senate for nine-year terms. It hears and determines private claims against the state.

Each of the 62 counties (unless wholly included in a city) has its own officials. The voters elect the more important officials such as the county judge, surrogate, sheriff, district attorney, clerk, treasurer and coroner. A board of supervisors which has one supervisor from each town and city ward has executive, legislative and financial powers. The five counties within New York city (*q.v.*) operate under a different pattern and a few counties such as Nassau and Westchester have created the elective position of county executive. Towns provide government for those citizens living outside the borders of cities. Within the towns are villages whose government is organized according to which one of the four classes they belong. Second class towns (generally those under 10,000 population), the most numerous, are governed by a board consisting of the supervisor, two councilmen and two justices of the peace. Cities range in size from Sherrill with about 2,000 people to New York city. Most cities are administered by a mayor and a city council or board of aldermen.

Finance and Taxation.—The state is financed through the

*New York: Places of 5,000 or More Population (1960 Census)**

Place	Population 1960	1950	1940	1920	1900
Total state	16,782,304	14,830,192	13,479,142	10,385,227	7,268,894
Albany	129,726	134,995	130,577	113,344	94,151
Albion	5,182	4,850	4,660	4,683	4,477
Amityville	8,318	6,164	5,058	3,265	2,038
Amsterdam	28,772	32,240	33,329	33,524	20,929
Arlington	8,317	5,374	—	—	—
Auburn	35,249	36,722	35,753	36,192	30,345
Babylon	11,062	6,015	4,742	2,523	2,157
Baldwin	30,204	—	—	—	—
Baldwinsville	5,985	4,495	3,840	3,685	2,992
Batavia	18,210	17,799	17,267	13,541	9,180
Bath	6,166	5,416	4,696	4,795	4,994
Beacon†	13,922	14,012	12,572	10,996	9,480
Bellmore	12,784	—	—	—	—
Bethpage-Old Bethpage	20,515	—	—	—	—
Binghamton	75,941	80,674	78,309	66,800	39,647
Brentwood	15,387	2,803	—	—	—
Briarcliff Manor	5,105	2,494	1,830	1,027	—
Brockport	5,256	4,748	3,590	2,980	3,398
Bronxville	6,744	6,778	6,888	3,055	579
Buffalo	532,759	580,132	575,901	506,775	352,387
Canandaigua	9,370	8,332	8,321	7,356	6,151
Canton	5,046	4,379	3,018	2,631	2,757
Catskill	5,825	5,392	5,429	4,728	5,484
Cedarhurst	6,954	6,051	5,463	2,838	—
Centereach	8,524	—	—	—	—
Cheektowaga-Northwest	52,362	—	—	—	—
Cheektowaga-Southwest	12,766	—	—	—	—
Cohoes	20,129	—	—	—	—
Colonie	6,992	2,068	1,407	10,196§	7,035§
Commack	9,613	—	—	—	—
Copiague	14,081	—	—	—	—
Corning	17,085	17,684	16,212	15,820	11,061
Cortland	19,181	18,152	15,881	13,294	9,014
Croton-on-Hudson	6,812	4,837	3,843	2,286	1,533
Dansville	5,460	5,253	4,976	4,631	3,633
Deer Park	16,726	—	—	—	—
Depew	13,580	7,217	6,084	5,850	3,379
Dobbs Ferry	9,260	6,268	5,883	4,401	2,888
Dunkirk	18,205	18,007	17,713	19,336	11,616
East Aurora	6,791	5,962	5,253	3,703	2,366
East Hills	7,184	2,547	343	—	—
East Massapequa	14,779	—	—	—	—
East Meadow	46,036	—	—	—	—
East Northport	8,381	3,842	—	—	—
East Rochester	8,152	7,022	6,691	3,901	—
East Rockaway	10,721	7,970	5,610	2,005	739
Eggertsville	44,807	—	—	—	—
Ellenville	5,003	4,225	4,000	3,116	2,879
Elmira	46,517	49,716	45,106	45,393	35,672
Elmira Heights	5,157	5,009	4,829	4,188	1,763
Elmira Southeast	6,698	—	—	—	—
Elmont	30,138	—	—	—	—
Endicott	18,775	20,050	17,702	9,500	—
Fairport	5,507	5,267	4,644	4,626	2,489
Fairview	8,626	1,721	—	—	—
Farmingdale	6,128	4,492	3,524	2,091	—
Floral Park	17,499	14,582	12,950	2,097	—
Franklin Square	32,483	—	—	—	—
Fredonia	8,477	7,095	5,738	6,051	4,127
Freeport	34,419	24,680	20,410	8,599	2,612
Fulton	14,261	13,922	13,362	13,043	5,281
Garden City	23,948	14,486	11,223	2,420	—
Garden City Park-Herricks	15,364	—	—	—	—
Geneva	17,286	17,144	15,555	14,648	10,433
Glen Cove	23,817	15,130	12,415	8,664	—
Glens Falls	18,580	19,610	18,836	16,638	12,613
Gloversville	21,741	23,634	23,329	22,075	18,349
Great Neck	10,171	7,759	6,167	—	—
Greenlawn	5,422	1,000	—	—	—
Hamburg	9,145	6,938	5,467	3,185	1,683
Hamburg-Lake Shore	11,527	—	—	—	—
Hastings-on-Hudson	8,979	7,565	7,057	5,526	2,002
Haverstraw	5,771	5,818	5,909	5,226	5,935
Hempstead	34,641	29,135	20,856	6,382	3,582
Henrietta Northeast	6,403	—	—	—	—
Herkimer	9,396	9,400	9,617	10,453	5,555
Hicksville	50,405	—	—	—	—
Hornell	13,907	15,049	15,649	15,025	11,918
Horseheads	7,207	3,606	2,570	2,078	1,901
Hudson	11,075	11,629	11,517	11,745	9,528
Hudson Falls	7,752	7,236	6,654	5,761	4,473
Huntington	11,255	9,324	31,768‖	13,893‖	9,483‖
Huntington Station	23,438	9,924	31,768‖	13,893‖	9,483‖
Ilion	10,199	9,363	8,927	10,169	5,138
Inwood	10,362	—	—	—	—
Irvington	5,494	3,657	3,272	2,701	2,231
Ithaca	28,799	29,257	19,730	17,004	13,136
Jamestown	41,818	43,354	42,638	38,917	22,892
Jericho	10,795	—	—	—	—
Johnson City‡	19,118	19,249	18,039	8,587	3,111
Johnstown	10,390	10,923	10,666	10,908	10,130
Kenmore	21,261	20,066	18,612	3,160	318
Kings Point	5,410	2,445	1,247	—	—
Kingston	29,260	28,817	28,589	26,688	24,535
Lackawanna	29,564	27,658	24,058	17,918	—
Lancaster	12,254	8,665	7,236	6,059	3,750
Larchmont	6,789	6,330	5,970	2,468	945
Lawrence	5,907	4,681	3,649	2,861	558
Levittown	65,276	—	—	—	—
Lindenhurst	20,905	8,644	4,756	—	—

Place	Population 1960	1950	1940	1920	1900
Little Falls	8,935	9,541	10,163	13,029	10,381
Lockport	26,443	25,133	24,379	21,308	16,581
Locust Grove	11,558	—	—	—	—
Long Beach	26,473	15,586	9,036	282	—
Lynbrook	19,881	17,314	14,557	4,371	—
Malone	8,737	9,501	8,743	7,556	5,935
Malverne	9,968	8,086	5,153	—	—
Mamaroneck	17,673	15,016	13,034	6,571	—
Massapequa	32,900	—	—	—	—
Massapequa Park	19,904	2,334	488	—	—
Massena	15,478	13,137	11,328	5,993	2,032
Mechanicville	6,831	7,385	7,449	8,166	4,695
Medina	6,681	6,179	5,871	6,011	4,716
Merrick	18,789	—	—	—	—
Middletown	23,475	22,586	21,908	18,420	14,522
Mineola	20,519	14,831	10,064	3,016	—
Monticello	5,222	4,223	3,737	2,330	1,160
Mount Kisco	6,805	5,907	5,941	3,944	1,346
Mount Vernon	76,010	71,899	67,362	42,726	21,228
Newark	12,868	10,295	9,646	6,964	4,578
Newburgh	30,979	31,956	31,883	30,366	24,943
New Hyde Park	10,808	7,349	4,691	—	—
New Rochelle	76,812	59,725	58,408	36,213	14,720
New York City	7,781,984	7,891,957	7,454,995	5,620,048	3,437,202
Niagara Falls	102,394	90,872	78,029	50,760	19,457
North Bellmore	19,639	—	—	—	—
North Merrick	12,976	—	—	—	—
North New Hyde Park	17,929	—	—	—	—
North Pelham	5,326	5,046	5,052	2,385	684
Northport	5,972	3,859	3,093	1,977	1,794
North Syracuse	7,412	3,356	2,083	—	—
North Tarrytown	8,818	8,740	8,804	5,927	4,241
North Tonawanda	34,757	24,731	20,254	15,482	9,069
North Valley Stream	17,239	—	—	—	—
Norwich	9,175	8,816	8,694	8,268	5,766
Nyack	6,062	5,889	5,206	4,444	4,275
Oceanside	30,448	—	—	—	—
Ogdensburg	16,122	16,166	16,346	14,609	12,633
Olean	21,868	22,884	21,506	20,506	9,462
Oneida	11,677	11,325	10,291	10,541	6,364
Oneonta	13,412	13,564	11,731	11,582	7,147
Ossining	18,662	16,098	15,996	10,739	7,939
Oswego	22,155	22,647	22,062	23,626	22,199
Owego	5,417	5,350	5,068	4,147	5,039
Patchogue	8,838	7,361	7,181	4,031	2,926
Peekskill	18,737	17,731	17,311	15,868	10,358
Pelham Manor	6,114	5,306	5,302	1,754	1,571¶
Penn Yan	5,770	5,481	5,308	4,517	4,650
Plainedge	21,973	—	—	—	—
Plainview	27,710	—	—	—	—
Plattsburgh	20,172	17,738	16,351	10,909	8,434
Pleasantville	5,877	4,861	4,454	3,590	1,204
Port Chester	24,960	23,970	23,073	16,573	7,440
Port Jervis	9,268	9,372	9,749	10,171	9,385
Port Washington	15,657	—	—	—	—
Potsdam	7,765	7,491	4,821	4,039	3,843
Poughkeepsie	38,330	41,023	40,478	35,000	24,029
Rensselaer	10,506	10,856	10,768	10,823	7,466
Riverhead	5,830	4,892	8,922§	5,753§	4,503§
Rochester	318,611	332,488	324,975	295,750	162,608
Rockville Centre	26,355	22,362	18,613	6,262	1,884
Rome	51,646	41,682	34,214	26,341	15,343
Roosevelt	12,883	—	—	—	—
Rotterdam	16,871	—	—	—	—
Rye	14,225	11,721	9,865	5,308	12,861§
Salamanca	8,480	8,861	9,011	9,276	4,251
San Remo	11,996	—	—	—	—
Saranac Lake	6,421	6,913	7,138	5,174	2,594
Saratoga Springs	16,630	15,473	13,705	13,181	12,409
Scarsdale	17,968	13,156	12,966	3,506	885§
Schenectady	81,682	91,785	87,549	88,723	31,682
Scotia	7,625	7,812	7,960	4,358	3,010♀
Sea Cliff	5,669	4,868	4,416	2,108	1,558
Seaford	14,718	—	—	—	—
Seneca Falls	7,439	6,634	6,452	6,389	6,519
Sidney	5,157	4,815	3,012	2,670	2,331
Sloan	5,803	4,698	3,836	1,791	873
Solvay	8,732	7,868	8,201	7,352	3,493
South Farmingdale	16,318	—	—	—	—
South Huntington	7,084	1,274	—	—	—
South Westbury	11,977	—	—	—	—
Spring Valley	6,538	4,500	4,308	3,818	—
Stony Point	8,739§	5,485§	4,898§	3,211§	4,161§
Suffern	5,094	4,010	3,768	3,154	1,619
Syracuse	216,038	220,583	205,967	171,717	108,374
Tarrytown	11,109	8,851	6,874	5,807	4,770
Tonawanda (city)	21,561	14,617	13,008	10,068	7,421
Tonawanda	83,771	—	—	—	—
Troy	67,492	72,311	70,304	72,013	60,651
Tuckahoe	6,423	5,991	6,563	3,509	—
Tupper Lake	5,200	5,441	5,451	2,508	3,045♂
Uniondale	20,041	—	—	—	—
Utica	100,410	101,531	100,518	94,156	56,383
Valley Stream	38,629	26,854	16,679	—	—
Vernon Valley	5,998	—	—	—	—
Wantagh	34,172	—	—	—	—
Waterloo	5,098	4,438	4,010	3,809	4,256
Watertown	33,306	34,350	33,385	31,285	21,696
Watervliet	13,917	15,197	16,114	16,073	14,321
Waverly	5,950	6,037	5,450	5,270	4,465

(*Continued*)

*Populations are reported as constituted at date of each census. †Fishkill Landing and Matteawan villages consolidated and incorporated as Beacon since [illegible]. ‡Name changed from Lestershire since 1910. §Township. ‖Huntington township, which includes the population [illegible] Huntington and Huntington Station. ¶Pelham township, which includes the population of Pelham Manor. ♀Glenville township, which includes the population of Scotia. ♂Altamont township, which [illegible] the [illegible]opulation of Tupper Lake.

Note: Dash indicates place did not exist during the reported census, or data not available.

New York: Places of 5,000 or More Population (1960)—(Continued)*

Place	Population				
	1960	1950	1940	1920	1900
Wellsville	5,967	6,402	5,942	4,996	3,556
Westbury	14,757	7,112	4,524	—	—
West Elmira . . .	5,763	3,833	—	—	—
West Haverstraw .	5,020	3,099	2,533	2,018	2,079
West Hempstead-Lakeview	24,783	—	—	—	—
West Seneca . . .	23,138	—	—	—	—
White Plains . . .	50,485	43,466	40,327	21,031	7,899
Williamsville . . .	6,316	4,649	3,614	1,753	905
Williston Park . . .	8,255	7,505	5,750	—	—
Woodmere . . .	14,011	—	—	—	—
Yonkers .	190,634	152,798	142,598	100,176	47,931

'Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during the reported census, or data not available.

general fund which is divided into two subsidiary funds; the local assistance fund from which appropriations are made in support of units of local government and the state purposes fund from which appropriations are made for the operation of state departments and for debt service. The state's capital construction is provided for through the capital construction fund.

The constitution requires that on or before Feb. 1 of each year the governor shall submit a budget to the legislature. The budget contains a complete plan of expenditures for the next fiscal year and also the year's estimated revenues. State expenditures and revenues rose sharply after World War II. The budget for the fiscal year beginning April 1, 1946. called for the expenditure of about $600,000,000; 15 years later the figure was about $2.000,000,000 of which local governments received over $1,000,000,000. State aid for local education increased from about 24% of the total budget to about 33% for the same period. New York spent more money per pupil than any other state. At the same time the state government spent almost 35% of the total budget for its own departments. The largest expenditure was for mental hygiene, followed by public works and correction. In addition, about $300,000,000 annually was appropriated from the separate capital construction fund, most of which was assigned to highways, parkways and grade crossings. By 1959 the state debt totaled nearly $900,000,000.

In 1959 the legislature raised taxes on gasoline and on cigarettes and the income tax was placed on a withholding basis and the maximum rate raised to 10% on taxable income over $15,000. The chief kinds of taxes in New York are individual income taxes, corporation net income taxes, motor fuels taxes, motor vehicle and operators licences, tobacco products taxes, alcoholic beverages taxes and property taxes. New York ranked after Connecticut and Delaware in size of per capita income. In 1959 it was $2,736.

The state banking department was created in 1851. It is required to examine every bank, trust company and other financial institution within the state but not the national banks. In the second half of the 20th century there were more than 600 banks in the state with total assets of nearly $75,000,000,000. At the same time the assessed value of property subject to state and local government tax was more than $35,000,000,000.

POPULATION

The population of New, York remained scanty and scattered throughout the colonial period. In 1664 there were fewer than 10,000 inhabitants of whom about two-thirds were Dutch; the others were divided between Swedes, French, Germans, Negroes and English. It is estimated that the population was about 19,000 in 1700 and about 75,000, 50 years later. The figure was about 170,000 at the time of the American Revolution and included approximately 20,000 Negroes. Practically all of these persons lived within a few miles of the Hudson river or the Atlantic ocean. The emigration of more than 25,000 Loyalists (Tories) during and after the Revolution was more than offset by the great influx of New Englanders after 1783. The first federal census of 1790 revealed New York had 340,120 inhabitants. This made it fifth among the 18 states and territories that then composed the union. Approximately one-half of the white population in 1790 was of English descent with the large families of Connecticut as important a source of English blood as the United Kingdom itself. Long Island east of Brooklyn was a Yankee stronghold; the Dutch element, less than one-fifth of the total, was strong in Albany and in Ulster county. Germans from the Palatinate district along the Rhine were scattered through the Schoharie valley, the upper reaches of the Mohawk river and the Hudson valley. The small French contingent settled in New York city. New Rochelle and New Paltz. Scots from northern Ireland and Scotland were numerous in Orange and Ulster counties and in the Cherry valley region. The Negro minority, the largest among the northern colonies, became relatively less important after the American Revolution when immigration from New England and Europe increased.

More than half of the 1,372,812 inhabitants of New York in 1820 were of New England descent. At that time, fewer than 15% of the people lived in urban centres of more than 3,000 persons. New York became the nation's most populous state in 1820 and has remained so ever since. Another wave of immigration flooded New York between 1840 and 1860 when great numbers of Irish and Germans poured into the state. In 1855 persons born in Europe constituted more than one-fourth of the people of the state and nearly one-half of the population of New York city. In 1860, just before the Civil War, the population was 3,880,735, nearly two-fifths of which was centred in urban places.

The Irish and Germans provided the largest number of immigrants until about 1890 at which time the influx of Italians, Russians: Poles and Greeks increased rapidly until World War I. The restrictions placed on immigration by congress during the 1920s checked the number of immigrants and the economic depression of the 1930s brought immigration to a virtual standstill.

In 1960 the population showed a total of 16,782,304 persons living in the state, 85.4% of whom were urban dwellers. Following World War II there was a heavy influx of people from Puerto Rico and the south Atlantic states. The population of the state in 1960 was 78.0% native white; 12.9% foreign-born white; and 8.9% nonwhite. The percentage of the population 65 years old or over was 9.9%, and 57.5% of the population 14 years old and over was in the labour force. There were seven standard metropolitan statistical areas in 1960 and they cdntained 85.5% of the total population. They were Albany-Schenectady-Troy (comprising Albany, Rensselaer, Saratoga and Schenectady counties) ; Binghamton (comprising Broome county); Buffalo (comprising Erie and Niagara counties); New York (comprising New York city, Nassau, Rockland, Suffolk, Westchester counties); Rochester (comprising Monroe county); Syracuse (comprising Madison, Onondaga and Oswego counties); and Utica-Rome (comprising Herkimer and Oneida counties).

In 1960 New York had a population of 16,782,304, an increase of 1,952,112 or 13.2% over 1950. The population per square mile in 1960 was 338.5, as compared with 49.6 for the U.S. as a whole. The percentage of persons 65 years old or over was increasing, being 8.57; in 1950. The percentage of the population 14 years old and over that was in the labour force (54.5% in 1950) was steadily increasing, the result of prolonged schooling for that age group. Foreign-born whites numbered 2,181,868 in 1960 with the Italians (430,843) and English (406,128) in the lead. In 1960 New York city with about half of the state's population had more than 67.1% of the foreign-born white residents in the state. About 48.6% of the city's residents were foreign born or of foreign or mixed parentage. Comparable figures for other centres were: 48.1% for Yonkers; 37.8% for Rochester; 35.4% for Buffalo; 32.4% for Syracuse.

EDUCATION

Historical and Administrative.— A,majority of the children in colonial New York never saw the inside of a schoolroom. The Dutch in 1633 established the first school at New Amsterdam (now New York city). Under the British the Society for the Propagation of the Gospel in Foreign Parts set up a few schools for the children of the Indians and the poor. Middle-class families often employed tutors or sent their children to private schools. The few youths preparing for the ministry or the law attended college usually at Yale or Princeton (then the College of New Jersey). The Anglicans founded King's college (later Columbia university) in 1754. During the Revolutionary War most of the schools were closed.

In 1784 the legislature established a system of education which was supervised by a board of regents and was authorized to establish secondary schools and colleges. Later the board's functions mere extended to include the jurisdiction of the professional, scientific and technical schools, the administration of laws relating to the admission to the professions, the charge of the state library at Albany, the supervision of local libraries and the custody of the state museum. Although the regents proposed a public-school system in 1787. little was done until 1795 when the legislature granted money for five years to elementary schools under county sponsorship. In 1812 the legislature provided for a permanent system of public schools with school districts in each township. By 1828 schools had been established in more than 8.000 districts. These schools received funds from the state. the locality and the parents of the children attending them. As many parents could not or would not pay the fees there was a movement for free public schools. The legislature in 1851 granted $800.000 for schools but it was not until 1867 that all the elementary schools became free.

Secondary schools called academies were founded by private groups with some financial assistance from the regents. Such schools charged tuition and prepared students for college. During the 1850s a few cities began to set up free public high schools. After the Civil War the movement swept across the state and most academies were taken over by the public high schools. The larger church groups founded. colleges principally as a place where they could train young men for the clergy.

The legislature in 1904 reorganized the educational system. While the regents kept authority over colleges and universities, a commissioner of education was made responsible for elementary and secondary education. The commissioner became the chief officer of the whole educational system.

Among the major educational trends in the 20th century have been expanding enrollments; broader curriculums; consolidation of district schools into centralized schools; increase in state aid to localities and expansion of publicly supported colleges and universities. The consolidation or centralization of school districts has proceeded rapidly until fewer than 10% of the original districts remained in the second half of the 20th century. This trend was encouraged by a law of 1925 which granted additional state aid to districts setting up centralized schools.

The State University of New York, established in 1948, comprises 46 colleges; 30 of them are state-operated; 16 are locally sponsored community colleges. The university offers four-year programs in liberal arts: hcme economics, industrial and labour relations, veterinary medicine, ceramics, agriculture, forestry, maritime service, medicine and teacher preparation as well as two-year programs in a variety of fields, including technical courses in agricultural, industrial: health and service areas. Several of its colleges offer graduate programs. The university is governed by a board of trustees appointed by the governor. Each college is locally administered. The teachers colleges are located at Albany, Buffalo. Oneonta. Brockport, Cortland, Fredonia. Geneseo. New Paltz. Oswego, Plattsburgh and Potsdam. There are agricultural and technical schools at Morrisville, Delhi, Cobleskill. Farmingdale: Canton and Alfred; the maritime college is at Fort Schuyler; four colleges are at Cornell university (agriculture, home economics, veterinary and industrial and labour relations) ; the college of forestry is at Syracuse university; a college of ceramics is at Alfred university; the upstate medical centre is at Syracuse; the downstate medical centre is at Brooklyn; the state university college is at Oyster Bay; and Harpur college, a four-year liberal arts institution, is at Endicott.

The College of the City of New York comprises the municipal four-year colleges administered by the board of higher education of the city of New York. The colleges are City college (1847); Brooklyn college (1930) ; Hunter college (1870) ; and Queens college (1937). Under federal control are the United States Military academy at West Point, founded in 1802 and the United States Xlerchant Marine academy at Kings Point. founded in 1938. Columbia university (*q v*) in New Work city. one of the nation's most famous schools, was founded in 1754 as King's college. Its activities suspended during the Revolutionary War, it was reopened in 1784 as Columbia college under a charter granted by the state of New York By an act of the state legislature the name of the institution was changed in 1912 to Columbia University of the City of New York. Barnard college (1889) in New York city is the undergraduate college for women of Columbia university.

Among the other notable privately controlled colleges and universities in New York are Colgate university (Hamilton 1819); Cooper Union (1859). founded by Peter Cooper: Cornel! university (Ithaca. branches at New York city, Geneva and Buffalo, 1865), especially noted for its agricultural and medical schools; Fordham university (New York city, Roman Catholic. 1841); Hamilton college (Clinton. 1793); New York university (New York city, 1831): Sarah Lawrence college (Bronxville, 1926), for women; and Vaisar college (Poughkeepsie. 1861), for women. Other privately controlled colleges and universities in the state include in New York city: College of Mount St Vincent (Roman Catholic 1910), Finch college (1900). Jewish Theological Seminary of America (1887). Juilliard School of Music (1905). Manhattan college (Roman Catholic, 1849), Manhattan School of Music (1917). Mills College of Education (1909). New School for Social Research (1919). Pace college (1906). Yeshiva university (Jewish Orthodox, 1897); in Brooklyn: Long Island university and C. W. Post college (Brooklyn and Brookville, 1926). Polytechnic Institute of Brooklyn (1854). Pratt Institute (1887). St. Francis college (Roman Catholic, 1884). St. John's university (Roman Catholic. 1870), St. Joseph's College for Women (Roman Catholic. 1916): in Buffalo Canisius college (Roman Catholic, 1870) D'Youville college (Roman Catholic 1908), Mount St. Joseph Teachers college (Roman Catholic. 1937). Rosary Hill college (Roman Catholic, 1947), University of Buffalo (1846); in Rochester: Nazareth college (Roman Catholic. 1924). Rochester Institute of Technology (1829) St. John Fisher college (Roman Catholic, 1951), University of Rochester (1850). Among the other such New York schools might be included Adelphi college (Garden City, 1896); Alfred university (1836); Bard college (Annandale-on-Hudson, 1860); Clarkson College of Technology (Potsdam, 1895): College of New Rochelle (Roman Catholic, 1904); College of St. Rose (Albany, Roman Catholic. 1920); Elmira college (1855); Good Counsel college (White Plains, Roman Catholic, 1923); Hartwick college (Oneonta, related to United Lutheran Church, 1928); Hobart and William Smith colleges (Geneva. Hobart, an affiliate of Episcopal Church 1822); Hofstra college (Hempstead. 1935): Houghton college (Wesleyan Methodist. 1883); Iona college (New Rochelle. Roman Catholic, 1940); Ithaca college (1892); Keuka college (Keuka Park. affiliate of American Baptist Church, 1892); Le Moyne college (Syracuse, Roman Catholic. 1946); Manhattanville College of the Sacred Heart (Purchase. Roman Catholic. 1541); Maryknoll Teachers college (Roman Catholic, 1931); Niagara university (Roman Catholic, 1856); Notre Dame College of Staten Island (Roman Catholic. 1931): Rensselaer Polytechnic institute (Troy, 1824); Russell Sage college (Troy. 1916); St Bernardine of Siena college (Loudonville. Roman Catholic 1937); St Bonaventure university (St Bonaventure. Roman Catholic. 1659); St Lawrence university (Canton, 1856): Skidmore college (Saratoga Springs, 1911); Syracuse university (founded by Methodist Church. 1870); Union college and university (Schenectady and Albany, 1795); Utica college (1946); Wagner college (Staten Island related to the United Lutheran Church of America, 1883); Webb Institute of Naval Architecture (Glen Cove, 1889); and Wells college (Aurora. 1868).

HEALTH, WELFARE AND CORRECTIONS

Until the latter part of the 19th century private charity or the almshouse were the chief means of caring for the unfortunate but gradually public agencies expanded their scope of activities to include suitable care to dependent children, the mentally ill, the aged and infirm and the destitute. Local, state and federal governments participate and co-operate in the administration and financing of welfare services.

Public health services in New York are handled largely through the department of health and the department of mental hygiene. The latter has the largest staff and budget of all of the state's departments and cares for more than 100,000 mental patients in 18 hospitals. It also administers six state schools for mental defectives, one colony for epileptics, one psychiatric institute for research in New York city and one psychiatric hospital for observation in Syracuse. The department of health is responsible for the administration and enforcement of the public health laws and state sanitary code. It supervises all the local health agencies except those of New York city. Despite spectacular progress in diminishing the death rate from tuberculosis, the department, in the second half of the 20th century, still operated sanitoriums at Oneonta, Ray Brook and Mt. Morris. The department also sponsors research in the treatment and care of cancer at the Roswell Park Memorial institute in Buffalo and the Rehabilitation hospital at West Haverstraw. The five regional health offices of the state, located at Albany, Buffalo, Syracuse, Rochester and White Plains carry out programs in their regions and aid local agencies.

The welfare services offered by New York are administered by many departments. For convenience, however, public welfare functions are understood to mean the services controlled by the department of social welfare established in 1867 although under a different name. This department in 1873 received authority to visit and inspect all charitable and correctional institutions whether supported by state, local government or private funds. In the late 1950s it supervised nearly 2,500 agencies including about 600 hospitals and dispensaries, more than 400 homes and orphanages and more than 100 child-placing organizations. At the same time, it supervised more than 60 local public welfare districts, granting them financial aid for such programs as old-age assistance, aid to the disabled, assistance to the blind, home relief, veteran aid, foster care of children and other programs.

The change in title from prison department to department of correction in 1925 indicated a significant change in attitude toward offenders. The main concern was no longer to punish but to restore prisoners to a useful position in society. New York has pioneered in penology as is shown in the development of the Auburn system *(see* **PRISON:** *United States)* and the establishment of the first state reformatory. Six prisons are of the maximum security type: they are Attica, Auburn, Green Haven, Clinton prison at Dannemora, Great Meadow at Comstock and Sing Sing at Ossining. Wallkill prison and Westfield state farm at Bedford Hills are medium security prisons. Reformatories for boys and young men are those at Elmira and the vocational institute at West Coxsackie. Other special institutions are located at Albion, Woodbourne and Napanoch. The state hospitals for the criminal insane are Matteawan at Beacon and Dannemora.

New York has had a department of labour since 1901. It enforces laws designed to protect the health and safety of employees; to improve working conditions; to establish minimum wages; to provide benefits to workers eligible for unemployment insurance, workmen's compensation and disability benefits; and to promote peaceful labour relations.

THE ECONOMY

Living Conditions. — New York state residents have one of the highest standards of living in the world. In the second half of the 20th century wages and salaries accounted for 68% of all income flowing to New Yorkers, a substantial increase over the 56% for 1929. Property income in the same period fell, however, from 30% to 15%. Proprietors' income was 9%, a figure lower than the national average because of the lesser role played by agriculture in the economy of the state. Other income, including transfer payments and fringe benefits, have tripled since 1929 and accounted for 5.7% of the total.

Income and living conditions improved substantially after World War II. Median income per family reached $5,500 ten years after the war. New York differed from the rest of the U.S. in that there was a much higher percentage of residents engaged in clerical and sales work and a much lower percentage engaged in farming. Nearly 10% of the employed persons in the U.S. lived in New York.

Housing standards in New York are markedly higher than the national average. By the second half of the 20th century more than 83% of the dwelling units had private baths, toilets and hot water; about 90% had mechanical refrigeration and about 82% had central heating. Approximately 11.1% of the houses dated from 1940 or later; almost 53% were built before 1919. Since 1950 a large number of one-family units have been built in the suburban areas.

Agriculture. — Good soil, excellent transportation facilities and nearby markets have kept New York an important agricultural state. The value of farm products totaled more than $800,000,000 in the second half of the 20th century.

The economy of colonial New York was based on agriculture which supported more than 80% of the people. The colonial aristocracy acquired an unusually large share of the land because of close relations with the governors. Most of the landlords rented their lands for perpetuity or for the lives of the two or three persons named in the lease. Westchester county had six manors which covered more than half its total acreage. Scarsdale, Cortlandt Manor and Philipse Manor included about 400 sq.mi. Livingston Manor, the seat of one of the most distinguished families in New York history, included 160.000 ac. while Van Rensselaer Manor covered about 750,000 ac. surrounding Albany. Tenants owed the Van Rensselaer family 10 to 14 bu. of wheat for each 100 ac., four fat hens and one day's service with a team. When the tenant sold his farm, he had to pay an alienation fee equal to one-fourth of the sale price.

This land system retarded the development of upstate New York since few immigrants wished to become tenants when freehold farms were obtainable in Pennsylvania, New Jersey and New England. The tenants, resentful of their economic and political inferiority, rose up in revolt on several occasions. In the 1760s antirent agitation swept through the leasehold areas on the east bank of the Hudson but the governor sent troops to put down the rebellion. The tenants, however, won some victories. The confiscation of loyalist (Tory) estates during the Revolution broke up the manors and estates along the lower Hudson, but the farmers in Albany, Rensselaer, Columbia, Schoharie and Delaware counties had to wait until the 1840s for an end to the-leasehold system. *(See* ANTIRENT WAR.)

The rise of commercial farming came hard on the heels of the conquest of upstate by pioneer farmers. At first, wheat was the main cash crop, but by 1850 dairying had advanced to first place. The amount of land cultivated reached its peak in 1880 after which much marginal land was allowed to revert to brush, forest or pasture.

The number of farms fell from about 160,000 in 1930 to 106,000 25 years later; these farms comprised more than 15,000,000 ac. During the same period the average size of farms rose from 112 ac. to 142.6 ac. and the value per farm from $6,180 to $15,844.

Dairying is by far the most important source of farm income, providing about one-half of the total. Other important sources of farm income are poultry and eggs, livestock products, fruit, vegetables and field crops. The state raises a variety of horticultural specialties including nursery products, crops grown under glass, flower bulbs and seed and competes with Vermont in the production of maple sugar. The fruit and vegetable farms supply the large food-processing industry with such products as apples, cherries, peaches, currants, berries, tomatoes, peas, beans, sweet corn and cabbage.

Manufacturing. — In New York manufacturing developed slowly as artisans in small shops took care of most local needs. Workingmen, in colonial days, belonged to one of four groups: free labour, apprentices, indentured servants and slaves. Bound labour gradually declined since it was less efficient than free labour.

By 1840 New York city won top rank among the cities of the nation in manufacturing. A chain of commercial and manufacluring centres grew up along the Erie canal and New York Central railway. The Industrial Revolution progressed fairly slowly, however, and as late as 1850 most goods were made by hand in the home or in the shops of craftsmen. The textile industry had started during the War of 1812 when British imports were unobtainable. Small textile factories grew up along the streams of Oneida, Columbia and Dutchess counties. The clothing manufacturers employed the largest number of workers by 1860, with New York city and Rochester as the main centres of the industry. The processing of foodstuffs — brening, milling. meatpacking—gradually moved from small local establishments which used water power to larger concerns in the cities where coal was the source of power.

New York has ranked first among the states in the value of its manufactures since 1830. The exceptional transportation facilities, the commercial supremacy of New York city, the location of the state near the great trade routes, the influx of millions of immigrants both skilled and unskilled, the ample financial resources and the availability of power were the major factors stimulating the industrial development of the Empire state.

New York's pattern of manufacturing activity has been distinctive in several respects. For decades the nondurable goods industries employed more than 60% of all the state's manufacturing workers, a percentage considerably higher than that for the nation. Since World War II, however, the durable goods industries have grown rapidly offsetting the drop in employment in textiles, clothing and other nondurable goods. Similarly, an unusually large percentage of employed workers were engaged in the service trades. The apparel trades accounted for 21% of all manufacturing employees compared with only 6% for the rest of the United States. The ten leading industries in 1860 were flour, men's clothing, sugar refining. leather, liquors, lumber, printing, boots and shoes, machinery and oil; in 1960 they were apparel, printing and publishing, food, machinery, electrical machinery, chemicals, transportation equipment, instruments, fabricated metal products and primary metals. In 1860 most of the industry was engaged in the processing of the products of farm or forest, but by mid-20th century heavy goods such as machinery, metals and transportation equipment were very important to the economy of New York.

In the second half of the 20th century, New York state led all of the others in the number of persons employed in the apparel, printing and publishing, paper and paper products, instruments and furniture industry groups. The state produced approximately 50% of the country's total output of women's dresses, coats and blouses, 90% of the women's furs and 35% of men's and boys' tailored clothes. It produced about 70% of the value of photo equipment manufactured in the nation. The total value added to manufactures, rising steadily each year, exceeded $17,000,000,000 by 1960.

In upstate New York there are six metropolitan areas that are leading industrial centres. They are Buffalo. Rochester. Albany-Troy-Schenectady, Syracuse, Utica-Rome and Binghamton. The Buffalo area has the largest steel-producing plants in the state and great aircraft and chemicals plants. Rochester is famous for its manufacture of cameras and scientific instruments. The state's electrical machinery industry is centred in the Schenectady, Utica and Syracuse areas. Syracuse also is famous for china, chemicals and machinery. The Binghamton region specializes in the manufacture of business machines, photographic supplies and shoes. Also, tremendous industrial expansion has taken place on Long Island since 1945, especially in the making of aircraft and instruments. The construction of the St. Lawrence power project has led to the construction of many new factories particularly aluminum plants.

Minerals.—New York produces more than 30 mineral substances. Among them are cement, iron ore, stone, sand and gravel, coke, clays, gypsum and zinc. Deposits of petroleum and natural gas are found in the southwestern part of the state. New York is a leading producer of salt (about 20% of U.S. total) for domestic, industrial and chemical uses. Minor minerals such as talc, emery, garnet and titanium are mined in the Adirondack region. The stale ranked 18th in 1958 among the states in the value of its mineral output — more than $200,000,000.

Iron and lead have been mined in New York since colonial days. Troy became a steel-processing centre and steel processed there was used in the construction of the "Monitor" in 1862. Until about 1880 the state remained an important centre of iron mining, but thereafter the industry declined steadily in importance until World War II. Following the war, however, there was an increase in the mining of lead, zinc and titanium. For many years, New York mas the only producer among the states of emery and it has been a leader in the production of talc, soapstone and pyrophyllite.

Commerce and Finance. — New York is by far the leading state of the union in wholesale and retail trade and employs over one-fifth of the total persons employed in these occupations. Commerce has been significant to the economy of New York from its earliest history. The export of breadstuffs increased so rapidly that the flour barrel was placed on the official seal of Ne York city in 1682. Most trade, at that time, consisted of the exchange of foodstuffs and furs for manufactures from England and for sugar and molasses from the West Indies. Shiponners often ignored the navigation acts by trading with the planters in the French and Spanish West Indies. The port of New York became the leader in foreign trade between 1810 and 1820, and by 1840 had achieved unquestioned supremacy. During the next century it controlled roughly one-half of the nation's foreign commerce, measured in terms of value. It ordinarily handled more than half of the nation's imports and over a third of its exports. The rapid expansion of population and industry in the Gulf states and on the Pacific coast since 1920 has gradually reduced New York's relative share of the nation's commerce, but in the second half of the 20th century it still handled 35% of imports and 27% of exports (by value). The three northern customs districts (Buffalo. Rochester and St Lawrence) handle almost 30% of all United States trade with Canada, the nation's largest customer. One-half of all passengers to and from foreign countries overseas pass through the port of New York.

New Tork city is the world's financial centre because of its stock exchanges, banks and other financial institutions. Upstate cities also have important financial resources. It has been estimated that about 20% of the total liquid savings in the United States, including time deposits, life insurance equities, savings bonds, saving and loan shares and postal savings are held by residents of New York. New York city banks in the late 1950s granted nearly 30% of all commercial and business loans in the United States and handled about three-fourths of the financing of the nation's foreign trade. At the same time, investors transacted on the New York stock exchange and the American stock exchange 93% (based on value) of all security transactions reported on all exchanges. More than 20 life insurance companies, including three of the first four in assets, have their headquarters in New York city. The city also dominates the marine-insurance field. (*See* NEW YORK [CITY] .)

Transportation.—New York has one of the finest harbours on the North Atlantic coast, the best route through the Appalachian barrier and an excellent system of waterways, both natural and man-made. The success of the Erie canal, opened in 1825, led to the construction of several lateral canals and the enlargement of the Erie between 1836 and 1862. The steam railnays. honever, began to challenge the canal especially after 1850. The first railroads began operations about 1831. During the 1850s the eight short lines across the state began to take freight away from the canal. The establishment of the New York Central railroad in 1853 dramatized the fact that the railroads had become large corporations. In 1851 New Tork city was linked with Greenbush across the Hudson from Albany by the Hudson River railroad and the Harlem railroad, and it was indirectly connected with Lake Erie by the Erie railroad which had a line from Piermont on the Hudson to Dunkirk on the lake. Cornelius Vanderbilt got control of the Hudson River railroad and in 1869 took over the New York Central This system subsequently acquired connections with Chicago, Montreal and Boston, leased the West Shore railroad in 1886 and purchased several feeder lines. Other important railroads in New York were the Lehigh Valley; the Delaware, Lackawanna and Western; the Pennsylvania in the central and western part of the state; the Delaware and Hudson; the Boston and Maine in the east; and the Long Island railroad. Railroad mileage in 1960 was about 7.000.

Transportation by water. highway and air challenged the supremacy of the railroads in the 20th century. In 1903 the voters approved the construction of a new Barge canal partly because they wanted to punish the railroads for granting lower through rates from Chicago to Philadelphia and Baltimore than from Chicago to New Tork city. The Barge canal, which was not completed until 1918, included 522 mi. of canal with branches to Oswego, Lake Champlain. Seneca lake and Cayuga lake. The Barge canal normally carries about 4,000,000 tons of goods a year, more than half of which are petroleum products. The taxpayers subsidize the canal system since the shippers do not pay tolls.

In the second half of the 20th century New York had about 90,000 mi. of roads which ranged from dirt roads to multilane parkways. In 1948 the state Thruway authority began the construction of a 559-mi. superhighway connecting New York city with Buffalo and the Pennsylvania line. The last link of the thruway from Albany eastward to Massachusetts was opened in 1958. Airlines connect the various cities and the state as a whole with the rest of the country and the world. In the 1960s New York had more than 250 airports, including the huge New York International (Idlewild) airport on Long Island. See also Index references under "New Tork" in the Index volume.

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NEW YORK (CITY), the largest city in the U.S.. is situated at the mouth of the Hudson river. there sometimes called the North river. The five boroughs comprising the city are: the Bronx (Bronx county), 54.4 sq.mi., on the southernmost part of the mainland adjacent to and below Westchester county and separated from the borough of Manhattan by the Harlem river (a canalized waterway connecting the Hudson and East rivers); Manhattan (New York county), 31.2 sq.mi., on Manhattan Island between the Hudson and East rivers; Queens (Queens county), 126.6 sq.mi., on Long Island adjoining and to the west of Nassau county and separated from the Bronx and Manhattan by the East river: Brooklyn (Kings county), 88.8 sq.mi., adjoining and to the south of Queens at the western end of Long Island: and Richmond (Richmond county), 64.4 sq.mi., on Staten Island in New Tork bay, southwest of Brooklyn and separated from it by the Narrows (a strait connecting Upper and Lower New Tork bays) and from the mainland of the state of New Jersey by tidal estuaries known as Kill van Kull and Arthur Kill. The total area of the city is 365.4 sq.mi. The greatest width of the city, from the eastern boundary line of Queens to the western border of Richmond. is 25 mi.; from the same point in Queens to the western end of 23rd street at the Hudson river in Manhattan, is 16.5 mi. The greatest over-all length, north to south, is 36 mi.

The city's more important small islands are: North and South Brother. Rikers. City, Hunter. Hart. Governors (occupied by a U.S. military reservation. Ft. Jay), Welfare (formerly Blackwell's), Ward's, Randall's (latter three occupied by state and city institutions) and numerous islands in Jamaica bay. Liberty Island (name changed from Bedloe's Island June 29. 1960; the site of F. Bartholdi's Statue of Liberty) and Ellis Island where the federal government formerly maintained the best-known and most active immigration station are in Upper New York bay, within the bounds of New Jersey.

The total water front within New York city is 578 mi. of which Manhattan has 43 mi.; Brooklyn, 201 mi.; the Bronx. 80 mi.; Queens. 197 mi.; and. Richmond, 57 mi. The two flanking rivers, the Hudson and the East. are not true rivers. The former, up to Troy, is a tidal arm or narrow inlet of the sea; the latter, a 16-mi. tidal strait, connects New Tork bay with Long Island sound.

HISTORY

Discovery **and Exploration.**—New York bay and the Hudson river were apparently first discovered by Giovanni da Verrazzano, a Florentine navigator, on April 17, 1524. The first conclusive exploration of New York bay and the Hudson river, however, was made by Henry Hudson, an Englishman sailing for the Dutch East India company, in the "Half Moon" during Sept. and Oct. 1609. Unable to reach the orient around the north of Siberia by way of the ice-packed Arctic ocean. instead of returning to Holland Hudson sailed westward and ultimately into New York harbour. Beginning in 1610, Dutch captains such as Adriaen Block. Hendrick Christiaensen and Cornelis Jacobsen May, voyaged to Manhattan. The fur trade was the primary attraction. Block explored New York harbour. Long Island sound, the Connecticut river as far as present-day Hartford and discovered Block Island in 1614. On March 27, 1614, the states-general of the Netherlands granted a general charter to 13 shipowners whose five vessels mere trading in the New York area; they were required to make four voyages by Jan. 1, 1618 and were given a monopoly of trade in New Netherland. When their charter expired in 1618 the Dutch government declined to renew it. Instead, seeking a western counterpart for their Dutch East India company the government chartered the Dutch West India company in 1621. This powerful trading corporation was granted a monopoly of trade throughout the western hemisphere.

Dutch Period. — In 1624, 30 Protestant Walloon families were sent by the company to augment the few trading post settlers already there. Only about eight men remained on Manhattan. The next year more colonists came. and when the first director, Cornelis May was succeeded by director Willem Verhulst in 1625, the colony numbered almost 200 persons. The government of the New Netherland province was vested in a director-general and a council. These officers, though formally appointed by the company, were subject to the approval of the states-general. The first director-general, Peter Minuit, arrived with additional colonists in 1626, purchased Manhattan Island from the local Algonkin Indians with pieces of bright cloth, beads and other trinkets to the value of 60 guilders, or about $24, erected Ft. Amsterdam at the lower end of the island and changed the name of Manhattan to New Amsterdam and made it the seat of government. Recalled by the company in 1631, Minuit was replaced first by Bastiaen Jansen Rrol, and then by Wouter van Twiller in March 1633 who in turn remained until March 1638, when he mas recalled because of his mismanagement. He was succeeded by Willem Kieft, an Amsterdam merchant, whose Indian policy proved disastrous to the colony. He levied a tax on the Algonkin tribes for the presumed purpose of protecting them from the neighbouring fierce Iroquois, but declined to assist them after the Iroquois attacked. The result was four years of intermittent but savage warfare between the Dutch and Algonkins. Kieft's one great virtue was his tolerance of freedom of worship.

Peter Stuyvesant (*q.v.*), last of the Dutch governors, was appointed in 1636 and administered the colony until the English conquest in 1664. He defied colonists and company alike. Grudgingly, under the compariy's specific orders, he was compelled to grant the first municipal charter to New Amsterdam on Feb. 2, 1653, but kept the city under such close supervision the new municipal powers were virtually nullified. In view of Stuyvesant's shortcomings and the feeling that they were employees of an indifferent corporation rather than Dutch nationals, it was inevitable that the populace declined to obey the governor and resist the English ultimatum for the surrender of the province. Accordingly, Stuyvesant was compelled to capitulate on Sept. 8, 1664, to Col. Richard Nicolls without the firing of a shot. The English flag was raised over the fort, which was renamed Ft. James, after the new proprietor, James, duke of York, and New Amsterdam became New York.

English Rule. — The rights of the Dutch settlers were carefully maintained at first, and established institutions changed only gradually. The English reorganized the city government (1665) with a mayor, five aldermen and a sheriff to be appointed by the governor of the province for a term of one year, and also extended the city limits to include all of Manhattan Island. The third Anglo-Dutch War broke out in 1672, and on Aug. 8, 1673: New York was recaptured by the Dutch. Capt. Anthony Colve became the governor-general until the treaty of Westminster ended the war in 1674, and Colve turned the city over to Sir Edmund Andros, the new English governor, who restored the English form of city government.

The next century was a continuous struggle for control of the city government between the Tory-supported royal governors, and the largely Whig populace. The first serious manifestation of American resistance came with the refusal of the merchants of New York and other parts of the province to pay certain duties exacted by the "duke's laws" which had been promulgated in 1665, and which were essentially a code of laws and a constitution for the newly created county of Yorkshire (Westchester, Long Island and Staten Island).

Gov. Thomas Dongan, one of the colony's ablest governors, arrived in 1683 with instructions to call a general provincial assembly for which the colonists had been petitioning. Accordingly, the first general assembly met on Oct. 17, 1683, in Ft. James, consisting of Dongan, 10 councillors and 17 representatives elected by the free citizenry. The new assembly on Dec. 8, 1683, divided the city into six wards, each to choose one alderman and one assistant alderman; these 12, together with the mayor and the recorder (a new judgeship of the mayor's court for trying criminal cases) were to comprise the new common council. All former rights and privileges were confirmed; the city was given eminent domain; it could sue and be sued; it could acquire and grant lands; and it could grant and regulate franchises and rights. Freemen could also elect constables and assessors. All these rights were now legally confirmed by Dongan's formal grant of a municipal charter, the first under English rule, on April 27, 1686. In addition, the charter provided for sources of income for the city and conveyed to it the proprietorship of the city hall, the market houses, bridges, wharves, docks, cemeteries: ferries, unoccupied lands and the waters within the city. The city seal presented to the corporation the same year is that which it now employs except that an eagle was substituted for the royal crown in 1784.

One of the most important occurrences in this period was Leisler's rebellion (1689–91), the local counterpart of the revolution in England which had dethroned James II. Jacob Leisler (*q.v.*), loyal to the new monarchs. William and Mary, seized the local government in their name, and was appointed by the local committee of safety as the equivalent of the first popular governor of New York province. In turn, he obtained the election of Peter de Lanoy as the first popular mayor of the city, a privilege that was to lapse until 1834. William's and Mary's new governor, Col. Henry Sloughter, persuaded by Leisler's foes that he was a traitor, had him and his son-in-law hanged in 1691, the only persons ever hanged in the province or state for treason. In 1695 parliament exonerated them and two years later restored the martyrs' property that had been forfeited by the provincial court.

Governor Sloughter appointed as mayor, Abraham DePeyster, who was effective in conciliating the warring factions for the time and responsible for many public improvements. The old "rattle watch" or police of the city was reorganized by DePeyster in 1697 and placed again under civil control. DePeyster built new wharves, provided the first system of poor relief and instituted improvements in sanitation. The incompetence of governors Benjamin Fletcher, Lord Cornbury and Francis Lovelace increased resentment against English government; and appointed mayors, though in the main men of good standing and usually merchants, were so frequently changed that few made noticeable impressions upon municipal affairs. An exception was William Peartree (1703–07) who established the first free grammar school and a school for Negro slaves and also improved the jail and provided a debtors' prison in the city hall. Gov. Robert Hunter (1710–20) was one of the ablest administrators in America. In 1710 he endeavored to settle about 3,000 German Palatines in the Hudson valley to produce naval stores, but the attempt failed. Between April 7–21, 1712, an insurrection of Negroes took place but was promptly suppressed by Hunter. Nine white men were slain and many more wounded; in retaliation, 21 Negroes were convicted and executed, some most barbarously, and many others were imprisoned. Twenty-nine years later, on Feb. 28, 1741, the alleged Negro conspiracy to burn the city was uncovered, and between then and Oct. 22, 1742, 14 Negroes were burned at the stake and 18 were hanged; 71 were transported out of the colony, and 3 whites were also executed. In 1730 New York received the Montgomerie charter from Gov. John Montgomerie which increased the municipal power by enabling the mayor to appoint subordinate officers with the advice and consent of the common council, and permitted the mayor with a majority of the common council to enact or repeal any by-laws or ordinances they saw fit.

Of especial significance was the trial of John Peter Zenger in the New York city hall in Aug. 1735 on the charge of printing libelous statements in his *New York Weekly Journal* about Gov. William S. Cosby. Zenger was acquitted in what proved to be a tremendous victory for freedom of the press.

The Revolution. — By the middle of the 18th century New York city was regarded as the focal point of resistance to the royal authority. Causes of resentment against English rule were soon forthcoming. One was the impressment of New York sailors onto British men-of-war in the harbour of the city. The merchants of the city reacted vigorously in 1764 and 1765 in protest against the Sugar act of 1764. When New York learned of the passage of the Stamp act on April 11, 1765. the citizenry was stunned and indignant. The Stamp Act congress was convened in the city hall from Oct. 7-25, 1765, with 27 delegates from nine colonies. A Declaration of Rights and Grievances, and additional protests were dispatched to the British government. The Sons of Liberty (*q.v.*) commenced perhaps the earliest committee of correspondence in New York city in 1765. While the congress was still in session, a British vessel arrived loaded with stamps, but in the face of popular passion the stamps were secretly landed at night and placed in Ft. George for safekeeping, On Nov. 1, 1765, the date of the act's inception, a crowd proceeded to the fort and to Bowling Green where Lieut. Gov. Cadwallader Colden mas hanged in effigy. Mayor John Cruger, Jr., finally induced Colden to turn the stamps over to the city corporation, but the Sons of Liberty and the merchants were firm in their resistance to the enforcement of the Stamp act and it was finally repealed on March 18, 1766.

Rioting between the Sons of Liberty and the British soldiery became an almost daily occurrence. The first serious bloodshed occurred on Aug. 11, 1766, when the Sons of Liberty mere erecting a liberty pole; the soldiers charged the citizens with drawn bayonets, wounding several including their leader Isaac Sears. On Jan. 2. 1769, Gov. Henry Moore dissolved the assembly for failing to co-operate with the provisions of the Quartering act. In Jan. 1770 another liberty pole was cut down by soldiers resulting in the "battle of Golden Hill" (John and William streets) on Jan. 19, about six weeks before the Boston Massacre. Several patriots and soldiers were badly wounded, none fatally, but "much blood was spilt." Frays continued in the days following, and finally Mayor Whitehead Hicks issued a proclamation forbidding soldiers to leave their barracks unless accompanied by a noncommissioned officer. Rumours in early 1774 that tea ships were on their way to New York to carry out Lord North's program of taxation by means of the Tea act of 1773 kept public indignation at high pitch. The "London" arrived in April 1774 and a party of Sons of Liberty boarded it and dumped 18 cases of tea into the harbour. The closure of the port of Boston in punishment for the Boston Tea Party was the signal for the calling of a meeting at Fraunces' tavern and the election of a committee of 51, which issued the call for the first intercolonial congress. The committee of 51 was dissolved with the election of a new committee of observation of 60 to enforce in New Tork the Nonimportation act of the first continental congress.

When the news of Lexington and Concord reached New York on April 23, 1775, a crowd took possession of city hall and seized the munitions stored there and two British ships in the harbour were seized and their cargoes unloaded. The committee of 60 called for the election of a new committee of 100 to arrange for the calling of a war congress of deputies from all New York counties. This provincial congress met in New York and declared its obedience to the continental congress. On April 4, 1776, New York was placed under military rule by Gen. Israel Putnam and Washington later moved his headquarters there. On July 12, British Adm. Richard Howe appeared with his fleet in the harbour, but it was not until Aug. 22 that British troops were landed at Gravesend bay. On Aug. 27 the British took Brooklyn heights. Washington withdrew his troops from Long Island and reorganized in New York on Aug. 29. The British then landed at Kips bay on Sept. 15, threw the Americans back and next endeavoured to cut off the American army by throwing a line of troops across Manhattan at about present-day 34th street. The Americans slipped through to Harlem heights. where Washington again reorganized. On Sept. 16 the British attacked unsuccessfully at Harlem heights. On Sept. 21 a fire broke out near Whitehall slip and almost completely destroyed the lower part of the city. Trinity church was burned but St. Paul's and King's college were saved by a shifting of the wind. The following day Nathan Hale, a young spy for the American army who had been condemned by Gen. William Howe, was hanged at a spot near present-day 45th street and First avenue.

New Tork was held by the British troops for the remainder of the war. It was used largely as a prison camp, and as a gathering place for loyalists (Tories). Churches, warehouses, jails and stores were packed with men sick and well. On the site of the fire, a village of huts and tents had sprung up which was called "Canvas Town." A second disastrous fire on Aug. 3, 1778, destroyed another 60 houses and many stores. Robberies were a daily occurrence and citizens could expect no help from the British soldiers. In Wallabout bay, on the East river. an old hulk. the "Jersey," was used by the British as a prison ship and there more than 11.000 men died. The city was in desperate straits for want of supplies. and sickness ravaged the people. There was no government except military rule and the oppression of civilians by the soldiery was the cause of frequent riots. The revenues of the city were appropriated by the military for their private uses. After the surrender of Lord Cornwallis at Yorktown. Sir Guy Carleton succeeded the intolerant Sir Henry Clinton in May 1782 and immediately undertook the restoration of law and order. By the time of the British evacuation, Kov. 25, 1783, confidence in British government had partially returned.

Formative Years.—The parting of Washington from his troops came on Dec. 4, 1783, at Fraunces! tavern. After the departure of Washington on Jan. 21, 1784, the state legislature began its sessions in New Tork's city hall, and the city remained the state capital until 1797, when it was permanently removed to Albany. From 1785 to 1790. the federal congress also met in the city hall, and thus the city was for a time both the national and state capital. James Duane was appointed by Gov. George Clinton the first American mayor of New Tork on Feb. 5, 1784; on Feb. 22 the "Empress of China." sailing from New York, was the first American vessel to enter Asiatic waters; on March 15, the second bank in the U.S., the Bank of New York, was organized with Alexander Hamilton as one of its directors, and on May 15, by act of legislature, King's college became the state university and its name was changed to Columbia college. Several events foreshadowed the important shape of things to come in the city: in 1786 the city's population was 23,614; on June 15, 1787, the Mutual Assurance Co., the city's first fire insurance company, was organized; on Oct. 27, 1787, the first number of the *Federalist Papers* appeared, an effort sponsored by Hamilton and John Jay, both New Yorkers, and James Madison, to ensure the ratification of the constitution by the state; and in 1789 the Tammany Society was founded.

On April 30, 1789, Washington was inaugurated president at Federal hall at the corner of Broad and Wall streets. The rise of commrrce and wealth drew many people to New York and it began to take on the appearance of a metropolis. Washington made his last official visit to Federal hall on Aug. 12, 1790, and then went to the new capital, Philadelphia. New streets and public utilities were laid out. Bellevue hospital, originally established as the Alms house in 1736, was located on its present site in 1794 for the treatment of contagious diseases. Collect pond, later the site of the Tombs (city prison), was the scene of the first trials of John Fitch's steamboat in 1796. The New Tork Historical society was founded in 1804. With the help of Mayor De Witt Clinton (1803-15) and of several of the founders of the society, there was organized, in 1805, the Society for Establishing a Free School in the City of New York. Under Clinton, schools were built and Columbia college improved, philanthropic organizations increased in number and arts and letters were stimulated. In 1807 there were 19 newspapers, of which 8 were dailies. Although the Embargo act of 1807 struck New York trade a serious blow, it was not without benefit in stimulating domestic industries. The new city hall was completed in 1812, and there was at this time a considerable advance, both in architecture and building construction. Many new buildings, including churches, were built, new streets were graded and sn-amps filled in along the water front. Collect pond was filled in and the hills and valleys of lower Manhattan were rapidly leveled for homes and other structures.

In the midst of this prosperity, war was declared against Great Britain on June 18, 1812. 'The commerce of the city suffered from blockade, and the city was put in a posture of strong defense, with additional forts built. On Feb. 11, 1815, the ship "Favorite" arrived in New York under a flag of truce with British and American messengers and the peace treaty of Ghent. Under Mayor Jacob Radcliff (1815–17), the common council appropriated $1.000 for free vaccination against smallpox which periodically ravaged the city. hlayor Cadwallader D. Colden (1818–21) likewise advanced governmental and private services for public welfare. By 1820 the city's population had reached 123.700, for great numbers of immigrants from Europe were arriving and the problems of dealing with this influx of newcomers were taxing the city and its facilities to the limit. Yellow fever broke out in 1819, 1822 and 1823, and hundreds died daily; another epidemic occurred ten years later and smallpox and malaria also took their toll. Yet. the city continued to grow. The opening of the Erie canal on Nov. 4, 1825, ushered in an even more important phase of New York's commercial history.

By 1830 the population of Manhattan Island was 202,589 and mass transportation became a problem, only partly solved by the horse-drawn stages and the later horse cars. On Dec. 16, 1835, the "great fire" broke out and destroyed nearly 700 buildings in the heart of the city and virtually wiped out the last vestiges of the old Dutch city that had survived the fires of 1776 and 1778. Croton water was furnished the city on July 4. 1842. Blackwell's (now Welfare) Island, purchased in 1828 for S50.000, mas made the site of the city's correctional institutions and hospitals. The *New York Sun* was begun in 1833 by Benjamin H. Day. The *Herald* of James Gordon Bennett appeared in 1835, the *Tribune* of Horace Greeley in 1831 and Henry J. Raymond's *Times* in 1851. On May 7, 1847 the state legislature authorized the city's board of education to charter a free academy, and the academy (later the College of the City of New Tork) was established at Lexington avenue and 23rd street in Jan. 1849. Beyond Cnion square, which was a residential centre, there was little but open fields at the middle of the 19th century. The World's fair at the Crystal palace on Murray hill was the outstanding event of 1853; in 1856 Central park was purchased. The panic and depression of 1857 paralyzed business. thousands were without employment, more than 900 merchants failed and riots and disturbances of all kinds ensued.

The Civil War Years.—That same year the state legislature actively stepped into the political picture in New York city. Mayor Fernando Wood (1855–58; 1860–62), in the manner of Aaron Burr, had converted Tammany hall from a political organization into a personal political machine. To weaken his control, the Republicans at Albany reduced his second term from two years to one. and created a metropolitan police board to take over the control of the city's police from Wood's municipal police board. Wood resisted the enforcement of these and other acts and precipitated a riot. Just before the outbreak of the American Civil War, in his message of Jan. 6, 1861 to the common council, Mayor Wood, opposed to the war and a leader of the Copperheads (*q.v.*), favoured the establishment of Sew York city as a separate state. It was in New York that Abraham Lincoln strengthened his claim to the Republican nomination in 1860 by his Cooper Union speech on Feb. 27 of that year.

With the coming of the Civil War, the city, recovered from the financial panic of 1857, boomed by supplying military needs. It authorized a loan of $1,000,000 for the defense of the Union, and hundreds of thousands of dollars more were privately pledged. New York was again filled with soldiers. On April 19, 1861, its 7th regiment entrained for Washington, and a week later a mass meeting in Union square pledged loyalty to the Union cause. George Opdyke defeated Wood in the election for mayor. The city's war effort was marred by the draft riots of July 13–16, 1863, a protest against conscription and the $300 bounty system for obtaining substitutes. More than 1,000 persons were killed or wounded and property damage exceeded $1,000,000. Mayor Opdyke reported in 1863 that the people of New York had contributed up to that time $300,000,000 for war purposes and had furnished more than 80,000 men to the Union army.

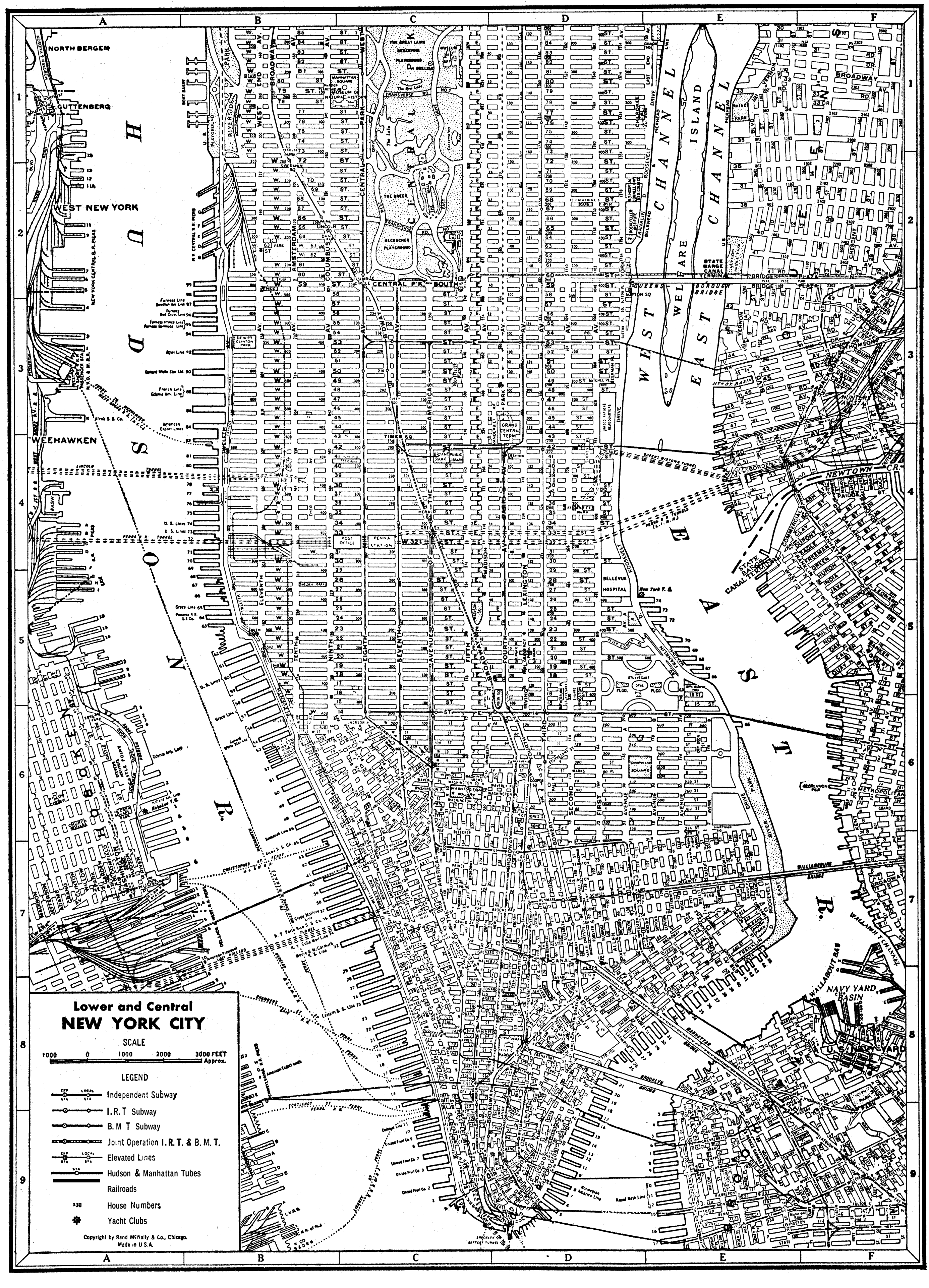
The Brooklyn bridge was begun in 1870, and sanitary conditions, which in 1865 had been thoroughly studied by a citizens' committee and found to be deplorable, were on their way to betterment. The old volunteer fire department was replaced in 1865 by a Metropolitan Fire district that included both New York and Brooklyn, and which possessed a paid, uniformed and trained force. In May 1867 the first tenement house law was passed to regulate the growing number of tenements. 'The American Museum of h'atural History was incorporated in 1869 and in that same year the Nfetropolitan Museum of Art and the future Hunter college were founded.

Boss Rule And Corruption.—At this time the urban political machine appeared. led by the "boss." The chief prototype of this leader was "Boss" William Marcy Tweed (*q.v.*), who by 1868, as master of Tammany hall, had manipulated control of the city and county of New York, and enjoyed a virtual stranglehold upon the state as well. He had moved John T. Hoffman into the governorship and A. Oakey Hall into the mayoralty. Together with other officials. these constituted the "Tweed ring." The ring stole from between $75,000,000 to $200,000.000 during its time of power. Ultimately, the disclosures of this graft by the *New* York *Times* in 1871, the biting cartoons of Thomas Nast in *Harper's Weekly* and the unrelenting campaign of the reform-minded committee of 70 brought about the downfall of the Tweed ring and the imprisonment of some of its members, including Tweed who died in prison in 1878. The next Tammany chieftain was "Boss" John Kelly (1874–86) who fought against political reform.

In 1874 the corporate limits of the city were extended to include about 13,000 ac. across the Harlem river taken from Westchester county and formed into the lower Bronx; and on June 6, 1895, the state legislature further annexed about 20,000 ac. including several incorporated villages in Westchester, thereby rounding out the present boundaries of the Bronx. Following Kelly as leader of Tammany mas Richard Croker (1886–1902). Reform movements and investigations complicated his regime and in 1894 William L. Strong became Republican mayor and headed a reform administration. Col. George Waring was made commissioner of street cleaning and inaugurated the modern system of street cleaning and refuse collection. Theodore Roosevelt made an enviable reputation as a member of the Board of Police Commissioners. On Jan. 1, 1898, Greater New York city came into being by a charter passed by the state legislature and plebiscites by the communities absorbed. Kings, Richmond and parts of Queens counties were annexed to Manhattan and the Bronx. Croker had led Tammany to a Democratic victory in a bitter four-cornered mayoralty campaign in 1897 and thus the first mayor of the enlarged city was his candidate Robert **A.** Van Wyck. The Republican party has failed to win a single mayoralty campaign in the greater city's history. Tammany's defeats have been by fusion movements combining reform, anti-Tammany organizations and sometimes the Republicans. Thus, in 1901, Seth Low, fusion candidate, defeated Tammany's Edward M. Shepard because of investigations disclosing Tammany graft and complicity in police corruption. In 1903, Low, however, was defeated by George B. McClellan, Jr., Tammany's candidate.

Tammany and Reform Movements.—Tammany was in power for approximately 18 out of the next 30 years, and between 1902 and 1924 was led by "Boss" Charles Francis Murphy whose skill permitted him to survive many defeats that would have deposed a lesser leader. He persisted despite a falling out with Mayor McClellan during the latter's second administration (1905–09); he was repudiated by Mayor William J. Gaynor (1910–13); and he was badly shaken by the victory of perhaps the most able of the city's mayors, John Purroy Mitchel (1914–17).

In McClellan's second term Mitchel had been appointed special investigator after a citizens' civic group published a report on irregularities in the administration of the offices of borough President John F. Ahearn of Manhattan and borough President Lewis F. Haffen of the Bronx. Mitchel secured sufficient evidence of these irregularities to warrant Gov. Charles Evans Hughes' removal of both Ahearn and Haffen. In 1912 District Attorney Charles S. Whitman's exposure of police corruption under Mayor Gaynor helped to make Whitman governor in 1915; Gaynor, wounded in an attempt upon his life, died Sept. 10. 1913. The police scandals during Gaynor's administration, although not of his making, swung popular sympathy against Tammany, and


Lower and Central
NEW YORK CITY
SCALE
1000 0 1000 2000 3000 FEET Approx.
LEGEND
Independent Subway
I. R. T. Subway
B. M. T. Subway
Joint Operation I. R. T. & B. M. T.
Elevated Lines
Hudson & Manhattan Tubes
Railroads
130 House Numbers
Yacht Clubs
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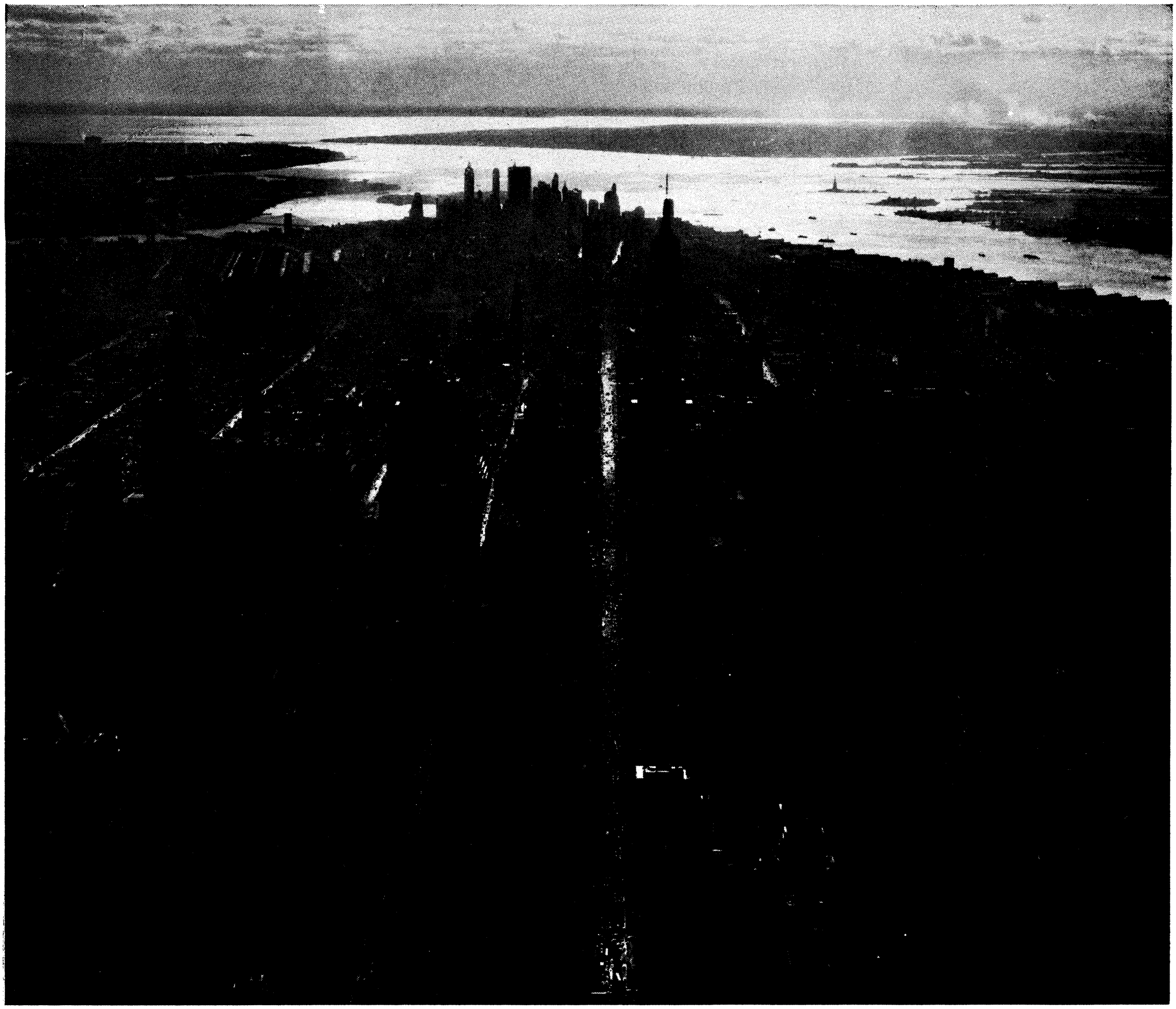
NORTH BERGEN
GUTTENBERG
WEST NEW YORK
WEEHAWKEN
HUDSON R.
EAST R.
WEST CHANNEL
EAST CHANNEL
WELFARE ISLAND
CENTRAL PARK
NEWTOWN CR.
NAVY YARD BASIN
WALLABOUT BAY
QUEENSBORO BRIDGE
WILLIAMSBURG BRIDGE
MANHATTAN BRIDGE
BROOKLYN BRIDGE
GRAND CENTRAL TERM.
PENNA STATION
POST OFFICE
TIMES SQ.
BELLEVUE HOSPITAL
TOMPKINS SQUARE
A B C D E F

In the foreground (centre) is the Empire State building, tallest skyscraper in the world, 1,250 ft. above street level, exclusive of its television aerial. At left in the background is the Chrysler building. Oblong building at right. on the edge of the East river, is the headquarters of the United Nations

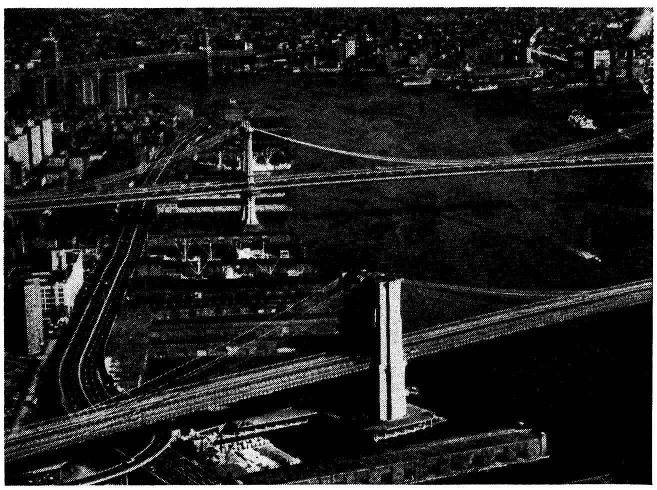
MIDTOWN NEW YORK

BY COURTESY OF AMERICAN AIRLINES

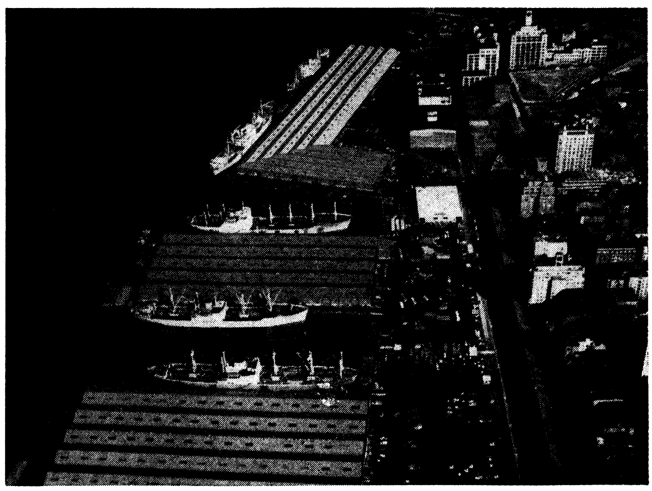
NEW YORK (CITY)



Looking south from above Manhattan Island. The brightly-lighted street in the centre is Fifth avenue. In the bay at the right may be seen the Statue of Liberty; beyond it, Staten Island and New Jersey



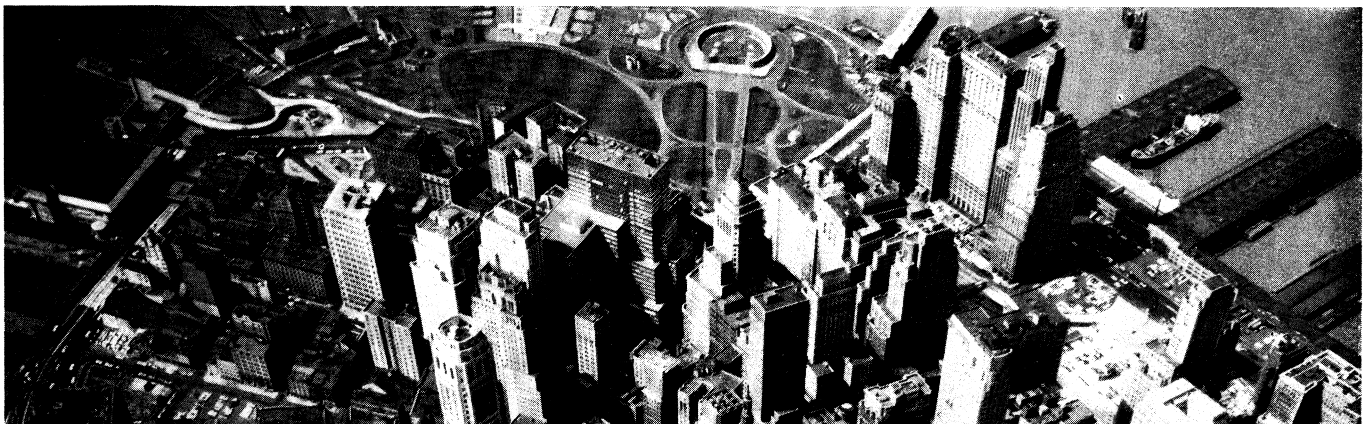
Three of the bridges crossing the East river. From top to bottom, Williamsburg, Manhattan, Brooklyn. The Brooklyn bridge, the first to span the river, was opened for traffic in 1883



Freighters tied up at piers along the Brooklyn water front. The busiest in the U.S., the port of New York handles more than 25,000,000 long tons of bulk cargo annually through its water front, which has a developed frontage of about 460 mi.

NEW YORK FROM THE AIR

Looking north along the Hudson river. Right, apartment houses of upper Manhattan; centre, Henry Hudson parkway (West Side drive) and Riverside drive, major traffic arteries to the city: left, a section of the George Washington bridge to New Jersey

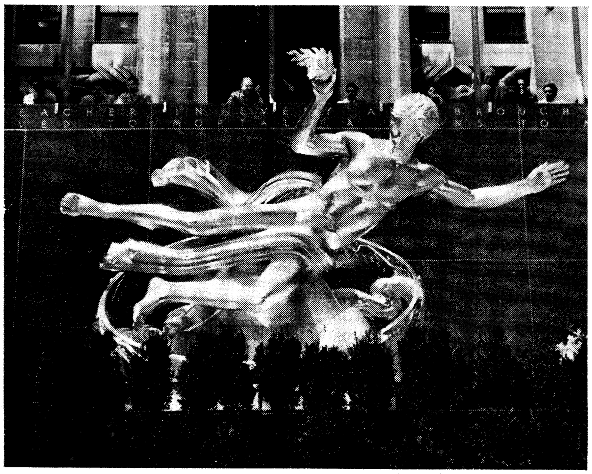


Cluster of skyscrapers at the southern tip of Manhattan (the Battery). The area is the centre of the city's financial operations, including banks and trust companies, the New York Stock and American Stock exchanges and other product and commodity exchanges

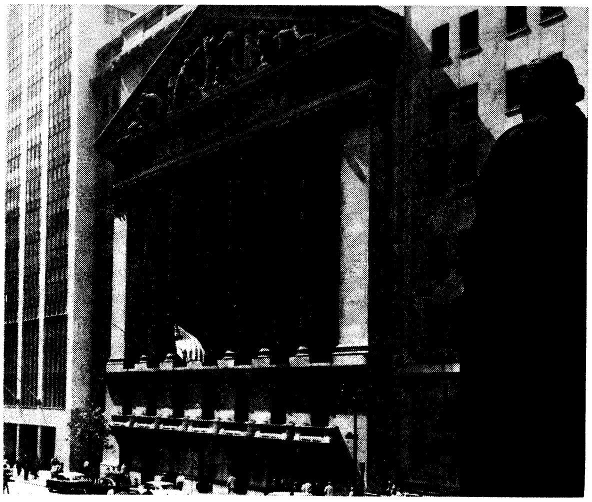
NEW YORK FROM THE AIR

BY COURTESY OF (TOP) NEW YORK STATE DEPARTMENT OF COMMERCE; PHOTOGRAPH (BOTTOM) FAIRCHILD AERIAL SURVEYS

NEW YORK (CITY)



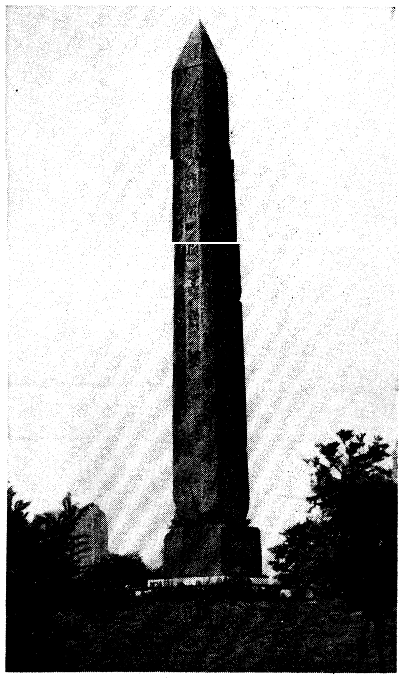
Gilded bronze statue of Prometheus by Paul Manship, in the plaza of Rockefeller Center. The eight-ton statue is 18 ft. high; it was installed in 1934



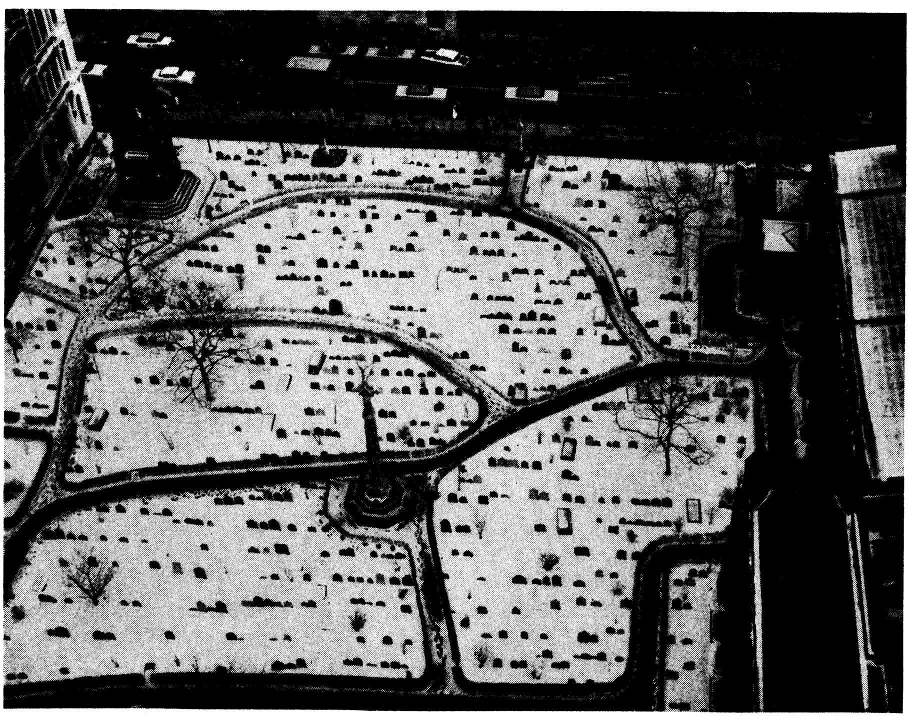
The New York Stock exchange, Wall street. At right is a statue of George Washington on the steps of the Federal Hall memorial (formerly the subtreasury building) where he took his oath of office as the first president of the U.S.

Washington arch, a memorial to the first president at the foot of Fifth avenue in Greenwich Village. The arch was designed by Stanford White and erected in 1895. The Empire State building may be seen in the distance

FAMILIAR LANDMARKS IN NEW YORK CITY

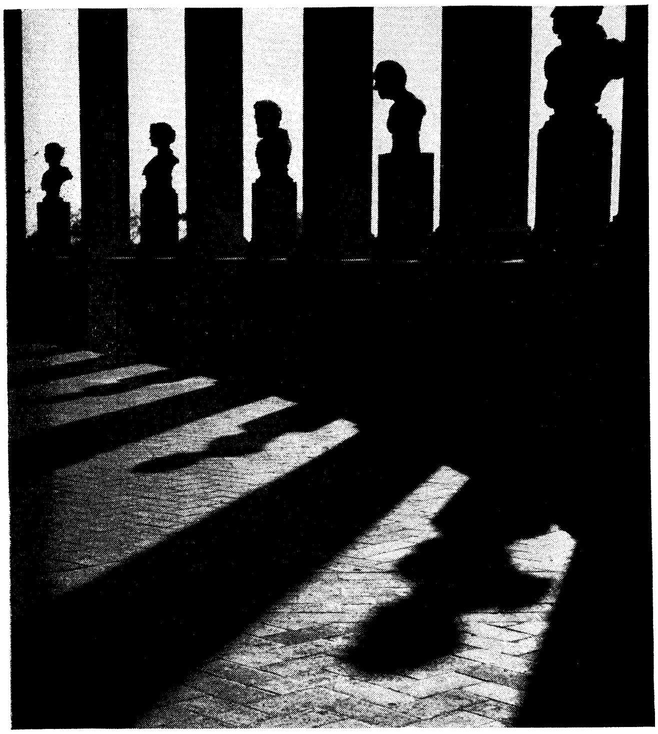


"Cleopatra's Needle," an Egyptian obelisk of about 1500 B.C., in Central park, behind the Metropolitan Museum of Art. Installed in 1880

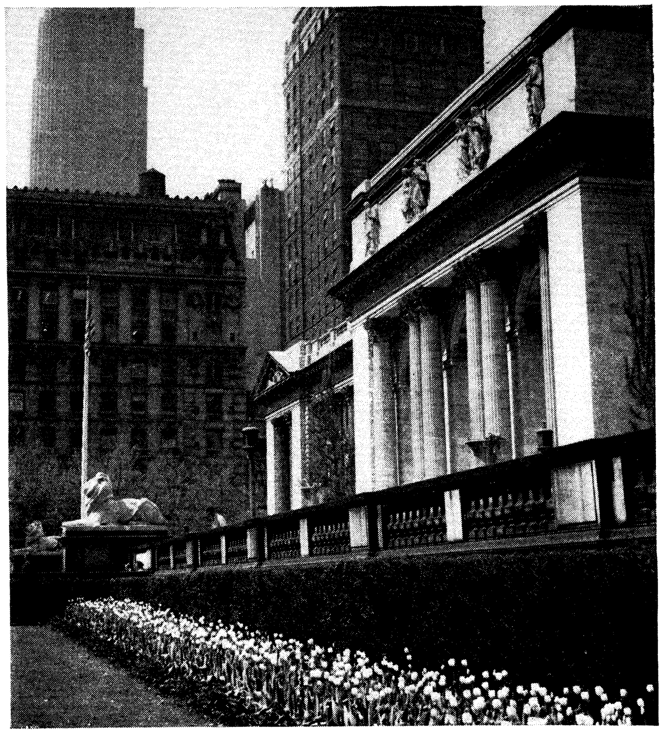


Winter view of the cemetery of Trinity church, in the heart of the financial district at Broadway and Wall street. The original church was established in 1697

PHOTOGRAPHS, (TOP LEFT) AUTHENTICATED NEWS, (TOP RIGHT) JOSEF MUENCH, (CENTRE LEFT, BOTTOM RIGHT) A. DEVANEY. (BOTTOM LEFT) UNITED PRESS INTERNATIONAL

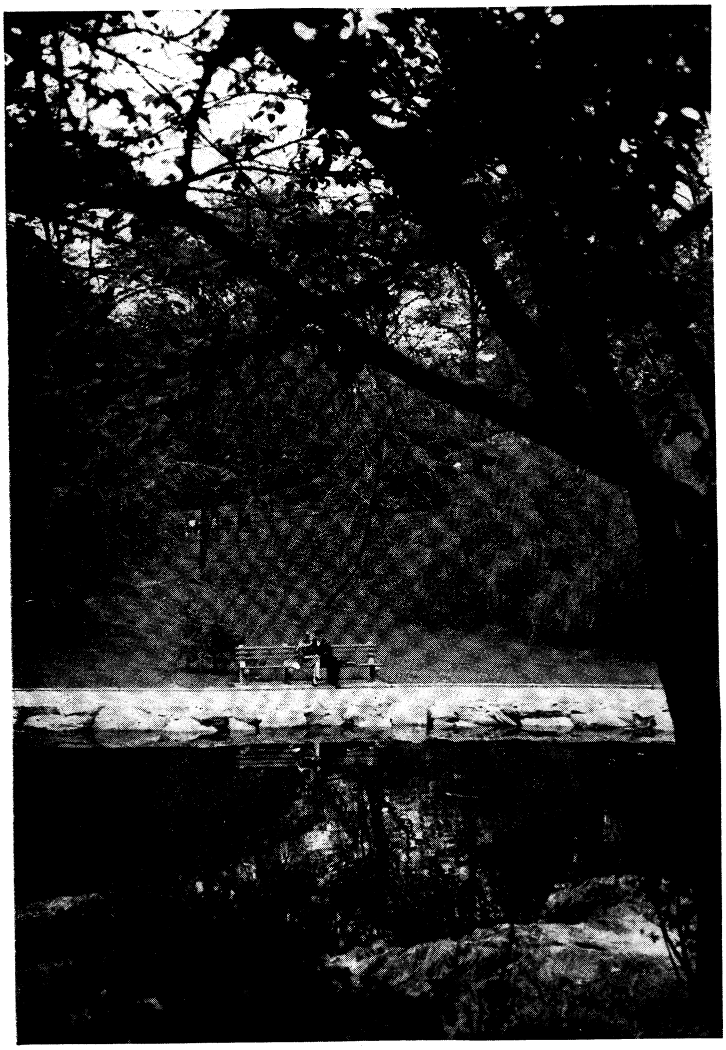


Busts of famous U.S. citizens in the colonnade of the Hall of Fame for Great Americans, on the campus of New York university



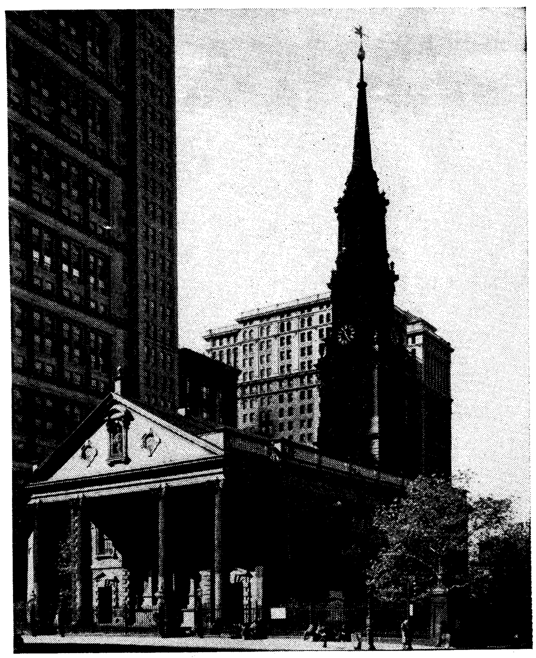
The New Yoik Public library, in midtown Manhattan, one of the world's great libraries with a collection of almost 6,000,000 volumes and more than 50 branches

POINTS OF INTEREST IN NEW YORK CITY



Scene in Central park, an 840-ac. tract in the middle of the city from 59th to 110th street, between Fifth and Eighth avenues

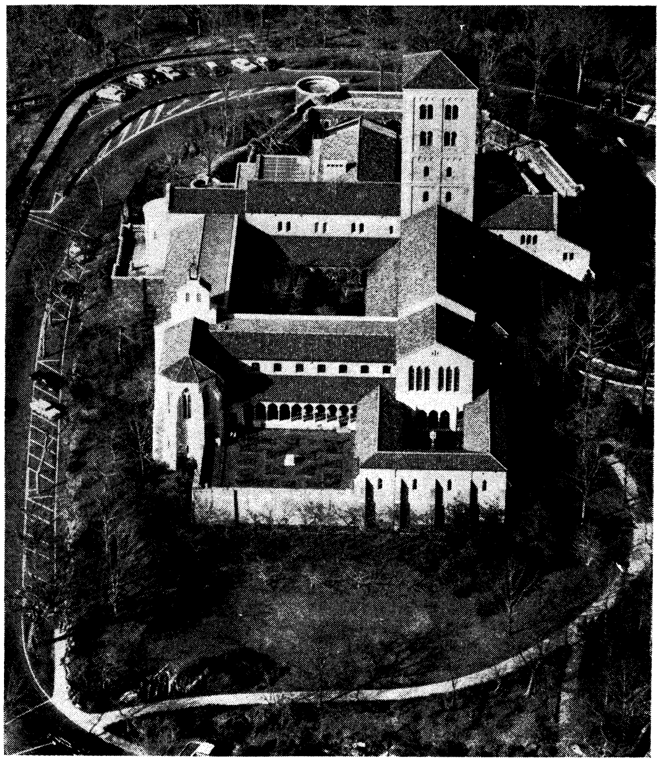
St. Paul's chapel, the oldest church edifice in the city, was built in 1766; the spire was added in 1794



PHOTOGRAPHS, (TOP LEFT) SAMUEL HERSCH FROM A. DEVANEY, (TOP RIGHT) A. DEVANEY, (BOTTOM LEFT) D. JORDAN WILSON—PIX FROM PUBLIX, (BOTTOM RIGHT) WAYNE ANDREWS

NEW YOKK (CITY)

Sidewalk exhibition of paintings in Greenwich Village, home of many of the city's artists. Such exhibitions are frequent throughout the warm months of the year



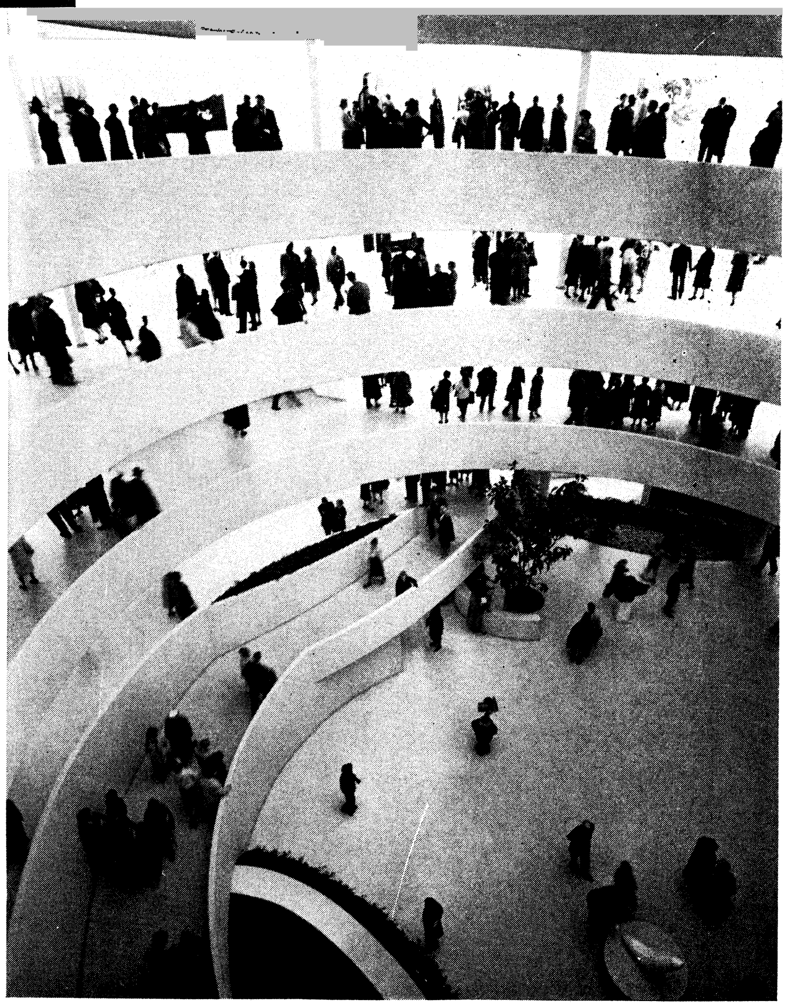
The Cloisters, medieval art museum located in Fort Tryon park. The building incorporates sections of several European monasteries and a complete Romanesque chapel. Collection includes many famous Gothic tapestries

[illegible] statuary at the Metropolitan Museum of [illegible] park. The Metropolitan houses the largest collection [illegible] objects in the U.S., including painting, sculpture and decorative arts of all ages and cultures

ART AND MUSEUMS

IN

NEW **YORK** CITY



View of the spiral ramps which serve as the galleries of the Solomon R. Guggenheim Museum of Non-Objective Art. The last major public building to be designed by Frank Lloyd Wright, the Guggenheim was completed in 1959, the year of Wright's death. Collection includes painting, sculpture and drawings

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) D. JORDAN WILSON FIX FROM PUBLIX, (TOP RIGHT) FAIRCHILD AERIAL SURVEYS, (BOTTOM RIGHT) SCHUPPE—FIX FROM PUBLIX

Mitchel, candidate for mayor on a fusion ticket, was elected in 1913. In Sept. 1914 a special aldermanic committee of investigation undertook a complete survey of police administration and methods The facts finally disclosed furnished clear evidence of police incompetency and corruption. Mayor Mitchel's administration was regarded as exceptionally efficient because of the administrative reforms which he instituted.

In the election of 1917 Mitchel was defeated by an overwhelming vote in a four-candidate race, mainly by the combined forces of Murphy, William Randolph Hearst and "Boss" John H. McCooey of Brooklyn. The victor was John F. Hylan who held office for two terms (1918–25). Hylan was refused party support for a third term. The Tammany leaders selected James J. Walker in 1925. Walker defeated the Republican candidate, Frank D. Waterman. The great issues of the Hylan administration — rapid transit and subway fares — continued paramount under Walker. In 1932 Walker was summoned before Gov. Franklin D. Roosevelt to answer charges of graft brought by Samuel Seabury, counsel for the Hofstadter legislative committee, and, failing to halt proceedings for his removal, resigned Sept. 1, 1932. After an interim under president of the board of aldermen Joseph V. McKee (Sept. 1–Dec. 31, 1932). surrogate John P. O'Brien succeeded in a special election to fill Walker's unexpired term throughout the year 1933.

The combination of the Seabury disclosures of widespread Tammany graft and corruption throughout the city government and the serious financial difficulties of the municipality put Fiorello H. LaGuardia into city hall as the fusion victor in the election of 1933. He won re-elections in 1937 and 1941. The LaGuardia administration n-as noted for the unification of the transportation system under municipal operation; the completion of the Triborough bridge and the Lincoln and Queens Midtown tunnels; the development of the Delaware water supply system; and the World's fair of 1939 and 1940. The wave of civic regzneration begun by the Seabury investigations was carried on by District Attorney Thomas E. Dewey and his staff, and by John H. Amen, with a series of political and gangster prosecutions and convictions.

LaGuardia did not run for re-election in 1945, and William O'Dwyer, a Democrat. was elected mayor. The notable achievements of his administration included an extensive building program. with emphasis on schools, hospitals, traffic speedways and public housing. The mayor also instituted a far-reaching program of administrative reform, creating the division of analysis in the bureau of the budget; corresponding methods analysis units in 24 of the major city departments; and the mayor's committee on management survey.

Among the major political issues of the period were the abolition by popular referendum in 1947 of proportional representation as a means of electing the 25 city councilmen and the consequent reduction of the opposition and reform element of the council to a minority of one. Other notable political decisions involved the adoption of a ten-cent fare for the transit system (July 1948), the acceptance of collective bargaining with the subway unions, the refusal to deal with so-called Communist unions, the transfer of the city's airports to the Port of New York authority on a 50-year lease and the sharp increase in salary rates for the top elected officers.

O'Dwyer was re-elected in 1949, but resigned on Sept. 1, 1950, to accept the assignment of U.S. ambassador to Mexico. After his departure the reputation of his administration suffered with the conviction of James J. Moran, former first deputy fire commissioner, for income tax evasion, perjury, conspiracy and extortion. In Nov. 1950 Vincent R. Impellitteri, a Democrat running on the independent Experience party ticket, handed Tammany (now known officially as the New York County Democratic committee) a setback by his surprising defeat of its candidate, Ferdinand Pecora, in a special election to fill the vacancy resulting from O'Dwyer's resignation, Instead of building up the Experience party into an anti-Tammany organization the mayor tried to wrest control of the regular organization from its leader Carmine de Sapio, but without success.

Impellitteri did not run for re-election in 1953 and Robert F. Wagner, Jr., was nominated as the Democratic candidate. Wagner defeated both Rudolph Halley and Harold Riegelman in the election. Four years later. Wagner went on to deieat Robert K. Christenberry. the Republican candidate. Among Mayor Wagner's achievements were the completion of the removal of the elevated transit linei from Manhattan; the opening of the great exhibition hall, the Coliseum: the renovation of city hall; and the start of the great Lincoln Square cultural and art centre With the mayor's efforts, a world's fair was assured for New York city in 1964.

POPULATION CHARACTERISTICS

New Tork had fewer than 200 inhabitants in 1625. and about 1.000 in 1656 and about 16.200 in 1755. Around 1783 New York began its rapid growth as the leading port of the nation. The first federal census in 1790 showed the city's population at 33.131; by 1796. the population nearly doubled over 1786; in 1850. it was 515.394: in 1870, the first post-Civil War census indicated a population of 912.292; and, in 1890. the figure had risen to 1.441.216. In 1898 the present five boroughs were united by the state to form the city of Greater New Tork and its total population in 1900 was 3,437,202. In 1950 the figure was 7,891,957. The 1960 population was 7.781.984 and divided as follows: Manhattan. 1,698.281; Bronx. 1,424.815; Brooklyn, 2,627,319; Queens, 1,809.578; and Richmond 221.991. This was a loss of 1.4% over the 1950 figure.

Almost every national and racial group in the world is represented among the inhabitants of the city. The location of the Cnited Nations in the city adds a diplomatic cosmopolitanism comparable to the ethnic diversity.

The Negro population in 1950 was 747,608. constituting the largest Negro community in the country, and representing a gain of 63.1% over the 1930 figure of 458,444. Negroes between the two world wars had increasingly made Manhattan's Harlem their centre. both residentially and culturally, bounded generally between 110th street on the south and 155th street on the north, Third avenue on the east and Amsterdam avenue on the west. The increase of their population and migration from the south after 1940. coupled with the sharp influx of Puerto Rican immigrants into the east Harlem and Bronx areas, led to the expansion of the original Harlem area and encouraged Negro movement into other neighbourhoods in other boroughs with formerly small Negro populations. Negro population by boroughs. as of 1950 was: Bronx, 97.752; Manhattan. 384,482; Brooklyn, 203,478; Queens, 51.524; and Richmond, 5.372.

Puerto Rican immigrants constitute the city's newest marginal economic and social group. The Chinese quarter is in the neighbourhood of Chatham square. on Mott, Pell and Doyers streets. The city of New York has the largest Jewish population of any city in the world.

The foreign-born population. as revealed by the 1950 census, was distributed by native countries as follows:

Foreign-Born Population as of 1950 Census

Native country	Bronx	Brooklyn	Manhattan	Queens	Richmond	Total
England and Wales	8,646	15,451	15,782	12,100	1,634	53,614
Scotland	4,303	7,633	6,437	6,860	1,172	26,405
Northern Ireland	637	704	1,058	536	150	3,085
Ireland	37,367	29,013	48,015	24,741	2,587	141,723
Norway	940	17,205	2,563	2,306	2,538	25,552
Sweden	2,490	7,689	5,319	4,073	853	20,424
Denmark	625	2,554	1,812	1,375	341	6,707
Netherlands	581	1,157	2,318	1,389	126	5,511
France	2,181	2,766	10,470	4,681	363	20,461
Germany	28,555	29,038	64,976	59,920	2,978	185,467
Poland	45,283	79,582	37,019	16,453	1,541	179,878
Czechoslovakia	4,976	5,496	12,372	7,016	270	30,130
Austria	31,508	42,729	32,363	16,908	748	124,256
Hungary	15,334	10,661	15,521	9,901	551	51,968
Yugoslavia	759	1,065	2,779	1,994	139	6,736
USSR	86,926	154,949	50,492	21,072	1,164	314,583
Lithuania	1,825	7,204	1,882	2,579	109	13,599
Finland	1,946	2,048	3,621	955	321	8,891
Rumania	9,245	12,080	5,641	2,369	74	29,409
Greece	3,721	6,747	13,372	5,698	277	29,815
Italy	62,407	153,727	61,451	56,599	9,931	344,115
Other Europe	5,741	8,855	17,774	8,020	709	41,099
Asia	5,655	11,000	9,967	5,148	207	31,977
Canada—French	718	1,212	1,809	1,253	113	5,105
Canada—Other	3,933	9,842	9,439	6,591	950	30,755
Mexico	411	646	1,701	433	43	3,244
Other America	5,874	6,507	20,353	5,187	374	38,295
All Other	1,307	2,966	4,795	2,040	224	11,332

The population decline in Manhattan accentuates the continuing application of choice Manhattan real estate to skyscraper and other commercial, office and service usage and the fact that the island is increasingly becoming an area of extremes. of either very high-rental units or low-income and slum units. Manhattan is increasingly the borough of employment and livelihood for millions from the outside. Urban renewal has been unable to keep pace with slum blight.

The Bronx and Brooklyn do not reflect the same extremes and pressures of Manhattan. but a slight exodus already was apparent in their demographic data, accelerated to some degree by the uncontainable population thrust of the Negro and Puerto Rican families. This is less true of Queens. That borough's continued progress makes it one of the fastest growing counties in the nation, because of realty development within an area greater by far than that of any of its sister boroughs. to a growing native birth rate and to in-migration by all strata of the economic spectrum. Staten Island, also growing slightly in numbers, has room to accommodate a great population increase.

The New York-Northeastern New Jersey Standard Consolidated area, as defined by the U.S. census bureau, includes 17 counties in New York and eastern New Jersey. This land area had a population of 14,643,404 according to the 1960 census. In addition to New York city. it includes such important centres of industry and population as Kewark. Paterson, Elizabeth Bayonne. Hoboken, Passaic. Union City. East Orange, Perth Amboy, Orange and New Brunswick in New Jersey; and Yonkers. Mount Vernon, New Rochelle and White Plains in New Tork. For comparative population figures for New Uork city *see* table in NEW YORK: Population.

GOVERNMENT AND SERVICES

Administrative Organization.— The city's basic form of government was inaugurated by the charter passed by the state legislature that created Greater New York on Jan. 1. 1898. It provided for a mayor elected at large, five borough presidents, a board of aldermen of 65 elected members with a president elected at large. A comptroller, elected at large, was head of the department of finance.

A new city charter. adopted by popular referendum on Nov. 3, 1936, became effective on Jan. 1. 1938. To replace the board of aldermen. it provided for a 25-member city council: elected by a system of proportional representation. This system of electing councilmen was abolished, however, by popular referendum in the 1947 election. Under a new law, one councilman is elected for a term of four years from each of the state senate districts wholly within the city. Election is by a simple majority vote. The city council is the legislative body and may pass a law over the mayor's veto by a two-thirds vote; it may reduce a budget passed by the board of estimate but may not raise it; and it may call for an investigation of the conduct and administration of any city department. The 25 councilmen are divided as follows: 9 from Brooklyn, 6 from Manhattan, 5 from Queens, 4 from the Bronx and 1 from Richmond.

The board of estimate constitutes the general administrative branch of the city and has limited control over legislation. Its main consideration is the budget. The board has exclusive authority to grant franchises, but no franchise may be for more than 25 years, except a tunnel-railroad franchise. The board is a nonelective body; its membership consists of the mayor, the comptroller, the president of the city council and the five borough presidents.

New York city has a strong mayor-council type of go ernment. The mayor is the chairman of the board of estimate, recommends legislation, appoints and may dismiss the city administrator, the city construction co-ordinator. the corporation counsel, the commissioner of investigation and the director of the bureau of the budget; in addition, he appoints the commissioners or executive heads of the police, fire, health, hospitals, welfare, correction, sanitation, public works, markets and 18 other municipal departments, of 16 boards and commissions and of 3 agencies operating from his offices, as well as many lesser officials. He may veto a bill of the city council.

Civil service regulations apply to all officers and employees of the city except those who are elected, to legislative officers and to staffs of those educational institutions which have special professional standards. In 1920 the city employees' retirement system was put into effect. All persons in city service became eligible for the benefits of this retirement system, except those entitled to share in the police pension fund, the fire department relief fund, the teachers' retirement system or the department of street cleaning relief and pension fund.

An amendment to the state constitution, approved by the voters in Dec. 1935, provided for a reform of the county government within the city of New York. There are five county governments within Greater New York. namely, New York, Bronx, Kings, Queens and Richmond. The officers of the five different counties function almost independently of the city officers. Under the amendment the city has the theoretical power through the enactment of local laws to abolish any county office within its limits except that of judge, county clerk or district attorney; or it may reassign the functions of county officers, with certain exceptions, to city or other county officials or to the courts. The county clerks are appointed and removable by the appellate division of the supreme court in the judicial department in which their respective counties are located.

Finance and Taxation.— The annual expense budget of New York city in the second half of the 20th century amounted to more than $2,000,000,000 or nearly double the amount ten years previously. Approximately 18% was allocated to education; 12% to welfare; 7% to police protection; 7% to hospitals; 4% to fire protection; 4% to sanitation; 17% to debt service; 9% to pensions; and 22% was allocated to all other purposes. To meet this expense budget, the city received revenues as follows: approximately 45% from real estate taxes; 34% from the general fund; and 21% from other funds. The general fund included sales taxes, general business and financial taxes, other special taxes, water charges and other charges, local assistance from the state and "carry-over" funds. Grouped under "other funds" were state aid, federal aid, sewer charges, parking meter revenue and all other sources. Since the nation's beginnings, Sew York city has contended that it has been required to supply more revenue for the state's needs proportionately than have other areas of the state, but that generally it has received less benefits, services or aid proportionately. Many of the generally Democratically controlled city's financial difficulties have been blamed upon the discriminatory treatment by the generally Republican-controlled state legislature. It occasioned more than ordinary intereit, therelore, when Republican governor Nelson A. Rockefeller and Democratic mayor R'agner on March 26, 1960, agreed upon a fiscal program whereby the city would gain substantial state aid.

Expenditures for capital improvements are considered separately. The so-called capital budget does not include capital expenditures to be paid for by special assessments. Expenditures for capital improvements are allocated among the board of education; the transit authority; public works; gas, electricity and water supply; docks and piers; health, hospitals and sanitation; the parks. libraries and museums; and other recipients.

The assessed valuation of all taxable real estate in the city in the second half of the 20th century aggregated more than $23,000,000,000. Three independent, agencies enjoyed revenues of their own. They were the New York city transit authority, the New York city housing authority and the Triborough Bridge and Tunnel authority.

The comptroller is the chief financial officer of the city government. It is his business to advise the board of estimate, to approve the disbursement of funds, to audit the accounts of the city departments and agencies and to manage the sale and retirement of the city's securities. Aside from the office of comptroller and the bureau of the budget there is a department of finance, headed by the treasurer (formerly the city chamberlain), appointed by the mayor. This department includes the bureau of city collections and the bureau of receipts and disbursements. Four agencies handle the tax and licence work of the city: the tax department, the board of assessors, the board of revision of assessments and the department. of licences. The financial organization of the city also includes a department of purchase which has sole authority to purchase supplies and equipment for all departments and agencies of the city government except the institutions and offices of the board of higher education and the department of education.

Courts. — The judicial system of the city is composed of the following courts: magistrates', including felony, municipal term, gamblers', night, narcotics. probation, traffic, week-end, women's and adolescents' courts; municipal (civil actions involving amounts of $3,000 or less); county (in New Work county, the court of general sessions; for major crimes); city (civil actions involving amounts of $6,000 or less); special sessions (all misdemeanours except criminal libel and paternity cases); domestic relations: consisting of the family and children's court divisions (children under 16 and the physically handicapped under 21. with exception of first degree murder); surrogates (estates of infants and deceased persons); and the small claims courts in each borough for cases involving claims of $100 or less. The mayor appoints the magistrates and designates the chief magistrate. the chief justice and associate justices of the court of special sessions and the judges of the domestic relations courts; whereas the justices of the city courts. the justices of the municipal courts, the judges of the court of general sessions, the county court judges and the surrogates are all elected.

Police.——The total police force of the city of New York, including patrolmen. detectives, the safety division, emergency, harbour and helicopter personnel, the youth division including the juvenile aid bureau, and plainclothesmen, numbered more than 27,000 in the second half of the 20th century. In addition, there were about 1,200 part-time school crossing guards employed by the city. There were about 90 station houses) more than half of them in Manhattan and Brooklyn. A significant feature of the police department is its academy of training, through which all recruits must pass.

Fire.——A fire commissioner heads the fire department. which in the second half of the 20th century had more than 12.000 employees. Under an intensified campaign of specialized inspection and education two school inspections annually have been the rule since Jan. 1. 1959; there are factory-loft inspections; fire wardens receive fire-prevention instruction: as do building superintendents and school custodians; and a new centralized training school was established on Welfare Island.

Health.—Within the department of health is the board of health which consists of the commissioner and four other members, two of whom must be physicians. The department operates offices, health centres and health stations in each borough.

The board of health is responsible for matters of public health policy and for drafting the city's sanitary code. The department exercises sanitary supervision of food supplies and regulates sanitary conditions in establishments that manufacture, handle or store food or patent medicine products.

In the second half of the 20th century the department has been particularly active in the identification of virus diseases, the control of radiological hazards, case finding campaigns against tuberculosis and diabetes, immunization against poliomyelitis, research into the causes of coronary heart disease, a transport service for premature infants and the development of techniques for the early detection of cancer. A new agency, the New York City Health Research council! was created in 1958. That year marked the 50th anniversary of the founding of the maternal and child health services; in that half-century there was a reduction of 77% in the city's infant mortality rate. A considerable number of voluntary health agencies operate in the city and co-operate with the health department.

Hospitals. — The department of hospitals was established in 1930 by the consolidation of the general and special hospitals of the departments of health and welfare. and Bellevue and allied hospitals. Among the chief private general hospitals are Mount Sinai, St. Luke's. Presbyterian, New Work. Roosevelt, Lenox Hill and Post Graduate, all in Manhattan. In the Bronx are the Montefiore and Misericordia hospitals. In Brooklyn are the Long Island college hospital, Jewish, Brooklyn and Methodist Episcopal hospitals. Of the private special hospitals for women and children, the Lying-in. Sloane Maternity and Woman's are the largest. Other special hospitals of note are the Joint Diseases. Special Surgery, New York Eye and Ear infirmary: Manhattan Eye. Ear and Throat hospital, Skin and Cancer clinic and Neurological institute. The larger municipal hospitals, each providing 1.000 beds or more, are Bellevue, Kings county, City, Metropolitan, Sea View and Triboro.

Among the events of interest in connection mith the private hospital services of the city have been the establishment of the Columbia-Presbyterian Medical centre and the New York Hospital Medical centre. In upper Manhattan are clustered the buildings of five separate units: the Presbyterian hospital (including the Presbyterian hospital, the Sloane hospital for women, the Vanderbilt clinic, the Squier urological clinic, the Stephen V. Harkness private patient pavilion and the Presbyterian hospital school of nursing); the Columbia University group (including the college of physicians and surgeons, the school of dental and oral surgery, the school of oral hygiene and the DeLamar Institute of Public Health); the Babies' Hospital of the City of New York; the Neurological Institute of New York; and the New York State Psychiatric institute and hospital. The New Tork Hospital Medical centre includes the Lying-in-hospital, the Manhattan maternity and dispensary, the Nursery and Child's hospital, the Payne Whitney psychiatric clinic and it is associated with Bloomingdale hospital for mental diseases and the convalescent hospital for children at White Plains, N.Y.; all of these services are affiliated mith the Cornell university medical school.

Public Assistance. — The objectives of the department of welfare are to grant financial aid to those in need who are eligible to receive it, and also to return recipients and their families to self-support as soon as possible. The forms of public aid from city, state and federal funds administered by the department are: home relief; veteran assistance; old-age assistance; blind assistance; aid to dependent children; aid to the disabled; shelter care; child welfare; day care; custodial care; and hospitalization.

In 1941 the work of various independent city agencies were made a part of the larger central welfare agency. The private relief agencies of the city offer a great variety of services for family welfare and institutional care. The more important ones are affiliated with the Welfare council of New York city, which seeks to co-ordinate the efforts of the individual agencies and carries on special research and informational services in the interest of all agencies and the general public. Mention should be made also of the Jewish Board of Guardians: the many Catholic charities and of the Community Service society of New York. The latter was formed by the merger in 1939 of the Association for Improving the Condition of the Poor (1848) and the Charity Organization society (1883).

Correction. — The department of correction has a threefold goal: to relieve acute overcrowding in all penal institutions, a result of the steady increase in the number of prisoners since World War II; to close obsolete prison buildings; and to separate inmates properly in order to promote rehabilitation and academic and vocational training. The department administers the city institutions for the care and custody of criminals and misdemeanants and for the detention of persons anaiting trial. In 1957 the correction academy nas established to provide essential training for the department's personnel. In 1958 an agreement was reached whereby self-committed narcotics addicts would no longer be dealt with as prisoners, but as patients to be cared for by the department of hospitals. Apart from the department of correction, the city magistrates' courts, the courts of domestic relations. the courts of special sessions and the county courts provide an extensive system of probational investigation and supervision. There is also a city parole commission nhose jurisdiction extends to prisoners given indeterminate sentences by the city courts and the parole officer assigned to each offender retains supervision for three years. A large number of private agencies also deal mith correctional problems.

Public Water Supply. — In the early years, the water supply of New York was derived from wells, streams and ponds. In 1799 the Manhattan company was incorporated ostensibly to supply the city with water but. under a clause in its charter, devoted itself primarily to the banking business. In 1834 the legislature authorized the city to begin the necessary works to bring water from the Croton watershed more than 30 mi. N., and the first Croton water was delivered to the city in 1842 through the Croton aqueduct. In 1883 a new Croton aqueduct was authorized and thus additional water became available in 1890. In 1905 the board of water supply was created and work was begun on a new system to bring water from the Catskill mountains, more than 100 mi. N. This commission developed an additional water supply from the Esopus and Schoharie watersheds with a total dependable yield of about 600,000,000 gal. daily flowing through the Catskill aqueduct which delivers its water just north of the city line into Hill View reservoir in Yonkers having a storage capacity of 900.000.000 gal. A new construction program to draw water from the Delaware river, begun in 1936, was planned by the board in three stages. The first stage. comprising the Rondout and Neversink reservoirs and the Delaware aqueduct, began contributing to the city's water supply in 1944. The second stage began to contribute its water in 1955. The third stage of the Delaware system commonly is known as the Cannonsville project. The three stages together were planned to yield an additional 920,000,000 gal. daily. A drainage area of 1,700 sq mi., greater than the entire land area of Rhode Island, is required for the city's water-supply system.

Sanitation. — A department of sanitation was created in 1929, consolidating five separate borough departments into one division of street cleaning. In 1933 the three-member sanitation commission was replaced by a single commissioner. In Oct. 1955 the city undertook its largest crusade against litter. In 1958 a related drive against "litterbugs" was begun which used both education of the public and a rigorous enforcement of the sanitary code. The department, aided by other departments and agencies, summoned violators.

Public Works. — The department of public works also is directed by a commissioner. The department has charge and control of planning, construction and repair work of all structures, buildings and other public works, paid for wholly or in part by city funds and is charged with maintaining and operating them. It also has charge of sewers and sewage-disposal plants. Under its jurisdiction are public buildings of every description. including city hall, bridges. court buildings, hospitals, health centres, parking facilities and libraries. The city has been engaged in a vast sewage-disposal program to eliminate the pollution of its harbours for many years. An engineering bureau was established in 1930 to tackle this problem and in 1938, under the new charter, it came under the department of public works. The early bureau commenced work on the Ward's Island plant, and completed the Coney Island plant, giving the city its first modern sewage-disposal plant in 1935. Within five years three additional plants had been completed and put into operation: Ward's Island plant. Tallmans Island plant and a part of the Bowery bay plant. In 1948 this program was given additional impetus when the Interstate Sanitation commission stipulated that all sewage pollution of waters within its jurisdiction should end by Dec. 1959. The department has undertaken a refuse-disposal program in conjunction with the sanitation department which involves the construction of new incinerators, new marine transfer stations, marine unloading stations, the modernization of older incinerators and the improvement of transfer stations.

Postal Services. — The post office of New York city in 1827 was located in a small two-story frame building on Garden street (now Exchange place) and the entire force consisted of about eight clerks and six letter carriers. In 1869 the city hall post office at Park row and Broadway was the main post office. It was razed in 1939. In 1914 a new general post office building was opened on Eighth avenue from 31st to 33rd streets, containing 500,000 sq.ft. of floor space. The transportation of mails is expedited by means of an underground pneumatic-tube system consisting of 27 mi. of double-line eight-inch tubes with a carrying capacity of approximately 200,000 pieces of mail per hour.

City Planning and Zoning. — The Greater New York charter adopted in 1898 provided that the responsibility for laying out street systems should be primarily vested in the borough presidents, with specific approval resting on the board of estimate and apportionment and independent approval by the mayor for changes in plan. In 1903 the board of aldermen created an improvement commission; in 1913 a heights of buildings commission was created. The latter led to the building zone resolution of 1916 which regulated the height and bulk of buildings thereafter erected and the boundaries for trades and industries. The new charter of 1938 provided for a city planning commission. This body was charged with the preparation of a master plan for the future development of the city. It is responsible for completing and maintaining the city map; zoning changes; the preparation of a capital budget and a five-year capital program; the approval of assessable improvements; and the selection and acquisition of land for streets and sites for large public improvements. In 1958 the commission initiated plans for urban renewal and in 1960 the stage was set for the final plan for the West Side Urban Renewal project.

Public Markets. — The department of markets supervises and controls public markets, pushcarts, indoor and outdoor street markets and terminal markets to assure adequate distribution of food, purity of content and protection from profiteering and fraud; it issues market and pushcart permits; il supervises the manufacture and sale of ice; it inspects weights, measures and scales; and it provides consumers with price information.

The city's chief wholesale markets are the Bronx terminal, the New York city live poultry terminal in Queens, the Gansevoort market meat centre, the Peck Slip in Manhattan and the Brooklyn terminal markets. In addition, there are a few pushcart or street markets, a picturesque remainder and feature of the city's congested foreign districts.

COMMERCE AND INDUSTRY

Harbour. — The port of New York has the greatest harbour in the world. During the second half of the 20th century the port was the busiest in the U.S , averaging more than 25,000 ship arrivals and departures annually. New York's harbour is naturally divided into several parts. At the entrance from the Atlantic is the outer harbour (about 122 sq.mi.), known as Lower bay. Raritan bay lies adjacent to the Lower bay on the west and the Raritan river and the Kill van Kull flow into the west side of Raritan bay. The Ambrose channel is the chief of several channels crossing the broad bar at the entrance to the outer harbour. It leads northwestward and then northward into the inner harbour through the Narrows, a neck about 1 mi. wide between Long Island and Staten Island. The inner harbour consists of the Upper bay, 4 mi. long and 4 mi. wide, the lower Hudson river, the East river. Long Island sound and tributary waterways. Anchorage channel, an extension of Ambrose channel, extending through the Upper bay to the mouth of the Hudson river at the Battery, affords a depth of 40 ft. at mean low water for a width of 2,000 ft. Within the port are 42 channels, from 38 to 45 ft. deep.

The port of New York has a total length of developed frontage measured around piers and shore lines of about 755 mi., with about 460 mi. in New York and 295 mi. in New Jersey. The harbour has two northern entrances: the northeast entrance from Long Island sound by the East river, principally used by New England coasting vessels and the h'orth (lower Hudson) river, by which the inland water-borne traffic of the Hudson river and Erie canal is brought to the port of New York. There are nearly 400 vessel berths in the port. In the second half of the 20th century the ocean-borne foreign trade passing through the port, in terms of general cargo, was more than 12,000,000 long tons and in terms of bulk cargo, more than 25,000,000 long tons annually.

In 1921 the states of New Jersey and New York adopted the principles under which the Port of New York authority was established; its purpose was to co-ordinate the terminal, transport and other facilities of commerce in and about the port of New York. This agency and the department of marine and aviation operate most of New York city's port facilities; most of the docks are controlled by the latter, most terminal, transport and other facilities are controlled by the former. The area of the port of New York district within the jurisdiction of the port authority is about 1,500 sq.mi., extending from below Sandy Hook on the south to Tarrytown on the north. The Holland vehicular tunnel, opened in 1927, mas brought under the port authority's control in 1930. The Lincoln vehicular tunnel opened in 1938. (See PORT AUTHORITY: *The* Port *of New* York.)

Banking, Exchange and **Insurance.**—New York city, the headquarters of major enterprises and of professional, executive and managerial personnel, is the nation's executive capital. At the same time. it is the financial capital of the world. From the beginning of the city's history, the financial district of New York has been at the end of Manhattan Island. below Fulton street. The largest banks and trust companies, the exchanges and many insurance headquarters are there as are the New York Stock and American Stock exchanges, the Coffee and Sugar exchange, the New York Cocoa exchange, the New York Cotton exchange, the Maritime exchange: the New York Produce exchange and the Commodity exchange. In 1784 Alexander Hamilton wrote the constitution for the Bank of New York. the first to be established in the city and in operation five years before the U.S. constitution was adopted. The first bank of the United States was established in 1791, and a branch known as the office of discount and deposit was opened in New York in the same year. The Bank of the Manhattan company, in which Aaron Burr was interested, was the third bank to be organized in the city and its charter is notable as being the first to enable a public utility company to engage in banking.

The subtreasury of the United States, formerly on Wall street. was abolished in 1914. On Feb. 21, 1940, it became a national monument — Federal Hall memorial. A part of the functions of the subtredsury are carried on by the U S. assay office at 32 Wall street. The New York clearinghouse. located on Cedar street. was established in 1853. Bank clearings in the second half of the 20th century have been exceeding more than $600,000,000 000 annually. New York is the centre of federal reserve district no. 2. The New York Stock exchange has more than 1.300 members. The American Stock exchange was formerly an open-air market for unlisted securities. It is now housed in its own building at 78 Trinity place, completed in 1921. In Jan. 1953 the exchange took its present name and dropped its former title of New York Curb exchange.

Wholesale Trade. — New York city, the largest wholesale trade centre in the U.S, employs more than 300,000 persons in wholesale establishments. The total wholesale trade conducted amounted to more than $45,000,000,000 annually in the second half of the 20th century.

The clothing industry is chiefly centred in Manhattan, between Washington square and 42nd street. and in cross streets between Seventh avenue and Broadway. Silk establishments have two principal centres, one bounded roughly by 23rd and 34th streets and Third and Fifth avenues; the other, on or adjacent to Broadway between Canal and Eighth streets. Fur establishments are sharply localized between Broadway and Eighth avenue and 26th and 30th streets. The millinery business has moved to a centre between Broadway and Fifth avenue above 34th street. Boot and shoe establishments are almost exclusively in lower Manhattan between Broadway and West Broadway below Canal street. Jenelry, formerly concentrated in and about Maiden lane, later became distributed in smaller groups between Maiden lane and 50th street along Broadway and Fifth avenue, with large and growing centres at and about the intersection of Canal street and the Bonery and on 47th street between Fifth and Sixth avenues. Fruit and produce markets are centralized in Manhattan betneen Canal and Cortlandt streets and West Broadway and the North river. The fish, butter, egg and cheese markets are highly concentrated on the loner west side between Harrison and Greenwich streets and meat establishments centre at West 14th street and the North river. The coffee. tea and spice markets are mainly in a small area on the lower east side about Water and Front streets. Hardware houses are nest of Broadway, between Houston and Fulton streets; paper and stationery are much more widely scattered than formerly, largely because of the uptown movement of printing and publishing establishments. one great centre being at or near Park row and the other in the neighbourhood of the main post office about 34th street. Drug establishments are chiefly in loner Manhattan, while leather dealers are just below Brooklyn bridge.

Retail Trade. — The retail trade has followed the northward movement of the population. In 1850 it was at Canal street and by 1880 at 14th street. By mid-20th century it was between 31st and 59th streets, and Third and Eighth avenues. Fifth avenue was formerly exclusively residential but later was given up to retail trade as far north as 60th street. Beyond that a zoning ordinance reserved Fifth avenue for residence. Some of the largest department stores are on 34th street and the greatest volume of trade is done there. But the northward trend of the residential section affected the character of the trade. and the more expensive shops, including some of the oldest retail firms. are farther up Fifth avenue. Madison avenue, because of its situation between Park and Fifth avenues. rapidly took on the aspect of the latter, and is lined with shops from 42nd street to 84th street. The art and antique dealers are on 57th and adjacent streets and also on Madison and Lexington avenues. There are a number of small antique shops on Eighth street. Automobile houses are near Columbus circle and up Broadway from 55th street for more than ten blocks. Brooklyn and the Bronx have important shopping and financial districts of their own. The growth and decentralization of population precipitated a trend among large department stores toward building branches of their stores in suburban areas of the city and in many cases in the neighbouring counties. In the second half of the 20th century retail trade establishments had an annual sales volume of more than $9,000,000,000.

Building Construction.— —More than half of the city's homes and apartments were less than 50 years old and were built in three great waves of housing construction since 1921. Vast projects, such as Stuyvesant Town, Cooper Village, Parkchester, Fordham Hill and Fresh Meadows. have been constructed with funds supplied by large institutional investors. In addition, two large-scale urban renewal projects for the development of municipally sponsored modern industrial parks to aid industry have been undertaken on former slum sites. From 1958 there has been a marked increase in private-enterprise housing built with the aid of federal, state or city government.

Modern building construction in New York dates from the erection of the ten-story Tower building in 1889. The loftiest edifice in the world, the Empire State building on Fifth avenue at 34th street, rises to a height of 1,250 ft. from the street level and has 102 stories. Rockefeller Center, the largest privately owned business and amusement centre in the United States, begun in 1931 and completed in 1947 with the addition of a new building to the group completed before World War II, covers almost 13 ac. between Fifth and Sixth avenues from 48th to mid-51st streets. There are 15 separate buildings and the 5 edifices of the western section of the centre comprise Radio City. From the end of World War II, New York city has experienced a phenomenal building boom resulting in nearly 150 new office buildings. Manhattan's midtown area especially has been the centre of this commercial office and skyscraper building renascence, with the downtown area assuming the secondary role. Several commercial offices and skyscrapers built after World War II include: Chase Manhattan (60 stories), Union Carbide and Carbon (52), Time & Life (48), National City Bank (43), Socony Mobil (42). Equitable Life (42), International Telephone and Telegraph (33), Produce Exchange (33) and Pfizer (32).

Laws affecting building in the city date back to 1647 and they dealt primarily with fire prevention. In 1867 a law dealing with fire prevention and ventilation was passed; in 1879 this law was amended so that no new tenement could occupy more than 65% of the lot and there had to be at least 600 cu.ft. of air space per person per room; in 1899 a new building code was adopted; in 1901 a tenement house law was enacted. In 1916 the city's first zoning ordinance was adopted regulating use, height and percentage of lot; and in 1929 the Multiple Dwelling law was passed, superseding the act of 1901.

Manufacturing. — New York city is the leading manufacturing city in the U.S., a position it has held since 1824. In the second half of the 20th century the metropolitan area accounted for more than a fourth of the industrial production of the country's dozen largest industrial areas. At that time there were more than 35.000 manufacturing establishments in the city which employed nearly 1,000.000 persons. The ten leading manufacturing industries in terms of the number of workers employed were apparel and other finished products; printing, publishing and allied industries; food and kindred products; electrical machinery; chemicals and allied products; fabricated metal products; textile products; machinery, excluding electrical; leather and leather products; and paper and allied products. Nearly 80% of the total manufacturing employment was in these industries.

TRANSPORTATION AND COMMUNICATION

Rapid Transit. — The problem of transportation and communication in New York city is unique, not only because of the extraordinary concentration of people in certain areas at a given moment, but also because of the narrow and elongated shape of Manhattan, and of the rapid growth and shifting areas of population that must be served.

The vast 237.41 route-mile city-owned rapid-transit system had its beginnings with the primitive steam locomotives that pulled cars along the Ninth avenue elevated railway, which opened in 1870 and extended slightly more than 3 mi. from Battery place near the southerly end of Manhattan to 30th street. The next decade witnessed its growth to 32.5 route-miles of track, forming four separate transit lines extending north and south on Manhattan. These lines were entirely private enterprises operated under perpetual franchises granted by the state legislature. For the next 20 years there were no extensions to the rapid transit lines on Manhattan, but some progress was made in other boroughs — the Third avenue "L" in Manhattan was extended into the Bronx across the Harlem river as far as 169th street in 1888, to 177th street by 1891, to Fordham road by 1901 and to its terminus at Bronx park by 1902. In Brooklyn the first elevated, the Lexington avenue line, was opened in 1885. This line was extended and other lines built until by 1900 the Brooklyn system had a route length of 62 mi. In 1902 the motive power of these elevated lines was changed from steam to electricity. In 1900 the first subway was planned and finally extended from the Bronx through Manhattan and under the East river to Brooklyn. This rapid transit-system was a municipal undertaking. Between 1908–10 two tubes under the Hudson river connecting Manhattan with Hoboken and Jersey City and a connecting tube which extends up Sixth avenue from Cortlandt street to 33rd street were completed. In 1913 a new Lexington avenue line and the extension of the west side subway down Seventh avenue to lower Manhattan and then under the East river to Brooklyn were begun. A four-track subway on Broadway and Seventh avenue, Manhattan, extending through tunnels to Brooklyn and Queens was authorized at about the same time. In 1925 the city began building an independent subway system, the main unit of which, the Eighth avenue line, commenced operation in 1932. During the LaGuardia administration, many more miles of track were opened on the Independent subway and the new Sixth avenue line was completed. The Sixth avenue "L" was razed and buses rapidly replaced surface cars. Unification of the transit system of the city was accomplished in June 1940; through condemnation proceedings the city acquired title to "L" lines in Brooklyn and Manhattan which with the exception of a part of the Third avenue line in the Bronx were abandoned.

The New York City Transit authority administers the largest municipally owned transit system in the U.S., comprising a total mileage of nearly 800 mi. The subway division is divided into three systems; the Interborough Rapid Transit, the Brooklyn-Manhattan Transit and the Independent system.

Railroads. — The New York Central and the New York, New Haven and Hartford railroads have a common terminal in Manhattan (Grand Central terminal), at 42nd street and Park avenue; and the Pennsylvania has its terminal at 32nd street and Seventh avenue, with tunnels to Long Island and New Jersey. The Pennsylvania terminal is used also by the Long Island railroad which has its own terminal at Atlantic and Flatbush avenues in the borough of Brooklyn. The other railroad terminals are on the New Jersey bank of the Hudson and are reached either by tunnel, ferry or subway.

Streets. — The first comprehensive street plan was the Randel plan. drawn up by John Randel, Jr., in 1807. By 1811 the plan was in effect, and nith a few changes. notably the laying out of Madison avenue, midway between Fourth and Fifth avenues, north of 23rd street, and Lexington avenue between Third and Fourth avenues, north from 21st street. this is now the street plan of Manhattan as far north as 155th street. The 120,000 population at that time was concentrated south of Houston street. The plan provided straight line "avenues," with a uniform width of 100 ft. extending longitudinally along the island and separating block lengths ranging from 610 to 920 ft. At right angles thereto, "streets," usually 60 ft. wide, were laid out separated by a block depth of 200 ft. The plan included the extension of Broadway, which has a general direction diagonally across Manhattan to 79th street, whence it parallels the other avenues. The rapid growth of the city and the ever-increasing use of motor vehicles produced serious traffic congestion in many sections of the city and this necessitated extensive street widening and the development of new thoroughfares.

The Port authority operates the largest bus terminal in the world, plus two motor truck terminals, one in New York and the other in Newark and the Union Inland terminal in Manhattan.

Notable accomplishments in the city's highway system have been the West Side highway. a 13-mi. nonstop drive from one end of Manhattan to the other that connects directly onto the Henry Hudson parkway in the Bronx and finally with the Westchester county parkway system in Yonkers; the Franklin D. Roosevelt (East river) drive. a nonstop drive from the Battery to 125th street and then into the Harlem river drive; and the Major Deegan expressway that runs the length of the Bronx and connects the Triborough bridge with the New York State thruway. Other improvements have been the 3-mi. viaduct on the Jersey side of the river, leading from the Holland tunnel to the main highway to Trenton; the extension of the Hutchinson river parkway, the Henry Hudson parkway and the Bronx river parkway, extending for 15 mi. through Westchester county; the bridges and highways in the Triborough bridge project, opened in 1936; and the Belt parkway, primarily a three-lane superhighway. which from the Brooklyn-Manhattan tunnel rims the boroughs of Brooklyn and Queens for a distance of more than 40 mi.

The more notable streets include Wall street, on lower Manhattan, the centre of the financial district; Fifth avenue with its fine shops, clubs, library and museum; Riverside drive, overlooking the Hudson; Park avenue, which continues as Fourth avenue above 32nd street to the Grand Central terminal and then from 45th street to the Harlem river, and is lined with fine apartment houses and office buildings in the middle section up to 96th street; the Bowery. which runs diagonally through the east side of lower Manhattan from the Brooklyn bridge to meet Fourth avenue at Eighth street; and Broadway, which extends more than 18 mi. from the southern tip of Manhattan to the northern limits of the city. In its middle part, from 10th to 79th streets, Broadway cuts through the heart of the business and amusement district. From 34th street to Columbus circle at 59th street it forms the centre of the automobile, theatre, moving picture, restaurant and nightlife sector.

Bridges and Tunnels. — There are eight bridges spanning the East river. One, completed in 1951. links the east Harlem area with a large playground and park on Ward's Island. The Brooklyn, Manhattan and Williamsburg bridges have their Manhattan terminals at Park row, Canal and Delancey streets, respectively. All are suspension bridges and connect Manhattan with Brooklyn. The Brooklyn bridge. the first to span the East river, was opened in 1883. The Williamsburg bridge was opened in 1903. the Queensborough bridge in 1909 and the Manhattan bridge the same year. The Hell Gate bridge over the East river is exclusively for railroad traffic. The Triborough bridge over the East river. opened in 1936, actually consists of three bridges connected by several long viaducts over land, its arms extending into Manhattan, the Bronx and Queens. The vertical lift bridge between Randall's Island and Manhattan is one of the largest of that type in the country. The Bronx-Whitestone bridge, opened in 1939, connects the Bronx with Queens.

The George Washington bridge, crossing the Hudson river, extending from a point near 178th street, Manhattan, to Fort Lee, N J., was opened in 1931 and is the third longest suspension bridge in the world. Construction was begun in 1959 on a second deck below the original deck.

The Harlem river is traversed by 13 bridges of various types and designs. The most notable is the famous High bridge (1848) which carries an aqueduct of the city's Croton water supply, and which mas rebuilt in 1928 to remove impediments to navigation.

Transportation of passengers by rail between the boroughs of Manhattan, Brooklyn, the Bronx and Queens and New Jersey is provided by means of tunnels constructed below the beds of the East, Hudson and Harlem rivers. Vehicular transportation between Manhattan and Jersey City was made possible by the opening of the Holland vehicular tunnel in Sov. 1927 In Dec. 1937 the Lincoln tunnel, connecting 39th street in Manhattan with Weehawken in New Jersey, was opened. A third tube was added to this tunnel in 1957 making it the only triple underwater tunnel in the world. (See HOLLAND AND LINCOLN VEHICULAR TUNNELS.) The Queens Midtown tunnel, finished in 1940, connects Manhattan on the east side at 36th and 37th streets nith Long Island city. The Brooklyn-Battery tunnel was opened in 1950. This tnin-tube 11,000-ft. structure was the longest under-river ventilated vehicular tunnel in the country at the time of its completion. It connects the southern tip of Manhattan with Gowanus parkway, which branches into the Belt system or into downtown Brooklyn. The Pennsylvania railroad has four tubes across the East river and two across the Hudson and the Hudson and Manhattan railroad has two systems, each comprising two single-track tubes from Jersey City. The Brooklyn-Manhattan Transit system has six rapid-transit tubes under the East river, laid in pairs and the Interborough Rapid Transit system also has three pairs of transit tubes leaving Manhattan. Practically all of the railroad and rapid-transit tunnels were completed between 1900 and 1920. In connection with the Independent subway system, the board of transportation designed five new tunnels, four of which nere opened for service in 1933 and one in 1936.

Ferries. — There were 12 ferries operating from New York city in the early 1960s. Four operated from City Island, the Bronx, to Hart Island; from the Battery, Manhattan, to St. George, Staten Island; from East 134th street, the Bronx, to North Brothers and Rikers Islands; from 69th street, Brooklyn, and St. George. Others were operated by railroads, private companies and the federal government. The Staten Island ferry ride is one of the city's recreational features, offering a ten-mile, one-hour round trip through the New Tork harbour, and affording a view of the city's sky line. the Statue of Liberty and Governor's Island.

Airports. — In 1947 four major airports in the metropolitan area were combined into a single integrated air-terminal system under the control of the Port of New York authority. These were the LaGuardia airport in Queens; the New York International airport (Idlewild) in Queens, one of the world's largest; Newark airport in Newark, N J.; and Teterboro airport in Teterboro, N J. In addition. the authority operates the West 30th street heliport which nas opened in 1956.

Telephone and Telegraph. — Between 1950 and 1960. the number of telephones in the city increased by more than 1,000,000 to make a total of more than 4,000,000. The volume of telegraph traffic is so great that the company operating the system dedgnated the New York city area as a separate division. There are approximately 115 mi. of cable under the streets of Manhattan, which is one of the methods used to speed distribution of local telegraph traffic. These cables are all concentrated in a relatively small area of 3 sq.mi. and there are entrances to approximately 1.000 buildings in the financial and midtown area.

International communications services are provided by coaxial and conventional underwater cables and landlines, radiotelegrapli circuits, radiotelephone circuits and ship-to-shore radiotelegraph.

EDUCATION AND CULTURAL ACTIVITIES

Public-School System. — The public-school system is administered by a department of education of nine persons appointed by the mayor. The chief executive officer is the superintendent of schools who is elected by the board for a term of six years.

The board of education has created the "600" schools for maladjusted students and those presenting disciplinary problems and has pioneered in the education of the gifted. Serious problems include the absorption of the numerous Puerto Rican children into the schools and the integration of Negro pupils into predominantly white schools.

Higher Educational Facilities. — The city provides higher educational facilities through the College of the City of New York which comprises City college, Hunter college, Brooklyn college and Queens college. City college was established as the Free academy in 1847. The name was changed to the present one in 1929. A modern structure in loner Manhattan houses its business school. Hunter college was founded in 1870 as the "normal and high school." In addition, New Tork is the seat of Columbia University (*q.v.*) and New York university, which was founded in 1831. In 1835 it moved to Washington square and in 1891 added a site of about 48 ac. on University heights in the Bronx. Fordham university was founded in 1841 as St John's college. In 1846 it was turned over to the Jesuits and incorporated. The name was changed to Fordham in 1907. It is situated in the Bronx. Long Island university is in Brooklyn. In 1928 Yeshiva university (Jewish) was opened and it occupies buildings of ancient Semitic architecture in upper Manhattan. Among the professional schools are: the General Theological seminary (Protestant Episcopal); Union Theological seminary (Presbyterian); Jewish Theological Seminary of America; Cornell university medical college; Brooklyn law school; the Institute of Public Administration; the New School for Social Research; and the professional schools of the various universities. The chief technical institutions are the Mechanics institute, founded in 1820; Cooper Gnion (*q.v.*); and Pratt and Polytechnic institutes, both in Brooklyn. The New York State Maritime college is at Fort Schuyler in the Bronx.

In 1956 New York city and New York state combined to establish the Staten Island community college offering either a two-year course in the liberal arts or a two-year program in varied categories of technical training. The Bronx community college was founded in 1957 and the Queensborough community college opened its doors in 1960. These three colleges are sponsored by the New York city board of higher education under the program of the State University of New York. Cnder the related city-state community college plan are two two-year colleges. the Fashion Institute of Technology and the New York City Community College of Applied Arts and Sciences.

Libraries. — The first public library in New York was the New York Society library. founded in 1754 in the city hall. It remained at the city hall until 1795 and was the library of congress nhen New York was the nation's capital. Other libraries are the Columbia University library (1754), that of the New York Historical society (1804) and the Mercantile library. founded in 1820 by merchants' clerks. The municipal library system consists of the New York Public library serving Manhattan, the Bronx and Richmond; the Brooklyn Public library and the Queens Public library. There are also numerous college, university and important special libraries in the city.

Art and Architecture. — Augustus Saint-Gaudens is represented by his "Peter Cooper." the equestrian statue of Sherman, the Admiral Farragut statue, the bronze relief of the Rev. Henry W. Bellows and other works; John Quincy Adams Ward, by the "Pilgrim," "Shakespeare," "Indian Hunter" and a monumental bronze "Washington"; Frederick W MacMonnies by his "Nathan Hale," "Civic Virtue," "Horse Trainers and a Quadriga"; Daniel Chester French by the "Alma Mater"; George Gray Barnard by a fountain at Columbia; Karl Bitter by "Abundance" and an equestrian statue of Franz Sigel; Anne Hyatt by "Jeanne D'Arc"; Kirke Brown by an equestrian Washington; F. Auguste Bartholdi, the French artist, by "Lafayette"; H. P. Proctor by a bronze group of panthers; and Edward Kemeys by "Still Hunt." On the front of the Public library is a statue by Paul Bartlett. A group by Albert Weinter depicting the purchase of Manhattan Island is in the city hall of records. On Liberty Island the Statue of Liberty by Bartholdi. a gift of France on the 100th anniversary of American independence, rises 305 ft. above the harbour. *(See* LIBERTY, STATUE OF.) Modern U.S. sculpture is well represented by the works of such men as William Zorach, Jo Davidson and Isamu Noguchi.

The largest collection of art objects in America is in the Metropolitan Museum of Art. Other museums of importance are the Whitney Museum of American Art. which exhibits works of U.S. artists and the Museum of Modern Art, and the Solomon R. Guggenheim museum, housed in a building designed by Frank Lloyd Wright.

Aside from the public museums, among the important art galleries is that of the Associated American Artists. The Cloisters in Fort Tryon park, a branch of the Metropolitan Museum of Art. was a gift of John D. Rockefeller, Jr. It contains an outstanding set of Gothic tapestries, "The Hunt of the Unicorn."

A few striking examples of 18th and early 19th-century architecture remained in 1960, notably St. Paul's chapel, designed by MacBean and built in 1764; the old church of St. Mark's-in-The-Bouwerie, completed in 1799; and city hall. the work of Joseph F. Mangin and John McComb, Jr., completed in 1812. James Renwick designed the Gothic Grace church, completed in 1845 and St. Patrick's cathedral, which was built between 1858 and 1879. After the Civil War Richard M. Hunt., a graduate and teacher in the Paris School of Fine Arts, began his American career. Among his first works were the Astor and Gerry houses and the old *Tribune* building. Charles F. McKim, William R. Mead and Stanford White were designers of the old Madison Square Garden, the Washington arch and the Metropolitan club. R. H. Robertson is known for his work on the American Tract Society and United Charities buildings. John Carrère and Thomas Hastings planned the National Academy of Design and the New York Public library; H. I. Hardenburg, the Waldorf. Savoy and Manhattan hotels and the American Fine Arts building; and Ernest Flagg, the Singer building, St. Luke's hospital and the Scribner building.

Since 1945 there has been an office building boom. Several of these structures and skyscrapers have been innovational from an architectural point of view. Conspicuous among these have been the United Nations group, the Seagram, 260 Madison Avenue and Manufacturers Trust Company (with its unbroken glass façade) buildings, Lever and Canada houses and the New York coliseum.

Music.—In the first quarter of the 19th century, the Park theatre became a famous stage for dramatic and musical art. In the 1840s and 1850s the musical centre was Tripler hall on lower Broadway, which became Metropolitan hall in 1854 and then, following its destruction by fire shortly afterward, was rebuilt and rechristened the New York theatre and Metropolitan Opera house. Later its name was changed to the Winter Garden. The present Metropolitan Opera house was built in 1883. In the latter half of the 19th century several other large halls for musical recitals mere opened, notably, Steinway, Chickering, Hardman and Carnegie halls.

In the 20th century there has been a growth of interest in all forms of musical activity. Typical of this were the Lewisohn Stadium concerts; performed by the New York Philharmonic-Symphony orchestra and distinguished soloists before large audiences in the City college stadium. Besides the Metropolitan Opera company, opera was represented in New York city by the New York City Opera company at the City centre. New York's Centre for the Performing Arts, part of the Lincoln Square development, was dedicated in 1959.

Literature.—Cadwallader Colden, author of the *History of the Five Nations* (1730), mas perhaps the first New York author of general reputation. The first authors' club, the Ancient Club of New York, was founded in the latter part of the 18th century and later included among its members Washington Irving, Fitz-Greene Halleck. James Kirk Paulding and Joseph Rodman Drake. A little later John James Audubon, Richard Henry Dana, James Fenimore Cooper, Edgar Allan Poe, William Cullen Bryant. Herman Rfelville, John Bigelow, Julia Ward Howe and Robert Bonner were members of New York's literary life. In the 19th century the Bread and Cheese club brought together a most creditable group of writers. In the early 1920s Greenwich Village *(see* below) became the centre of American letters. During this period Edna St. Vincent Millay, Eugene O'Neill and Theodore Dreiser, among many, made this part of New York their headquarters.

The chief society of authors having headquarters in New York is the American Academy of Arts and Letters. Other notable literary organizations are the Authors' guild, Grolier club and Century association.

Theatres. — The first dramatic performances in New York were probably those given in a building on Pearl street by a company of actors from London in 1732. Another company from London came to New York in 1749. The real beginning of the permanent theatre in New York was, however, in 1750, when a company under the management of Thomas Kean and Walter Murray came from Philadelphia and established themselves in a house on Kip street (now Nassau), between John street and Maiden lane. Lewis Hallam arrived in 1753 from Virginia and erected a theatre in Nassau street. the first building constructed for theatre purposes, and opened it in 1753 with *The Conscious Lovers* and *Damon and Phelleda*. The first performance of *Romeo and Juliet* in New York was given at this theatre in 1754 with Mrs. Hallam as Juliet. This theatre was abandoned the same year and was converted into a church by a society of Calvinists. The next theatre was at Crugers wharf on the East river and was opened by David Douglass in 1758, with *Jane Shore*. Douglass also opened another theatre at the corner of Nassau and what is now Beekman street in 1761 with *The* Fair *Penitent* and later gave the first performance of *Hamlet* in New York; he also established the John Street theatre in 1767. In 1789, the first professional play by an American playwright, *The Contrast*, by Royall Tyler was produced there.

In 1798 a three-story stone theatre, the Park, was built between Ann and Beekman streets on Park row, for Hallam and John Hodgkinson. This building was magnificent for its time, costing about $180,000. In 1837 New York had five theatres: the Park, Bowery. Olympic, Chatham and Richmond Hill. Palmer's Opera house was built in the 1840s as was the Astor Place Opera house. where the Astor Place riot occurred as the result of a dispute between friends of the U.S. actor Edwin Forrest and his English rival William Macready. Twenty-two persons were killed and 36 were wounded by the militia called to quell the disturbance. In 1850, P. T. Barnum brought Jenny Lind to the U.S. for a series of concerts which began at Castle Garden at the Battery. Similar "pleasure gardens" as Niblo's, the New York, Cold Springs, East River, Vauxhall and Ranleagh, were utilized for concerts and other performances for which the capacity of theatres was inadequate. The Crystal palace at Sixth avenue and 42nd street was also a great amusement centre in the early 1850s.

By the middle of the 19th century the theatrical district was well established in the neighbourhood of Union square. The Academy of Music, the Union Square, Irving Place and Wallack's, were the chief theatres in this area. By 1870, 23rd street had become the upper limit of the theatrical centre, with the Fifth Avenue theatre and Booth's. Ten years later the theatres had invaded the lower 30s with Daly's, the Standard, Wallack's and the Casino. In 1883 the erection of the Metropolitan Opera house at 39th street started an invasion of the 40s and by the end of the century, 42nd street had become the real centre of the theatrical district.

The modern theatre district comprises roughly a strip of Manhattan extending from 41st to 53rd streets, and from Fifth to Eighth avenues.

Scientific Collections and Learned Societies. — Chief of the scientific collections is that of the American Museum of Natural History. The Hayden planetarium is a part of this museum. The zoological park in Bronx park is under the control of the New

York Zoological society. The botanical garden in Bronx park occupies about 400 ac. The museum contains a library. collections with about 1.800.000 specimens and research laboratories. The Brooklyn Institute of Arts and Science maintains another large botanical garden.

The Hispanic Society of America, founded by Archer M. Huntington, maintains an excellent museum of Spanish and Portuguese paintings, manuscripts. maps, coins and antiquities. Other interesting collections are in the museum of the American Numismatic society and the American Museum of Safety (industrial safety appliances).

The New York Historical society, the Long Island Historical Society of Brooklyn. the New York Genealogical and Biographical association. the Museum of the City of New York, the New York Academy of Medicine and the Academy of Political Science also deserve mention.

(For New York city press data *see* NEWSPAPER. For foundations *see* FOUNDATIONS, PHILANTHROPIC, etc. For museums *see* MUSEUMS AND GALLERIES.)

Clubs.—Club life in New York is less significant in the second half of the 20th century than in the earlier part of the century. The first social organizations of importance were the authors' Bread and Cheese club (1824) and the artists' Sketch club (1829). It was not until 1836, however, that club life in New Tork really began with the founding of the aristocratic Cnion and Hone clubs. The Knickerbocker (1871) was popular among the descendants of original New York settlers. The St. Nicholas was formed a little later for those whose ancestors were early residents of the colonies.

The Metropolitan (1891), with its costly house. was in fact a protest against the exclusiveness of many of the older clubs. The Union League (1863) was established for the purpose of aiding the Union. and its first work was the organization of regiments of Negro troops. To offset this Republican influence. the Manhattan was organized in 1864 to advance Democratic ideals.

The chief sport and athletic clubs are the New York Yacht (1844), the New York Athletic (1868) and the Racquet and Tennis. Other important clubs with more or less specialized interests are the Camera. Century, City. Colony, Engineers. Explorers. Harvard, Lambs, Yale, Lawyers. Lotos, Players and Salmagundi clubs.

Churches.— The Dutch Reformed Church (1628), the first church in the city. is known as the Collegiate Church of New York city. The Presbyterians organized there as early as 1638 and were tolerated by the Reformed Church. but it was not until the English occupancy that they made their influence felt. In 1719 the first Presbyterian church was built in Wall street. It was not until 1847 that a Congregational church attained prominence in New York. when the Plymouth church of Brooklyn was founded with Henry Ward Beecher as pastor. In 1664 the Lutherans obtained permission from'the English governor Richard Nicolls to establish a church. The first Lutheran church. at Broadway and Rector street. was destroyed in the fire of 1776. The Protestant Episcopal Trinity church was built in 169i at Broadway and Wall street where Trinity church (1846) now stands. St. Paul's chapel (1766) at Broadway and Vesey street is the oldest church edifice in the city; Grace. St. Thomas', the Church of the Transfiguration, familiarly known as "The Little Church Around the Corner." and the Cathedral of St. John the Divine. at 110th street and Morningside avenue. are other notable Episcopal churches. The first Methodist church (1768) was erected in John street. The Baptists had built their first church on "Golden Hill." on John street between William and Nassau streets by 1728. St. Peter's (1785) was the first Roman Catholic church and in 1808 New York was made the seat of an Episcopal see. In 1858 the present St. Patrick's cathedral at Fifth avenue and 51st street was begun, and in 1879 it was dedicated.

PARKS AND RECREATION

The department of parks has two long-range objectives: the construction and rehabilitation of recreation plants and facilities, and the expansion of park acreage through reclamation. A consolidated department was established in 1931 and is directed by a commissioner appointed by the mayor. In all. in the second half of the 20th century. the park system consisted of more than 33.000 ac. Also under the jurisdiction of the department are public beaches. swimming pools and other recreational facilities ranging from archery to football fields and yacht basins.

Central park extends from 59th to 110th streets. between Fifth and Eighth (Central Park West) avenues. It was purchased in 1856 for about $5.500.000. and laid out and developed by architects Frederick Law Olmsted and Calvert Vaux. Van Cortlandt, Pelham bay and Forest parks are the largest generally devoted to outdoor sports and recreation. In Van Cortlandt park is the Van Cortlandt mansion. built in 1748. and now maintained as a museum. The Bronx park is noted for its zooiogical and botanical exhibits, the African veldt. opened in 1931. being one of its major attractions. Riverside park. in Manhattan. extends along the east bank of the Hudson river from 72nd to 129th streets. a distance of about three miles. City Hall park constitutes a part of what was called the "fields." or "commons." in the middle of the 17th century. Roger Morris park is the site of the Jumel mansion, the home of Mme Jumel, wife of Aaron Burr, and there Cen. George Washington made his headquarters during the battle of Harlem heights. In Audubon park was the home of the naturalist John James Audubon. Poe park. in the Bronx. is the site of the Edgar Allan Poe cottage, moved from its nearby original location.

Indoor recreation centres have been constructed with indoor pools; "golden age" centres are especially designed for older people: and a dance and concert schedule in the city's parks has been instituted: the Shakespeare workshop functions in Central Park and the Wollman memorial alternates between square dancing and ice skating.

GREENWICH VILLAGE

Bounded on the north by 14th street. on the south by Spring street. running west from Broadway. Greenwich Village is a roughly triangularly shaped segment of New York city perhaps most commonly thought of as a home of American arts and letters. It is often associated with Bohemianism; radicalism. struggling artists and exotic night clubs and restaurants maintained chiefly for visitors. This atmosphere was a carry-over from the period before and after World War I. when the "Village" was locally considered the centre of the American literary and artistic renaissance. The Village has never relinquished its important role in the development of the experimental theatre and the off-Broadway theatre. The sidewalk art shows still persisted into the second half of the 20th century, and many artists still lived and worked in the Village. but the area was losing its uniqueness and early character before the impact of modern urban transformation. Some parts, however, still retained their former quaintness and charm. Southwest of Sheridan square and in the area west of the Avenue of the Americas was a maze of winding streets where could be found the age-worn dwellings erected by the burghers in the late 18th and early 19th centuries.

Elsewhere in the Village, other buildings were giving way to huge modern apartments and developments typical of a hundred other neiqhbourhoods. Houses and mews—converted stables with their interior gardens— that gave the Village its old-world look were rapidly being torn down. Washington square, at the foot of Fifth avenue, dominated by Washington arch, erected in 1892. was the last vestige of the dignity and taste of the early wealthy settlers who built there when Washington square was the centre of high society. Even the square, however, was gradually succumbing to the advances of the skyscraper apartments and New \-ork university. In 1950 and 1951 the Rhinelander mansion and other fine old buildings along the northern border of the park were torn down. On the southern side of the park. "genius roll-." including the homes of some of the country's best-known artists and writers, had also disappeared.

See also Index references under "New York (City)" in the Index volume.

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NEW YORK FERN (*Dryopteris noveboracensis*), a beautiful North American fern of the shield-fern group. While named after New York, it is native to a much greater region, occurring in moist woods from Newfoundland to Minnesota and southward to Georgia and Arkansas. The delicate fronds, one to two feet high, rise on slender stalks (stipes) from widely creeping rootstocks. See SHIELD FERN.

NEW ZEALAND, a member country or realm of the Commonwealth of Nations, consisting of a group of islands in the South Pacific. New Zealand proper, defined by letters patent of 1842 and an imperial act of 1863 as extending from 33° to 53° S. latitude and from 162° to 173° E. longitude, comprises: (1) the North and South Islands (44,281 and 58,093 sq.mi., respectively), cut asunder by Cook strait, a channel varying in width from 14 to 58 mi.; (2) Stewart (or Rakiura) Island (670 sq.mi.), separated from the southwest end of the South Island by Foveaux strait; (3) the Chatham Islands (372 sq.mi.), about 420 mi. E.S.E. of Cook strait; and (4) a number of outlying minor islands included within the political boundaries of 1842. Of the minor islands (total area 307 sq.mi.), the Aucklands (234 sq.mi.), Campbell Island (43 sq.mi.) and the Antipodes (24 sq.mi.) are the principal; the Aucklands and Antipodes are uninhabited. About 925 mi. N.N.E. of Wellington (and thus just outside the 1842 boundary) are the volcanic Kermadecs (13 sq.mi.), annexed in 1887 and included in New Zealand proper. In Polynesia a number of inhabited islands were brought under New Zealand control in 1901. Rarotonga and Mangaia, in the Cook group (89 sq.mi.), and Niue or Savage (100 sq.mi.), of islands outside the Cook group, are the largest of these island territories. Rarotonga is hilly, well watered and very beautiful; Penrhyn and Suvarov (Suwarrow), small coral atolls outside the Cook group, contain excellent harbours. The Tokelau Islands (4 sq.mi.) were detached from the Gilbert and Ellice Islands colony and placed under New Zealand administration by an imperial order in council of 1925; by an act of 1948 they were finally made part of New Zealand's island territories. Total area of New Zealand (including island territories) 103,930 sq.mi.; of New Zealand proper (*i.e.*, excluding island territories) 103,736 sq.mi.

New Zealand also administers Western Samoa (main islands Upolu and Savai'i, 430 and 703 sq.mi. respectively), a United Nations trust territory, and the Ross dependency (about 175,000 sq.mi.), an antarctic region claimed by Great Britain in 1923. The island trust territory of Nauru (9 sq.mi.) is held jointly with the United Kingdom and Australia, although Australia undertakes the administration.

PHYSICAL FEATURES

The North Island is 515 mi. long from North cape to Cape Palliser in the south and varies in breadth from 6 to 200 mi. It is almost divided where the Hauraki gulf penetrates to within 6 mi. of Manukau harbour, south of Auckland. From the isthmus thus formed a narrow, very irregular peninsula reaches out northward for about 200 mi., moist and semitropical and beautiful rather than uniformly fertile. South of the Auckland isthmus the North Island rapidly broadens out. Its central physical feature is the series of unbroken mountain chains running northeastward from Cook strait to East cape, ranges seldom less than 3,000 ft. but never attaining 6,000 ft. in height. Hikurangi, their highest summit, though a fine mass, does not compare with the isolated volcanic cones which, rising west of the main mountain system and quite detached from it, are among the most striking sights in the island. Ruapehu (9,175 ft.) is intermittently active and Ngauruhoe (7,515 ft.) emits vapour and steam periodically. Egmont (8,260 ft.), in the west of the island, is quiescent; its symmetrical form and dense clothing of forest make it the most beautiful of the three. North of the two first-mentioned volcanoes Lake Taupo spreads over 238 sq.mi. in the centre of a pumice-covered plateau from 1,000 to 2,000 ft. above the sea; and round and beyond the great lake the region of the thermal springs covers 5,000 sq.mi. and stretches from Mt. Ruapehu to White Island, an ever-active volcanic cone in the Bay of Plenty. The most uncommon natural feature of the district, the Pink and White terraces, was blown up in the eruption of Mt. Tarawera in 1885, when for great distances the country was buried beneath mud and dust and a chasm 9 mi. long was opened. Fine lakes and waterfalls, innumerable pools, in temperature from boiling point to cold, geysers, solfataras, fumaroles and mud volcanoes attract tourists in large numbers. The healing virtue of many of the springs is widely known. The government maintains a sanatorium at Rotorua and Te Aroha, and there are private bathing establishments in other places, notably near Lake Taupo. (In the South Island there are hot pools and a state sanatorium at Hanmer Springs.) Though the overlying porous pumice reduces the fertility of the Taupo plateau, except under treatment, it has a good rainfall and is drained by unfailing rivers running through deep terraced ravines. The Waikato and Waihou (Thames) flow north, the Rangitaiki northeast, and Mokau, Wanganui, Rangitikei and Manawatu west or southwest. The first named, the longest river in the dominion, though obstructed by a bar like all western—and most eastern—New Zealand rivers, is navigable for about 70 mi. The Mokau and Wanganui run between ferny and forest-clad hills and precipices, often of great beauty.

East of the Taupo plateau and south of Opotiki on the Bay of Plenty are steep, thickly timbered ranges. On the southern frontier of this mountainous tract Waikaremoana extends its arms, the deepest and most beautiful of the larger lakes of the island.

From the mouth of the Waikato southward to about 25 mi. from Cape Terawhiti on Cook strait, and for a distance of from 20 to 40 mi. inland, the western coast skirts fertile grazing and dairy-farming country. On the east coast the same fertility is seen and, round Hawke bay, there is a hotter and drier summer. In the south centre, the upland plain of the Wairarapa has a climate ideal for grazing. The southern end of the island, rough though well grassed, is redeemed by the fine harbour of Wellington (formerly Port Nicholson), which is second only to the Waitemata (Auckland) as a commercial port. Everywhere the farmer may count on an adequate rainfall and—except on the plateau and the mountain highlands—mild winters and genial summers.

The dominating features of the South Island are not ferny plateaus or volcanic cones, but stern chains of mountains. The Southern Alps rise range upon range, almost touching the western shore and stretching from end to end of the island. In the southwest region, which has a heavy rainfall, there are many deep fjords which have been carved out by glacial action. One of these sounds, Milford, has become an important tourist centre, but none of them, because of the difficult nature of the country, can be developed for settlement.

The South Island has two large and highly developed areas of flat country, the Canterbury plains and the Southland plains, which produce a large proportion of New Zealand's cereal crops. They are also important areas for the growing of root crops and the fattening of stock for export. The sunny valleys of the Nelson and Marlborough districts in the northern part of the South Island produce a large part of New Zealand's crops of apples and pears, hops and tobacco. Another important fruit-growing area is central Otago, which has the lowest rainfall in the country. The high country of the South Island has been developed for sheep rearing since the earliest days of settlement. The narrow coastal strip facing the Tasman sea, with its high rainfall, is particularly suited to dairy- and beef-cattle farming. Although the ports of the South Island handle a considerable overseas trade, good natural harbours are not as numerous as in the North Island.

There are many rivers even on the drier eastern coast; some are snow-fed and the rate of flow varies according to the season. The largest river, the Clutha, 154 mi. long (or 210 mi. from its true source at the head of the Makarora river), discharges a volume of water estimated at nearly 2,000,000 cu.ft. a minute. On the west the only two rivers of importance are the Buller and the Grey, the former justly famous for the grandeur of its gorges. Te Anau and Wakatipu (52 mi. long) are the chief lakes in the south though Manapouri is the most romantic. Mt. Cook is easily first among the mountain peaks. Its height, 12,349 ft., is especially impressive when it is seen from the sea off the west coast. On the northeast a double range, the Kaikouras, scarcely falls short of the Southern Alps in height and beauty. Apart from the fjords and lakes the chief beauties of the Alps are glaciers and waterfalls. The Tasman glacier is 18 mi. long and has an average width of $1\frac{1}{4}$ mi.; the Murchison glacier is 11 mi. in length. To the west of Mt. Cook the Franz Josef glacier crawls into the forest as low as 900 ft. above sea level. Among waterfalls the Sutherland is 1,904 ft. high, but has less volume than the Bowen and others. The finest mountain gorge, the Otira, is also the chief railway route from the east to the west coast. (A. T. CL.)

Geology. — Yew Zealand is part of the Australasian festoon on the Pacific edge of the Australasian arc. Because of its critical position it has had a particularly varied geological history, and includes, for its size, an unusually complete series of marine sedimentary rocks. It is still a matter of doubt whether Pre-Cambrian rocks constitute any portion of the islands. The oldest rocks, however, extend at intervals down the western side of the South Island. They include a complex of gneisses, schists and dioritic igneous rocks in Fiordland, and sillimanite gneisses on Stewart Island. The main mountain axis of the South Island is a one-sided structure, with a narrow belt of schists on the west and a broad zone of Palaeozoic and Mesozoic altered sediments on the east. This alpine axis is bounded to the west by the Alpine fault extending from Cook strait to south Westland and forming a complete structural division of the island.

Main Divisions. — The first evidence of life appears in rocks of Lower Ordovician age, forming a folded belt in the south at Preservation inlet and in the extreme northwest at Collingwood. They comprise graptolitic slates, quartzites and marbles, and are characterized by an Arenig fauna including *Tetragraptus, Bryograptus,* Dichograptus and Didymograptus. In Fiordland they pass north and east into metamorphic types and they appear to grdde into the Fiordland gneisses.

In the Cobb-Takaka district, strata of Silurian age (Haupiri beds) extend north from the Cobb river in a wide belt to the Haupiri mountains. Lower Devonian rocks form an important series on the Baton river and at Reefton. The fauna consist of brachiopods, a few trilobites, lamellibranchs, corals and Bryozoa, the beds now being assigned to the Upper Siegenian or Louer Coblenzian.

Much of the highlands are built up of folded greywackes, slates and some limestone, with a volcanic horizon recognized near the base of this folded series. The whole is divided into a Permian (Te Anau and Maitai) series and a Mesozoic (Hokonui) series. The nature of the junction between the two is still little understood, various authorities claiming a complete conformity, much regression or marked diastrophism with plutonic (dioritic) intrusions.

In the type locality (Nelson district) the Maitai series (limestones, shales and slates) contain Platyschisma, Strophalosia, Martiniopsis and *Spirifer bisulcata,* a fauna characteristic of the Permian beds of eastern Australia. An extensive series of basic breccias (Te Anau series) forms the base of the Maitai series upon which the fossiliferous sediments rest. The top of the series is formed of greywackes, in places containing annelid tubes (Terebellina). These are referred to a Lower Triassic age. This Permian series has a wide distribution in the South Island. The succeeding events are not clear. Probably there followed a regression of the sea, succeeded in turn by a transgression when the Hokonui beds were laid down. The base of this series is of middle Triassic age, these beds being followed by Upper Trias. They include the Carnic, Noric and Rhaetic stages, the sediments being greywackes, limestones, a horizon of basic tuffs (Noric) and Rhaetic plant beds. The sequence or portions of it are recognized from both the South and North Islands.

The Noric beds, characterized by an abundance of *Pseudomonotis,* have a very wide distribution, extended throughout the Southern Alps in Canterbury, along the Hokonui hills, in the Nelson district and in the Mokau district of North Taranaki. The series extending from the middle Trias to the Rhaetic is of great thickness, of the order of 10,000 ft. The beds are followed conformably by Jurassic feldspathic sandstones, conglomerates, plant beds and some thin coal seams. Liassic, Bajocian and also Upper Jurassic marine faunas have been described. A widespread series of sediments containing Inoceramus occurs in the east of the North Island, probably, in part, of Upper Jurassic age, but extending into the Lower Cretaceous. The problematical schists of the South Island, well developed in the Otago region and referred to as the Otago schists, are perhaps of Mesozoic age, though they have been referred to horizons from the Archaean to the Jurassic. They appear to pass outward into sediments indistinguishable from Ordovician or Mesozoic strata.

At the close of this sedimentation, in Lower Cretaceous times, a strong orogenic movement supervened, in which the Hokonui system was folded along meridional lines, the earth movements being accompanied by widespread plutonic intrusions throughout the length of New Zealand. The dunite sills of the Dun mountain region and the gabbros and norites of North cape belong to this epoch, as perhaps do also some of the diorites of the southwestern district of the South Island. The most intense folding in the North Island is developed in the east; in the west the flexures become more open and undulating strata predominate. In the Otago region, the Otago schists have recently been interpreted as a flat lying series forming a packet of recumbent folds, the participating rocks being referred to members of the Maitai and Hokonui series.

Following the Hokonui diastrophism a series of sediments ranging from middle Cretaceous to Upper Pliocene was deposited, but the record has received diverse interpretations. particularly in regard to the structural relations of the beds and the correlation of formations in neighbouring regions. According to the view of P. Marshall, the whole series is conformable throughout, a difference in age of the basal strata in different districts being ascribed to overlap over an irregular surface of the older rocks. Summarily, the sequence of formations is as follows:

Middle Cretaceous	(Albian)	Marine beds (in Kaikoura ranges)
Upper Cretaceous	Senonian	Greensands, basal coal measures
	Danian	Limestones (partly foraminiferal)
Eocene		Marine beds and coal measures
Oligocene, Miocene		Marine beds
Pliocene.		Marine beds and gravels

The oldest rocks of this sequence are developed in the Kaikoura mountains of Marlborough, where a thickness of from 3.000 to 9,000 ft. of sandstones and mudstones, with conglomerates and some coal measures, were deposited. These Alhian beds are followed by the Amuri limestones (2,500 ft.), but in Canterbury and the coast of Marlborough Senonian strata underlie the limestone series. In the succeeding Eocene period the coal measures of the southwestern district of the South Island were formed and constitute the most valuable coal seams of New Zealand. The transgressions of Oligocene and Miocene times submerged much of both South and North Islands, but in the central region of Otago the land remained emergent. Fluviatile and lacustrine deposits, however, covered large parts of this area. They are frequently auriferous. A general retreat of the sea from the South Island took place in Pliocene times, but the North Island remained largely below sea level. In the Wanganui area a wonderful development of clays, 3,500 ft. thick, was deposited, apparently without break. The present topography of New Zealand developed as a result of important crust warpings and block faulting. The faults are not simple tensional movements, but involved strong lateral pressure, in which overthrusting and overfolding are developed. The isoclinally folded Tertiary rocks of the Lake Wakatipu region show particularly well the extreme effects of this movement. The earliest development of vulcanicity after the post-Hokonui orogeny is seen in the middle Cretaceous basalts of the Clarence region and the Upper Cretaceous rhyolites near Christchurch. Vulcanicity became more widespread in mid-Tertiary times. To this period belong the pillow lavas and tuffs of the Oamaru district and the rhyolites, andesites and dacites of the Coromandel peninsula. Propylitization of these andesitic rocks gave rise to the auriferous deposits of this latter area. Somewhat later came the alkaline eruptions of the Dunedin district and the basalts forming Banks peninsula. The alkaline rocks of the former area include a varied succession of alkaline trachytes, phonolites, trachydolerites and basalts.

Volcanic activity of Upper Tertiary time extending to the present day led to extensive eruptions of andesites and rhyolites in the North Island. Mt. Egmont consists largely of andesite. The main centres of activity lie on a northeast line of crustal weakness extending from Ruapehu to Mt. Edgecumbe, and the great rift of the Tarawera eruption extending to Lake Rotomahana has a similar trend. The great rhyolite plateau in the Taupo region is built largely of welded tuffs or "ignimbrites," representing white-hot volcanic ashes which became welded as they accumulated and developed jointing as they cooled.

Study of the fossil fauna and flora of the New Zealand region points from many lines of evidence to intimate connection, in Mesozoic times, between this land, Australia and Malaysia. In the later Cretaceous period the connection between Australia and New Zealand was severed, though the latter was directly associated with Antarctica. The complete isolation of the New Zealand region seems to have been accomplished by middle Tertiary time. by a gradual breakup of the circumpacific connections.

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(C E. T)

Climate. — The main islands of New Zealand extend through more than 12° of latitude, but contrasts of climate are modified by the influence of ocean currents and prevailing winds.

Table I gives some important data.

TABLE I.—New Zealand Climate Data

Station	Mean temp. (° F.)		Rainfall	
	Jan.	July	Total	Remarks
Auckland	66.3	51.2	45.3	Greater in winter
Rotorua	66.2	47.5	55.2	Greater in winter
Napier	64.8	47.3	35.2	Greater in winter
Wellington	60.9	47.2	47.5	Greater in winter
Nelson	61.5	45.0	38.0	Greater in winter
Hokitika	59.0	44.0	114.3	Spring often wettest
Lincoln (near Christchurch)	60.3	42.5	25.6	Generally distributed
Dunedin	58.6	39.5	37.0	Generally distributed
Ophir (central Otago)	62.3	36.9	17.6	Spring often wettest
Invercargill	57.0	41.4	45.3	Spring often wettest

The range of mean temperatures is small: the rainfall moderate save on the west slopes of the Southern Alps. The snow line reaches down to 3,000 ft. on the eastern side of the Southern Alps, which has rather lower temperatures than other parts, but on the western side it is at 3,700 ft. Nelson, sheltered from the west, is famed for its sunny climate with cool bracing nights.

The winter maximum of rainfall in the north is affected by prevailing winds and the all-year-round distribution of the light rainfall on the east side of the South Island contrasts with the tendency to a spring maximum on the western and southern fringes of the Southern Alps. Heavy rainfall on the west has allowed glaciers to exist and to reach down into the lowlands in some places in spite of the general mildness. The mountainous Stewart Island has about 65 in. of rainfall a year. (A. T. CL.)

Vegetation. — There are about 1,000 ,species of flowering plants, of which about three-quarters are endemic. Most of those not peculiar to the country are Australian; others are South American, European and antarctic; and some have Melanesian affinities. Ferns and other cryptogamic plants are in great variety and abundance. The New Zealand flora, like the fauna, has been cited in support of the theory of the remote continental period.

The early colonists found at least half the surface of the archipelago covered with dense evergreen forest, a luxuriant growth of pines and beeches, tangled and intertwined with palms, ferns of all sizes, wild vines and other lianes and a rank, bushy, mossed undergrowth. Though much of the timber is of commercial value —notably the kauri pine *(Agathis australis),* totara *(Podocarpus totara).* puriri *(Vitex lucens)*, rimu *(Dacrydium cupressinum)*, matai *(Podocarpus spicatus)* and kahikatea *(P. dacrydioides)*— this has not saved the forests from wholesale: often reckless, destruction for settlement purposes. In late years active operations by the state, private companies and the settlers themselves, in reafforestation with European, Californian and Australian softwoods, have been doing much to restore the earlier ravages. These improvements are mainly in the naturally open and grassy regions of the eastern side of both main islands.

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Fauna. — In their natural state the islands had no land mammals except for two species of bat. The Polynesians brought a dog, now extinct, and a black rat, now very rarely seen. The wild dogs and pigs in outlying districts are descendants of domestic animals which have escaped into the bush. There are no land snakes. Of the two bats, one *(Mystacops tuberculatus)* belongs to a peculiar genus and one *(Chalinolobus morio)* is related to Australian and South African forms.

New Zealand is rich in birds, with 23 native species, some of which show Malayan affinity from before the isolation of the islands. The tui and the bellbird or makomako are famed as songsters, while the flightless and weak-winged birds are numerous: the kiwi *(Apteryx),* kakapo *(Strigops habroptilus),* takahe *(Notornis)* cannot. fly. New Zealand formerly had 20 species of the gigantic running bird called the moa *(Dinornis)*, a huge rail *(Aptornis)* and other bird types now extinct. The earlier destruction of the forests had disastrous effects on bird life. In the Alps a hawklike green parrot, the kea, which has been known to kill sheep, holds its ground. The pukeko, a handsome rail, abounds in swamps. The principal animal pests are deer, opossums and rabbits.

The most famous New Zealand animal, scientifically, is the tuatara *(Sphenodon punctatus)*, the sole survivor of the reptilian order of the Rhynchocephalia, otherwise extinct since Mesozoic times so far as is known. This creature, lizardlike in appearance, grows to about two feet in length. The butterflies are few (only 16 species) and moths numerous (more than 1,200 species) and there is a poisonous native beach spider called katipo. An organism called *Peripatus (see* ONYCHOPHORA) has a New Zealand species; it is intermediate in structure between the annelids and the arthropods and species occur in various isolated regions, mostly in southern lands.

Resolution, Kapiti and Little Barrier islets have been set aside as sanctuaries ior the native fauna.

The minute young *Galaxias attenuatus* or native trout is fished as whitebait in tidal waters; and flounders are taken in salt or brackish lagoons and estuaries. Oysters, both mud and rock, are good and plentiful. Sharks are found everywhere and are common around the north; they rarely attack man. The albatross is the most conspicuous sea bird. Various penguins are found, the king penguin being confined to the Macquarie Islands.

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HISTORY

Even the approximate date of man's arrival in New Zealand is uncertain. All that can be safely asserted is that by the 14th century A.D. Polynesian canoemen had reached its northern shores in successive voyages. By 1642 they had spread to South Island, for there Abel Janszoon Tasman found them when, in the course of his circuitous voyage from Java in the "Heemskerk," he chanced upon the archipelago, coasted along much of its western side, though without venturing to land, and gave it the name it still bears. One hundred and twenty-seven years later, Capt. James Cook, in the barque "Endeavour," gained a much fuller knowledge of the coasts, which he circumnavigated, visited again and again and mapped out with fair accuracy. He annexed the country, but the British government disavowed the act. After him came other navigators. French, Spanish, Russian and American; and, as the 18th century neared its end came sealers, whalers and trading schooners in quest of flax and timber. English missionaries, headed by Samuel Marsden, landed in 1814, to make for many years but slow progress. They were hindered by murderous tribal wars in which muskets, brought in first by the chief Hongi, more than decimated the Maori. Still, cruel experience and the persevering preaching of the missionaries gradually checked the fighting, and by the year 1839 peace and Christianity were in the ascendant. So far the British government had resisted any pressure brought to bear in Downing street in favour of annexation. In vain Edward Gibbon Wakefield, organizer of colonizing associations, prayed and intrigued for permission to repeat in New Zealand the experiment tried by him in South Australia. Lord Glenelg, the colonial minister, had the support of the missionaries in withstanding Wakefield's New Zealand company, which at length resolved in desperation to send an agent to buy land wholesale in New Zealand and dispatch a shipload of settlers thither without official permission. Before, however, the "Tory" had thus sailed for Cook strait, it had become known to the English government that a French colonizing company—Le Compagnie Nanto-Bordelaise—was forming, under the auspices of Louis Philippe, to anticipate or oust Wakefield. With the assent of the Protestant missionaries the British authorities reluctantly instructed Capt. William Hobson, R.S., to make his way to northern New Zealand with a dormant commission of lieutenant governor in his pocket and authority to annex the country to Australia by peaceful arrangement with the natives. Hobson landed in the Bay of Islands on Jan. 22, 1840, hoisted the Union Jack and had little difficulty in inducing most of the native chiefs to accept the queen's sovereignty at the price of guaranteeing to the tribes by the treaty of Waitangi possession of their lands. forests and fisheries. Some French settlers, convoyed by a man-of-war, reached Akaroa in South Island in the follouing May. But Hobson had forestalled them. and those who remained in the country became British subjects. Meanwhile, a week after Hobson's arrival, Wakefield's colonists had sailed into Port Nicholson, and proposed to take possession of immense tracts which the New Zealand company claimed to have bought from the natives, and for which colonists had in good faith paid the company. Other bands of the company's settlers in like manner landed at Nelson, Wanganui and New Plymouth, to be met uith the news that the British government would not recognize the company's purchases. Then followed weary years of ruinous delay and official inquiry, during which Hobson died after founding Auckland. His successor, Robert Fitzroy, drifted into an unsuccessful native war. A strong man, Capt. (later Sir) George Grey (*q.v.*), was at last sent over from Australia to restore peace and rescue the unhappy colony from bankruptcy and despair. Grey, much the best of the absolute governors, held the balance fairly between the white and brown races and bought large tracts of land for colonization, including the whole South Island, where the Presbyterian settlement of Otago and the Anglican settlement of Canterbury were established.

SELF-GOVERNMENT

In 1852 the mother country granted self-government and, after much wrangling and hesitation, a full parliamentary system and a responsible ministry were set going in 1856. For 20 years thereafter the political history of the colony consisted of two long, intermittent struggles—one constitutional between the central government (first seated at Auckland, but after 1865 in Wellington) and the powerful provincial councils, of which there were nine charged with important functions and endowed with the land revenues and certain rating powers; the other racial.

The Maori Wars.—The native tribes, brave, intelligent and fairly well armed, tried, by means of a league against land selling and the election of a king, to retain their hold over at least the central North Island. But their kings were incompetent, their chiefs jealous and their tribes divided. Their style of warfare, too, caused them to throw away the immense advantages which the broken bush-clad island offered to clever guerrilla partisans. They were poor marksmen, and had but little skill in laying ambuscades. During ten years of intermittent marching and fighting between 1861 and 1871 the Maori did no more than prove that they had in them the stuff to stand up against fearful odds and not always to be worsted. Round Mt. Egmont, at Orakau, at Tauranga and in the Wanganui jungles, they more than once held their own against British regiments and colonial riflemen. The storming of their favourite positions—stockades strengthened with rifle pits—was often costly; and a strange anti-Christian fanaticism, the Hau-Hau cult, encouraged them to face the white men's bullets and bayonets. But even their fiercest fighting leaders, Rewi and Te Kooti, scarcely, deserved the name of general. Some of the best Maori fighters, such as the chiefs Ropata and Kemp, were enlisted on the white side, and with their tribesmen did much to make unequal odds still more unequal. Had Gen. Thomas Pratt or Gen. Duncan Cameron, who commanded the imperial forces from 1860 to 1865, had the rough vigour of their successor, Gen. Trevor Chute, or the cleverness of Sir George Grey, the war might have ended in 1864. Even as it was the resistance of the Maori was utterly worn out at last. After 1871 they fought no more. The colonists too, taught by the sickening delay and the ruinous cost of the war to revert to conciliatory methods, had by this time granted the natives special representation in parliament. A tactful native minister, Sir Donald McLean, did the rest. Disarmament, roads and land purchasing enabled settlement to make headway again in the North Island after 12 years of stagnation. Grey quarrelled with his masters in Downing street, and his career in the imperial service came to an end in 1868. His successors, Sir George Bowen, Sir James Ferguson, the marquess of Normanby and Sir Hercules Robinson, were content to be constitutional governors and to respect strictly the behests of the colonial office.

Sheep Farming and the Discovery of Gold.—Mean hile the industrial story of New Zealand may be summed up in the words wool and gold. Extremely well suited for sheep farming, the natural pastures of the country were quickly parcelled out into huge pastoral crown leases, held by prosperous licensees, the squatters, who in many cases aspired to become a country gentry by turning their leases into freeholds. So profitable was sheep farming seen to be that energetic settlers began to burn off the bracken and cut and burn the forest in the North Island and sow English grasses on the cleared land. In the south artificial grassing went on for a time hand in hand with cereal growing, which by 1876 seemed likely to develop on a considerable scale, thanks to the importation of American agricultural machinery, which the settlers were quick to utilize. Even more promising appeared the gold fields. Gold had been discovered in 1852. Not, however, until 1861 was a permanent field found—that lighted upon by Gabriel Read at Tuapeka in Otago. Thereafter large deposits were profitably exploited in the south and west of South Island and in the Thames and Coromandel districts of the Auckland province. Gold mining went through the usual stages of alluvial washing, deep sinking, river dredging and quartz-reef working. Perhaps its chief value was that it brought many thousand diggers to the colony, most of whom stayed there. Pastoral and mining enterprise, however, could not save the settlers from severe depression in the years 1867 to 1871. War had brought progress in the north to a standstill; in the south wool growing and gold mining showed their customary fluctuations. For a moment it seemed as though the manufacture of hemp from the native *Phormium tenax* would become a great industry. But that suddenly collapsed, to the ruin of many, and did not revive for a number of years.

In 1870 peace had not yet been quite won; industry was depressed; and the scattered and scanty colonists already owed £7,000,000 sterling. Yet it was at this moment that a political financier, Sir Julius Vogel, in that year colonial treasurer in the ministry of Sir William Fox, audaciously proposed that the central government should borrow £10,000,000, make roads and railways. buy land from the natives and import British immigrants. The house of representatives, at first aghast, presently voted £4,000,000 as a beginning. Coinciding, as the carrying out of Vogel's policy did, with a rising wool market, it for a time helped to bring great prosperity, an influx of people and much genuine settlement. A total of £14,000,000 of borrowed money, spent in ten years, was on the whole well laid out.

But prosperity brought on a feverish land speculation; prices of wool and wheat fell in 1879 and went on falling. Faulty banking ended in a crisis, and 1879 proved to be the first of 16 years of almost unbroken depression. Still, eight prosperous years had radically changed the colony. Peace, railways, telegraphs (including cable connection with Europe), agricultural machinery and a larger population had carried New Zealand beyond the primitive stage. The provincial councils had been swept away in 1876, and their functions divided between the central authority and small local bodies. Politics, cleared of the cross issues of provincialism and Maori warfare, took the usual shape of a struggle betweeh landed wealth and radicalism. Sir George Grey, entering colonial politics as a Radical leader, had appealed eloquently to the workpeople as well as to the Radical "intellectuals," and though unable to retain office for very long he had compelled his opponents to pass manhood suffrage and a triennial parliaments act. A national education system, free, nonreligious and compulsory, was established in 1877. The socialistic bent of New Zealand was already discernible in a public trustee law and a state life insurance office. But the socialistic labour wave of later years had not yet gathered strength.

Sixteen years of depression, from 1879 to 1895, were followed by 26 years of great prosperity and in turn by 6 years of depression again, from 1921 to 1927. The slump conditions which prevailed in the 1880s (caused by a fall in the world price level) intensified the political atmosphere. In politics nearly 12 years of Conservative government were succeeded by 20 years of radicalism. The main aim of the legislation, which evoked world-wide interest, was social justice. Up to Jan. 1891 the Conservative forces controlled the country and for ten years progressive legislation was confined to a mild experiment in offering crown lands on perpetual lease, with a right of purchase (1882), a still milder instalment of local option (1881) and an ineffective Factories act (1886). In Sept. 1889, however, Sir George Grey succeeded in getting parliament to abolish the last remnant of plural voting. Finance otherwise absorbed attention; by 1890 the public debt had reached £38,000,000, against which the chief new asset was 1,300 mi. of railway, and though the population had increased to 650,000, the revenue was stagnant. (W. P. RE.; X.)

During the years 1879–90, the leading political personage was Sir Harry Atkinson. In Dec. 1890 he was overthrown by the progressives under John Ballance. Atkinson's party never rallied from this defeat, and a striking change came over public life, though Ballance, until his death in April 1893, continued the prudent financial policy of his predecessor. The change was emphasized by the active intervention in politics of the trade unions. These bodies decided in 1889 and 1890 to exert their influence in returning workmen to parliament, and mhere this was impossible, to secure pledges from middle-class candidates. The number of labour members elected to the general assembly was small, never more than six during more than 20 years, and no independent labour party of any size was formed. But the influence of labour in the progressive or, as it preferred to be called, Liberal party. was considerable and the legislative results noteworthy. Ballance directed his energies to constitutional reforms and social experiments. These in general did not interfere with the general lines of Atkinson's strong and cautious finance.

On Ballance's death in 1893, his place was taken by Richard Seddon, who put through the bill of that year granting woman suffrage; in 1919 women became eligible as parliamentary candidates. The Advances to Settlers act, 1894, inaugurated a series of schemes of state moneylending to farmers on mortgage of freehold or leasehold land; most classes of such advances were later administered by the State Advances corporation, created in 1936. Workers' wages were first safeguarded by the Truck act, 1891, and a series of acts between 1892 and 1899 aimed at making the payment of wages more certain and secure and at limiting creditors' rights to attach future earnings Subsequently this code was consolidated into the Wages Protection dnd Contractors' Liens act, 1908, and that was superseded by a measure of like title in 1939.

The keystone of the regulative system was laid by the passing of the Industrial Conciliation and Arbitration act. 1894, under which disputes between employers and unions of workers were compulsorily settled by state tribunals; these. the arbitration courts, were empowered in 1898 to prescribe minimum rates of wages; and an amendment in 1903 prohibited any employer, worker, union of employers or union of workers from taking proceedings to defeat any of the provisions of an award during its currency. The Old-Age Pensions act, 1898, a pioneer measure in British countries. was the precursor of several in an outstanding program of social security. In 1898, also, the municipal franchise was greatly widened. Borrowing on a larger scale was begun in 1895, and in 12 years twice as many millions were added to the public debt. The general election of 1899 was the most languid held in 15 years, for politics ceased to be the chief topic of interest after New Zealand sent troops to serve in the South African War.

A marked commercial revival had taken place, mainly caused by the steady conversion of the colony's wastelands into pasture; the development of frozen meat and dairy exports, following the successful introduction of refrigeration to shipping in 1882; the continuous increase in the output of coal; the invention (in New Zealand) of gold dredging; the revival and improvement of hemp manufacture; the exploiting of the deposits of kauri gum; the reduction in the rates of interest or, mortgage money; and a general rise in wages, obtained without strikes, which increased the spending power of the working classes. Commercial confidence was restored by the reconstruction of the Bank of New Zealand in 1895, and activity was stimulated by large public loans, while more cautious banking and the systems of taxation and rating on land values contributed to check land speculation.

The Liberal party headed by Ballance, Seddon and Sir Joseph Ward held office without a break for 21 years. mainly because of the general support given to its agrarian and labour policy by the smaller farmers and the working classes. In 1912 it fell. and the more conservative side, which by then had taken the title of Reform party, at last returned to office. The farmers, who had been organized into a powerful union, sought to destroy the liberal system of state tenancy in favour of freehold tenure mith complete right of sale under a cheap and speedy land transfer law. The Reform party was prepared to give them this and numbers of them joined it. At the same time labour began to break away from the Liberals, under whose regime very few labour leaders had gained seats in parliament. After 1910 New Zealand labour followed the example of Australia in creating its own party and, though serious strikes occurred in 1913, 1916 and 1921–22, the dominion remained on the whole industrially pacific.

Period of World War I.—In 1914 came World War I and a coalition ministry of Reformers and Liberals was formed in which William Ferguson Massey, the prime minister, had the help of Sir Joseph Ward as finance minister. New Zealand was not unprepared to be of service in wartime. A law passed in 1909 paved the way for compulsory training of the militia. Volunteers for service overseas came forward with enthusiasm and their fine physiques, initiative and self-reliance were qualities which distinguished the New Zealand contingents.

Heavy taxation and other severe war measures had to be endured in the dominion. Largely by forced loans from the banks and others direct from the taxpayers. £55,000,000 were borrowed internally. The output of gold and the chief products of food and raw materials were commandeered at war prices for the imperial govrrnment, The war debt, for the size of the population enormous. finally exceeded £81,500,000; but the interest on it was punctually paid. The £26,340,245 owing to the British government in 1912 because of war expenditure was funded, and funded-debt payments continued until 1931 when the British government, following the Hoover proposals, voluntarily suspended these obligations of New Zealand. At the peace New Zealand received a League of Nations mandate to administer Western Samoa.

Social legislation was more or less at a standstill in wartime but an important change was made in the liquor law. Local option was abandoned in favour of a triennial poll for and against national prohibition, which might be voted by a bare majority. Maintenance of the *status quo* was increasingly favoured in successive polls.

Between **World Wars I and** 11.—Peace in 1918 was followed by three years of feverish activity and a wild speculation in rural land. When a very sudden fall of prices in 1921 stopped the orgy, the reaction was extremely severe. Thousands had mortgaged themselves in buying freeholds without adequate capital, nearly 1.000 farmers sought the bankruptcy court in the seven years 1921–27, and a large number had to part with their holdings. Because of rural embarrassment, a law of 1919 providing for a moratorium in the case of mortgages, other than trade mortgages, and of deposits, other than bank deposits, was continued until 1927.

The government had also to deal with many thousands of demobilized soldiers without employment. Pensions were bestowed on a liberal scale and more than 9,000 soldiers were settled on the land. There was a good deal of miscalculation, disappointment and failure in this scheme of military settlements. In 1936 soldiers' mortgages were transferred to the State Advances corporation. The Small Farms Amendment act, 1940, provided for settlement on the land of soldiers who had served in World War II, giving them absolute preference over all other applicants for land made available for selection under the legislation of 1932–33. With a view to protecting soldier settlers against the inflation of land values which ensued after the previous war. the Servicemen's Settlement and Land Sales act, 1943, controlled the price at which land could be sold or leased.

In 1919 the Liberal ministers withdrew from the coalition government. and the Reformers continuing in office had to meet industrial depression by economies in expenditure. The general elections of 1922 left Massey with a bare majority in the house of representatives, but the hopeless division of Labour from the Liberals enabled the Reformers just to hold their ground. Massey, the veteran premier who had led the Reformers to victory in 1912, died in 192;.

Following the 192j general election the premiership went to Joseph Gordon Coates, newly elected leader of the Reform party, a comparatively young Auckland farmer. The elections proved to be the most complete triumph ever gained by a conservative party in the dominion. Labour won but 12 seats, but subsequently gained some by-elections and became the official opposition.

As a result of the encouragement given to farming, pastoral production constantly expanded. so that New Zealand had become one of the world's largest exporters of pastoral produce. As a consequence, its national income was extremely sensitive to price fluctuations of these products; so that, with the advent of the world-wide financial depression in 1930, its economic position became most vulnerable. Measures adopted during 1930–35 to help the farmers were numerous and often of a drastic character. The steps taken included the raising of the exchange rate, so that £N.Z.125 equalled £100 sterling; the adjustment of mortgages and farm indebtedness; the lowering of interest rates and farm costs; remission of certain rates and taxes; abolition of the graduated land tax; and the subsidization of farm labour.

Although New Zealand had obtained a unitary constitution in 1870, the country retained the status of a colony until Sept. 26, 1907, when it became a dominion. In common with the other dominions, representatives of the country shared in the direction of Great Britain's part in World War I, and in accordance with the independent status which it had attained, New Zealand was a signatory to the peace treaties and became a member of the League of Nations. As member of the British group of nations it signed the 1928 General Act for the Pacific Settlement of International Disputes (the "Kellogg pact") and the London naval treaty of 1930, and it was an individual signatory to the naval treaty signed in London in 1936. The New Zealand parliament approved in 1931 the draft Statute of Westminster (*q.v.*), which gave legal recognition to the autonomy of the dominions; New Zealand (in common with Australia and Newfoundland) requested that the operative parts of the statute should not become applicable until adopted by its own legislature. This step was not deemed necessary until 1947.

Sir Joseph Ward became prime minister in Dec. 1928, was succeeded in May 1930 by George William Forbes, and in 1931 the latter formed a coalition administration. At the Imperial Economic conference in Ottawa. Ont., in 1932 New Zealand agreed to more liberal tariff preferences for goods of British origin, and these were given legislative effect in 1934. Because of a worsening economic condition, there was a general reduction of 10% in wages and salaries in 1931, and the next year reductions were effected in pensions, salaries of state employees, rent, interest rates and other fixed charges. Such was the condition of the country at the time that between 1931 and 1935 there was a net exodus from New Zealand of 9,918 persons.

At the general election in 1935 the Labour party came into office under the premiership of Michael Joseph Savage, the party winning 53 seats against 20 for the National party (formed by the coalition of the Liberals and Reformers in 1931) and 7 held by Independents. Much legislation of the highest importance followed. The Reserve Bank of New Zealand, which had been established in 1934, was nationalized in 1936, the government subscribing the capital of £500,000 previously held privately. The government became the sole purchaser of dairy products for export. and their sole marketer; guaranteeing fair prices to the farmers for their butter and cheese. An amendment to the Arbitration act in 1936 restored the powers of the arbitration court! fixed basic wages and decreed a 40-hour week for industry, while a government bureau of industry was invested with wide powers for industrial planning. In 1936 free postprimary education was made available to every child. Most existing schemes of government advances for farming and industry were placed under the administration of the State Advances corporation, created in 1936, and the government embarked upon an ambitious scheme of building houses to be rented to workers.

In 1936 the prohibition against election of public servants to the house of representatives was removed (though, if elected, they ceased to be public servantsj, and with repeal of legislation of 1932 trade unions and like societies once more were permitted to use their funds for political purposes. The customary three-year life of parliament was extended to five years during World War I and, because of the acute economic crisis, to four years during 1934–37; in 1941, during World War II, the term of the 26th parliament was extended to four years. Parliament passed in 1936 the Mortgagors and Lessees Rehabilitation act, which made provision for the adjustment of excessive mortgage indebtedness; and sanctioned resumption and expansion of schemes of public works, which had been seriously curtailed during the previous period of financial stringency. The year 1938 saw passage of the Social Security act, which consolidated pension measures and initiated extensive health and medical benefits. At the 1938 general election. at which Labour was returned to office. 92.85% of the electorate exercised their votes. The Labour party held j3 seats, the National party 2j and the Independents 2; as a result of by-elections and resignations from the party. immediately prior to the 1943 general election Labour representation had been reduced to 50, with 25 Nationals, 4 Independents and 1 Democratic Labour. Approximately 84.6% of the electorate voted at the general election in 1943, at which Labour seats fell to 45, the Sational party secured 34 and there was 1 Independent.

World War **II.**—Savage continued to head the Labour government until his death in March 1940; his successor as prime minister was Peter Fraser who, the following July. formed a special war cabinet. The country, no longer a belligerent automatically n-hen the United Kingdom was at war. elected voluntarily and unanimously to support Britain's declaration of hostilities against Germany in 1939. The year 1940 marked the centenary of the proclamation of British sovereignty in New Zealand. A centennial exhibition was held in Wellington during Nov. 1939–May 1940, historical publications were produced and special stamps and coins issued.

Early in the conflict emergency war legislation was enacted, including the prohibition of strikes. a volunteer force was recruited for overseas service and service for home defense again became compulsory. After Dunkirk the dominion shipped half of its stock of rifle ammunition to Britain. where it was urgently needed. and in 1942, when the onrush of Japanese aggression was still unchecked, New Zealand dispatched half its trained troops, half of its limited bomber force and all of its anti-aircraft guns to deiend the outpost of Fiji, key to strategy in the Pacific. The country became a base for U.S. forces.

Further reference to the part played in World War II is made in the section *Defense* helon-. (W. B. Pn.; X.)

After World War 11.—The war placed a great strain on the basis of the welfare state and. while a policy of stabilization was adopted with much success during the hostilities, the inevitable shortage of consumer goods which occurred following the war weakened stabilization measures and public irritation urged more scope for private enterprise. Largely because of these factors. together with the fact that it had been in power for 14 years. the Labour party was defeated in 1949 by the National party led by S. G. Holland.

The new administration immediately enacted a policy giving more freedom to employers and traders and generally relaxed many government controls which had been placed on the economy during the war. With the general shortage of foodstuffs and consumer goods. New Zealand was well placed to benefit by rising prices for its exports and the country experienced prosperity with little unemployment. A more vigorous policy of selective immigration was also adopted.

In the legislative field important acts passed were the Westminster Adoption act of 1947, which ratified the Statute of Westminster passed by the U.K. parliament in 1931. In 1949 the Military Training act introduced compulsory military training and the Gaming Amendment act instituted government-controlled off-course betting. In 1950 capital punishment, which had been abolished by the Labour government in 1941, was restored. and a major constitutional change was made by the introduction of an act abolishing the legislative council, the upper house of the New Zealand parliament. The peace treaty with Japan was ratified in 1952. A Land Settlement Promotion act was designed to prevent undue aggregation of land and assist further settlement on farmlands.

In 1953 an act dealing with geothermal energy gave sole rights to the crown to develop this field and important experiments were begun at Wairakei. An agreement was also signed with the U.K. Atomic Energy authority for co-operation in this sphere. The Tasman Pulp and Paper act (1954) set up a highly promising new industry. A £30,000,000 scheme for the production of pulp and other products from the fast-growing pine forests in the Sorth Island was established at Kawerau. A iurther development was the establishment, after much scientific investigation. of grassland farming on the hitherto unproductive pumice lands of the central Sorth Island. Great areas of hill countrv were treated nith fertilizers by aerial means and in 1957, 3,943,000 ac. had been so treated. Consequent upon these and other developments agricultural production steadily increased. The system of bulk purchase by Britain of dairy and meat exports, set up in 1939, was abandoned in 1954 and free marketing was reinstituted.

In the conduct of external affairs there was little dissension. None questioned the primary loyalty to Great Britain and the commonwealth or the country's strong support of the United Nations and its specialized agencies. Recognition of the predominant power of the U.S. in the Pacific was implicit in the Australia-New Zealand-U.S. pact signed in 1951, but New Zealand spokesmen also insisted that all who fought against the axis and Japan should take part in the negotiation of the peace treaties: and they showed some apprehensiveness at the rearming of Japan. When war broke out in Korea. New Zealand troops were sent to support the UN command. New Zealand also warmly supported the Colombo plan.

The rapid changes in the political and economic position of the far east and growing recognition of the importance of Pacific affairs led to partnership in the Southeast Asia Treaty organization (SEATO) and the establishment of a commissioner for southeast Asia in Singapore. Agreement was also reached with the U.K. that in spheres of strategic defense New Zealand would accept commitments in the southeast Asia area. Subsequently a contingent of troops was sent to Malaya. In 1953–54 New Zealand had a seat on the Security council of the Cnited Nations.

With a renewal of interest in the antarctic area a New Zealand party. under the leadership of Sir Edmund Hillary, took part in the Commonwealth Trans-antarctic expedition in 1956–58.

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POPULATION

In Jan. 1840 New Zealand had a fluctuating population of about 1,000 whalers. sealers. traders. missionaries and settlers. By 1861 it was slightly less than 100.000. Gold discoveries in the 1860s and a vigorous development policy of public works and assisted immigration in the 1870s increased the number of colonists nearly five times to 489.933 in April 1881. Subsequently the increase slackened because of economic depression, hut with the development of the frozen-meat trade and rising world prices in the 1890s the population again increased steadily. and by March 1901 New Zealand's white population numbered 770,000. Natural increase rather than migration proved the principal factor for growth during the first 30 years of the 20th century. The rate of increase declined substantially, however. and in the depression years 1931–35 there was actually a net exodus from New Zealand of 9.918. Excluding Maori, at the census in 1921 the population numbered 1,218,913; in 1926 it was 1,344,469; in 1936, 1,491,484; in 1945, 1,647,635; in 1951, 1,939,472 and in 1956, 2,174,062. A census was taken in Sew Zealand proper on April 18, 1961, and in the island territories on Sept. 25, 1956. The following are the population totals: New Zealand proper (excluding Maori) 2,249,978, Maori 165.006. total 2,414.984: Cook Islands 16,680; Tokelau 1,619; Niue 4,407; trust territory of Western Samoa 96,969.

At June 30. 1957, the population of New Zealand was estimated at 2,229,437.

Based on the 1961 population census, in the North Island Xuckland had a population of 143,583, and Wellington, the capital: had 123.069.

In the South Island are Christchurch (151.671) and Dunedin (73.215). Other towns are, in the North Island. Hamilton (42.-212). Gisborne (21.769). Napier (24,579). Hastings (23.363). New Plymouth (29,368). Wanganui (33.316) and Palmerston North (41.014); and in the South Island. Nelson (23,971). Timaru (24.821) and Invercnrgil 135.605). In recent years the greatest increases in population have been those of Auckland and Christchurch, but Hamilton and Hutt have also grown very rapidly.

The birth rate declined steadily after 1921. reaching a figure of 16.17 per 1.000 of the population in 1935. Thereafter a steady improvement set in. and the rate for 1947 (27.70) was the highest attained after 1922; in 1960 the rate was 21.44 per 1.000. The Maori birth rate was about double that of the white population. the figure for 1960 being 46.41 per 1.000. The fa\-ourable climate of the country and the high efficiency of health services contrihutcd toward a comparatively low death rate. In 1933 the death rate reached a new low point of 7.99 per 1.000: thereafter there was an increase. in 1960 the death rate being 8.79 per 1.000 mean population. More than 90% of New Zealand's population is of British extraction.

Immigration.—People who are wholly of British birth and parentage and wholly of European race and colour are given verbal permission to enter New Zealand at the time of their arrival. provided they are in good health, of good character and in possession of a valid passport. Such people do not need written permits, visas, guarantees of work or to have any prescribed sum of money. Persons not wholly of British birth and parentage (that is aliens. naturalized British subjects and people both or either of whose parents were not born British subjects) and those not wholly of European race and colour must obtain written permits from the immigration division of the department of labour.

The New Zealand government introduced an assisted passage scheme in 194; for migrants from the United Kingdom and from that time accepted single men and women under 46 for a wide variety of occupations. The scheme also included farnily groups nominated by a friend. relative or employer in New Zealand.

In the period 1946 to March 31, 1957, 41,172 migrants settled in New Zealand under a free passage but selective migration scheme. During the same period 166.098 other persons settled there; these included 5,201 displaced persons taken under the Intergovernmental Committee for European Migration.

In the same period there were 113.470 settlers from the United Kingdom, 58,124 from other commonwealth countries, 14.968 from the Ketherlands and 20,599 from other countries. The general policy (1955) was to aim at a target of 15.000 a year net increase of population, both from natural increase and immigration.

Religion. — According to the 1956 census. percentages of adherents to the various denominations were: Church of England 35.9; F'resbyterian 22.2; Roman Catholic 14.3; Methodist 7.4; Baptist 1.6.

No separate figures were available for the Maori people but among the specifically hlaori Christian sects Ratana (0.9%) and Latter-Day Saints (Mormon; 0.60%) were the strongest. (*See* also MAORI.)

Christianity was brought to the country in 1814 by an Anglican missionary priest. Samuel Marsden, "the apostle of New Zealand." New Zealand was constituted a mission archbishopric of the Church of England, with see at Auckland, in 1841, but in 1857 became an autonomous metropolitan see. In that year the Church of the Province of New Zealand was inaugurated. in full communion with Canterbury. Government is by a general synod, which elects the archbishop-metropolitan or primate from among the diocesan bishops. Thus the primate's see is not fixed in any one city. There are nine dioceses (including two with jurisdiction over Melanesia and Polynesia) and a separate bishopric (Aotearoa) for the Maori. The Roman Catholic Church is organized in three dioceses subject to the archepiscopal see of Wellington.

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Education.—The Education act of 1877 made state education in New Zealand free. secular and compulsory between the ages of 7 and 14 (subsequently raised to 15). It is controlled by a state education department and local education boards.

Kindergartens.—Children between the ages of three and five may be rnrolled at free kindergartens maintained by the New Zealand Free Kindergarten association. The government makes annual grants toward the support of the kindergartens. but the system is far from universal. In 1956 there were 185 free kindergartens and 12,810 children on the rolls for morning and afternoon sessions.

Primary Schools.—Entry to primary school is permissive from the age of five. All state primary schools are coeducational. The syllabus of instruction includes. besides the "three R's." elementary science, agriculture and cultural subjects. Older boys receive instruction in woodwork and metalwork at manual-training centres, and older girls are taught domestic subjects. In country districts where there are not enough children to warrant separate secondary schools. older pupils attend district high schools, which are under the same control as the primary schools. In addition, there are intermediate schools (formerly termed junior high schools) which provide varied and enriched courses for older children to help them decide on their lines of further education. In 1956 there were 1,931 public schools within the primary-schools system, these including district high schools and intermediate schools or departments. and pupils enrolled at the end of that year totaled 335,433.

Postprimary Schools.—In 1936 free postprimary education to the end of the year in which he is 19 was offered to every child completing a primary-school course or attaining the age of 14 years. A total of 94% of the children leaving public primary schools continue to full-time postprimary schooling. Postprimary (secondary) schools are termed grammar schools in Auckland, colleges in Wellington and high schools in the North Island and over most of the South Island. Where a secondary and a technical school are amalgamated under a single governing body the resulting institution is known as a combined school. Technical schools fall roughly into two types: those in the small centres distinguishable from secondary schools only by having a rather more strongly developed practical aide; and large technical schools in the main centres—where city secondary schools provide an academic curriculum. In 1956 the state conducted 66 secondary schools. 7 combined schools, 113 secondary departments of district high schools and 36 technical high schools. In 1938 the government assumed responsibility for vocational guidance at postprimary schools.

Rural Education.—Country children. as far as practicable, are provided with the same educational facilities as town children. Small rural schools have been consolidated and school buses or free railway passes are furnished. Correspondence classes are conducted for those in very remote areas, and broadcasting is much used. Country teaching positions are relatively better paid, and every city teacher, to qualify for promotion, serves three years at a country school. The teaching of agriculture is a special feature in rural schools, and projects are undertaken by boys' and girls' agricultural clubs.

Private Schools.—In 1922 registration of every private school was made compulsory and srandards of efficiency and suitability of staff. premises, equipment and curriculum required. In 1956 there were 318 private primary schools. of which 253 were conducted by the Roman Catholic Church. That denomination and the Anglican and Presbyterian churches maintain their own secondary schools (there were 102 in 19j6), generally boarding establishments. In 1956, 48.434 pupils attended registered private primary schools and 15,385 registered private and endowed secondary schools. Some of the private secondary schools are run on English public-school lines and the headmasters of some of the boys' schools belong to the Headmasters' Conference of Great Britain. Of such schools Christ's college, Christchurch (1850), is the oldest. Others are King's college, Auckland (1896), and Wanganui Collegiate school (1854).

Maori *Education.*—In 1879 the department of education took over direct control of bfaori education and has continued to direct it since. The system has worked well and has contributed much to the progress of the Maoris. More than half the Maori children attend public schools with white children, administered under education boards. The remainder attend Maori schools which, in 1956, numbered 163. with a primary enrollment of 12,422. The Maoris are entitled to free secondary education in postprimary schools and by scholarship in the 11 Maori secondary schools. In 1956, 4.760 attended public secondary schools. 824 Maori secondary schools and 879 registered private secondary schools. The Maori has complete equality in citizenship with the European and because of the tremendous advances in their adjustment to social and economic life, it is possible to foresee a time when they will receive no special treatment as regards education and their schools will be absorbed by the general system.

Higher Education. — The University of New Zealand (founded 1870 as an examining body; refounded 1926 as a federal university) comprises four university colleges — at Auckland (1882), Wellington (Victoria University college, 1897). Christchurch (Canterbury University college, 1873) and Dunedin (University of Otago, founded 1869 as a degree-granting institution; granting of degrees put in abeyance 1874). Although each provides the customary arts and science courses. Auckland specializes in architecture, commerce and engineering; Wellington in law; Christchurch in engineering and music; and Otago in medicine. dentistry, mining and metallurgical engineering. An integral part of the University of New Zealand are the two "associated" agricultural colleges— Massey (1926), near Palmerston North! and Canterbury (1873), at Lincoln near Christchurch. The government provides liberal scholarships, bursaries and studentships. In 1956 of 11,077 enrolled students at the six colleges. 5,750 received financial assistance.

Adult Education. — The Workers' Educational association was the pioneer of adult education classes, working with the university colleges through tutorial classes. During 1945–55, however. a National Council of Adult Education supervised grants to the university college areas where local directors of adult edueation, with trained staff, organized adult classes in a wide variety of subjects. Similarly, postprimary schools expanded the night classes of a vocational nature to cover nonvocational subjects.

Educational Research. — With the financial assistance of the Carnegie Corporation of New York, the New Zealand Council for Educational Research was founded in 1933. Research is also fostered through the assistance of traveling grants under schemes provided by the Imperial Relations trust of the United Kingdom and the U.S. Fulbright grant scheme.

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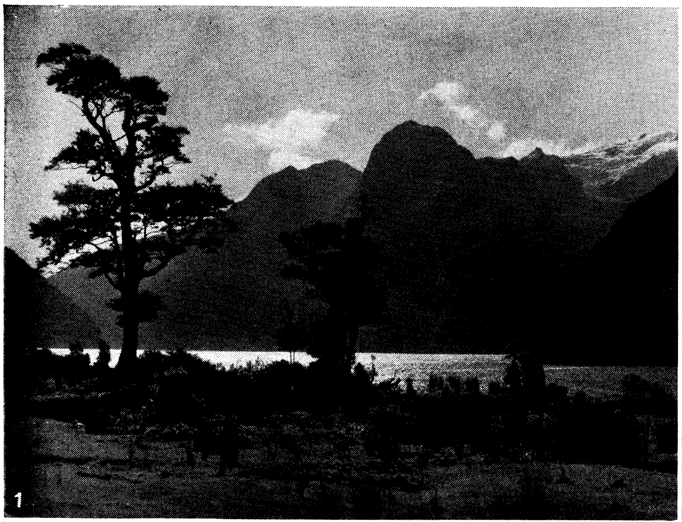
CONSTITUTION AND GOVERNMENT

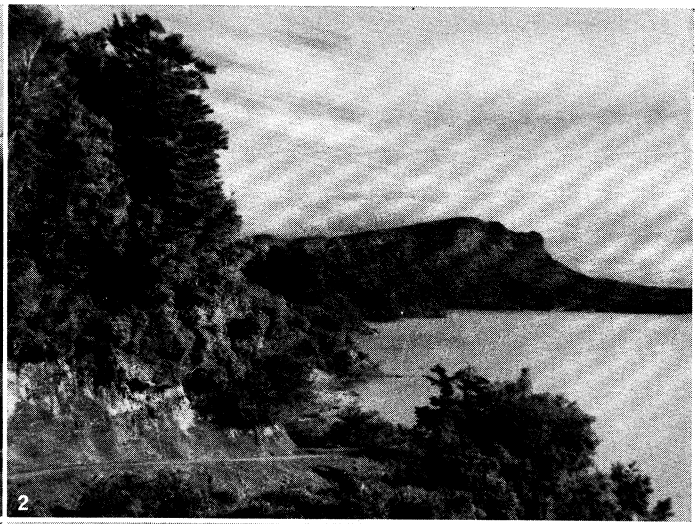
New Zealand was constituted a dominion in 1907. The Statute of Il'estminster (see History above), though not formally adopted until 1947, recognized its autonomy in 1931. In accordance with parliamentary legislation Queen Elizabeth II mas proclaimed in Wellington on May 29, 1953, "by the Grace of God, of the United Kingdom. New Zealand and her other Realms and Territories Queen. Head of the Commonwealth, Defender of the Faith." This now declared the British monarch's specific and separate sovereignty over New Zealand, as also over other commonwealth realms. The sovereign is represented by the governor general, whom the former appoints after consultation with the New Zealand government. Representing a constitutional monarch, he must be guided in the execution of his powers and authority by the advice of the New Zealand cabinet; while he does not "govern'! and his functions are formal, his signature affixed to an act of parliament or order in council expresses legislative or executive decision.

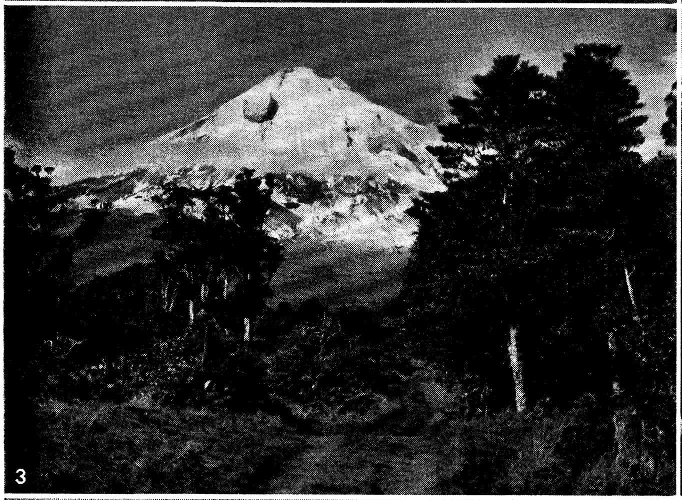
Although the Statute of Westminster was not formally adopted until 1947 by the New Zealand parliament. the dominion had freedom to conduct both its internal and external affairs as it saw fit. New Zealand is represented overseas (1957) by high commissions in the United Kingdom, Australia, Canada and the Federation of Malaya: by embassies in the U.S. (the first New Zealand mission to a foreign country, established as a legation in 1942), France and Thailand and also by a commissioner for southeast Asia at Singapore. The United Kingdom, Australia and Canada have high commissioners in New Zealand. while, with India and Pakistan, the high commissioner in Australia is also accredited to New Zealand. The United States maintains an embassy and Belgium, France. Italy. the Netherlands, Sweden, the U.S.S.R., Denmark, the German Federal Republic and Japan have legations. The representatives of Finland, Greece, Israel and the Philippines in Australia are also accredited to New Zealand.

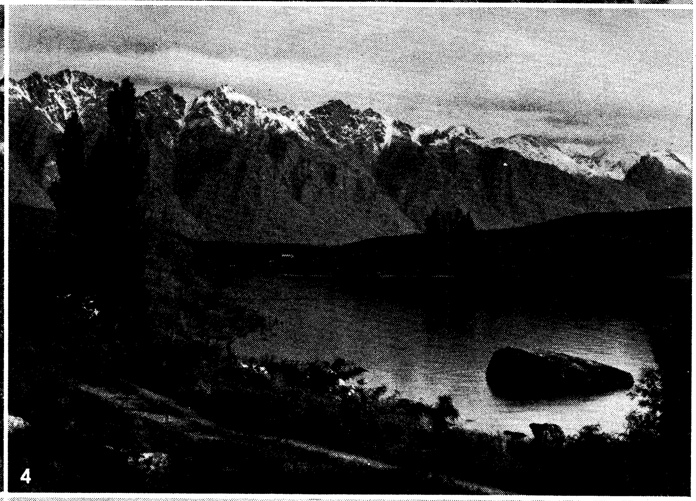
Central Government. — There were in the early years of New Zealand six distinct settlements—Auckland, Wellington, Nelson, New Plymouth, Canterbury and Otago—between which communication was for years irregular and infrequent. To meet their political needs the Constitution act of 1852 made them into provinces, with elective councils and superintendents subordinated to one colonial legislature. In 1876 the provincial system was abolished and full control passed to the legislature, properly called the general assembly but usually known simply as parliament. This body consisted of the legislative council (the upper house) and the house of representatives (the lower house j. The number of members of the legislative council was indeterminate and they were appointed for seven years by the crown; *i.e.,* by the governor general on the advice of the cabinet. Women became eligible for appointment in 1941. Members mere paid and, subject to certain exemptions, could be fined for absence. As in the case of the Cnited Kingdom house of lords, the legislative council could not initiate or amend taxation and revenue bills, and as a general rule most legislation was in fact first introduced in the lower house. In 1951, however, by an act passed in 1950. the legislative council was abolished.

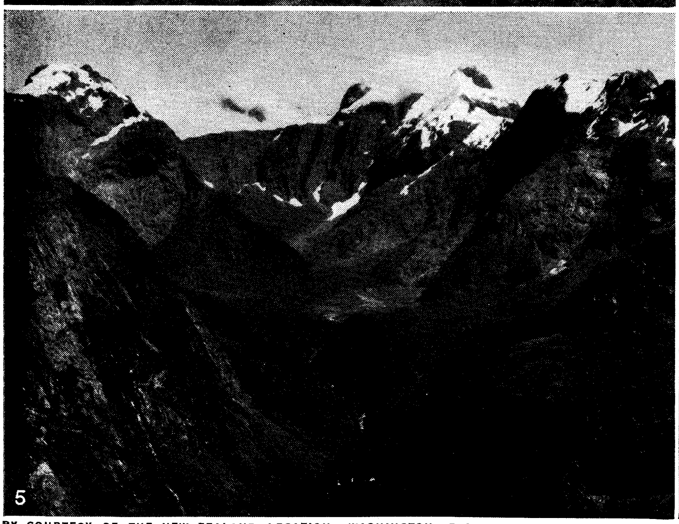
The house of representatives has 80 members, four of whom are Maori. After each population census the 76 European electorates are readjusted according to population distribution. Until 1945 an addition was made to rural population so that the number of rural electorates, in proportion to their population, was higher than urban electorates. The "country quota." as this allowance was called, first appeared in 1881; it was computed on the basis that 28% is added to the rural population — for electoral purposes. From 1952 quotas for European electoral districts were obtained from the total population as disclosed by the census. Provision exists for an allowance or subtraction of $7\frac{1}{2}\%$ of the total population where districts containing the exact quota could not be formed consistently with consideration to topography. community of interest, communications and existing electoral boundaries. In 1934, legislation provided for the introduction of four-yearly parliaments in place of three-yearly ones. but in 1937 the normal life of parliament was fixed at three years. Women became eligible as parliamentary candidates in 1919 and public servants in 1936, the latter with the provision that if elected they immediately ceased to be public servants. In 1956 there were four women members in the house of representatives. Members of the

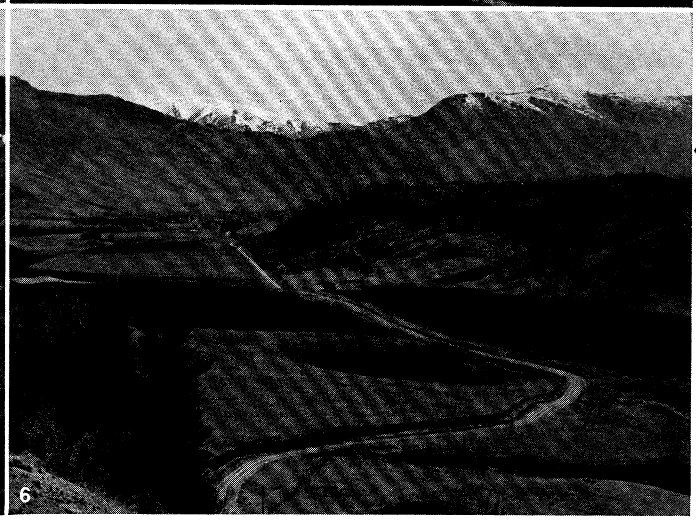












BY COURTESY OF THE NEW ZEALAND LEGATION, WASHINGTON, D.C.

MOUNTAIN AND LAKE SCENES OF NEW ZEALAND

1. Milford Sound, one of the most magnificent fiords on the coast of South Island. In the background is Pembroke Peak and the Lion, so called because it resembles a lion couchant
2. Lake Waikaremoana and Panekeri Bluff, in the southeastern portion of the Auckland district. This is the scene of an extensive hydro-electric development
3. Mount Egmont, visible from nearly every part of Taranaki, is an extinct volcanic cone. on the western side of North Island
4. Lake Wakatipu, bordered on one side by the majestic Remarkables mountains. lies between Kingston and Queenstown, South Island
5. Arthur Valley and Diamond Gully lie at the head of Milford Sound on the west coast of Otago, on South Island
6. View of the agricultural country near Arrowtown, in the Wakatipu district, South Island

NEW ZEALAND

BY COURTESY OF THE NEW ZEALAND LEGATION, WASHINGTON, D.C.

CITIES AND HARBOURS OF NEW ZEALAND

1. Wellington, capital of New Zealand, lies on the south end of North Island, on Port Nicholson
2. Queenstown, picturesquely located midway up Lake Wakatipu, is a favourite resort town in South Island
3. St. Kilda, a suburb just outside Dunedin, South Island, has a fine sandy beach on the ocean where there is good surf bathing
4. Picton, at the head of Queen Charlotte sound (Marlborough district, South Island), is 50 miles from Wellington, across Cook strait
5. Parliament buildings in Wellington, the seat of government and political centre of the dominion
6. Napier, capital of the Hawke's Bay district, showing the Cenotaph erected to the memory of soldiers of World War I. Napier has been rebuilt since it was destroyed in the earthquake of 1931
7. General view of Dunedin, capital of the Otago district, South Island
8. Christchurch, capital of the Canterbury district, South Island, showing Cathedral square in the heart of the city, which is on the plains 5 miles from the sea
9. Auckland, the largest city in New Zealand, on a beautiful deep-water harbour, North Island

legislative council were also ineligible as parliamentary candidates, as were individual contractors to the public service where payment of more than £50 was involved. An elector must be a British subject resident for one year in New Zealand and for three months in the electoral district in which he claims to vote.

Registration became compulsory in 1924. The Electoral Amendment act of 1937 introduced a secret ballot for Maori voters and the Maori people now enjoy the same electoral privileges as non-Maoris in exercising their votes for the representative~of the four Maori electorates. In 1948 a further amendment was made to provide for the registration of Maori voters.

Executive administration is conducted on the principle of the British parliamentary system, that is, executive power is vested in a cabinet (the members of which, with the governor general, also constitute the executive council) responsible to the elected chamber of the legislature — the house of representatives. The cabinet. chosen from members of the majority party in the house, consists of the ministers or "political heads" of departments of the government. The Maoris are usually represented by one member in the cabinet. Members of the house of representatives are paid.

Local Government. — With the abolition of provincial administration in 1876 (see above) the dominion was divided into 63 counties. with provision for elective councils to deal with such primary needs as road and bridge building. For purposes of local administration the 63 counties were later subdivided into 125 and, in addition. there were 138 borough councils (for areas not greater than 9 sq.mi. having a population of at least 1,000), 18 dependent town districts (where there were 50 householders in an area of not more than 2 sq.mi.) and 25 independent town districts (having a population of joo). Besides the 125 counties, and the boroughs and independent town districts within them regarded as separate administrative entities, there were numerous autonomous, overlapping districts formed from parts of counties (concerned with roads, drainage and rivers) and others made up of groups of adjacent districts of other types united for a common purpose. By 1955 there were altogether 956 local authorities.

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(W. B. Pn.; A. T. Cl.)

Judiciary and Police. — The chief justice of New Zealand and a number of puisne judges constitute the supreme court and court of appeal. There are also three special courts — arbitration, compensation and land valuation. Magistrates' courts have both civil and criminal jurisdiction, but more serious criminal cases are not tried summarily but are sent to the supreme court for trial or sentence. Maoris may use their own language in court.

The police force is a national organization maintained wholly by the central government. A national police training school was established in 1955. (X.)

Defense

Before **1939.**—To assist the empire in the South African War of 1899–1902 New Zealand sent ten contingents of mounted rifles numbering 6,495 officers and men. In 1909 compulsory training in peacetime was introduced and in 1916, two years after New Zealand had joined in World War I, recourse was had to conscription for service overseas; 98,950 men went overseas in that war, serving in many parts of the world, notably at Gallipoli (where the title Australian and New Zealand army corps was condensed to 'the famous "Anzac") and in France; 16,697 lost their lives in active service.

Compulsory military training in peacetime was suspended in 1930 and Kew Zealand faced the beginning of World War II with a small voluntary territorial force together with the New Zealand division of the royal navy (established 1920) and the Royal New Zealand air force (established as a separate service in 1937).

World War 11.—The New Zealand government had, for several years before 1939, been very strong in its advocacy of collective action to check aggression and it showed no hesitation in joining the United Kingdom when Germany attacked Poland. In June 1940 both home and overseas service were put on a compulsory basis. After the "total" mobilization that followed Japan's entry into the war. industrial conscription was introduced. The New Zealand 2nd division, as the new expeditionary force was called, suffered severe casualties in 1941 in Greece and in Crete where the defense of the island was entrusted to its commander. Maj. Gen. B. C. (later Lord) Freyberg. Later in the year the division took part in the advance into Libya. In June 1942 it played a decisive part, at Minkar Kuaim, in stemming the axis advance into Egypt. It was one of the assaulting divisions at El Alamein and was prominent in the pursuit of the axis forces until their surrender in Tunisia. In Oct. 1943 the division crossed to Italy where it saw further hard fighting — particularly at Monte Cassino.

The 3rd division, formed for action in the Pacific, took part in operations in the Solomons. The New Zealand naval forces (designated the Royal New Zealand navy in 1941) took an active part in hostilities from Dec. 1939 when the New Zealand cruiser "Achilles" took part in the battle of the Rio de la Plata against the German pocket battleship "Admiral Graf Spee." Seven squadrons of the Royal Kew Zealand air force served in Europe with the R.A.F. and 26 with the U.S. forces in the Pacific. In all, 135,000 New Zealanders served overseas — 10.130 were killed, 19,-345 wounded and 8.086 taken prisoner. Although conscription did npt apply to the Maoris. 7,000 of them served voluntarily.

In 1939 Yew Zealand had no munitions industry but during the war its factories turned to the manufacture of small arms ammunition, shells, mortars, small vehicles such as carriers, etc. However, apart from its fighting men. its main contribution was in the maintenance of supplies of meat and dairy produce on which the U.K. was dependent. Five New Zealand merchant ships were lost through enemy action. To assist the large U.S. forces stationed in New Zealand and elsewhere in the Pacific from 1942, substantial assistance was given by New Zealand under reciprocal aid both in defense construction and the supply of foodstuffs.

A Labour government was in office at the outbreak of war but from July 1940 the war effort was controlled by a war cabinet representing both sides of the house. A short-lived attempt at fuller co-operation between the parties in the form of a war administration failed in 1942, after which the opposition withdrew support from their two members who continued to sit in the war cabinet. There was, however, complete agreement between the parties that the war effort should be prosecuted to the utmost.

Postwar. — In 1949 all male New Zealanders were made liable for a 11-week period (altered to 10½ weeks in 1956) of military training on becoming 18. to be followed by 60 days' service over the next three years. For the following six years they remain members of the reserve with no training liabilities. The introduction of compulsory training made possible the organization and training of a division in peacetime.

In fulfilment of its obligations under the United Nations charter New Zealand sent a voluntarily recruited field regiment of artillery with auxiliary units to join the United Nations forces in Korea. New Zealand frigates served there from almost immediately after the outbreak of fighting. New Zealand also supplies some officers for the Fiji military forces. Following the Southeast Asia Defense treaty of Sept. 1954 and the commonwealth prime ministers' conference of Jan. 1955, a redirection of New Zealand's defense effort became evident. In Jan. 1955 it was announced that a New Zealand fighter-bomber squadron which had been stationed in Cyprus and part of a transport squadron from New Zealand were to be sent to Malaya. In March 1955 it was made known that New Zealand's existing commitments in the middle east were to be transferred to the Pacific area. A division was to be raised for service in the latter in the event of war. Two frigates. and a third if necessary, were to be sent to Malaya and a special air-borne commando unit was to be sent there for operations against terrorists. New Zealand co-operates with Australia and the United Kingdom in planning the defense of Malaya through a body of service representatives known as XNZAM (Australia, New Zealand and Malaya organization).

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SOCIAL CONDITIONS

Labour Legislation.—As a result of the legislation of the Liberal government which came into power in 1891 New Zealand acquired world fame as a land of advanced social legislation while still in the pioneer stage of economic development. The labour code, established principally by the Industrial Conciliation and Arbitration act of 1894, provided for the settlement of industrial disputes by judicial means and not by strike action and enabled working conditions to be modified to meet changes in the country's economy without constant recourse to acts of parliament. The system of compulsory arbitration was modified to the point of abolition during the depression of the 1930s. It was restored by an amending act of 1936 which also empowered the court to fix basic wage rates for adult workers and. where practicable. to fix the work week at 40 hours (exclusive of overtime). Union membership was made compulsory. During World War II strikes and lockouts were illegal. As a result of the serious waterfront strike of 1951 legislation was passed to ensure democratic control of unions. It provided for the election of officials by secret postal ballot and gave the state power to require a secret ballot to be taken at any stage during a strike. After 1944 all workers had a minimum paid holiday period of 14 days annually.

Social Security.—New Zealand's Old-Age Pensions act (1898) was the first such measure in any British country. Widow's pensions were introduced in 1911; pensions were granted in 1915 to miners incapacitated through pthisis; in 1926 allowances were granted to families where the parents had more than two children and limited incomes; blind persons and chronic invalids also received pensions. The Social Security act of 1938 increased the rates of the various noncontributory civil pensions and placed them on a universal contributory basis. It also introduced a universal superannuation scheme under which benefits were to be paid irrespective of income received or property owned. Provision was also made for new health and medical benefits (see below). In 1945 family benefits were made payable for each child irrespective of size of income or number of family. In 1948 many New Zealand social security benefits were put on a reciprocal basis with those in Australia and family benefits only were made reciprocal with the United Kingdom. A reciprocal agreement for other benefits took effect from April 1, 1956. New Zealanders pay 1*s*. 6d. in each £1 of income to the Social Security fund which is also supplemented from general revenue.

Hospitals and Health.—Before 1938 the expenses of hospital boards were met by payments from local ratepayers, government subsidies and contributions from those patients who were able to pay. By the Social Security act the responsibility for the patient's share was transferred to the Social Security fund. The contribution of local ratepayers was being reduced in the mid-1950s and it was intended that by 1958 the entire cost should be borne by the state.

Under the social security scheme 7*s*. 6d. is paid from the fund toward the cost of a visit to or by a doctor. Medicines prescribed by a doctor are free. Maternity benefits include antenatal and postnatal advice and treatment. services of doctors and nurses at confinements and treatment and maintenance in hospital. In the case of private hospitals part of the fee for treatment and maintenance is covered by payments from the Social Security fund.

Housing.—Through the state advances department, created in 1894, the government lent money for the purchase of homes and the improvement of farms. In 1934–35 the department was reconstituted as the Mortgage corporation, a limited amount of private share capital being subscribed, but by another change in 1936 the State Advances corporation came into being, with the elimination of private share capital and the liberalizing of provisions governing advances. The government undertook direct home building in 1937. While actual erection was by private builders the purchase of land and the designing and letting of houses were carried out by the state. From 1950 tenants were given the opportunity of purchasing these state houses. The housing shortage became acute during World War II and continued into the 1950s. The continuing flow of immigrants together with increased local needs made the housing position still somewhat difficult, especially in rental housing. (Rents were controlled from 1936.)

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ECONOMY

Agriculture.—The total area of Sew Zealand, excluding the Cook and other Pacific islands annexed in 1901, but including the Kermadec Islands and the outlying islands within New Zealand proper. is 66,390,677 ac. Of this total 43,355,869 ac. were returned in 1956 as being in occupation, including reserves and native lands leased, but excluding areas within borough boundaries, holdings of less than 1 ac. in extent and native land held on the communal system; the total area grassed or cultivated was 19,961,369 ac. and 23,394,500 ac. were unimproved land.

The principal items cultivated are wheat, oats, grass seeds, potatoes, onions, tobacco and orchard produce and the produce of market gardens (truck farms), nurseries and hop gardens Wheat is the most important grain crop in New Zealand—three-quarters of it in the Canterbury district and most of the remainder in north Otago. As not enough is grown for home consumption, large amounts have been imported for several years. Local growers' wheat prices are fixed yearly on a cost-of-production basis.

Grass is by far the most important crop to the farmer, and in many parts of the country tussock and other naturally established grasses have given way, after hard labour, to artificially sown pasture grasses. Aerial top-dressing was an important development. Large tracts of land in the Nelson district, formerly regarded as practically useless, were proved eminently suitable for growing fruit, particularly apples Nearly one-third of the apple and pear crops are exported. The local market absorbs practically all the stone fruits (mostly cultivated in central Otago) and citrus fruits (produced in Auckland and Hawke's Bay). In 1956 the area under field crops was 1,166,816 ac.; under artificially grown pasture grasses, 17,532,626 ac.; under fruit trees, 23,317 ac.; and in plantations, 962,j92 ac.

After much scientific investigation large-scale work began on the conversion of formerly useless pumice land in the central North Island to grasslands. With the use of trace elements, mainly cobalt, much success was achieved and about 100 farms (mostly dairy), of an average size of 150 ac., were (1956) being established each year. These would add an estimated £6,000,000 at current prices to the value of the country's exports.

The practice of top-dressing grasslands with fertilizers spread by airplane, which commenced on a commercial scale in 1948, continued to make remarkable progress.

Pastoral *Production*.—New Zealand is primarily a grazing country; it became the world's largest exporter of mutton, lamb, butter and cheese Almost all kinds of sheep find a favourable habitat in the dominion; as of Jan. 31, 1956, the total number of sheep was 40,2j5,000, the average size of the flocks being 1,055. Although ranking fifth among the principal sheep countries of the world, in 1952 New Zealand was fourth largest as a producer of wool and second as an exporter.

In 1955 the total number of cattle in the dominion was 5,887,000. Beef breeds increased after chilled shipments to overseas markets proved satisfactory in 1933. Dairy cows accounted for 34% of total cattle in 1955.

Dairy Produce.—Scientific management increased the season's yield of butterfat per cow from 152 lb. in 1920 to 265 in 1955–56. Co-operative dairy factories, some exclusively concerned with turning out butter, a larger number with cheese and a few producing dried milk powders and casein, in 1956–57 produced 3,966,000 cwt. of butter and 1,888,000 cwt. of cheese. The Primary Products Marketing commission, set up in 1947, acquired ownership of butter and cheese, at f.o b. rate or in store. marketing or disposing of it in the United Kingdom or regulating its distribution on the local market.

Forestry. — The total area of state forests (March 31, 1957) was 9,599,605 ac. and annual forest revenue, £2,665,818. The amount of sawn timber produced in the same period mas 28,051,000 bd.ft. and 5,025,000 bd.ft. were exported, mainly to Australia. The total timber production, however, was 596,867,000 bd.ft. of both indigenous and exotic species. The New Zealand forest service has built up a highly efficient system of planting — for the year 1956–57, 6,583 ac. were planted — and fire protection, in which both radio and aircraft are used. Measures are also employed to prevent soil erosion and land denudation. Much has also been done to regenerate natural forests. The development of the Kawerau paper pulp scheme whereby state forests supply the timber, particularly Murupara forest, is a highly interesting development based on the fact that pines grow about 20% faster than in northern European climes.

Fisheries. — The most important of the edible fishes are snapper, terakihi, flounders of various species, blue cod and groper or hapuku. Except for groper and ling fishing by means of long lines, most fishing is carried on at depths of less than 40 fathoms. Fishery products marketed in 1956 were valued at £2,722,672. The principal oyster beds were those in Foveaux strait. With the enormous development of pelagic whaling, New Zealand's formerly important whaling industry greatly declined, and after 1940 the only shore station in commercial operation was that in Tory channel, Queen Charlotte sound. The taking of seals was prohibited. Swordfish (the common big-game fish), striped black marlin and broadbill (a rare visitor), mako shark and other big-game fish are found off the east coast of Auckland province and the Bay of Plenty.

Minerals and Mining. — Coal was mined in the 1930s to a greater value than gold, the mining of which had been New Zealand's chief industry in the 19th century. In 19j6. 2,627,716 tons of coal, valued at almost £2 15s. a ton, were produced. Gold production declined considerably, and in 1956 only 26.063 oz. were produced, valued at £322,832. Silver is found alloyed with gold in the Hauraki region, and other minerals of commercial importance include tungsten. pumice, manganese, iron and silica sand and scheelite. Copper, mercury, tin, platinum, sulphur. asbestos, bentonite and phosphatic rock also occur. Limited amounts of good quality petroleum exist. Production of kauri gum, the fossilized resin of former kauri forests, was considerable until its displacement by synthetic lacquers and resins.

Factory Production. — —While the farming industries were of major importance, the government made every effort to encourage local manufactures. During the early colonization days bounties frequently were offered to aid new industries and to induce experienced factory workers to immigrate. Subsequently, in the development of New Zealand's tariff policy, locally manufactured products were afforded a measure of protection. Nevertheless, industrial expansion was necessarily limited by the size of the available market and by the competition of products of large-scale enterprises established in the more densely populated countries.

In 1930–31 there were 5,194 factories in operation in the dominion, the value of their output being £77,645,249. As a concomitant of the world-wide depression in trade and industry, factory production declined during the next two years. but a period of recovery then followed, reaching in 1941–42 a record high level with 6,367 factories having an output valued at F155,566,195.

World War II and postwar shortages further stimulated industrial development and in 1955–56 the number of factories had increased to 8,515 with an output valued at £584,035,667. The principal industries are meat freezing and preserving, butter, cheese, condensed and dried milk production, fellmongering and scouring, sawmilling and the manufacture of forestry products. Other major products include hydroelectric power, fertilizer, woolens and clothing.

Water Power. — New Zealand is topographically well suited to hydroelectric development. An installed capacity of 1,746,000 kw. is planhed. capable of generating 8,537,000,000 units each year. In 1903 sole right to use the water power of the dominion, subject to any existing rights, was vested in the crown. This right might be delegated to local authorities and private concerns, and these were required, by regulations amended in 1934, to obtain permission to generate power from the minister of public works and to pay an annual rental. Hydroelectric power is put to a variety of uses on the farms and in industry. Many railway lines have been electrified. The government generating stations are: in the North Island. Maraetai (194,400 kw.), Karapiro (109,700 kw.), Arapuni (162,500 kw.), Tuai (52,000 kw.), Piripaua (40,000 kw.), Kaitawa (32,000 kw.)—the last three constituting the Waikaremoana scheme — and Mangahao (21,300 kw.), and in the South Island, Waitaki (107,200 kw.), Lake Coleridge (38,600 kw.), Highbank (29,300 kw.), Lake Tekapo (28,700 kw.), Lake Monowai (6,800 kw.), Cobb River (34,120 kw.) and Arnold (3,300 kw.). In 1943 the government adopted a ten-year plan for increasing the hydroelectric supply on the North Island. By 1953 three stations of ten planned — hrapuni, Karapiro, Maraetai — had been built on the Waikato river; long-distance power lines were to carry 220,000 v. instead of the existing 110,000 v. A major scheme was being built (1957) at Roxborough and would have a capacity of 320,000 kw. when completed. In 1953 about 93% of the population had access to electric supply, at a cost to consumers (83% of them domestic) of less than one penny per kilowatt-hour. During 1953 a project for a 20,000-kw. geothermal steam station at Wairakei near Taupo in the central North Island was started; geothermal potential was estimated at 200 to 400 Mw.

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External Trade

The total trade of New Zealand per capita is one of the highest in the world. In 1956 the figure for exports and imports combined was just slightly more than £246 per person. This high volume of trade means that the New Zealand economy is very dependent on prices and conditions in world markets, especially in the United Kingdom, which is New Zealand's largest customer, and also in North America, Europe and Australia. Total merchandise trade (excluding specie) for the years 1951–54 is shown in Table II.

Table 11.—*Merchandise Trade of New Zealand*

Calendar year	Exports £000	Imports £000	Total trade £000	Excess of exports £000
1953 . .	235,860	192,180	428,040	43,680
1954 . .	244,466	245,820	490,286	− 1,354
1955 . .	259,289	287,134	546,423	−27,845
1956 . .	275,134	268,564	543,698	6,570

Total overseas receipts and payments made by the New Zealand banking system during the same period are shown in Table III.

Table 111.—*Overseas Receipts and Payments*

Item	1953 £000	1954 £000	1955 £000	1956 £000
Receipts for.				
Exports . . .	243,469	221,154	253,081	282,112
Otheritems . . .	22,849	50,130	41,024	42,221
Total . . .	266,318	271,284	294,105	324,333
Payments for:				
Imports (excl. govt.) .	170,473	217,647	246,362	229,680
Govt. debt and other services incl. govt. imports	41,379	37,433	38,468	39,954
Other items . . .	28,298	32,800	35,812	45,826
Total . . .	240,149	287,880	320,642	315,460
Balance . . .	+26,169	−16,596	−26,537	+8,871

Note: Due to rounding of figures the total shown may not be the same as the sum of the items.

Exports. — In 1954 dairy products, meat and wool accounted for 99% of total exports. The quantity and value of the major exports

TABLE IV.—*Quantity* and Value *of Major* **Exports**

Calendar Year	Butter		Cheese		Mutton		Lamb		Beef		Wool		Sheepskins	
	000 tons	Value £000	000 tons	Value £000	000 tons	Value £000	000 tons	Value £000	000 tons	Value £000	000 tons	Value £000	Number 000	Value £000
1953	158.9	51,385	101.4	18,373	72.6	4,459	179.5	25,784	40.4	4,437	174.4	84,370	18,254	7,905
1954	132.6	44,715	92.3	16,381	70.0	4,849	206.7	34,146	57.6	7,082	175.4	88,437	18,900	7,660
1955	155.5	50,830	83.9	13,413	63.5	4,633	203.7	37,295	83.8	11,761	187.0	93,780	20,820	6,209
1956	163.1	52,151	89.3	22,511	64.3	4,664	207.5	38,837	106.7	12,593	188.4	90,158	20,436	7,249

from 1953–1956 are shown in Table IV.

After World War II, New Zealand became the world's greatest exporter of meat and dairy produce, and the world's second largest exporter oi wool. The United Kingdom takes almost two-thirds of New Zealand's total exports, the United States being the next best customer with 7%.

In 1955 an important new export industry was being developed in New Zealand by the manufacture of pulp and paper, together with sawmilling of logs, from the exotic forests in the North Island. It was expected that in a few years this project would make a substantial contribution to New Zealand's export trade.

Since 1938 exports from New Zealand have been subject, as an exchange control measure, to licensing. The object of the export licensing system is not to restrict exports in any way but to ensure that the full value of the exports in terms of foreign currency becomes available to the banking system.

Imports.—More than 80% of New Zealand's total imports normally consist of articles wholly or mainly manufactured, a large proportion of them being goods (as, for instance, vehicles and tractors) which could not be produced economically in the country. In addition, many imports of manufactured or semimanufactured goods form the raw material of further factory processes in the country (*e.g.,* cotton piece goods). The principal groups of commodities imported are textile piece goods and drapery, metals and machinery, sugar, tea, alcoholic liquors, tobacco, paper and stationery, oils, motor vehicles and accessories, chemicals and drugs and manures. In 1956, 54% of New Zealand's imports came from the United Kingdom, 14% irom Australia, 7% from the United States and 3% irom Canada. Before World War II, imports irom North America were more than 20% of total, but the percentage fell to about 10% because of the stricter controls applied in postwar years to economize on dollar expenditure. Table V shows overseas receipts and payments for 1954 by currency areas and countries.

TABLE V.—Overseas Receipts and Payments, *1956*

Area	Trade transactions			Balance on all transactions £000
	Export receipts £000	Import payments £000	Balance £000	
United Kingdom	178,787	174,602	4,185	− 7,206
Australia	9,226	30,032	−20,806	−23,915
Total, all sterling area countries	195,007	216,115	−21,108	−36,966
United States of America	21,902	20,324	1,579	2,701
Canada	4,496	6,328	− 1,832	− 2,493
Total, all dollar area countries	27,049	26,693	356	800
Total, all nonsterling E.P.U. countries	47,221	11,668	35,553	35,211
Total, all other countries	12,683	2,302	10,381	9,826

Import and Exchange Controls.—In order to meet a serious decline in overseas funds, control of imports by a licensing system was introduced in 1938. This system was continued throughout World War II and early postwar years. After 1950, however, a wide range of goods was ireed irom licensing control when obtained from soft-currency areas. By 1952 about two-thirds oi New Zealand's imports were not subject to licensing and many licences were retained solely to protect local industries pending a review of the customs tariff. Imports from dollar and other hard-currency sources continued to be strictly controlled in the light of the available dollar resources not only of New Zealand but oi the sterling area as a whole.

In 1952 a large influx of imports and a fall in export receipts, particularly for wool, again caused a heavy drain on overseas iunds. The Reserve bank, after consultation with the government, introduced a scheme oi exchange allocation, to ration exchange among importers. The allocation scheme remained in operation until Dec. 31, 1954, when it was terminated.

In the meantime various relaxations were made in import licensing and many major items of an essential category were permitted to be imported from any source without the need for an import licence. Apart irom additions to this "world exemption" list, the import licensing schedule for 1956 remained much the same as in the preceding years but imports of motor vehicles which had risen under licence to £21,000,000 a year were to be reduced to £14,000,000.

Customs **Tariff.**—New Zealand maintains a general tariff, a most-favoured-nation tariff at lower rates and a preferential tariff at still lower rates applying to imports from commonwealth countries. New Zealand is a party to the General Agreement on Tariffs and Trade (G.A.T.T.) and usually participates in tariff negotiations in accordance with this agreement. The New Zealand board of trade, set up in 1950, was in 1956 engaged in a complete review of the New Zealand tariff which had not been subject to major revision since 1934. The government policy was to rely on tariffs rather than import control to protect domestic industries. (G. D. L. W.)

TRANSPORT AND COMMUNICATIONS

Railways.—The railway system is state owned (there are a few minor private lines mainly serving colliery and sawmilling areas). In 1957 there were 3,418 mi, of state railways open for traffic. The gauge is 3 ft. 6 in. Many mountain chains and rivers make railway construction both difficult and expensive. By 1957 the capital cost had amounted to £120,101,251; *i.e.,* the cost per mile of open line was £35,138. There was a net loss on earnings of £269,373. In 1953 the government set up a commission to administer the system on an economic basis. In 1956–57 more than 9,500,000 tons of goods were carried by rail.

Roads.—On March 31, 1955, there were 56,118 mi. of formed road in the country, 4,943 mi. of bridle track and 16,090 mi. of unformed legal roads, for a total of 77,151 mi. The configuration of the country and the abundance of rivers made road construction as difficult as that of railways. Bridges of 25 ft. or more in the roads system in 1953 numbered 8,666. Of the 12,777 mi of main highways, 5,224 mi. (the principal traffic routes) were classified as state highways and maintained at state expense. The cost of other main highways is shared between the state and local bodies and, with some exceptions, the cost of other roads is borne by local bodies.

Civil Aviation.—In 1945 complete control of air transport was given to the state-owned New Zealand National Airways corporation which took over the existing commercial operators. In 1948 provision was made for other concerns to operate new services and in 1951 the Air Services Licensing act provided ior an authority to determine applications ior licences. The National Airways corporation remained by iar the largest operator, nearly all the 118,756,000 passenger-miles flown in the year ended March 31, 1957, being flown by its services. Private concerns were, however, beginning to be active in the mid-1950s in the transport of freight by air, a service which received impetus during the longshoremen's strike of 1951. The most important international air service so far as New Zealand is concerned is that of Tasman Empire Airways, Ltd., a company formed to operate a service from Australia to New Zealand on capital subscribed by the United Kingdom. Australian and New Zealand 'eovernments. It began operations id 1940 and now Operates services irom New Zealand to the Pacific islands as well as to Australia. Other services operating to New Zealand are Pan American World Airways (Auckland to San Francisco), British Commonwealth Pacific Airlines and Canadian Pacific Airlines (both Auckland to Vancouver). (A. T. CL.)

FINANCE

The money composing the public debt of New Zealand was borrowed on the security of the country's public revenues, no part of the public estate being pledged for payment of either principal or interest. At March 31, 1957, the gross public debt stood at £757,119,000 (excluding £24,100,000 of funded debt owing to the British government, on which payments were suspended in 1931 as part of an international moratorium on inter-Allied debts incurred during World War I). Of this total £100,425,000 was domiciled in London. After 1933, when the nominal amount of the external debt was £138,100,000, new public borrowings overseas, other than for conversion and war purposes, ceased and a policy of repaying external debt was put into effect. Almost all the decrease occurred after 1945 In addition, £60,800,000 borrowed from the British government during World War II was repaid by 1946. With the exception of that portion incurred for war purposes (about £240,000,000), most of the borrowings was for productive and developmental purposes and resulted in revenue-producing assets such as railways, hydroelectric installations. telephones and houses. At March 31, 1957, £422,066,000 (56% of the total debt) was held by government departments and quasi-government organizations, and the balance of £230,199,000 was held by the public.

The ordinary revenue and expenditure of the government are shown in the consolidated fund. There are a number of other specialized accounts covering such activities as capital items, social security, commercial and other undertakings, etc. Successive changes in system have largely destroyed the comparability of the figures over any length of time.

Most of the receipts of the consolidated fund come from taxation of various kinds but iurther small amounts are obtained from interest on public moneys, profits of state trading enterprises (such as post office, electricity supply and national airways) and irom income earned by government departments for services rendered to the public. Payments from the fund are grouped under permanent or annual appropriations. The latter heading covers payments under departmental votes and the former covers interest on and amortization of the public debt and payments under numerous special acts. Table VI shows transactions in the consolidated fund for the year ended March 31, 1957, together with budget estimates for the year ending March 31, 1958.

TABLE VI.—*Consolidated* Fund—Year Ended *March 31*

Item	1957 (£000,000)	Estimate 1958 (£000,000)
Receipts		
Customs	29.0	30.0
Sales tax	22.3	22.8
Stamp duty	15.0	15.3
Income tax	98.1	98.7
Miscellaneous	8.3	8.5
Other receipts	33.6	34.5
Total receipts	206.3	209.8
Expenditure		
Interest and debt payment	35.4	33.7
Permanent appropriations	4.6	5.3
Annual appropriation		
Stabilization	12.4	13.0
Defense	26.2	24.8
Development of primary add secondary industries	16.7	17.0
Social services	74.0*	80.8*
Other votes	33.7	34.1
Total expenditure	203.0	208.7
Surplus	3.3	1.1

*Expenditure includes £14,000,000 transfer to Social Security fund.

The Social Security fund derives most of its receipts from a uniform charge of 1*s.* 6d. in the pound on nearly all forms of income, including salaries, wages and the income of companies; the balance is mainly in the form of a transfer from the consolidated fund. Table VII shows transactions in the Social Security fund for the year ended March 31, 1957, together with budget estimates for the year ending March 31, 1958.

TABLE VII.—*Social* Security Fund
(£000,000)

Year ended March 31	1957	1958 (est.)
Total receipts	75.9	79.9*
Total expenditure	75.6	79.8
Surplus	+.3	+.1

*Includes transfer of £14,000,000 from consolidated fund.

Table VIII shows the totals of the consolidated fund and Social Security fund for the same period.

TABLE VIII.—*Total* Consolidated Fund and Social Security Fund
(£000,000)

Year ended March 31	1957	1958 (est.)
Total receipts	268.1	275.7
Total expenditure	264.6	274.6
Surplus	+3.6	1.1

For the year ended March 31, 1957, taxation receipts per head of mean population amounted to just less than £100, slightly less than the record figure of £102 7s. 9*d.* in 1951–52 but more than four times the figure of £23 9s. zd. for 1938–39, the last financial year before World War II. Direct taxes on income (income tax and social security charge) amounted to £159,753,000 in 1956–57 and represented £71 a head and 68% of total taxation. In 1938–39 the corresponding figure was £14,-296,000, representing £8 17*s.* 5*d.* a head and 37.8% of total taxation. Other major taxes are customs and excise duties, sales taxes and death duties. The total tax revenue for 1956–57 was £234,284,000, which represented 26.5% of the national income. In 1938–39 the corresponding figures were £37,797,000, or 19.5% of the national income. When assessing the high level of taxation in New Zealand, it is necessary to bear in mind the considerable proportion of government revenue which is returned to the taxpayers as monetary payments (without means test) ; *e.g.,* medical, hospital and family benefits.

Government capital expenditure runs at a rate of between £60,000,000 and £70,000,000 a year. For the year ended March 31, 1957, the capital program allowed for expenditure of £78,700,000 but this sum was underspent by about £6,000,000 because of shortages of labour and materials. The program for the year ended March 31, 1958, is set out in main headings in Table IX.

Finance to meet this program is normally drawn partly from current revenues and depreciation reserves; but the main sources of capital funds are loans, national savings and savings bank accounts, departmental investments and miscellaneous capital receipts.

Private capital investment has in recent years been larger than capital investment by the central government and local authorities. In the year ended March 31, 1956, gross capital investment (excluding changes in stocks) was £221,000,000, of which £128,000,000 was private and £93,-000,000 by central and local government authorities. Gross capital investment represents more than 20% of gross national product.

TABLE IX.—*Government* Capital Expenditure
(£000,000)

Item	Estimates year ended March 31, 1958
Hydroelectric	25.5
Land settlement	10.0
State housing	10.0
Education building	7.5
Railway construction	8.5
Telephone and telegraph extension	6.2
Roads (transfer to National Roads fund)	8.8
Forest development	1.7
Murupara development	1.0
Other works	4.7
Less deduction for working expenses	11.4
Subtotal	72.5
State Advances corporation	9.0
Other requirements	2.5
Total	84.0

Banking.— The banking institutions of New Zealand are the Reserve Bank of New Zealand, five trading banks, the Post Office Savings bank and five trustee savings banks. The Reserve bank, which began operations as the central bank of the country on Aug. 1, 1934, is state owned, the original private shareholders having been bought out by the government in 1936. As the central bank, it is authorized to control credit, currency, the transfer of money to and from New Zealand and the disposal of export receipts being held overseas. It also has the duty of maintaining a high and stable level of activity in New Zealand insofar as this can be effected by monetary means. Between 1939 and 1950 the minister of finance was empowered to issue directives to the bank on any aspects of central banking practice or policy. In 1950 the law was amended and the bank must now give effect to any resolutions of parliament in respect of any of its functions or business. It remained a general function of the bank to give effect to the monetary policy of the government. The right of note issue was transferred from the trading banks to the Reserve bank on its establishment and it issued notes in denominations of 10*s.*, £1, £5 and £10 and a few £50. Total notes in circulation amounted to £71,998,000 at the end of March 1957. The bank also issues and regulates the supply of coin and since 1936 has managed the public debt.

Two of the trading banks, the Bank of New Zealand and the National Bank of New Zealand, are incorporated by acts of the New Zealand parliament. All the share capital in the former, which had been partly state owned, was acquired by the government in 1945. It conducts more than 40% of banking business.

The other three banks are predominantly Australian institutions. All five banks maintain a large number of branches and agencies throughout the country. At the end of March 1957 demand deposits with the five banks amounted to £233,800,000, time deposits (on which interest rates range from 2% to 3%, depending on the period of deposit) to £36,602,000 and advances and discounts to customers to £168,741,000.

In 1955 the number of open accounts in the Post Office Savings bank was 1,650,000, or 74% of the population, and the total deposits amounted to £236,606,000. Interest at the rate of 3% is paid on deposits up to £1,000, 2½% from £1,000 up to £7,500. The, five trustee savings banks had at March 31, 1957, 400,000 deposits amounting to £49,121,000. In addition, all the savings banks carry national savings accounts which cannot be withdrawn, except in certain circumstances, for two to three years. They pay 3% interest and were originally opened in 1940 to help meet war expenditure. At March 31, 1957, these deposits amounted to £67,322,000.

Coins and Currency.— Gold, silver and bronze coins of Great Britain and Australian gold coins were legal tender in New Zealand until 1935 with Australian silver and bronze in free, though not legal, circulation. Distinctive New Zealand silver coins were introduced in 1933 and bronze coins in 1939, the denominations and standards of fineness being the same as in the U.K. After 1947 cupronickel coins were issued in place of silver.

Following the assumption by the Reserve bank in 1934 of the sole right to issue notes, the trading bank notes were withdrawn from circulation and in 1936 the Reserve bank assumed liability for trading bank notes not yet presented. Until 1950 the Reserve bank was required to maintain a minimum reserve of 25% of the aggregate amount of the notes and other demand liabilities. This obligation was abolished in 1950 and the bank is now required to hold such reserves as, in the opinion of the board of directors, will provide a reasonable margin for contingencies "Reserve" is defined as including gold coin and bullion, sterling exchange (deposits at the bank of England, British treasury bills and bills of exchange), net gold exchange and net holdings of currencies freely convertible into sterling. From 1933 to 1948 exchange rates were based on a selling rate of £N.Z.125 = £100 sterling, but from Aug. 1948 the New Zealand pound was at parity with sterling.

In 1938, to meet a serious fall in overseas reserves, control over foreign exchange was introduced in conjunction with export and import licensing regulations. The exchange control system was extended in 1940 as a war measure and continued, with modifications. The system is administered by the Reserve bank with the trading banks acting as its agents Broadly, the situation in 1957 was as follows: the foreign currency receipts on account oi exports must be paid to a bank; payments ior imports are not subject to exchange restrictions (though, as mentioned above, the imports themselves are in some cases subject to import licensing); other payments within the sterling area are not restricted with the major exceptions of capital exports by New Zealand residents and travel allowances; remittances to countries outside the sterling area are treated on their merits; interest, dividends and profits may be remitted to any country but capital movements are strictly controlled; the export of money is subject to permission but the importation of money is not limited except in the case of silver coins and United Kingdom bank notes; dealings in nonsterling securities held by residents are subject to Reserve bank approval and the bank is empowered to acquire such securities if necessary.

In pursuance of its function of controlling credit in New Zealand, the Reserve bank introduced in 1942, with the co-operation of the trading banks and as a government policy measure, a selective control over bank advances aimed at preventing the expansion of credit for speculation and other purposes inconsistent with the war effort. This control was continued after the war to avoid the creation of new money for nonessential purposes or for the financing of capital expenditure when funds were available from other sources. The policy was subsequently modified to meet changing conditions and in 1952 was supplemented by raising the cash balances which the trading banks were required to hold at the Reserve bank Up to 1952 each bank had to maintain a balance of not less than 7% of its demand liabilities and 3% of its time liabilities. By mid-1955 these ratios had been raised to 21½% and 7½% respectively, and, as an additional measure of credit restriction, the bank rate was raised to 7%.

(D. L. Ws.; G. D. L. W.)

NEXØ, MARTIN ANDERSEN (1869–1954), Danish novelist who describes working-class life with warmth and unshakable faith in the virtues of the proletariat. He was born June 26, 1869, into a working-class family in Copenhagen. As a boy he worked on a farm and as a cobbler's apprentice. He attended high school from 1891 to 1893 and during 1894–96 traveled in southern Europe following an attack of tuberculosis. He taught for several years, but after 1901 he was able to earn his living as a writer. During 1923–30 Nexø lived on Lake Constance and from 1951 to 1954 in eastern Germany. He died at Dresden, June 1, 1954.

Nexø's early works are stamped with the decadence of the 1890s, especially the novel *Dryss* ("Drizzle"; 1902), though his collection of short stories, *Skygger* (1898), contained realistic descriptions of working-class life. A trip to Spain, described in *Soldage* (1903; Eng. trans., *Days in the Sun,* 1929), substituted for his pessimism a belief in the people, the labour movement and the international solidarity of the proletariat — concepts which became dominant in his life. His epic novel, *Pelle Erobreren* (4 vol., 1906–10; Eng. trans., *Pelle the Conqueror,* 1913–16) describes the progress of a worker — "the unendowed man" — from poverty on the land to an artisan's life in a little provincial town and to trade unionism in the city. Nexø's other great novel, *Ditte Menneskebarn* (5 vol., 1917–21; Eng. trans., 1920–23), is the chronicle of a woman's destiny, fraught with suffering and sacrifice. During this period Nexø also wrote short stories collected in *Muldskud,* i–iii (1922–24).

After the Russian Revolution, Nexø sided with the Soviet Union, which he visited often and praised in his travel book *Mod Dagningen* (1923). His Communism antagonized Danish public opinion. His later works include four volumes of reminiscences (1932–39) which are among the most human and best-written memoirs in Danish literature. *Morten hin Rode* (1945) and *Den fortabte Generation* (1948) continue the story of Pelle with a Communist interpretation of political events between the wars.

His motives and ideals, the universal appeal of his subjects and the warmth of his style made Nexø the best-known Danish author after Hans Christian Andersen and his books have been widely translated.

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NEY, MICHEL (1769–1815), DUKE OF ELCHINGEN and PRINCE OF THE MOSKOWA, French soldier, one of Napoleon I's marshals, was born at Saarlouis on Jan. 10, 1769, son of a cooper; his mother was German, and he spoke German well. He had learned to write well enough to be a clerk in 1782, but in 1788 he enlisted in the hussars.

Ney first distinguished himself in the French Revolutionary Wars. His former colonel took him as aide-de-camp in 1792. A captain in 1794, he was picked out by J. B. Kléber as a hussar "partisan," and he led light cavalry and infantry in all the actions of the army of Sambre-et-Meuse to 1797, becoming general of brigade in 1796. Under J. Bernadotte, he boldly surprised Mannheim in March 1799. He was then promoted general of division to command André Masséna's "vanguard" in Switzerland, but was wounded on May 27, near Winterthur. In August he was transferred by Bernadotte, now minister of war, to Mannheim. In temporary command in chief, he formed the small army of the Rhine in mobile brigades, with which he acted offensively as a typical hussar leader. A division under J. V. Moreau in 1800 was his first command of infantry of the line in battle; he was conspicuous at Hohenlinden.

Napoleon Bonaparte, as first consul, received him cordially in May 1801; and Josephine arranged his marriage to Aglaé Auguié next year. Ney was put in charge of the political and military organization of Switzerland from Oct. 1802 to Dec. 1803; thence he was sent to command the camp at Montreuil. On May 19, 1804, he was made a marshal of the empire.

An admirable trainer of troops, he formed the fine 6th corps which served under his orders to 1811. In 1805 his brilliant attack across the Danube at Elchingen (for which in 1808 he was made duke of Elchingen) made the surrender of Ulm inevitable, after which he was sent to clear the Tirol flank. His premature attack at Jena in 1806 and his rash advance almost to Konigsberg in Jan. 1807 were blamed by Napoleon, and his action at Eylau (*q.v.*) was ineffective; but he led the decisive attack at Friedland (*q.v.*) and was described by the emperor as the "bravest of the brave." *(See* further NAPOLEONIC CAMPAIGNS: *The Campaign of 1805* and *Prussian and Polish Campaigns.)*

Ney was sent to Spain at his own request in Aug. 1808, hoping for the command in chief, and rallied King Joseph's troops on the Ebro. He resumed his corps in Napoleon's operations and occupied Galicia and the Asturias temporarily. He resented Masséna's supreme command (1810) and was pained by the losses of his corps; at last, after a most skilful retreat from Portugal, he refused to obey Masséna and was removed by him from his command. *(See* PENINSULAR WAR.)

In Aug. 1811, however, he was at Boulogne camp, forming the new 3rd corps for Russia. In 1812 Ney commanded the centre at Borodino and was created prince of the Moskowa (Moskva) on the evening of the victory. In the retreat he was a tower of strength, animating the rear guard with his sublime courage. Near Smolensk he was cut off, and his escape across the frozen Dnieper to rejoin Napoleon made him the hero of the army. At Kovno on Dec. 13 he stood in the ranks musket in hand; and he brought the last remnant to Königsberg. The strongest corps of the army of 1813 was given to him; and he commanded two corps in the battle of Bautzen (*q.v.*)—with less success than was expected. But on Aug. 23 he was called to command three corps detached before Berlin. His defeat at Dennewitz on Sept. 6 showed that he could not command an army, and in 1814 he had only 2,000 of the young guard under Napoleon's direct command. He was the most prominent of the army leaders who confronted Napoleon in April 1814, though the marquis de Caulaincourt, his colleague, thought that Ney exaggerated his account of their interviews and did not want the return of the Bourbons. *(See* further NAPOLEONIC CAMPAIGNS: *The Russian War of 1812* and subsequent sections.)

His conduct made him a peer and governor of Besanqon for Louis XVIII under the first restoration, but he felt the loss of his grants and was insulted by the attitude of the returned *émigrés* towards his wife at court. On Napoleon's return in 1815 he concentrated the Besanqon troops with the famous declaration that the usurper should be brought to Paris in an iron cage; but on March 13, on the impulse of the moment and certainly not by premeditation, he received Napoleon's envoy, and next day he publicly declared himself for Napoleon. He was received kindly but had no command. The army was already marching when

Napoleon called him to the front. He arrived on June 13 without horses or staff and, on June 15, was sent to take charge of the two corps on the left wing. Much controversy has raged over Ney's strategy and tactics in this improvised command at the battle of Quatre Bras (see WATERLOO CAMPAIGN, 181j).

At Waterloo he was a battle leader again, not a general. He did not co-ordinate the French attacks; and when he took the initiative of engaging the whole heavy cavalry Napoleon observed that this was premature, as Ney's action at Jena had been. With the cavalry he rode in four charges up to the British squares; and he was dismounted for the fifth time in the last desperate attack of the guards. When all was lost his courage was extinguished; he made no attempt to rally the troops and left the army at once. On June 22 he shocked opinion by a despairing speech in the chamber of peers and on July 6 he left Paris with a passport to Switzerland. He decided, however. to take refuge in the Cantal, where he was arrested on Aug. j. On hearing this news, Louis XVIII exclaimed: "By letting himself be caught he has done us more harm than he did on the 13th of March!"

Neither the king nor his ministers could resist the clamour of the ultraroyalists for blood. The duke of Wellington would not intervene. Though the court-martial declared itself not competent to try a peer, the result of trial by the peers. which began on Nov. 21, was a foregone conclusion (the young duc de Broglie—the future statesman of the July monarchy—alone voted for acquittal); but neither the members of the court-martial nor the peers were forgiven by public opinion. On Dec. 7, 1815, Ney was shot in the Luxembourg gardens, near the Observatory. He met his death with a soldierly dignity which effaced the memory of his political extravagances and made him, next to Napoleon, the most heroic figure of the time. 1 D. E.)

NEZ PERCE, a tribe of Sahaptin (*q.v.*) lineage on Snake river in Idaho and Oregon. The population was estimated at 6.000 in 1805. There were about 1,530 on the Nez Percé reservation in Idaho in 1950. In 1877, under Chief Joseph, they fought the United States, winning some engagements and engaging in a notable but finally unsuccessful retreat almost to Canada. They were the largest and easternmost Sahaptin tribe and most affected by influences from the Plains Indians.

See John R. Swanton, *The Indian Tribes of North America,* Bull. 145 of Bureau of American Ethnology (1953).

NGAMI, a shallow lake of variable size lying at the south-eastern (lowest) point of the 4,000-sq.mi. inland delta of the Okavango (Okovanggo) swamps in the Batawana Native reserve (Ngamiland) in the northwest of Bechuanaland. The lake is 43 mi. S.W. of Maun, Ngamiland; Ngamiland is flat country 3,000 ft. above sea level, and is part of the vast sandy central Kalahari plateau of south Africa. Lake Ngami receives water from the Okavango. Occasionally, when the Okavango is in flood, as in 1849 when discovered by David Livingstone, the lake extends for a length of 40 mi. and to a width varying from 6 to 10 mi. At other times it becomes almost dry.

The Okavango rises in the high rainfall region of Angola in country above 4.000 ft. It flows southeast across Angola to latitude 18° S., thence eastward forming the boundary between Angola and South-West Africa. At 20° 30' E. it is joined by a major tributary, the Kwito, which also rises in the Angola highlands On reaching Andaras, the Okavango turns southeast; crosses the Caprivi strip and, after passing the Popa falls at 21° 50′ E., it follows a winding course southeast within a 90-mi.-long valley about 7 mi. wide. At 18° 50' S. and 22° 25' E. the banks of this valley recede and merge with the flat surrounding country. There the Okavango divides into a number of channels which overflow, creating large swamps that drain slowly to the east and southeast for a distance of 100 mi. from the head of the delta. Discharge from the swamps, after heavy losses, is intercepted over a wide front by the Thamalakane river on a line northeast to southwest forming the "base" of the delta. The Thamalakane drainage is such that some water can flow northeast toward the Mababe depression; some to Lake Ngami; but the bulk is diverted abruptly to the east into the Botletle river 12 mi. below Maun. (W. G. BD.)

NGONI. About 500,000 people, belonging to about a dozen groups scattered throughout eastern Africa, call themselves Ngoni. They. like the Zulus, belong to the Nguni branch of the Bantu people. Each group of Ngoni has a history of migration from the vicinity of Zululand (*q.v.*), south Africa, in about 1820–35, and their common name is derived from a praise title current in the Zululand area. The growth of the Zulu empire under Shaka (Chaka) caused many refugee parties and bands led by his rivals to move outward from Zululand in search of more favourable conditions. Some, like the Fingoes who entered Cape Colony and the Tlokwa under Chief Mantatise, remained in the south; others, like many Ngoni, went north. Chief Zwangendaba led his Ngoni party to Lake Tanganyika, where it split into three, and the descendants of his group are located in northern Nyasaland, in Northern Rhodesia; and in Songea and Kahama districts of Tanganyika. Chief Soshangane's Ngoni went to Gazaland. Portuguese East Africa. Mzilikazi, one of Shaka's generals, took his party of Ndebele to Southern Rhodesia, and it is probably from him that the Maseko Ngoni, now in southern Nyasaland, broke away.

Each Ngoni group formed a small independent state with a central administration based on hereditary patrilineal succession. It raided its weaker neighbours for some of its food supply, and when the fertility of its own cultivated area was exhausted, the group as a whole moved elsewhere, seeking fresh fields and pastures at the expense of new enemies.

The superior Ngoni military organization, based like that of the Zulu on universal conscription into age-set regiments, enabled them to capture many of the people whose lands they seized or pillaged. Some captives, particularly in Tanganyika, were sold to Arabs as slaves, but many were assimilated into the tribe, some achieving high rank in the army and administration. Despite losses through continual warfare, the population increased greatly, leading eventually to splits in the state and dispersal of rival segments.

Internally each state, at least among Zwangendaba's people, was divided into numerous segments, many of which were under the nominal leadership of queens. Smaller segments controlled by lords were likewise each subdivided among the several wives of the lord. Selected captives were appointed lieutenants of their lord, were placed in command of his dependents and might succeed him if he had no son. The large compact villages, with their central cattle byres, were built fairly close to one another, each village containing about 2.000 or 3,000 inhabitants. A belt of empty no man's land surrounded the settled area, isolating it from the territories of the tribes raided by the Ngoni.

At the end of the 19th century Portuguese, British and German forces invaded the hinterland where the Ngoni had been virtually unchallenged for 50 years. By 1910 all Ngoni groups had come under white control. The high density of population consonant with their former life of migratory brigandage has, under settled conditions, caused serious shortage of land, accentuated in some instances by alienation of land to whites.

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NIAGARA, FORT, a historic fortification in Niagara county, N.Y., U.S., on the east bank of the Niagara river where that river flows into Lake Ontario. As the strategic key to the Great Lakes it was a major military objective in the Anglo-French contest for the interior of the North American continent in the 18th century. As early as 1678–79, La Salle established a trading post there, and in 1687 the French erected Ft. Denonville, only to abandon it the follouing year. Ft. Niagara was built by the French in 1725–27 and rebuilt in 1756, as tension mounted over control of the Ohio valley. A British force captured the fort on July 24, 1759, in one of the most decisive battles of the French and Indian War (*q.v.*). Gen. John Prideaux, the British commander, was killed on the field and Sir William Johnson took his place. The British enlarged the fort after the war and during the American Revolution used it as a base for raids into the Mohawk valley. Along with other British posts on soil nominally American by the peace of 1783, it was not evacuated until 1796. During the War of 1812 the British under John Murray captured the fort in 1813. From its return to the United States on March 27, 1815, until Dec. 31, 1945, it was garrisoned by the regular army, except for the years 1826–36. Later the vicinity was designated Fort Niagara State park.

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NIAGARA FALLS, a city and port of entry of Welland county, Ontario, Can., on the left bank of the Niagara river opposite the falls, 43 mi. S.E. of Hamilton. It is connected with the U.S. town of Niagara Falls on the opposite bank by the renowned Rainbow and Whirlpool Rapids bridges. First named Elgin in 1853, then Clifton in 1856, the town became known as Kiagara Falls in 1881. The first suspension bridge across the gorge at Niagara Falls was completed in 1855 by John Roebling (*q.v.*). In 1904 Niagara Falls was incorporated. Pop. (1956) 23,563. Its importance is largely due to the cataract, a tourist attraction and major source of electrical power for Ontario. Manufactures include chemicals, fertilizers, abrasives and refractories, silverware, cereals, machinery and sporting goods. Queen Victoria park, of the provincial Niagara Parks commission, extends along the bank of the river and includes the unique Oakes Garden theatre and carillon tower. (F. G. R.)

NIAGARA FALLS, a city and port of entry of Niagara county in western New York, U.S., is located about 20 mi N N W. of Buffalo at the great falls of the Niagara river, opposite Niagara Falls, Ont.

Each year the city accommodates more than 2,000,000 visitors to the falls, which have proved to be one of the most durable and popular tourist attractions in the world. At night the falls are illuminated by multicoloured floodlights from Victoria park on the Canadian side. Behind the façade of a busy tourist mecca, however, is a thriving industrial community which converts the power of the great river into useful products enjoying both local and national importance. Electrochemical and electrometallurgical industries predominate, with chromium silicon, silicon carbide, carbon and graphite, caustic soda, chlorine, fluorine and hydrazine accounting for a major part of their output. Paper products. rocket components, storage batteries, foods and business forms are also produced. Most of the industries are located in an L-shaped section which lies along the upper Niagara river east of the city and then northward along its eastern margin.

The falls, which Jacques Cartier (*q.v.*) heard about but did not visit on his voyage of 1535, were first described by Father Louis Hennepin (*q.v.*), a Jesuit missionary who saw them in 1678. As the only break in the all-water route between the St Lawrence river and the upper Great Lakes, the area around the falls had great strategic value in colonial times. A French fort was built in 1745 and another (Little Niagara) in 1750 to supplement Ft. Kiagara (see NIAGARA, FORT) at the mouth of the river. In 1759 both forts were burned by Chabert Joncaire, French master of the portage, to prevent their falling into British hands. Under Joseph Schlosser, a German captain in the British army, Ft. Schlosser, part of which has been restored, was erected in 1761. Augustus Porter. who purchased the area around the falls and established a gristmill in 1805, saw in the mighty cataract power that would some day build a thriving city, and so he named his settlement Manchester, after the great English industrial centre. Manchester, with Ft. Schlosser, was burned by the British on Dec. 19, 1813 during the fighting on the Niagara frontier in the War of 1812, and thereafter remained a small rural community which seemed to be caught in the backwash of its larger neighbour, Buffalo. The opening of the Erie canal in 1825 seemingly doomed the region to the life of a rural tourist centre, for traffic which had once moved over the portage from Lewiston below the falls to Ft. Schlosser dwindled and disappeared, apparently taking with it any hope of an industrial future. In 1847, Porter tried to interest speculators in an attempt to build a canal for hydraulic power from the river above the falls to a point roughly one mile downriver from the brink. He failed and others went bankrupt digging that canal, completed in 1862, through the tough Onondaga limestone that underlies the region. Jacob Schoelkopf bought the "ditch" in 1877 and began to sell the water to mills along the bank downstream from the falls. In 1882 he installed a small generator at the base of the cliff and the true future of Niagara Falls, hydroelectric power, was found. Another great step was taken when Edward Dean Adams (1846–1931) formed the Niagara Falls Power company in 1886 to develop the potential of the falls. During World War I the Schoelkopf holdings were merged with Adams' company and the modern era of industrial growth really began. To protect their aesthetic value, the amount of water which may be diverted from either the U.S. or Canadian (Horseshoe) falls is limited by international treaty. In addition, Goat Island, which separates the U.S. and Canadian falls, several smaller islands and Prospect park, 10 ac. on the brink of the gorge, were set aside as a state park in 1885.

In 1892 Manchester, by that time renamed Niagara Falls, and the downstream village of Suspension Bridge, formerly Niagara City, were merged and incorporated as the city of Niagara Falls nhich in 1916 adopted a council-manager form of government. Niagara university (Roman Catholic, 1856) is located in the suburbs.

A wagon and foot bridge was constructed across the gorge in 1848 and the first railway bridge, a suspension type by John Augustus Roebling (*q.v.*), was completed in 1855. The falls have been the scene of many daring exploits since Sam Patch leaped 100 ft. into the gorge from a specially built platform in 1829. Several persons have safely plunged over the Canadian falls or ridden through the whirlpool (about 1½ mi. below the falls) in barrels. In 1859 and again in 1860 (on the occasion of the visit of Edaard VII, then Prince of Wales) Blondin, a French acrobat, performed a series of daring feats on a tightrope stretched across the gorge. Probably the most amazing occurrence at the falls, however, happened in 1960 when seven-year-old Rodger Woodward was accidentally swept over the falls and survived with little injury.

Niagara Falls, with a population (1960) of 102,394, is part of the Buffalo standard metropolitan statistical area. For comparative population figures see table in NEW YORK: Population.

See also NIAGARA RIVER AND FALLS. (R. T. R.)

NIAGARA RIVER AND FALLS, flowing in a northerly direction from Lake Erie to Lake Ontario, a distance of about 28 mi., constitute part of the boundary between the United States and Canada, separating the state of New York from the province of Ontario. It is the drainage outlet of the four upper Great Lakes, whose aggregate basin area is about 260,000 sq.mi. The mean discharge of the river at its head is about 196,200 cu.ft. per second, with a range from a low monthly mean in winter of about 119,000 cu ft. to a high monthly mean in summer of about 245,000 cu.ft. per second.

For a distance of about 5 mi. from its head the river flows through a single channel; then it is divided into two channels by Strawberry and Grand islands, the eastern or U.S. channel being about 15 mi. long and the western or Canadian channel being about 12 mi. long. At the foot of Grand Island these two channels merge into one about 3 mi. long, extending to Niagara falls (see below). Downstream from the falls the gorge section of the river is 7 mi. long; the river then flows across a lake plain for a distance of 7 mi., to Lake Ontario.

The river is navigable from its source in Lake Erie to the upper rapids, a distance of 20 mi. in which the river descends about 10 ft. From the head of the rapids to the brink of the falls the river descends 50 ft.; then it drops 167 ft. in the falls and descends 98 ft. farther in the lower rapids of the Niagara gorge. In the last 7 mi. the river descends less than a foot, and this section (from Lewiston, N.Y., to the mouth) is navigable. The total descent of the river, from Lake Erie to Lake Ontario, is 326 ft.

Niagara Falls.—The falls of Kiagara are justly celebrated for their grandeur and beauty, and are viewed every year by over 2,000,000 visitors. The falls are in two principal parts, separated by Goat Island. The greater division, adjoining the left (Canadian) bank, is called the Horseshoe fall; its height is 1j8 ft., and the length of its curving crest line is about 2,600 ft. The American fall, adjoining the right bank, is 167 ft. high and 1,000 ft. broad.

NIAGARA RIVER AND THE FALLS

The American fall is at left, Horseshoe fall (Canada) in background. In the foreground is International bridge

NIAGARA RIVER AND FALLS

The American fall, 167 ft. high, 1,000 ft. wide. Divided portion at right is the Bridal Veil

Horseshoe fall, 158 ft. high, 2,600 ft. wide

THE AMERICAN AND CANADIAN FALLS

The water is free from sediment, and its clearness contributes to the beauty of the cataract. In recognition of the importance of the waterfall as a great natural spectacle, the province of Ontario and the state of New York retained or acquired title to the adjacent lands and converted them into public parks.

Excellent views of the falls are obtained from Queen Victoria park on the Canadian side; from Prospect point on the U.S. side at the edge of American fall; and from Rainbow bridge, which spans the gorge about 1,000 ft. downstream from Prospect point. Visitors may cross from the U.S. shore to Goat Island by footbridge, and may take an elevator to the foot of the falls and visit the Cave of the Winds behind the curtain of falling water. The Horseshoe fall has been receding, or migrating upstream, at the average rate of nearly five feet per year in historic time.

Geologic History. — The shaping of the gorge and the maintenance of the falls as a cataract depend upon peculiar geologic conditions. The rock strata in the Kiagara gorge are nearly horizontal, dipping southward only about 20 ft. to the mile. The uppermost layer of hard Niagaran dolomite is underlain by soft layers which are easily worn away, and this provides the conditions for keeping the water constantly falling vertically from an overhanging ledge during a long period of recession.

The river came into existence late in the Glacial or Pleistocene epoch (*q.v.*) when the margin of a great continental ice sheet melted back and exposed the escarpment of Niagaran dolomite rock, allowing the discharge from the Lake Erie basin to pour over it. Recession of the falls created the Niagara gorge, which extends about 7 mi. upstream from Lewiston to the present falls. The age of the gorge, when calculated by dividing its length by the average rate of recession of the falls in recent time, is about 7,000 years. Other considerations led some geologists to estimate an age as great as 25,000 years. Determinations of the age of the last glacial ice advance in the area suggest, hen-ever. that the Kiagara river is about 10.000 years old. Continued recession of the falls toward Lake Erie will ultimately cause the drainage of that lake but such an event is not expected to occur within the next 25,000 years.

The Niagara gorge runs 2¼ mi. N.N.E. from the Horseshoe fall to the railway bridges, and this stretch is known as the Maid-of-the-Mist pool. It has a descent of only five feet, and is navigable by excursion boats. Downstream, the river flows one mile northwest through the narrow, Whirlpool-rapids section to the Whirlpool; this section differs from the rest of the gorge because there the river intersects an old channel which was formed before the last glacial ice advance and was later filled with glacial drift. At the Whirlpool the gorge makes a go° bend to the northeast and extends two miles, then runs one-and-one-half miles north to the foot of the Niagara escarpment at Lewiston, N.Y.

Navigation. — Water-borne traffic from Lake Erie passes through the upper single channel and the U.S. channel to Tonawanda, N.Y., to enter the New York State Barge canal. That canal, with a 12-ft. minimum depth, connects with the Hudson river and has branches which connect with Lake Champlain and with Lake Ontario.

The principal shipping between Lakes Erie and Ontario, however, passes through the Welland ship canal which lies a few miles west of the Kiagara river. It extends from Port Colborne, Ont., on Lake Erie, about 27 mi. north to Port Weller, Ont., on Lake Ontario. The minimum depth in the canal is 27 ft., and the ships which pass through it include vessels engaged in trade between the upper Great Lakes and Europe. (*See* WELLAND SHIP CANAL.)

Hydroelectric Power. — Canada and the U.S. agreed, in a treaty signed in 1950, to reserve sufficient amounts of water for flow over Niagara falls to preserve their scenic value. The agreement provided for a minimum daytime flow during the tourist season of 100,000 cu.ft. per second, and a minimum flow of 50,000 cu.ft. per second at all other times. All water in excess of these amounts, estimated to average about 130,000 cu.ft. per second, was made available for diversion for power generation, to be divided equally between the U.S. and Canada. The total hydroelectric capacity of the river thus was fixed at about 3,600,000 kw. This was developed by power plant installations, completed or under construction by 1960. The power plants receive water diverted from the river above the falls and carried to them by open channels or tunnels, and they discharge the water into the gorge at various places below the falls. Much of the energy was used in nearby electrochemical industries for the manufacture of aluminum, ferrosilicon, carborundum, artificial graphite, liquid chlorine, calcium carbide, cyanamide and other products. The remainder was transmitted to various cities for miscellaneous uses. The maximum distance to which this power was transmitted was somewhat in excess of 200 mi.

The principal cities located along the river are Buffalo, S.Y., at the eastern end of Lake Erie; Tonawanda, N.Y.. the western terminus of the New York State Barge canal; Niagara Falls, N.Y., and Kiagara Falls, Ont., situated beside the falls and gorge; Leniston, N.Y., at the mouth of the gorge; and Niagara-on-the-Lake, Ont., at the mouth of the river.

Fort Niagara, a 288-ac. U.S. military reservation on the east hank at the mouth of the river, is on the site of a blockhouse built by the French in 1679 and it includes Old Fort Niagara, which was built by the French in 1725–27 and is still standing.

(J. L. Hh.)

NIAM-NIAM: *see* Azande.

NIAS, largest of the chain of islands off the western coast of Sumatra, Indonesia. It is 80 mi, long and nearly 30 mi. nide; hilly, with coasts that are rocky or sandy, landing on its shores is often dangerous; it is partly volcanic and earthquakes occur. There are three small rivers. Pop. (1956 est.) 265,840. Area is 1,569 sq.mi. The chief town and port is Gunungsitoli on the east coast.

The islets Nako, Bunga, etc.. near the northern and western coasts are inhabited by a race which appears to be Indonesian in character and to have some affinity with the Bataks of Sumatra. Marriage is exogamic and wives are bought. At death, wife and property pass to a man's brother. Land belongs to the settler and is inherited in the direct line. Slave trade was suppressed by the Dutch, who began trading there in 1669. Simple tattooing, teeth-filing and circumcision are practised.

Houses are built on piles and sometimes are fortified with double walls; they have windows, a common room in the centre, and separate rooms for the various families which occupy one house; and the entrance is through the floor, from underneath, in the centre of the house. Houses of chiefs are costly and have carved statues or seats of wood or stone outside.

The Kiasese are pagans: human sacrifice on the death of a chief and also head-hunting were prohibited by the Dutch. Statues of the household gods are hung up in the houses, the phallic symbol is known and in southern Nias menhirs and large dissoliths exist. The funeral rites of an important person are celebrated by the sacrifice of pigs.

There are good craftsmen in gold, silver and wood. The coconut is cultivated and the oil traded with Malay and Achinese settlers or taken to the Sumatran coast. Pigs are kept and form an important article of trade. Coal of poor quality, iron and copper have been found; gold is said to exist. (E. E. L.)

NIBELUNGENLIED, the generally accepted name of a German epic poem written about A.D. 1200, although *Der Nibelunge Nôt* would appear to have been an earlier title. Neither is entirely satisfactory as an indication of the content of the poem; that this was felt at an early date is shown by the superscription of one of the manuscripts, from the early 14th century: "the book of Kriemhild."

The story as we have it has a long history behind it, and as a result contains a number of disparate elements which have not always been completely reconciled; the following summary of the contents, while aiming at presenting the story as a consecutive and coherent whole, does not seek to suppress inconsistencies where they are prominent. The word *Nibelung* itself presents difficulties. In the first part of the poem it appears as the name of Siegfried's lands and people and his treasure, but throughout the second it is used as an alternate name for the Burgundians. A possible explanation is that the Nibelung treasure is, after

Siegfried's death, acquired by the Burgundians.

The Story of the Poem: Siegfried and **Kriemhild.**—The poem begins with two cantos (Aventiuren) which introduce respectively Kriemhild, a Burgundian princess of Worms, and Siegfried (*q.v.*), a prince from the Lower Rhine. The action begins in Canto 3, which describes Siegfried's determination to woo Kriemhild, in spite of his parents' warning of the dangerous nature of the suit; his departure; and his arrival at Worms. There Hagen, the henchman of King Gunther (Kriemhild's brother), identifies Siegfried, even though he has never seen him, and gives a brief account of his former deeds—the killing of a dragon, from which resulted Siegfried's horny skin, and the acquisition from two quarreling brothers of their treasure. Siegfried does not mention his suit, but challenges Gunther to fight to defend his lands; a reconciliation is achieved (but not before some hard words pass, with Siegfried twice addressing Hagen in challenging tones), and Siegfried stays at the court. Messengers arrive from the Danes and Saxons, declaring war, but Siegfried offers to lead the Burgundians and distinguishes himself in the battle. Kriemhild is delighted, and during the festivities on the warriors' return the two meet for the first time. Their mutual affection has the opportunity to develop during Siegfried's subsequent residence at the court, where he occupies a privileged position.

At this point an entirely new element is introduced, which is to dominate the action for a long time: the story of the wooing of Brunhild (*q.v.*). News from overseas reaches the court of Worms which tells of a queen of outstanding strength and beauty who may only be won by a man capable of matching her in athletic prowess. Gunther expresses his intention of wooing her, but he is warned by Siegfried of the danger to which he would expose himself. Hagen suggests that Gunther allow Siegfried to help him; Gunther accepts the suggestion and Siegfried agrees, on condition that Gunther promise him the hand of his sister Kriemhild if he succeeds. Throughout the expedition Siegfried takes charge, even more decisively than he did in the Danish-Saxon war, and gives instructions on the conduct of the expedition down to the smallest details; his ability to pilot the expedition to Brunhild's abode on Isenstein is a variant of the well-known motif in medieval German literature of the much-traveled warrior who is able to give advice and help to the master with whom he has taken service. It is in the same tradition when one of Brunhild's followers singles out among the newcomers one who "looks like Siegfried." This is no surprise to Brunhild because of the very nature of her vow, which was to marry only the best and bravest. Siegfried, however, presents himself not as the wooer, but as Gunther's vassal; and in the ensuing contests Gunther goes through the motions of deeds in fact performed by Siegfried in his cloak of invisibility. When Brunhild is defeated she accepts Gunther as her husband. After an interlude in which Siegfried goes to his own "Nibelung" lands—where his treasure lies—to fetch some followers, he is sent on ahead to Worms to announce Gunther's victory and his impending arrival with his bride. Siegfried and Kriemhild also are married, as promised; but Brunhild remains ill at ease, ostensibly because she is hurt at seeing her sister-in-law married to one who is, as she has been told, a vassal of Gunther's. After a period during which Siegfried returns with Kriemhild to his own domains, they are invited, at Brunhild's request, to Worms. During this visit the two queens quarrel over precedence. In the course of the quarrel Kriemhild reveals to Brunhild the treachery which had been practised on her when Siegfried entered the bridal chamber invisibly to overcome her resistance to Gunther.

It is at this point that the figure of Hagen becomes prominent. He seizes the opportunity of coming to the defense of the injured Brunhild and takes the initiative in plotting vengeance. The plan is to entice Siegfried away from the court so that he can be killed, but it is first necessary to ascertain where and how he is vulnerable. Hagen succeeds in ingratiating himself into Kriemhild's confidence, and learns the secret of Siegfried's one vulnerable spot; hc also strikes the fatal blow.

It is noteworthy that during and after these events Brunhild slips almost unnoticed out of the story, and the death of Siegfried is seen not so much as vengeance by her, but rather as a blow struck by Hagen, who was becoming suspicious of Siegfried's growing power; all emphasis is on Kriemhild's grief and her hatred of Hagen. Siegfried's funeral is conducted with great ceremony. Kriemhild decides to remain at Worms with her mother and younger brothers, but for long remains estranged from Gunther and Hagen. Hagen persuades Gunther to attempt a reconciliation, so that they may have the benefit of Siegfried's treasure; and Kriemhild agrees to make peace with Gunther. The treasure is then brought to Worms but Hagen, seeing that Kriemhild is distributing it, and fearing the influence she may gain, seizes it and sinks it in the Rhine.

The Fall of the **Burgundians.**—The preceding events close what is generally known as the first half of the poem; the second is simpler in structure. Etzel, king of the Huns, who is widowed, sends messengers to Worms to ask the hand of Kriemhild. Gunther is willing, in spite of Hagen's warnings, and Kriemhild agrees when she sees the possibilities for vengeance this match could offer her. After many years she persuades Etzel to invite her brothers to his court, and is particularly insistent that Hagen shall come. Hagen suspects Kriemhild's motives and warns his masters against accepting, but he only succeeds in persuading them to go armed; and it is not until they have crossed the Danube that they are convinced. On their arrival Kriemhild's plan is quickly revealed and, although there is much large-scale fighting, the poet makes clear the essentially personal nature of the conflict; the climax is reached when Hagen—as the last survivor of the Burgundians and, though bound, still defiant—faces Kriemhild, who kills him when he still refuses to reveal where Siegfried's treasure is hidden. She in turn is executed by Hildebrand, who is at Etzel's court with his master Dietrich von Bern (*q.v.*). "Daz ist der Nibelunge nôt" ("that is the story of the destruction of the Nibelungs [or Burgundians]") are the final words; and they are an apt description of the second half of the poem.

The Elements in the Story.—In this story some elements of great antiquity are discernible. In the first part one recognizes the story of Brunhild, which retains its separate existence in Old Norse literature; there are also the brief allusions in Canto 3 to the two ancient stories of the heroic deeds of Siegfried; and finally the whole of the second part is the story, albeit with a different motivation, of the Fall of the Burgundians which exists in an older form in the Eddaic poem Atlakvida ("Lay of Atli"). It was the great merit of the scholar Andreas Heusler to isolate the stories of Brunhild and the Fall of the Burgundians as the two mainstays of the action. It is, however, no mere formal joining together of two separate stories, which is what they originally were; the poet sought by various devices to combine the different elements into a meaningful whole in which the component elements would be integrated. One of the 'major alterations is in making Kriemhild, and not Etzel, as was originally the case, send the treacherous invitation; but this must have been done much earlier, for Saxo Grammaticus refers to the recital, in 1131, of the poem of the "well-known treachery of Kriemhild against her brothers." Once this step had been taken it would not be difficult to envisage a combination of the Burgundian and the Brunhild stories into one; for, although the emphasis in the latter was on Brunhild, Kriemhild suffers a blow through the death of her husband which she may well be expected to wish to avenge. Other inconsistencies and contradictions, which could not be revealed in the summary above, emphasize the long history of the subject matter. Karl Lachmann's view that it is a collection of 20 originally separate short poems was held, and debated, for many years; it was, however, superseded after the appearance of Heusler's principal work, in which he demonstrated the central position of two themes, and explained the difference in length between the old short lays and the long epic in terms of a different style of narration.

Heusler's views on the role of these two stories in the history and structure of the poem found such general acceptance that the importance of the other elements, with which he also dealt, tended to be overlooked. After about 1940, however, attention was concentrated on them, perhaps excessively. An example of these elements is the scene in which Siegfried meets his death. In the Norse versions, particularly in the older ones, the death of Siegfried is dismissed in a few words as a fact which has to be recorded, and this is perfectly consonant with the theme of the original story, in which Brunhild was the principal character and Siegfried the means by which her problem arose. The role Siegfried plays in the corresponding part of the *Nibelungenlied* is still comparable. Much is made, it is true, of his conduct of the expedition and of the part he plays in the actual contests, but from the time of Brunhild's arrival at Worms he becomes a passive participant, until the plot for his death is hatched. From this moment all attention is concentrated on him and Kriemhild. After Hagen has elicited his vital secret from Kriemhild there follows a carefully constructed scene in which she confesses her premonitions and tries to dissuade Siegfried from participating in the hunt which has been arranged: she claims to have had dreams which point to her husband's sudden death. He, however, with unquestioning confidence in his own powers and—note the dramatic irony—equally confident of the friendship of all, brushes aside her objections and goes out, utterly happy, to what is to be his last hunt. This picture of a young hero, in the fullness of his powers and at the height of his happiness, is further developed in the hunt itself, culminating in a boisterous practical joke which he plays on his fellows. In the final act, the race to the spring, he again demonstrates his physical superiority and, in his refusal to drink until Gunther has drunk, his meticulous regard for courtly precedence. By this very delay he gives Hagen the opportunity to strike the fatal blow while he is bending over the water. There is no source in Germanic antiquity for the details which make this scene so effective, and the poet would appear to have had his inspiration from a contemporary Romance epic *Daurel e Beton.*

Similarly there is a scene in the second half which also serves to heighten the tragedy by relieving the tension. The purpose of the journey of Gunther and his followers is known to the audience from the beginning; and although the participants, apart from Hagen, at first suspect nothing, the tension rises as they proceed. It is, however, relieved by a few days' rest at Bechelaren, where the party is entertained by the margrave Rudeger and his wife and daughter. The idyllic nature of the interlude is stressed by the betrothal of the youngest of the Burgundian princes Giselher and the margrave's daughter; it is agreed that the marriage shall take place on their return. The effectiveness of the scene has long been universally recognized, and in 1945 Friedrich Panzer suggested a source, not a literary one, but an event in 12th-century history. In 1189, when passing through Hungary on his crusade, the emperor Frederick I was festively entertained by King Bela of that country and his wife, and the marriage of Frederick's second son with King Bela's daughter was arranged; the marriage was to take place on the return of the emperor and his son from the crusade in which, in fact, both met death. Panzer has drawn attention to possible contemporary literary and topical historical sources for other incidents.

Both approaches have proved fruitful in determining the author's theme, or whether in fact he had a single theme, and in estimating his poetic achievement. It cannot be disputed that the second part of the poem deals with the disaster that overcame the Burgundians, or Nibelungs (and to that extent the title *Der Nibelunge Nôt* is apt), nor that this disaster was the deliberate purpose of Kriemhild. It is preceded by a story in which Siegfried plays a prominent part, and to the extent that Siegfried is Kriemhild's husband and attention is concentrated on his death, the events of this first part may be considered integrally connected with those of the second. There are other indications that it was the poet's intention to present the story in this way: Kriemhild is the first person to be introduced and the poem ends when she is killed. She is introduced, too, in a way which leads one to believe that she is to play an important role. The poet's treatment of Brunhild is consonant with such a purpose; her story once existed in its own right and ended when her honour was satisfied, but in the *Nibelungenlied* the death of Siegfried is presented in the very different light discussed above. Further, there is the attention paid to Hagen. Early in the story his words to and about Siegfried indicate anger and resentment; he takes the initiative in the plot against him and strikes the blow, earning Kriemhild's uncomprising hatred by having tricked her into revealing his one vulnerable spot. Particularly striking is the scene in the second part where, on their arrival at the court of the Huns, Hagen remains defiantly seated before Kriemhild, with Siegfried's sword ostentatiously laid across his knees. To what extent this concentration on Kriemhild and on the enmity between her and Hagen was already present in the sources must remain a matter of conjecture, but the consistency with which it is carried through would seem to suggest that it was the poet's intention to stress the theme.

Dating and Manuscripts.—The poem was written in the classical period of medieval German literature, but it holds a special position in it. A characteristic feature of the literature of that period is the emphasis on the current "courtly" virtues of moderation and refinement of taste and behaviour. The *Nibelungenlied,* with the violence of its emotions and its uncompromising emphasis on vengeance, bears unmistakably the mark of a different origin: the heroic literature of the Teutonic peoples at the time of the migrations. The basic subject matter also goes back to that period, for there can be no doubt that the story of the destruction of the Burgundians was originally inspired by the overthrow of the Burgundian kingdom at Worms by the Huns in A.D. 437, and the story of Brunhild and Siegfried may have been inspired by events in the history of the Merovingian house of the Franks about A.D. 600. Much of the heroic quality of the original stories has remained in the poem, particularly in the poet's conception of Hagen in the second half. Nevertheless, to judge by the manuscript transmission, which can be'traced through three whole centuries, the poem became and remained popular in spite of its "out-of-period" characteristics. The most important of these manuscripts are the Hohenems-Munich *(A)*, the St. Gallen (B) and the Hohenems-Lassberg (C). Lachmann regarded ***A*** as the best and based his edition on it; Holtzmann and Zarncke later made the same claim for C and used that; but the consensus of opinion now favours *B*, on which the standard edition of Karl Bartsch is based. C is the earliest and was written in the early 13th century. Some of the later manuscripts make quite substantial alterations to the subject matter, but even *A*, *B* and *C* show differences which go beyond mere verbal variation, including a difference of over 100 in the number of strophes.

BIBLIOGRAPHY.—The literature on the poem is enormous, and forms the subject of special bibliographies: *see* T. Abeling, *Das Nibelungenlied und seine Literatur* (1907; with a supplement, 1909); and M. Thorp, *The Study of the Nibelungenlied* (1940). The standard edition is *Der Nibelunge Nôt, mit den Abweichungen von der Nibelunge Liet, den Lesarten sämmtlicher Handschrijten und einem Worterbuch,* edited by K. Bartsch (1870 *et seq.)*; on this is based the smaller edition, with commentary, *Das Nibelungenlied,* re-edited by *H.* de Boor (1956). Two excellent monographs covering the whole problem are: A. Heusler, *Nibelungensage und Nibelungenlied,* 3rd ed. (1929; reprinted as 5th ed., 1955); and F. Panzer, *Das Nibelungenlied* (1956). Very helpful for detailed study of the elements of the story (*e.g.,* the figures of Siegfried and Brunhild) is the section, "Nibelungensagen," in H. Schneider, *Gerrnanische Heldensage,* vol. i (1928). An English trans. of the poem by M. Armour is in Everyman's Library (1908). (K. C. K.)

NICAEA (NICE; mod. ISNIK), an ancient town of Asia Minor in Bithynia, on the Lake Ascania. Antigonus built the city (316 B.C.?) on an old deserted site, and soon afterward Lysimachus changed its name from Antigonia to Nicaea, calling it after his wife. Under the Roman empire Nicaea and Nicomedia disputed the title of metropolis of Bithynia. Strabo describes the ancient Nicaea as built regularly, in the form of a square, with a gate in the middle of each side. From a monument in the centre of the city all the four gates were visible at the extremities of great cross streets.

After Constantinople became the capital of the empire Nicaea grew in importance, and after the conquest of Constantinople by the crusaders became the temporary seat of the Byzantine emperor; the double line of walls with the Roman gates is still well preserved. The possession of the city was long disputed between the Greeks and the Turks.

Nicaea remained an important city for some time after its final incorporation in the Ottoman empire; but became subsequently an insignificant village

NICAEA, COUNCIL OF. The Council of Nicaea (A.D. 325) is an event of the highest importance in the history of Christianity. Its convocation by Constantine and its course illustrate the radical revolution which the position of this religion, within the confines of the Roman empire, had undergone in consequence of the Edict of Milan. From his accession Constantine had shown himself the friend of the Christians; and, when his victory over Licinius (A.D. 323) gave him undisputed possession of the crown, he adhered to this religious policy, distinguishing and fortifying the Christian cause by gratuities and grants of privilege. This propitiatory attitude originated in the fact that he recognized Christianity — which had successfully braved so many persecutions—as the most vital and vigorous of religions, and as the power of the future. Consequently he directed his energies toward the establishment of a positive relationship between it and the Roman state. But the church could only maintain its great value for the politician by remaining the same compact organism which it had proved itself to be under the stormy reign of Diocletian. Scarcely, however, did it find itself in the enjoyment of peaceful relations with the state, when violent feuds broke out in its midst, whose extent, and the virulence with which they were waged, threatened to dismember the whole religious body. Donatism in the west was followed by the Arian struggle in the east. The former movement had been successfully arrested, though it survived in North Africa till the 5th century. The conflict kindled by the Alexandrian presbyter Arius with regard to the relation of Christ to God assumed a more formidable character (*see* ARIUS). Constantine therefore had recourse to an institution previously evolved by the Christian Church—the convocation of a synod to pronounce on burning questions — enlarging it, however, to correspond with the altered circumstances. He convened a council, designed to represent the whole church of the empire, at Nicaea in Bithynia, a town situated no great way from the imperial summer residence of Nicomedia and within easy reach by sea of the oriental bishops. In consequence of the vast distances, the west was not largely represented, but the able theologian Hosius bishop of Cordova, was present. The three most important bishoprics of the east were represented (Alexandria. Antioch and Jerusalem); a prominent part nas also taken by Eusebius, bishop of Nicomedia, and his namesake of Caesarea (the historian), along with a very large number of others from the east. Among the attendant clergy, the still youthful deacon Athanasius, destined to succeed Alexander in the see of Alexandria, was prominent as the most ponerful antagonist of Arianism (*see* ATHANASIUS, SAINT) The synod sat from May 20 to July 2j.

The deliberations on the Arian question passed through several distinct stages before the final condemnation of Arius and his doctrines was reached. A clearly defined standpoint with regard to this problem — the relationship of Christ to God—was held only by the comparatively small group of Arians and a not much larger group who adhered with unshaken conviction to the Alexandrian view. The bulk of the members occupied a position between these two extremes. They rejected the formulas of Arius, and declined to accept those of his opponent; that is to say, they were merely competent to establish negations, but lacked the capacity, as yet, to give their attitude of compromise a positive expression That the majority of the council should have adopted this neutral tendency is easily intelligible when we consider the state of theology at that period. True, at Nicaea this majority eventually acquiesced in the ruling of the Alexandrians; yet this result was due, not to internal conviction, but partly to indifference, partly to the pressure of the imperial will—a fact which is mainly demonstrated by the subsequent history of the Arian conflicts. For if the Nicaean synod had arrived at its final decision by the conscientious agreement of all non-Arians, then the confession of faith there formulated might indeed have evoked the continued antagonism of the Arians, but must necessarily have been championed by all else. This, however, was not the case; in fact, the creed was assailed by those very bodies which had composed the *laissez-faire* centre at Nicaea; and we are compelled to the conclusion that, in this point, the voting was no criterion of the inward convictions of the council.

In the synod, an Arian confession of faith was first brought forward and read; but it aroused such a storm of indignation that obviously, in the interests of a restoration of ecclesiastical peace, there could be no question of its acceptance. On this, Eusebius of Caesarea submitted the baptismal creed of his community. Since the creed dated from a period anterior to the outbreak of the Arian struggle, its reception would have been equivalent to a declaration on the part of the council that it declined to define its position with reference to the controversy of the hour. That the greater number of delegates were not disinclined to adopt this subterfuge, and to shelve the actual solution of the whole problem by recognition of this or some similar neutral formula, is extremely probable. But the emperor saw that, if the difficulties were eluded in any such way, it was inevitable from the very nature of the case, that they should rise again in an accentuated form, and that consequently no pacification could be expected from this policy.

Accordingly Constantine proposed that the Caesarean creed should be modified by the insertion of the Alexandrian passwords (including the decisive term ὁμοούσιος, "identical in nature"), as if for the purpose of more accurate definition, and by the deletion of certain portions. That he appreciated the import of these alterations, or realized that this revision was virtually the proclamation of a new doctrine. is scarcely probable. The creed thus evolved by an artificial unity was no ratification of peace in fact, it paved the way for a struggle which convulsed the whole empire. For it was the proclamation of the Kicene Creed that first opened the eyes of many bishops to the significance of the problem there treated; and its explanation led the Church to force herself, by an arduous path of theological work, into compliance with those principles. enunciated at Nicaea, to which, in the year 325, she had pledged herself without genuine assent.

BIBLIOGRAPHY.—*See* the Histories of Dogma by Harnack, Loofs and Seeberg; articles in Hastings, *Encyclopaedia of Religion and Ethics* and Herzog-Hauck, *Realencyklopädie*, 3rd ed.; Bethune-Baker, *Introduction to the early History of Christian Doctrine;* Gore, *Dissertations on Subjects connected with the Incarnation;* and (from another point of view) Mellone, "Athanasius the Modernist" in *The Price of Progress* (1924). In addition to the Arian problem, the council dealt with the question of the "lapsed" in the recent persecution, the question of "heretical baptism" and other matters (*see* Hefele, *History of Councils,* vol. i.).

NICANDER (2nd cent. B.C.), Greek poet, physician and grammarian, was born at Claros, near Colophon, where his family held the hereditary priesthood of Apollo. He flourished under Attalus III of Pergamum. He wrote a number of works both in prose and verse, of which two are preserved. The longest, *Theriaca,* is a hexameter poem (958 lines) on the nature of venomous animals and the wounds which they inflict. The other, *Alexipharmaca,* consists of 630 hexameters treating of poisons and their antidotes. In his facts Nicander followed the physician Apollodorus. Among his lost works may be mentioned: *Aetolica,* a prose history of Aetolia; *Heteroeumena,* a mythological epic, used by Ovid in the *Metamorphoses* and epitomized by Antoninus Liberalis; *Georgica* and *Melissourgica,* of which considerable fragments are preserved, said to have been imitated by Virgil (Quintilian x. 1. 56).

The works of Nicander were praised by Cicero (*De oratore,* i, 16), imitated by Ovid, and frequently quoted by Pliny and other writers His reputation does not seem justified; his works, as Plutarch says (*De audiendis poetis,* 16), have nothing poetical about them except the metre, and the style is bombastic and obscure; but they contain some interesting information as to ancient belief on the subjects treated.

Editions by J. G. Schneider (1792, 1816); O. Schneider (1856) (with the Scholia); H Klauser, "De Dicendi Genere · · · Nicandri" (*Dissertationes Philologicae Vindobonenses,* vi 1898). The Scholia (from the Gottingen ms) have been edited by G Wentzel in *Abhandlungen der k. Gesellschaft der Wiss. zu Göttingen,* xxxviii. (1892). *See* also W. Vollgraff, *Nikander und Ovid* (Groningen, 1909 *seq.*).

NICARAGUA (REPÚBLICA DE NICARAGUA), the largest country of Central America. lying between Honduras and Costa Rica, which form its northern and southern boundaries respectively, and reaching from the Caribbean sea on the east to the Pacific ocean on the west. Its area, which is still undetermined because of incomplete surveys, is generally put at 57,143 sq.mi. The coast line extends about 300 mi. on the Caribbean, and 200 mi. on the Pacific.

The Honduran boundary starts at Cabo Gracias a Dios, follows the Coco river inland and then at about 86° W. takes an imaginary line to the upper waters of the Negro river, which it follows to the Gulf of Fonseca.

The Costa Rican boundary is, under treaties of 1858, confirmed in 1888 and settled in 1896, a line 2 mi. S. of the San Juan river and Lake Nicaragua.

This article is divided into the following sections:

I. Physical Geography
II. Geographical Regions
III. History
IV. Population
V. Administration and Social Conditions
VI. The Economy

There are also separate articles on the departments and the more important cities.

I. PHYSICAL GEOGRAPHY

Geology. — Between Lake Nicaragua and the Pacific are Miocene lavas, calcareous shales and sandstones. In the Nicaraguan lowland, from the Gulf of Fonseca southeast to the mouth of the San Juan river, basic rocks are Miocene marine sediments, covered at both ends with Pleistocene and recent alluvium, and on the western margin by lavas and ashes of 30 Pleistocene volcanoes extending northwest to southeast from Cosiguina to Madera in Lake Nicaragua; highest volcano is Viejo (5,545 ft.). The central highlands are made up of Tertiary and of igneous and metamorphic rocks, overlain with volcanic ash in the northwest, Pre-Cambrian and Cretaceous intrusive granites in the north and northeast. The eastern lowlands consist of Pleistocene sediments, recent alluvium and areas of igneous rocks, sandstones and shales.

Relief and Drainage. — Level plains in western Nicaragua are fairly well drained by many short rivers flowing into the Pacific and into Lakes Managua and Nicaragua. The central highlands, 7,000 ft. high in the west, are rugged; eastward are lower undulating, plateaulike areas. From the divide, long rivers flow eastward: Coco (*q.v.*, or Segovia or Wanks), navigable for 200 mi.; Grande, navigable in its lower course; Escondido, navigable 60 mi. to Rama City; and San Juan, navigable 100 mi. to Lake Nicaragua. The flat eastern plains have large swamps and coastal lagoons.

Climate. — The mean annual temperature in the eastern lowlands is 80° F., with little variation. The western lowlands have mean monthly temperatures of 80° to 86° F. Above 3,000 ft. they average 10° F. lower. East of the central highlands divide, where there is no distinct dry season, annual precipitation decreases from 255 in. near San Juan del Norte (Greytown) to 100 in. on the Segovia river. On the western flanks of the central highlands annual rainfall decreases sharply, from 80 in. to 53 in. in the lowlands; slopes of volcanic mountains receive 15 to 25 in. more; the period December through April is very dry.

Vegetation. — In the eastern lowlands and eastern parts of the central highlands, which are rainy all year, natural vegetation consists of slash pine (*Pinus caribaea*), covering an expanse 40 to 100 mi. wide from Grande river to the northern boundary, and elsewhere, broad-leaved evergreen forests of many species. These forests contain 80% of Nicaragua's timber. The western central highlands and middle slopes of volcanic mountains have deciduous hardwoods (oak and others) and subtropical grasses. The western lowlands comprise savannas and, along streams, deciduous forests.

Animal Life. — Inhabiting rainy, hot areas are many species of reptiles: crocodiles, lizards (iguanas and others), snakes and turtles. In forested areas deer are common. Wild life also includes the puma, jaguar, monkey and peccary. Many species of water and land birds (some seasonal migrants), fresh-water and salt-water fishes (including mollusks), rodents and insects are abundant.

II. GEOGRAPHICAL REGIONS

Nicaragua may be divided into four clearly defined regions: (1) volcanic mountains and hills near the Pacific; (2) around and east of these mountains, the low plains and lakes of the great depressions, stretching from the Gulf of Fonseca to the mouth of the San Juan river; (3) the broad area of rough to rugged central highlands, extending from Honduras to ,near the San Juan; and (4) east of these, rolling plateaus and Caribbean lowlands.

The first two regions are characterized by much level and gently sloping land, rich volcanic and alluvial soils, annual precipitation of 53 to 80 in., a very dry season of from four to six months and high temperatures. Together they comprise 62% of the country's population, most of its large cities. modern transportation facilities and industrial establishments. They produce about 75% of the nation's agricultural products and minerals, including clays and cement making materials. Fertile valleys in the western part of the central highlands, inhabited by about 30% of the country's population, produce about 25% of the nation's cqffee, tobacco, corn, beans, cotton and animal products; and highland mines supply nearly 25% of the mineral production. The rolling plateaus and Caribbean lowlands, poorly drained near the coast, comprise nearly half the area of Nicaragua. Hot and rainy all the year, they are largely uninhabited except along the coast and rivers, but their tropical forests supply most of the forest products exported and consumed domestically. In these lowlands three commercial banana districts, important until 1936, were largely abandoned as a result of Panama disease. (C. F. J.)

III. HISTORY

By the 15th century there were several Indian tribes living along the Pacific coast, whose cultural and linguistic ties were with the northwest, and other groups at a lower cultural level in the central and eastern regions, whose associations were with the southeast. The country's name is said to have been derived from that of Nicarao, an Indian chief whose people lived on the shores of Lake Nicaragua. Christopher Columbus, on his fourth and last voyage to the New World and searching for a strait, landed on the east coast near modern Bluefields Sept. 16, 1502. Twenty years later Gil Gonzalez de Ávila, with about 100 Spaniards and four horses, marched overland from Panamá along the Pacific coast—reaching beyond Lake Nicaragua—but retired when he encountered hostility. Two more years passed before the conquistadores returned.

Colonial Period. — Nicaragua was the first of the Central American provinces to become firmly Spanish. Granada and León were founded in 1524 by Francisco Hernandez de Córdoba, acting for Pedro Arias de Ávila (Pedrarias Davila), governor of Panamb. When Pedrarias came to León in 1526 he executed Hernandez on suspicion of intrigue with Hernbn Cortés, then in Honduras. Pedrarias as governor of Nicaragua (1527–1531) developed an export trade in Indian slaves (who were used in Panama), had the San Juan river explored and tried unsuccessfully to establish his rule in Honduras and El Salvador. León was designated the seat of Central America's first bishopric in 1531, and the port of El Realejo developed in 1533. Rodrigo de Contreras, son-in-lam of Pedrarias, was the second governor (1535–44); during his rule the province was placed first under the jurisdiction of a new audiencia at Panamb (1538), then transferred to another at Gracias a Dios, Honduras (1544). Dissatisfaction with the Spanish code of New Laws of 1542 (which ended the Indian slave trade) and the loss of the governorship in 1544 led to a rebellion by the two sons of Contreras in 1550. Nicaraguan Bishop Antonio de Valdivieso was murdered and León, Granada and Panamá city seized before the uprising was halted.

The province of León along the Pacific developed quietly as an agricultural colony for the next 250 years, with a variety of products from farm and forest. Trade was carried on at El Realejo, and from Granada via Lake Nicaragua and the San Juan river. Ships were also built at El Realejo. Except for two seasons of buccaneer activity (in the 1660s and 1680s), life for Spaniards in the province was relatively easy, there being a plentiful supply of

Indian labour. (Visitors called it a "Mahomet's paradise.") The province was a part of the Audiencia de Guatemala, whose president, until 1786, directly controlled many Nicaraguan Indian communities through appointment of curregidores to manage their affairs. León had its own governorship which, in 1786, was raised to the status of an intendancy. By that time Spaniards, Negroes and persons of mixed blood were common residents of the "Indian" villages: Chinandega, Matagalpa, Managua and Masaya.

The country to the east and north, called the district of Tologalpa by the Spaniards, had a separate history because of the lack of Spanish settlement. Negroes moving in from the West Indies islands and mixing with the natives gave parts of the coast a new racial complexion. Buccaneer visits were frequent hut friendly, and by mid-17th century a few permanent settlements mere formed, including that at Bluefields. Later in the same century Great Britain formed an "alliance" with the chief of the Miskito tribe (of mixed Indians and Negroes)! and from 1740 to 1786 the Mosquito coast (*q.v.*), containing many English residents, was counted as a British dependency. The Spanish prevented in 1780 a British attempt to ascend the San Juan and establish a transisthmian route.

Independence.— The relative calm of Spanish Nicaragua was succeeded by more than four decades of confusion and turbulence. Violence began in Dec. 1811 when the governing intendant was deposed in a revolution inspired by earlier struggles in Mexico and El Salvador. I11 feeling developed between León and Granada when León returned early to the royalist cause and Granada bore the brunt of the punishment for disobedience. León declared independence from Guatemala on Sept. 28, 1821 (following Guatemala's act of independence from Spain, Sept. 15), but Granada chose to stay with Guatemala. Both accepted union with Mexico (1822–1823), but then fought until 1826, when Nicaragua was organized as a state in the Central American federation. Dissension remained the order of the day until 1838, when Nicaragua left the federation, and then was resumed as part of the general isthmian struggle between Liberals and Conservatives, Leon being the stronghold of the former, Granada of the latter. Meantime in the east relations between the "king" of the Miskito peoples and the British government were strengthened to the point where English officials were again living in Bluefields. San Juan del Norte (Greytown) was seized by the British in 1838.

The discovery of gold in California brought attention to Nicaragua's strategic position between the oceans. The Accessory Transit company of Cornelius Vanderbilt, which carried passengers by steamship and carriage from San Juan del Norte to the Pacific, began operations in 1852. Adventurer William Walker (*q.v.*) from Tennessee, invited to assist the Liberals in warfare in 1855, brought new excitement to Nicaragua. By 1856 Walker had made himself president of the country. In 1857 he was routed through the joint efforts of the five Central American republics and the Accessory Transit company.

Tomás Martinez, who assumed the Nicaraguan presidency in 1857 and held it for ten years, was the first of a line of Conservative chiefs of state who ruled until 1893. Under them Nicaragua enjoyed relative peace, though with little democracy. The capital was placed in Managua as a compromise between Granada and León. The first railroads were built, agriculture was revived to some extent and a treaty with Great Britain (1860) provided for the nominal reincorporation of the eastern coast with the nation, under the form of an autonomous reservation. José Santos Zelaya, Liberal president from 1893 to 1909, established real Nicaraguan jurisdiction over the Miskito peoples for the first time, and increased his power to the point where he could interfere in the affairs of Honduras and El Salvador. Two great writers sprang from Nicaragua during this quieter half century. Rubén Dario (*q.v.*) became recognized as one of Latin America's greatest poets. Salvador Mendieta (1879–1958) was a distinguished diagnostician of his own region's ills, who dedicated his life to the rebuilding of the Central American union. Both men were critical of the new interest taken in isthmian affairs by the United States once the decision was made to build the Panama canal.

United States *Intervention.*—A new era in Nicaraguan history involved intervention by forces of the United States government. It may be said to have begun when Philander C. Knox, secretary of state for President Taft, became angered at the execution of two U.S. citizens who had participated in a revolution against Zelaya. When Zelaya resigned late in 1909 the United States refused to recognize his successor, Jose Madriz. In 1910 its naval forces prevented government occupation of Bluefields, the revolutionary headquarters, an act leading directly to the success of the revolution. When new civil war broke out in 1912 U.S. forces took a direct hand in support of Adolfo Diaz, president from 1911 to 1917. A hundred marines stationed at the United States embassy also helped to maintain the peace under Emiliano Chamorro Vargas (1917–20) and his nephew successor. United States bankers meanwhile managed the Nicaraguan customs collections, the national bank and railway. The Bryan-Chamorro treaty of 1916 gave Nicaragua $3,000,000 in exchange for the U.S. right to build an interoceanic canal and to establish naval bases on the Gulf of Fonseca and Corn Islands.

Withdrawal of the marine guard (192j) led to new complications. Rebellion by Chamorro Vargas against a new administration brought Diaz back as a "compromise" president (1926–28), reinforced by 2,000 United States marines. Diaz was opposed in warfare (1927) by Juan Bautista Sacasa, Gen. José Maria Moncada, Gen. Augusto César Sandino and others. Though elections in 1928 under U.S. auspices brought Moncada to the presidency, followed in 1933 by Sacasa, Sandino fought on against both his old friends and the marines and came to typify for many Latin Americans the cause of resistance against Yanqui imperialism.

Later *Developments.*—Sacasa's inauguration (Jan. 1, 1933) terminated the stay of the U.S. marines. Within the year Sandino made peace with his government. Prominent on the scene by then were the Nicaraguan national guard, carefully trained by the marines before their withdrawal, and its commander, Gen. Anastasio Somoza, nephew of the president. In Feb. 1934, just after he had dined with Sacasa, Sandino was assassinated by members of the national guard with Somoza's approval. Against Sacasa's wishes Somoza decided he would next have the presidency, though both his position and his family relationship made him .ineligible to succeed Sacasa. Constitutional problems were "solved" by the deposition of Sacasa (June 1936) and a temporary relinquishment of the guard command. Somoza became president Jan. 1, 1937, backed by a coalition of segments of the old parties. Leonardo Argüello, his defeated opponent, also had support from both of the traditional parties.

One man then controlled Nicaragua for 20 years. A new eight-year term commenced March 30, 1939, under a revised constitution which increased the power of both president and national guard. In 1945, after *caudillos* had been removed from office in El Salvador and Guatemala, Somoza announced that the guard would remain loyal to the winner of the next elections. When Argiiello won those elections and took office May 1, 1947, Somoza (still at the head of the guard) had him ousted within a month. Somoza's uncle Victor Manuel Roman y Reyes, chosen by the party organization to succeed, was president until he died May 6, 1950. Somoza then reassumed the position, and was elected to another six-year term beginning May 1, 1951. A pre-election agreement with Emiliano Chamorro Vargas guaranteed the opposition a minority voice in the new congress.

The development of a small gold mining industry by foreign capital in the 1930s gave the nation its first sizable export commodity. Strict economic dictatorship was coupled after 1941 with wartime co-operation with the United States, which brought material benefits in its wake. (The United States navy used port facilities at Corinto, a road was begun to develop Rama City as a Caribbean port and crude rubber was collected for a few years.) After the war an aura of prosperity developed with new large plantings of coffee and cotton for export (subsistence crops suffered badly for a time), establishment of textile and food processing industries and the organization in 1953 of a private shipping line, Marina Mercante Nicaragüense (Mamenic). But observers noted the extent to which Somoza family holdings bound the economy together, while the people at large benefited little from the rise in national income.

Somoza's enemies were several, both inside and outside the country. After an attempt on his life in April 1954, charges of complicity mere hurled against the elderly Emiliano Chamorro; the "Caribbean legion," an international group openly dedicated to the overthrow of dictatorial regimes in the Caribbean area; and Pres. José Figueres of Costa Rica, whose left-of-centre regime contrasted rather sharply with that of Somoza. When Costa Rica was invaded from Nicaraguan soil in Jan. 1955 by Costa Rican opponents of the Figueres regime the Organization of American States intervened to stop the fighting.

Anastasio Somoza was shot Sept. 21, 1956; he died eight days later. Luis Somoza Debayle, a son, became president immediately. Anastasio, another son, remained head of the national guard. In elections of Feb. 1957 Luis was chosen president for a six-year term, which began May 1, 1957. An old boundary dispute with Honduras, which flared into fighting in April, was referred to the International Court of Justice for final settlement and a decision was made in favour of Honduras in 1960. R'ith a new regime in power in Costa Rica the feud on that border seemed settled. There was some easing of tension at home as some of the tighter controls mere relaxed. President Somoza Debayle stated in 1958 his belief that the Somoza family should yield the reins of power at the end of his term, in 1963. (F. D. P.)

IV. POPULATION

Number and Distribution. — A census taken in 1950 showed Nicaragua to have a total of 1,057,023 inhabitants, or the equivalent of 19.7 persons for each of the 57,143 sq.mi. of national territory (see Table). By 1958 the total population was estimated to have risen to 1,335,000, and after that time it continued to increase rapidly by about 35,000 per year. A very high birth rate (probably at least 45 per 1.000 population), coupled with a death rate of less than 20, is responsible for this increase.

Nicaragua's population, which is largely agricultural, is heavily concentrated in the western one-third of the country. especially in the small section near the Pacific coast that extends from the city of Chinandega on the north to the city of Granada and Lake Nicaragua on the south. According to the 1950 census 34.9% of the population resided in centres of 2,500 or more inhabitants, of which Managua (*q.v.*), the capital with a population of 109,352, was the largest. León and Granada (*qq.v.*), with populations (1950) of 30,544 and 21,035 respectively, are the next largest cities in the republic.

Composition. — Approximately 20% of Nicaragua's population is white and 10% Negro, with mestizos, *zambos* (Indian-Negroes) and mulattoes making up the remainder. Practically no full-blooded Indians remain and mestizos greatly predominate.

Because of the very high birth rate and the comparatively high death rate that has prevailed throughout the 20th century, Nicaragua's population is highly concentrated in the younger ages, as is evidenced by the fact that in 1950, 44.3% were under 15 years of age, 53.9% in the age group 15–64 and only 2.8% were 65 and over. The 1950 census also showed that there were 97.1 males in the population for every roo females, a ratio that probably is very near the one that prevails among the human race as a whole.

TABLE.—*Number of Inhabitants and Density of Population in Nicaragua by Departments, 1950*

Departments	Area (sq.mi.)	Population	Persons per sq.mi.
Total	57,143*	1,057,023	19.7
Boaco	2,085	50,039	24.0
Cabo Gracias a Dios†	5,521	17,323	3.1
Carazo	367	52,138	142.1
Chinandega	1,776	81,836	46.1
Chontales	2,050	50,529	24.6
Estelí	772	43,742	56.7
Granada	541	48,732	90.1
Jinotega	5,869	48,554	8.3
León	2,355	123,614	52.5
Madriz	531	33,178	62.5
Managua	1,332	161,513	121.3
Masaya	232	72,446	312.3
Matagalpa	3,378	135,401	40 1
Nueva Segovia	1,593	27,078	17.0
Rio San Juan	2,801	9,089	3.2
Rivas	849	45,314	53.4
Zelaya	21,616	56,497	2.6

*Includes 3,475 sq. mi. of lakes not included in the areas of the departments.
†Federal territory.

Spanish is the mother tongue of the Nicaraguan people, although many members of the upper and middle classes have a familiarity with English as well. Although the various tongues once spoken by the aboriginal inhabitants of this part of America have almost disappeared as languages, they have left their impress upon Nicaragua's place names, and many designations of things have been incorporated into the Spanish used in this part of the hemisphere.

The vast majority of the people of Nicaragua are of the Roman Catholic faith, although a sprinkling of Protestants of various denominations and small groups of those professing Judaism are found in the principal cities. In the religion of the common people few aboriginal beliefs and practices survive. (T. L. SH.)

V. ADMINISTRATION AND SOCIAL CONDITIONS

Government. — Nicaragua has had nine constitutions: 1838, 1854, 1858, 1893 (amended 1896), 1905, 1911, 1939, 1948 and 1950. The last, in force since Nov. 1, 1950, provides for separation of powers (legislative, executive and judicial branches) with strong, centralized, executive government. Nicaragua is one of the few Latin-American countries which has not attempted to control centralized, executive power through a semiparliamentary system. Although the president is theoretically elected for a six-year term and is ineligible for immediate re-election, Gen. Anastasio Somoza, the most distinguished *caudillo* or leader of the 20th century, dominated government from the 1930s until his assassination in Sept. 1956. Congress is empowered to appoint a designado to take the president's place when it is necessary to fill out an unexpired term. Luis Somoza Debayle, son of General Somoza, was elected for a six-year term on Feb. 3, 1957, and took office May 1.

Nicaragua is the only country in Central America with a bicameral legislature. It is also the smallest bicameral legislature in all of Latin America. The senate of 16 members (plus former presidents, who hold senatorship for life, and the defeated runner-up in the presidential contest, who receives a term of six years) and the chamber of deputies of 42 (one to every 30,000 of population, with each department guaranteed at least one representative) are elected directly for 6 years. The legislature meets only two months each year, the shortest legislative session of any Latin-American country.

With opposition practically eliminated during several decades of mid-20th century, the legislature was almost completely subservient to the executive. The legislature can and does delegate broad authority to the president to legislate by decree, even in economic fields. Local government is controlled by the central government. The country is divided into 16 departments and one *comarca* (national district) each with a political head, appointed by the president, nominally in control. The president governs Managua, the capital, through a minister. The supreme court of seven members, elected by congress, has authority to introduce bills in the legislature. Although Nicaragua, like Costa Rica, does not have an army, it does have a national guard of some 7,500 men, originally trained by the United States marines.

Education and Social Welfare. — Although about 18% of the national budget is usually devoted to education, probably over 60% of the people are illiterate. Schools are unavailable in many of the rural areas. Furthermore the average length of primary school enrollment is two to three years, a period which is considered inadequate preparation for the duties of citizenship. The National University of Nicaragua is in León, with branches in Managua and Granada.

Legislation limiting the total number of hours to be worked per year and establishing maximum daily and weekly working hours was introduced in 1945. The 1950 constitution contains many welfare guarantees, only some of which have been made effective. Although it is claimed that there are 15,000 members of trade unions, such development of labour unions as occurred in mid-

20th century was controlled by the government. (W. S. Ss.)

VI. THE ECONOMY

Production.— The Kicaraguan economy is predominantly agricultural. The chief crops are cotton, coffee, sesame, sugar, rice, corn and beans. Sorghum, cacao, yucca, tobacco, plantains and a variety of other fruits and vegetables are also produced on a relatively smaller scale for the local market. Exports of cotton and coffee account for roughly 75% of total export value. The importance of bananas has fallen markedly because of sigatoka disease. There are possibilities for greater agricultural development since only about one-fifth of the arable land is used for crop production. Cattle raising is significant for dairy produce in the west and beef in the eastern plains.

Gold mining has been an important activity since precolonial days and the principal mines are owned by U.S. and Canadian concessionaires.

Xicaragua's industrial output consists of a variety of consumer goods produced chiefly in the homes. The Institute of National Development was the principal government agency responsible for encouraging industrial development.

Trade and Finance.— In 1957 exports were valued at 424,000,000 cordobas, and imports at 567,000,000 córdobas. The sale of a large percentage of Nicaragua's cotton and coffee production to western Europe and Japan led to a decline in the U.S. share of Nicaragua's export trade, from 70% in 19jo to 39% in 1957.

The currency unit is the córdoba. A single exchange rate of seven córdobas to the U.S. dollar was established in 1955 and applied to all imports. The conversion of proceeds from exports was at the rate of 6.60 córdobas to the dollar. The Nicaraguan banking system is dominated by the state-owned National Bank of Nicaragua, the most important lending institution of the country, which exercises some central banking functions.

The gross national product in 1950 was estimated at 1,027,000,000 cbrdobas. The per capita product was 970 córdobas. Budgeted government expenditures for 1958–59 were estimated at 265,600,000 córdobas. The public debt in 1957 was 35,600,000 cordobas.

The main source of government revenue is through indirect taxation— import duties and surcharges, export taxes on coffee and sales taxes on liquor, cigarettes and other consumer items.

Transport and Communications.— The Pan-American highway is passable in all weather from the Honduran border to the Costa Rican border. However, it is unpaved for nearly half this distance. A railroad runs from Corinto on the Pacific coast to Granada and Diriamba. The chief ports are Corinto, San Juan del Sur and Puerto Somoza, all on the Pacific coast. Managua is on the north-south air route from the U.S. to Panama and is linked by air to the capitals of other Central American republics See also Index references under "Nicaragua" in the Index volume.

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NICARAGUA, LAKE, the largest of several fresh-water lakes in southwestern Nicaragua and the largest lake in Central America, is nearly 100 mi. long and 45 m i wide at its widest place, with an area of 3,089 sq.mi. In the lake are many picturesque islands, the largest of which is Ometepe, bordered by two high volcanic peaks. The lake has long been important for fishing, sailing, swimming and in local transportation, steamships having operated on it since 1882. The lake and San Juan river, which drains it from the southern end, have long been discussed as a possible canal route between the Caribbean sea and the Pacific ocean. (C. F. J.)

NICARO, a town on Lengua de Pájaro peninsula on the northern coast of Oriente province, eastern Cuba. Pop. (1953) 3,074. During World War II the United States government constructed a huge plant for Nicaro Xickel company in order to concentrate nickel ore to an oxide for refinement in the United States. Large quantities of the strategic mineral occur in the Nipe limonite, a nickeliferous iron ore, which is mined about 10 mi. S. of Levisa bay. This plant became inactive in 1947 because of high costs of operation, but was reopened in 1951. (D. R. D.)

NICCOLITE, a mineral consisting of nickel arsenide, containing 43.9% nickel. It usually occurs as compact masses of a pale copper-red colour, with metallic lustre on the uneven, fractured surfaces. It is opaque and brittle, and the streak is brownish black. It occurs with ores of cobalt, silver and copper at Annaberg and Schneeberg in Saxony, Ger., at Cobalt, Ont., and other localities. (See NICKEL.) The formula is NiAs. Crystals are hexagonal, but are rare and indistinct. The specific gravity is 7.5 and the hardness 5.5.

NICE, a city of France, the chief town of the *département* of Alpes-Maritimes and previous to 1860 the capital of the county of Nice (Nizza) in the kingdom of Sardinia, 739 mi. by rail from Paris. Pop. (1954) 208,453. The population fluctuates with the seasons, owing to the influx of winter visitors.

The town is situated at the mouth of the Paillon (Paglione), at the northern end of the Baie des Anges. The historical nucleus of the town is an isolated limestone hill, running back for some distance from the shore and formerly crowned by a castle. Toward its south-west corner stands a tower (Tour Bellanda or Clérissy) dating, it is said, from the 5th century. The old town stretches along the western base of the hill; the "town of the 18th century" on ground farther west slopes gently towards the Paillon; and to the north-east and north and west beyond the stream lies the modern city. To the east of the hill the commercial quarter surrounds the port. The whole frontage of Nice is composed of fine embankments, notably the Promenade des Anglais begun 1822–24 at the cost of the English colony, and the course of the Paillon also is embanked on both sides, Nice has a Roman Catholic cathedral—Ste. Réparate, dating from 16jo —two Russian churches, two synagogues and an Anglican chapel. Architecturally the most remarkable church is Notre Dame du Voeu, a modern Gothic building. The lycée was founded by the Jesuits in the 17th century. There is an astronomical and meteorological observatory on Mont Gros (1,220 ft.). The city is famous for its carnival festivities, especially the "battle of flowers."

Industry and Trade.—The industrial establishments are perfumery factories, distilleries, oil works, furniture and woodwork factories, confectionery works, soap works. factories for silk goods, straw hats, rubber goods, pianolas, metal goods and a national tobacco factory. Besides the vine, the trees principally cultivated in the neighbourhood are the olive, the orange, the mulberry and the carob; and the staple exports are oil, agricultural produce, fruits and flowers. Nice joins on the north-east the ancient episcopal town of Cimiez, where the most luxurious hotels are. From east to west the town is surrounded by a girdle of beautiful residential areas—Carabacel, St. Etienne, St. Philippe and Les Beaumettes. On the east of the port lie Montboron, Riquier and St. Roch, the last partly occupied by barracks. The entrances to the port of Nice and the outer pier have been improved; that of the outer port is 300 ft. wide, and that of the inner 220 ft. The area of the harbour is about 8 ac.; vessels drawing more than 23 ft. cannot enter; its trade is mostly coastal, principally in French and Italian vessels. Nice is an episcopal see (first mentioned at the end of the 4th century) under the archbishop of Aix. It belongs to the XV military division (Marseilles). It is the seat of a prefect, of tribunals of first instance and of commerce and of a board of trade arbitrators. The coastal railway is the main line of communication; an extension of the branch lint up the Paillon valley of l'Ecarène joining the Ventimiglia-Coni (Cuneo) line at Breil-Sur-Roya was opened on Oct. 30, 1928.

Climate.—Protected toward the north by hills which rise, stage behind stage, to the main ridge of the Alps, Xice is celebrated for the mildness of its climate. The mean temperature is 60°, that of winter being 49°, of spring 56°, of summer 72° and of autumn 63°. For a few nights in winter there is frost, but snow is practically unknown. The highest reading of the thermometer is rarely above go°. There are 67 days with rain in the course of a year; but it usually falls in heavy showers which soon leave the sky clear again; the whole annual amount exceeds 32 in. Fine days and rainy days are almost equally distributed throughout the different seasons. The winds are very variable, sometimes changing several times a day, but the most frequent is the east wind. April and May are the most windy months. The south-west wind (called *Libeccio,* or wind of Libya) is moist and warm: the north-east (or *Gregaou,* Greek), which is rare, brings storms of hail and even snow in winter. The mistral (from the north-west) and the tramontane (from the north) are generally stopped by the mountains. The climate of Nice, combining sea and sun, is suitable for convalescents, especially after acute affections of the lungs or surgical operations. Sufferers from the effects of paralysis or in the chronic stages of the rheumatic disorders are said to find its moderately warm character particularly soothing. Autumn is the best season. Patients with heart disease may find the summer heat trying.

History.—Nice (*Nicaea*) was founded about two thousand years ago by the Phocaeans of Marseilles, and was named in honour of a victory (νίκη) over the neighbouring Ligurians. It soon became a busy trading station, but had a rival in the town of Cemenelum, in existence till the time of the Lombard invasions, which has left its ruins at Cimiez. In the 7th century Nice joined the Genoese league formed by the towns of Liguria. In 729 it repulsed the Saracens; but in 859 and 880 they pillaged and burned it, and for the most of the 10th century remained masters of the surrounding country. As an ally of Pisa, Nice was the enemy of Genoa, and both the king of France and the emperor endeavoured to subjugate it; but it maintained its liberties. In the course of the 13th and 14th centuries it fell more than once into the hands of the counts of Provence; and at length in 1388 it placed itself under the protection of the counts of Savoy. The maritime strength of Nice rapidly increased till it was able to cope with the Barbary pirates; the fortifications were largely extended and the roads to the city improved. During the struggle between Francis I and Charles V great damage was caused by the passage of the armies invading Provence; pestilence and famine raged in the city for several years. In 1543 Nice was attacked by the united forces of Francis I and Barbarossa; and the inhabitants were ultimately compelled to surrender, and Barbarossa was allowed to pillage the city and to carry off 2,500 captives. Pestilence appeared again in 1550 and 1580. In 1600 Nice was taken by the duke of Guise.

By opening the ports of the countship to all nations, and proclaiming full freedom of trade, Charles Emmanuel in 1626 gave a great stimulus to the city. Captured by Catinat in 1691, Nice was restored to Savoy in 1696, but it was again besieged by the French in 1705, and in 1706 its citadel and ramparts were demolished. The treaty of Utrecht in 1713 gave the city back to Savoy; and in the peaceful years which followed the "new town" was built. From 1744 till the peace of Aix-la-Chapelle (1748) the French and Spaniards were again in possession. In 1775 the king of Sardinia destroyed all that remained of the ancient liberties of the commune. Conquered in 1792 by the armies of the French Republic, the county of Nice continued to be part of France till 1814; but after that date it reverted to Sardinia By a treaty concluded in 1860 between the Sardinian king and Napoleon III it was again transferred to France.

NICEPHORUS, SAINT (NICEPHORUS PATRIARCHA) (*c.* 758–*c.* 829), Byzantine theologian, historian and patriarch of Constantinople (806–815), whose historical works consist of a useful short history (*Breviarium*) from 602 to 769 and a chronological list from the Creation to his death. Like his father Theodorus he opposed the policy of the iconoclasts. He held office in the imperial secretariat at the time of the Council of Nicaea when the use of icons was restored. For some unknown reason he retired to a monastery on the Bosporus, although he was not a monk. He was then appointed director of the largest poorhouse in Constantinople and in 806 succeeded Tarasius as patriarch of Constantinople. In 815 he was deposed by the iconoclast Leo V and he died in exile in 828 or 829 and was later canonized by the Orthodox Church. His theological works (some unedited) demonstrate the use of new scholastic methods in defense of the icons.

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NICEPHORUS, the name of three emperors of the east.

NICEPHORUS I, emperor 802–811, was a native of Seleucia in Pisidia, who was raised by the empress Irene to the office of *logothetes.* With the help of the patricians and eunuchs he contrived to dethrone Irene, and to be elected emperor. His sovereignty was endangered by the revolt of his general Bardanes. But Nicephorus achieved the submission of Bardanes, who was relegated to a monastery. A conspiracy headed by the patrician Arsaber had a similar issue. Nicephorus set himself with great energy to increase the empire's revenue. By his rigorous imposts he alienated the favour of his subjects. and especially of the clergy. In 803 and 810 he made a treaty with Charlemagne, by which the limits of the two empires were amicably fixed. Venice, Istria, the Dalmatian coast and south Italy aere assigned to the east, while Rome, Ravenna and the Pentapolis were included in the western realm. By withholding the tribute which Irene had agreed to pay to Harun al-Rashid, Nicephorus committed himself to a war with the Saracens. Compelled by Bardanes' disloyalty to take the field himself, he sustained a severe defeat at Crasus in Phrygia (805), and only obtained peace on condition of paying a yearly contribution of 30,000 gold pieces. By the death of Harun in 809, Nicephorus was left free to deal with the Bulgarian king, Krum, who was harassing his northern frontiers. In 811 Nicephorus invaded Bulgaria and drove Krum to ask for terms, but in a night attack he allowed himself to be surprised and was slain along with a large portion of his army.

See Gibbon, ed. by Bury, vol. v, pp. 204–205 (1911); Bury, *Eastern Roman Empire.*

NICEPHORUS II (Phocas), emperor 963–969, belonged to a Cappadocian family which had produced several distinguished generals. He was born about 912, joined the army at an early age and, under Constantine VII, became commander on the eastern frontier. In the war with the Saracens he began with a severe defeat (956), which he retrieved in the years following by victories in Syria. In 960 he led an expedition to Crete, and wrested the whole island from the Saracens. He then returned to the east with a large and well-equipped army. In the campaigns of 962–963 he forced his way through Cilicia to Syria and captured Aleppo, but made no permanent conquests. Upon the death of Romanus II, Nicephorus was proclaimed emperor by the eastern troops, and was eventually acknowledged at Constantinople as colleague of the infant sons of Romanus. In 964–966 he definitely conquered Cilicia and again overran Mesopotamia and Syria, while the patrician Pu'icetas recovered Cyprus. In 968 he reduced most of the fortresses in Syria, and after the fall of Antioch and Aleppo (969), which were recaptured by his lieutenants, secured his conquests by a peace. On his northern frontier he began a war against the Bulgarians, to whom the Byzantines had of late been paying tribute (967), and by instigating an attack from the Russians distracted their attention effectively. Sicephorus was less successful in his western wars. After renouncing his tribute to the Fatimite caliphs, he sent an expedition to Sicily under Nicetas (964–965), but was forced by defeats on land and sea to evacuate that island completely. In 967 he made peace with the Saracens of Kairawan and turned to defend himself against their common enemy, Otto I of Germany, who had attacked the Byzantine possessions in Italy; but after some initial successes his generals were defeated and driven back upon the southern coast. Because of the care which he lavished upon the proper maintenance of the army, Nicephorus was compelled to exercise rigid economy in other departments. By his heavy imposts and the debasement of the coinage he forfeited his popularity with the rest of the community, and gave rise to riots. He was finally assassinated in his sleeping apartment by his nephew and successor John Zimisces. Pu'icephorus was the author of an extant treatise on military tactics.

NICEPHORUS III (Botaniates), emperor 1078–81, rose to be commander of the troops in Asia. He revolted in 1078 from Michael VII, and with the connivance of the Turks assumed the purple. In face of another rebellious general, Nicephorus Bryennius, his election was ratified by the aristocracy and clergy. With the help of Alexius Comnenus he drove out of the field Bryennius and other rivals, but failed to clear the invading Turks out of Asia Minor. Nicephorus ultimately quarreled with Alexius, and was banished to a monastery.

NICHOLAS, ST., bishop of Myra, in Lycia, a saint honoured by the Greeks and the Latins on the 6th of December. His cult is as celebrated as his history is obscure. He was bishop of Myra in the time of the emperor Diocletian, was persecuted, tortured for the faith, and kept in prison until the more tolerant reign of Constantine, and is said to have been present at the council of Nicaea, though Athanasius, who knew all the notable bishops of the period, never mentions Nicholas, bishop of Myra. The oldest known monument of the cult of St. Nicholas seems to be the church of SS. Priscus and Nicholas built at Constantinople by the emperor Justinian. (See Procopius, De *aedif.* i. 6.) In the West, the name of St. Nicholas appears in the 9th century martyrologies, and churches dedicated to him are to be found at the beginning of the 11th century. It is more especially, however, from the time of the removal of his body to Bari, in Apulia, that his cult became popular. The inhabitants of Bari organized an expedition, seized his remains by means of a ruse, and transported them to Bari, where they were received in triumph on May g, 1087, and where the foundations were laid of a new basilica in his honour. This was the origin of a famous and still popular pilgrimage. There are nearly 400 churches in England dedicated to St. Nicholas. He is the patron saint of Russia; the special protector of children, scholars, merchants and sailors; and is invoked by travellers against robbers. In art St. Nicholas is represented with various attributes, being most commonly depicted with three children standing in a tub by his side.

A legend of his surreptitious bestowal of dowries upon the three daughters of an impoverished citizen, who, unable to procure fit marriages for them, was on the point of giving them up to a life of shame, is said to have originated the old custom of giving presents in secret on the Eve of St. Nicholas, subsequently transferred to Christmas Day. Hence the association of Christmas with "Santa Claus," an American corruption of the Dutch form "Sinterklaas," the custom being brought to America by the early Dutch colonists. (For the ceremony of the boy-bishop elected on St. Nicholas' day see BOY-BISHOP.)

See N. C. Falconius, *Sancti Nicolai acta primigenia* (Naples, 1751); *Bibliotheca hagiographica Graeca,* p 96 (Brussels, 1895); *Bibl. hagiogr. Latina,* n. 6104–6221 (Brussels, 1899); F. Nitti di Vito, *Le Pergamene di S. Nicola di Bari* (Bari, 1901); Charles Cahier, *Caracttristiques des saints,* p. *354* (Paris, 1867); Frances Arnold-Forster, *Studies in Church Dedications,* i, 495–501, iii, 21 (London, 1899); L'abbé Marin, *Saint Nicholas, évêque de Myre* (1917).

NICHOLAS, the name of five popes and one antipope.

NICHOLAS I, SAINT, called THE GREAT, pope from 858 to 867, was of Roman birth and entered the service of the Lateran palace as a subdeacon under Sergius II. He was elected pope in succession to Benedict III in April 858. According to the annalist Prudentius of Troyes, "he owed his election less to the choice of the clergy than to the presence and favour of the emperor Louis II and his nobles"—who can hardly have foreseen with what ability and persistence the rights of the Holy See as supreme arbiter of Christendom were to be asserted even against themselves by the man of their choice. His pontificate of nine years and a half was marked by three memorable contests which left their mark in history. The first was that in which he supported the claims of the unjustly degraded patriarch of Constantinople. Ignatius; but two of its incidents, the excommunication of Photius (*q.v.*), the rival of Ignatius. by the pope in 863 and the counterdeposition of Nicholas by Photius in 867, were steps of serious moment toward the permanent separation between the eastern and the western church. The second great struggle was that with Lothair (*q.v.*), the eponymous king of Lotharingia, about the divorce of his wife Teutberga or Thietberga. The pope not only quashed the whole proceedings against Teutberga but even created a precedent by deposing Gunther and Thietgaud, archbishops of Cologne and of Trier respectively, who had brought to Rome the *libellus* of the synod of Metz that declared the marriage null (863). The archbishops appealed to Louis II, Lothair's brother, then at Benevento, to obtain the withdrawal of their sentence by force; but, although Louis actually occupied the Leonine city (864), he was unsuccessful in obtaining any concession and had to withdraw to Ravenna. The third great ecclesiastical affair of this pontificate was that in which the right of bishops to appeal to Rome against their metropolitans was maintained in the case of Rothad of Soissons, deposed by Hincmar of Reims. Nicholas, a strict upholder of the Roman Church's primacy of jurisdiction, took the view that the deposition of a bishop was beyond the competence of a metropolitan, all major causes being reserved to the pope.

Nicholas was indeed one of the master theorists of the papal plenitude of power. Deeply dependent on the writings of his great predecessors Leo the Great, Gelasius I and Gregory the Great, he was also the first pope to draw on the decretals of the Pseudo-Isidore (see DECRETALS: The False Decretals). For Nicholas. the Roman Church is both the head and the epitome of the Cniversal Church. It alone has all power by divine commission. As both the sacerdotal and royal functions were conferred by Christ on St. Peter, so they are exercised by St. Peter's successors, the popes. The sword of temporal power is delegated to the emperor for the protection of the church. Thus the teaching of Nicholas contained in embryonic form the complete doctrine of papal theocracy. His letter to the newly converted Boris, khan of the Bulgars, in answer to the 106 questions put by him, shows the pope exercising his function of supreme director of the secular power. Nicholas died on Nov. 13, 867.

The letters and decretals of Nicholas are printed by J. P. Migne (ed.), *Patrologia latina,* vol. cxix (Paris, 1852). *See* also L. Duchesne, *Les Premiers Temps de l'état pontifical* (Paris, 1911); E. Perels, *Papst Nikolaus* I *und Anastasius Bibliothekarius* (Berlin, 1920); F. Dvornik, *The Photian Schism* (Cambridge, New York, 1948); W. Ullmann, *The Growth of Papal Government in the Middle Ages* (London, Toronto, 1955).

NICHOLAS II (Gerard), pope from 1058 to 1061, a Burgundian, had been bishop of Florence since 1046 when, c. Dec. 1058, he was elected successor to Stephen X (IX) by the Hildebrandine party at Siena, with the approval of the empress-regent Agnes and the support of Godfrey of Lorraine, in opposition to Benedict X, the antipope sponsored by the Roman nobles. After the expulsion of Benedict, Nicholas was enthroned in Rome on Jan. 24, 1059. He was a major figure in the process of reform associated with the name of Hildebrand (later pope as Gregory VII).

One of the new pope's first acts was to send Peter Damian (Pietro Damiani) as legate to Milan to adjust the difference between the Patarenes and the archbishop and clergy. Archbishop Wido, in face of the ruinous conflict in the church there, was forced to acknowledge the subordination of Milan to Rome and to advertise the new relation by his attendance, with his suffragans, at the council summoned to the Lateran palace in April 1059.

This Lateran council is a milestone in the Gregorian reform movement because, besides disciplinary decrees, Ni'cholas enacted the famous decree governing papal elections. In this he was expressly reacting against the disorders which had preceded his own elevation. The leading part in elections was now assigned to the seven cardinal bishops, who were to deliberate together on a suitable candidate and then to call in the other cardinals. The rest of the clergy and the people were to acclaim the choice. The emperor's part in the matter was dismissed with a vague covering phrase. Stephen, cardinal priest of S. Crisogono, was sent to notify the German court of this but was refused an audience, and an imperialist version of the decree mas put into circulation. At a synod held in 1061 the German bishops declared the election decree void and quashed all the pope's acts. These proceedings signified the ending of the alliance between Germany and the Holy See and heralded the contest between empire and papacy.

Other business of the council included the examination of the Eucharistic heresy of Berengar of Tours, and his formal, but not final, recantation.

Nicholas had entered into friendly relations with the Normans of southern Italy in the early months of his pontificate, and this new alliance was cemented by the treaty of Melfi (Aug. 23, 1059), when he invested Robert Guiscard with the duchies of Apulia and of Calabria and with the lordship of Sicily and Richard of Aversa with the principality of Capua in return for fealty and the promise of assistance. This arrangement was destined to make the papacy more independent both of the western and of the eastern emperors. An immediate result was the reduction, in the following autumn, of Galeria, where the antipope Benedict had taken refuge. Nicholas died on July 27, 1061.

See A. Fliche, *La Re'forme grégorienne,* vol. i (Louvain, 1924); A. Michel, *Papstwahl und Königsrecht oder das Papstwahl-Konkordat von 1059* (Munich, 1936).

NICHOLAS III (Giovanni Gaetani Orsini), pope from 1277 to 1280, was a Roman nobleman who had been made cardinal deacon of S. Niccolo in Carcere in 1244. At Viterbo on Nov. 25, 1277, after a six months' vacancy in the Holy See, he was elected, largely through family influence, to be the successor of John XXI. A born politician, he negotiated, in the summer of 1278, a concordat with the German king Rudolph I whereby the Romagna, with the exarchate of Ravenna and other territories! was guaranteed to the pope; and in July of that year he issued a constitution, epochmaking in the administrative history of mediaeval Rome, whereby foreign princes were excluded from civil office (in consequence Charles of Sicily had to relinquish his office of senator in the following September). The bull *Exiit qui seminat* (Aug. 14, 1279) was issued to settle the strife within the Franciscan order between the Conventuals and the Spirituals. He strove in vain to realize Gregory X's project for a crusade and, to this end, pressed on with the collection of the subsidy voted at the council of Lyons (1274) and tried to make peace between Philip III of France and Alphonso X of Castile. He died suddenly at Soriano on Aug. 22, 1280.

See "Les Registres de Nicolas III," ed. by Jules Gay in the *Bibliothdque des écoles françaises d'Athènes et de Rome* (Paris, 1898–1916).

NICHOLAS IV (Girolamo Masci), pope from 1288 to 1292, was born at Lisciano near Ascoli. A Franciscan friar, he rose to be general of his order in succession to St. Bonaventura in 1274. Having been made cardinal priest of Sta. Pudenziana by Nicholas III in 1278 or 1279 and cardinal bishop of Palestrina by Martin IV in 1281, he was elected pope in succession to Honorius IV on Feb. 15, 1288, and re-elected (after a refusal of the dignity) and enthroned on Feb. 22, when the papacy had been vacant for ten months. A pious man, he showed no ambition save for the church and for the crusades. In Rome he steered a middle course between the factions, but his constitution of July 18, 1289, which granted to the cardinals one-half of the income of the Holy See and a share in the financial management of it, gave the Sacred college an independence that was later to prove damaging to the papacy. In an attempt to settle the Sicilian question, he cronned Charles II king of Sicily and Naples in May 1289 (after Charles had expressly recognized papal suzerainty) and concluded the abortive treaty of Brignoles (Feb. 1291) nith Alphonso III of Xragon and Charles in the hope of expelling James of Aragon from the island. To enlist Mongol support for Christendom against Islam, he sent Giovanni di Monte Corvino (q v.) on his great mission to the east, the loss of Tripoli in 1289 and of Acre in 1291 serving to emphasize the danger in the near east.

Nicholas spurred the Inquisition on to fresh efforts against the Joachimite sect and the Spiritual Franciscans. He granted many privileges to his order and himself composed the rule of 1289 for the Third Order of St. Francis. The revaluation of English benefices, made at his behest in 1291, remained the norm for fiscal purposes till 1535. Nicholas died on April 4, 1292.

See "Les Registres de Nicolas IV," ed by E. Langlois in the *Bibliothdque des e'coles françaises d'ilthdnes et de Rome* (Paris, 1886–93); also O Schiff, "Studien zur Geschichte Papst Nikolaus' IV" in *Historische Studzen,* ed by E. Eberling, vol v (Berlin. 1897)

NICHOLAS V (Pietro Rainalducci), antipope in Italy from 1328 to 1330, a native of Corvaro in the Abruzzi, joined the Franciscan order in 1310. An assembly of priests and laymen in Rome under the influence of the excommunicated emperor Louis IV the Bavarian elected him to the papacy on May 12, 1328, during the pontificate of John XXII (*q.v.*). His following was limited to six cardinals and the disaffected Franciscans. Little more than two months later he withdrew with Louis from Rome to Viterbo and thence to Pisa, where he was guarded by the imperial vicar. He was excommunicated by John XXII in April 1329 and sought refuge with Count Boniface of Donoratico near Piombino. Having obtained assurance of pardon, he presented an abjuration first to the archbishop of Pisa (July 25, 1330) and then to the pope at Avignon (Aug. 25). He remained in honourable imprisonment in the papal palace until his death on Oct. 16, 1333.

See G. Mollat, *Les Papes d'Avignon,* gth ed. (Paris, 1949).

NICHOLAS V (Tomaso Parentucelli), pope from 1447 to 1455, was born at Sarzana, where his father uas a physician, in 1397 or 1398. Pope Eugenius IV made him bishop of Bologna in 1444 and sent him to Frankfurt to negotiate an understanding between the Holy See and the empire with regard to the reforming decrees of the council of Basel. On his return to Rome, he was made cardinal priest of Sta. Susanna (Dec. 1446). He was elected pope in succession to Eugenius on March 6, 1447.

Faced with the continuing schism of the antipope Felix V and the council of Basel, Nicholas pursued a policy of conciliation. He prevailed on Charles VII of France to mediate, and discussions took place at Lyons and at Geneva. In 1449 his patience was triumphantly rewarded at Lausanne, whither the council had migrated. The antipope abdicated (April 7) and the rump of the council formally elected Nicholas pope (April 19) and then dissolved itself. Nicholas widely lifted all censures from the schismatics and consoled Felix with the cardinal bishopric of Sta. Sabina. The next year, 1450, he held a jubilee at Rome. In March 1452 he cronned Frederick III (who in Feb. 1448 had made a concordat with him concerning papal rights to annates and reservations in the German church) as emperor in St Peter's—the last occasion on which an emperor nas cronned in Rome. It was Nicholas who in 1450 sent Nicolaus Cusanus as legate to Germany and Bohemia, with the task of holding provincial councils and reforming abuses. This mission was an outstanding success.

Nicholas was a generous patron of humanists. He employed hundreds of copyists and scholars and, by his collection of manuscripts, began the formation of the great library in the Vatican. His last years mere darkened by Stefano Porcaro's conspiracy against papal government in Rome and by the fall of Constantinople, both in 1453. Nicholas died on March 24, 1455

See N Valois, *Le Pape et le conczle,* vol ii (Paris, 1909).

NICHOLAS I (NIKOLAI PAVLOVICH), emperor of Russia (1796–1855), eighth child of the emperor Paul I and his wife Maria Feodorovna, was born at Tsarskoe-Selo on June 25 (July 6, N S.), 1796. He was only five years old nhen his father's murder brought his brother Alexander I to the throne (1801). His education was supervised by RI. von Lambsdorff, director of the 1st cadet corps and former governor of Courland. But Nicholas and his brother Constantine had little taste for learning. They were interested mainly in military matters.

The grand duke Nicholas joined the Russian headquarters in France in 1814, but not to take part in any fighting. In 1815 he mas with the Allies in Paris, and in the following year set out on the grand tour visiting Moscow and the western provinces of Russia, Berlin (where he was betrothed to Princess Charlotte Louise, daughter of Frederick William III) and England. His marriage marked the beginning of intimate relations between the courts of Berlin and St Petersburg. On April 17/29, 1818, their first child, the future emperor Alexander II, was born. In the autumn Nicholas was placed in command of the 2nd brigade of the 1st division of the guard.

Alexander I died at Taganrog on Dec. 1, 1825. Constantine was at Warsaw; Nicholas was too conscious of his unpopularity in the army—the fruit of his drastic discipline—to dare to assume the crown without a public abdication on the part of the legitimate heir. The result (see CONSTANTINE PAVLOVICH) was a three weeks' interregnum, of which the discontented spirits in the army took advantage to bring to a head a plot that had long been hatching in favour of constitutional reform. When on Dec. 14 the troops who had already taken the oath to Constantine were ordered to take another to Nicholas, it was easy to persuade them that this was a treasonable plot against the true emperor. The Moscow regiment refused to take the oath, and part of it marched, shouting for Constantine and "Constitution," to the square before the Senate House, where they were joined by a company of the Guard and the sailors from the warships. In this crisis Nicholas showed high personal courage, if little decision and initiative. For hours he stood, or sat on horseback, amid the surging crowd, facing the mutinous soldiers—who had loaded their muskets and formed square—while effort after effort was made to bring them to reason, sometimes at the cost of life—as in the case of Count Miloradovich, military governor of St. Petersburg, who was mortally wounded by a pistol shot while arguing with the mutineers. When at last the emperor consented to use force, a few rounds of grape-shot sufficed to quell the mutiny. The chief conspirators—Prince Shchepin-Rostovski, Suthoff, Ryleyev, Prince Sergius Trubetskoi, Prince Obolenski and others—were arrested the same night and interrogated by the emperor in person. A special commission, consisting entirely of officers, was then set up; and before this, for five months, the prisoners were subjected to a rigorous inquisition. The prisoners were kept in solitary confinement in the casemates of the inner fortress of St. Peter and St. Paul. They were brought blindfolded before the commission, and then suddenly confronted with their interrogators. Many went mad under the ordeal, one died, and one starved himself to death (Schiemann, ii. 73). It was soon clear that the Dekabrist (December) rising was but one manifestation of a vast conspiracy permeating the whole army. A military rising on a large scale in the south was only averted by the news of the failure of the mutiny at St. Petersburg; and at Moscow there were many arrests, including that of Colonel Paul Pestel, the chief of the revolutionary southern league. The 121 prisoners were finally brought to trial before a supreme criminal court, established by imperial *ukaz* (June 1–12, 1826). Some were condemned to death, others to solitary confinement in fortresses, others to the Siberian mines and colonies. Of the latter many were accompanied by their wives, though the Russian law allows divorce in the case of such sentences; the emperor unwillingly allowed the devoted women to go, but decreed that any children born to them in Siberia would be illegitimate.

In spite of his reverence for his brother's memory, Nicholas made a clean sweep of "the angel's" Bible Society; as for Alexander's projects of reform, the pitiful legacy of a life of unfulfilled purposes, these were reported upon by committees, and shelved. Nicholas too saw the need for reform; the Dekabrist conspiracy had burnt that into his soul; but he had his own views as to the reform needed. The state was corrupt, disorganized; what was wanted was not more liberty but more discipline. So he put civil servants, professors and students into uniform, and for little offences had them marched to the guard-house; thought was disciplined by the censorship, the army by an unceasing round of parades and inspections. The one great gift of Nicholas I. to Russia, a gift which he really believed would be welcome because it would bring every subject into immediate contact with the throne, was—the secret police, the dreaded Third Section of the Private Chancery of the emperor.

The crowning fault of Nicholas was, however, that he would not delegate his authority; whom could he trust but himself? In this he resembled his contemporary the emperor Francis I. But Francis would "sleep upon" a difficult problem; Nicholas never slept. His constitution was of iron, his capacity for work prodigious; reviews and parades, receptions of deputations, visits to public institutions, then eight or nine hours in his cabinet reading and deciding on reports and despatches—such was his ordinary day's work. Under the "Iron Tsar" the outward semblance of authority was perfectly maintained; but behind this imposing façade the whole structure of the Russian administrative system continued to rot and crumble.

Revelations of the rottenness of the under-structure had, indeed, begun before the outbreak of the war with Turkey in 1828. The newly organized squadron which in 1827 set out on the cruise which ended at Navarino only reached Plymouth with difficulty, and there had to be completely refitted. The disastrous Balkan campaign of 1828 was an even more astounding revelation of corruption, disorganization and folly in high places. The weary and starving soldiers were forced to turn out amid the marshes of the Dobrudscha before the emperor as spick and span as on the parade grounds of St. Petersburg; but he could do nothing to set order in the confusion of the commissariat, which caused the troops to die like flies of dysentery and scurvy; or to remedy the scandals of the hospitals. His presence hampered the initiative of Prince Wittgenstein, the nominal commander-in-chief; for Nicholas was incapable of leaving him a free hand.

These then were the leading principles which underlay Nicholas's domestic and foreign policy from first to last: to discipline Russia, and by means of a disciplined Russia to discipline the world. The mission of Russia in the West was, in accordance with the principles of the Holy Alliance as Nicholas interpreted them, to uphold the cause of legitimacy and autocracy against the Revolution; her mission in the East was, with or without the co-operation of "Europe," to advance the cause of Orthodox Christianity, of which she was the natural protector, at the expense of the decaying Ottoman empire. The sympathy of Europe with the insurgent Greeks gave the tsar his opportunity. The duke of Wellington was sent to St. Petersburg in 1826 to congratulate the new tsar on his accession and arrange a concert in the Eastern Question. The upshot proved the diplomatic value of Nicholas's apparent sincerity of purpose and charm of manner; the "Iron Duke" was to the "Iron Tsar" as soft iron to steel; Great Britain, without efficient guarantees for the future, stood committed to the policy which ended in the destruction of the Ottoman sea-power at Navarino and the march of the Russians on Constantinople. By the treaty of Adrianople in 1829 Turkey seemed to become little better than a vassal state of the tsar, a relation intensified, after the first revolt of Mehemet Ali, by the treaty of Unkiar-Skelessi in 1833. In the West, Nicholas himself proposed an armed intervention of the Alliance "to restore order" in Belgium and France; and when his allies held back even proposed to intervene alone, a project rendered impossible by the outbreak of the great insurrection in Poland, which tied the hands of all three powers.

Then, the insurrection in Poland once crushed, and Poland itself scarce surviving even as a geographical expression, he drew the three eastern autocratic powers together in a new "Holy Alliance" by the secret convention of Berlin (Oct. 3, 1833) reaffirming the right and duty of intervention at the request of a legitimate sovereign. The cordial understanding with Austria, cemented at Münchengratz and Berlin, was renewed, after the accession of the emperor Ferdinand, at Prague and Toplitz (1835); on the latter occasion it was decided "without difficulty" to suppress the republic of Cracow, as a centre of revolutionary agitation. He allowed himself to be persuaded by Metternich to support the cause of Don Carlos in Spain, and so early as May 1837, in view of the agitation in Hungary, he announced that "in every case" Austria might count on Russia.

These cordial ties were loosened, however, by the fresh crisis in the Eastern Question after 1838. Metternich was anxious to summon a European conference to Vienna, with a view to placing Turkey under a collective guarantee. Nicholas refused to be a party to it. Moreover, as Austria showed an inclination to approach the maritime powers, he determined to come to an agreement with Great Britain, in order to settle the Eastern Question according to his own views; this is the explanation of those concessions in the Eastern Question which ended in the Quadruple Alliance of 1840 and the humiliation of Louis Philippe's government. The new Anglo-Russian *entente* led in 1844 to a visit of the tsar to the English court. (*See* EASTERN QUESTION.)

When the storm of revolution burst over Europe in 1848, Nicholas remained entrenched behind the barriers of his own disciplined empire. But in 1849 he intervened in Hungary, at the entreaty of Francis Joseph, crushed the insurgent Hungarians and handed back their country as a free gift to the Habsburg king. Scarcely less valuable to Austria was the tsar's intervention in the quarrel between Austria and Prussia arising out of the Hesse incident and the general question of the hegemony of Germany. In October 1850 he had a meeting with Francis Joseph at Warsaw, at which Count Brandenburg and Prince Schwarzenberg were present. Prussia, he declared, must in the German question return to the basis of the treaties of 1815 and renew her *entente* with Austria; this was the only way of preserving the old friendship of Prussia and Russia. In face of the threat conveyed in this, the Prussian government decided to maintain peace (Nov. z), Radowitz resigning as a protest. Thus Nicholas, who refused to believe in the perfidy ascribed by Frederick William to Austria, was the immediate cause of Prussia's humiliation at Olmütz.

Nicholas was soon to have personal experience of the perfidy of Austria in the troubles that led up to the Crimean War. Gratitude, in the tsar's opinon, should have made her neutral if not friendly. When the dispute arose with Napoleon III. over the guardianship of the Holy Places Nicholas could not believe that Christian powers would resent his claim to protect the Christian subjects of the sultan; he believed he could count on the friendship of Austria and Prussia; as for Great Britain, he would try to come to a frank understanding with her. The disillusionment that followed was profound. In October 1853 Nicholas met his brother monarchs of the triple alliance at Warsaw for the last time. In December, at the conference of Vienna, Austria had already passed over to the enemy. Prussia was wavering, neutral indeed, but joining the other powers in a guarantee of the integrity of Turkey (April g, 1854), urging the tsar to accept the decisions of the Vienna conference, and on his refusal signing a defensive alliance with Austria (April 20, 1854), which included among the *casus belli* the incorporation in Russia of the banks of the Danube and a Russian march on Constantinople. Thus Nicholas, the pillar of the European alliance, found himself isolated and at war, or potentially at war, with all Europe. The invasion of the Crimea followed, and with it a fresh revelation of the corruption and demoralization of the Russian system. At the outset Nicholas had grimly remarked that "Generals January and February" would prove his best allies. These acted, however. impartially; and if thousands of British and French soldiers perished of cold and disease in the trenches before Sevastopol, the tracks leading from the centre of Russia into the Crimea were marked by the bones of Russian dead. The revelation of his failure broke the spirit of the Iron Tsar, and on March 2, 1855, he threw away the life which a little ordinary care would have saved.

BIBLIOGRAPHY.—All other works on Nicholas I. were more or less superseded by professor Theodor Schiemann's *Geschichte Russlands unter Kaiser Nikolaus I.*, of which the 1st vol., *Kaiser Alexander I. und die Ergebnisse seiner Lebensarbeit*, was published at Berlin in 1904; the 2nd, carrying the history of Nicholas's reign down to the revolutions of 1830, in 1908. It is based on a large mass of unpublished material, and considerably modifies, *e.g.*, the account of the accession of Nicholas and of the Dekabrist conspiracy given in chapter xiii. of vol. x. of the *Cambridge Modern History*, and tells for the first time the secret history of the Russo-Turkish War of 1828–29. The great *Recueil des traités conclus par la Russie* of *T. T.* de Martens (St. Petersburg, 1874–1909) contains admirable introductory essays, based on the unpublish d Russian archives, and giving much material for the study of Nicholas's character and policy. Many documents are published for the first time in Schiemann's work; some, from the archives of Count Nesselrode, are published in the *Lettres et papiers du Chancelier Comte de Nesselrode, t.* vi. *seq.* For other works *see* bibliographies attached to the chapters on Russia in vol. x. and xi. of the *Cambridge Modern History*. (W. A. P.; X.)

NICHOLAS II. (1868–1918), tsar of Russia, eldest son of Alexander III., was born at St. Petersburg (Leningrad), on May 18, 1868. An English tutor, Mr. Charles Heath, taught him excellent English, and inspired a love of sports and healthy exercise, while a Russian general, Danilovich, supervised his military training, but there was no attempt to provide him with the comprehensive knowledge required from one whom fate had destined to rule an immense empire. The only occasion which was offered to the young tsarevich to acquaint himself with the problems of the world was his journey to the Far East, so abruptly cut short in Kyoto by the sabre cut of a Japanese fanatic.

He wedded Princess Alix of Hesse at the deathbed of his father; at the festival of his coronation more than 3,000 people were crushed to death through the negligence of the officials who had to arrange a distribution of bounties; and during the coronation itself the imperial chain on his breast fell to the ground. Such impressions contributed strongly to inspire him with a mystic resignation, especially unsuitable for a monarch who had to lead the nation through times of great crisis at home and in foreign affairs. Nicholas II. followed in the footsteps of his father, seeking to preserve peace in foreign relations, and continuing in home affairs, though in a much milder form, the policy of centralization and Russification which had characterized the previous reign. His pacific tendencies were shown by his systematic opposition to all bellicose excitement, by his maintaining M. de Giers in the post of minister of foreign affairs, by his offering the post, on the death of that statesman, to M. de Staal, by his restraining France from dangerous adventures, and by initiating the Peace Conference at The Hague. To these ought perhaps to be added the transformation of the Franco-Russian *entente cordiale* into a formal alliance, since the alliance in question might be regarded as favourable to the preservation of the *status quo* in Europe. In the internal administration during the first years of his reign he introduced by his personal influence, and without any great change in the laws, a more humane spirit towards those of his subjects who did not belong by language and tradition to the dominant nationality, and who were not members of the Eastern Orthodox Church; but he disappointed the men of liberal views by giving it to be clearly understood soon after his accession that he had no intention of circumscribing and weakening the autocratic power by constitutional guarantees or parliamentary institutions. In spite, however, of his desire for peace he let his country drift into the disastrous war with Japan; and notwithstanding his sincere attachment to the principles of bureaucratic autocracy, it was he who granted the constitutional reforms which altered the whole political outlook in Russia. (*See* RUSSIA.)

Nicholas II.'s political outlook was dominated by a kind of theocratic or hieratic spirit; he was looking back for inspirations to the ideas and customs of the Muscovite period; he was induced to impersonate the figure of Alexis Mikhailovich, the father of the western reformer Peter the Great; in 1913 the tercentenary of Michail Feodorovich's accession to the throne after the "Great Troubles" was celebrated with much splendour and emphasis. Pilgrimages were performed with great devotion and circumstance.

The courtiers and bureaucrats in the immediate surroundings of the tsar, men like Sipiaguin, Nicolas Maklakov and Sabler, took advantage of these prepossessions in order to keep up a constant hostility against progressive reformers and western adaptations. But the most dangerous representative of mystic reaction was the tsar's consort, the Empress Alexandra Feodorovna. Of German descent on her father's side and of English descent on the side of her mother (Princess Alice, the daughter of Queen Victoria), she had received her education in England, but, on coming to Russia, she surrendered completely to the most extreme form of theocratic exaltation.

While her sister, the widow of the Grand Duke Sergius, killed by a terrorist, had devoted herself to a simple life at the head of a community of hospital nurses, Alexandra Feodorovna, highly strung and hysterical, sought providential guidance in the midst of unbalanced women and false prophets like the French medium Philippe and the famous Rasputin. The latter obtained a hold on her through the hypnotising influence he exercised over her son. the tsarevich Alexis, a boy affected by the rare disease of hereditary haemophilia. But the crafty peasant had contrived to obtain gradually a psychical domination over the empress and her friends which made it possible for him to distribute political favours and to have his say in the most important affairs of state. The empress considered him as the God-sent representative of the Russian nation, of that mass of peasants which, as she was convinced, was the firm mainstay of autocracy in Russia. And in the later years of Nicholas II.'s reign, the years of great trial and danger, Alexandra Feodorovna stepped in more and more often to direct the tsar's choice of his ministers and to prevent him from making concessions to the spirit of the time. For the circumstances which brought Russia into the World War *see* RUSSIA: *History*.

The suspicion that Alexandra Feodorovna was secretly favouring the cause of Germany and revealing military secrets to the Kaiser—a suspicion often expressed abroad and popularly accepted in Russia—is, according to most competent witnesses, devoid of any basis in fact. The empress was intensely patriotic in her own way, opposed to the aggressive policy of the Hohenzollerns, and never advocated a treacherous compromise with the Central Powers. A former lady-in-waiting, Princess Vassiltchikov, who towards the close of 1916 brought the project of such a compromise from Germany, was promptly ordered out of St. Petersburg (Leningrad). Nevertheless, Alexandra Feodorovna proved to be the evil genius of the Russian dynasty, by her blind and obstinate support of reactionary tendencies and of worthless adventurers, at a time when a wise and firm policy of reform was more needed than ever. All the better representatives of the dynasty—the Dowager Empress, the Grand Duke Nicholas Mikhailovich, the Grand Duchess Victoria—warned her of the imminent danger of that régime of fleeting ministerial shadows which set in after the catastrophe of the War Office in 1915.

The emperor remained passive as commander-in-chief at headquarters while the Empress Alexandra spurned all advice with contempt and continued to pull the strings by dismissing men like Sazonov and Palivanov, and appointing timeservers like Sturmer, Protopopov or Galitzin. The assassination of Rasputin did not frighten but enraged her; she erected a kind of shrine over the body of the prophet and sent the Grand Duke Dmitry Pavlovich, who had taken part in the murder, into exile. Her power was broken only by the revolution.

The thread of the Romanov dynasty was cut without much resistance. When in March 1917 the emperor received at headquarters a telegram from the president of the Duma informing him of the events of St. Petersburg and demanding his abdication, and Gutchkov and Shulgin arrived with the act of abdication itself, he submitted with fatalistic composure. He refused to give up his crown to his son with Grand Duke Michael as regent, because he did not wish to trust the boy to the danger of a political storm; and his abdication was made in favour of the Grand Duke Michael, who in his turn refused to accept the crown unless it was tendered to him by the will of the people. The last chance of a régime of constitutional monarchy was cut short. Proposals were made on behalf of the British Government to allow Nicholas II. and his family to take up their abode in England; but the Provisional Government in St. Petersburg did not accede to that plan. Kerensky and Milyukov declared that the imperial family were in safety in Russia. Later on the emperor submitted meekly to be transferred from Pskov to Tsarskoe Selo and thence to Tobolsk, where he was interned with his family—his wife, his son and his four daughters—for months.

The end came with the rumour of a Czechoslovak advance on the Ural in 1918. The Soviet Commissaries in Moscow urged the greatest vigilance on the Ekaterinburg commissar, Yourkovsky, and the commander of the guard, Medvediev, without indicating any means for removing the prisoners from the threatened zone. The communists of Ekaterinburg held a secret meeting in which they decided to put the tsar and his family to death, and sent an order to Yourkovsky. The latter demanded that it should be duly signed, and 16 signatures were affixed to it. On the night of July 16 Yourkovsky roused the prisoners and conducted them into a cellar of the house. Medvediev, with the Lettish guards, entered the room while some Russian soldiers were looking in. Yourkovsky placed the doomed persons at one end of the room and read the sentence hurriedly by torchlight. The tsar stepped forward and said something indistinctly, when Yourkovsky drew his revolver and shot him in the head. A general fusillade followed. Later the corpses were removed and destroyed by fire. Although the belief is general that all members of the family perished, a claim arose in 1928 by Mrs. Anastasia Tschaikovsky that she was the Grand Duchess Anastasia, the tsar's youngest daughter, who had been rescued from the massacre by two soviet soldiers. (*See* RUSSIA.)

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NICHOLAS I (1841–1921), king of Montenegro, was born at Njeguš, the ancient home of the Njeguš-Petrović dynasty, on Sept. 1, 1841. His father, Mirko Petrović, was brother of the Vladika Danilo II. who had declined episcopal office, married and declared the succession hereditary in the direct male line. As, however, Danilo II. left no male issue, and Mirko declined the succession, Nicholas became heir to the throne of Montenegro. He was educated in Trieste and at the Academy of Louis le Grand in Paris, returning to Montenegro on the assassination of his uncle (Aug. 13, 1860). He took part in the campaign against Turkey of 1862, which, after Austria's intervention, was followed by a prolonged peace. In 1868 he travelled to St. Petersburg (Leningrad) to meet the tsar Alexander II., who received him with favour, and afterwards regularly supplied him with subventions of arms and money, referring to him on a memorable occasion as his "only friend." During the Near Eastern crisis of 1876 (*see* EASTERN QUESTION), Nicholas declared war on the Porte, and winning brilliant successes in this and the following wars at Vučidd, Podgorica and Nikćić, captured Antivari and Dulcigno. The Congress of Berlin (*q.v.*) brought Montenegro formal recognition as a sovereign State and doubled her area, besides giving her an outlet on the sea at Antivari. Nicholas now entered on a long period of peace largely filled with intrigues with and against his son-in-law, Peter, later King Peter I. of Serbia (*q.v.*) regarding a possible later Yugoslav state to comprise both Serbia and Montenegro. On Dec. 19, 1900, Nicholas assumed the title of Royal Highness.

In 1905 he was forced by public opinion, which was revolting against his despotic methods, to grant a constitution. He was at once involved in quarrels with his political opponents, culminating in the scandalous but obscure "Cetinje bomb plot" of 1905. On Aug. 28, 1910, encouraged by Austria, who helped to estrange him further from Serbia, Nicholas assumed the title of king. In the Balkan Wars (*q.v.*) he was the first to declare war on Turkey, but although these wars gave Montenegro an accession of territory, the dynasty lost prestige, its unpopularity and with it the movement for the union of Serbia with Montenegro, increased, In the World War Montenegro threw in her lot with Serbia; Nicholas, however, maintained touch with Austria, from whom he begged a separate peace (Jan. 13, 1916). Op Jan. 19, Nicholas fled to Italy and France. The breach widened between him and his people, and the "Great National Assembly" on Nov. 26, 1918, proclaimed his deposition and that of his dynasty. The old ex-king passed the remainder of his days in Italy. He died at Antibes on March 1, 1921.

A rude but often benevolent despot of the fighting type, Nicholas was also a poet of talent. His works include *Balkanska Tsaritsa* and *Knyaz Arvaniti* (dramas); *Haïdana, Potini Abenserage* and *Pesnik i Vila* (poems), *Skuplijene Pesme* and *Nova Kola* (songs). In Nov. 1860, Nicholas married Milena (1847–1923) daughter of the *voivode* Petar Vukotić. On the death of Nicholas, his eldest son Danilo was proclaimed by the small monarchist party king of Montenegro (Mar. 1, 1921), but abdicated on Mar. 7, 1921, in favour of his nephew Michael, eldest son of Prince Mirko (b. Sept. 1, 1908).

NICHOLAS (1856–1929), Russian Grand Duke and soldier. Nikolai Nikolaievich was born on Nov. 6, 1856, the grandson of the emperor Nicholas I. and first cousin of the emperor Alexander III. Educated at the school of military engineers, he received his commission in 1872, and in the following year, at the early age of 16, entered the military academy. In the war of 1877–78, as a general staff officer for special service, he joined the staff of his father, the very popular Grand Duke Nikolai Nikolaievich (Senr.), who had been appointed commander-in-chief of the Russian forces. He distinguished himself at the crossing of the Danube at Zimnicea on April 15, 1877, and in the attack on the Shipka.

After the war the Grand Duke joined the Guard Hussar Regiment, in which the emperor Nicholas afterwards served, and passed through every stage as officer till appointeci commander in 1884—a position he occupied for 6½ years. He then commanded in succession a brigade and a division, and in 1895 was appointed inspector-general of cavalry.

In 1905 Nicholas was appointed commander-in-chief of the St. Petersburg military district, a post he held till the outbreak of the World War in Aug. 1914.

In the same year (1905) as he was appointed commander-in-chief of the St. Petersburg military district, Nikolai Nikolaievich became the first president of the newly created council of national defence, and he held this position till 1908, when the council was abolished. On the council the Grand Duke worked in close co-operation with General Palitsin, who, in 1908, gave way to General Sukhomlinov as chief of the general staff, the latter, in the following year, replacing General Rediger as minister of war.

From 1908 to 1914 Nicholas took no part in the strategical preparation for the war, the work being delegated by the emperor to General Sukhomlinov and his nominees on the general staff. At the outbreak of war the emperor first intended to take command himself, and actually appointed the grand duke Commander-in-chief of the VI (Reserve) army at St. Petersburg (Leningrad). It was only on the evening of Aug. 1, the day of Germany's declaration of war, that he yielded to the entreaties of his ministers and decided to hand over the supreme command to the grand duke.

Services During the War.—The plan of the Russian general staff consisted of the invasion of East Prussia by a right group (I and II armies), while a left group (IV, V, III and VIII armies) operated against the Austrians in Galicia and a centre group (IX and X armies) assembled at Warsaw to advance on Posen. It was as a result of the decision of the grand duke that this centre group was broken up, the X army being sent north to fill the gap left by the failure in East Prussia, and the IX army sent south to overwhelm the Austrians in southern Poland.

When the Germans came to the rescue of their ally by advancing in Oct. 1914 to the outskirts of Warsaw, the transfer of the Russian armies from left to right in rear of the Vistula, and the concentration of superior forces on the enemy's left or northern flank which compelled his retreat, were masterly movements. If the next German advance, culminating in the operation of Lódz resulting from mistakes by Russian army commanders, definitely removed all possibility of an invasion of Posen, the Russians held on through the winter of 1914–15 to the line of the Narev-Vistula-San-Carpathians, and were only compelled by lack of munitions in the spring and summer of 1915 to retreat to a line that they held substantially through 1916–17.

There was no demand from the fighting men at the front for the change at G.H.Q. which occurred on Aug. 21, 1915, when the emperor announced that he would assume the supreme command.

The grand duke was appointed viceroy and commander in chief in the Caucasus. Up to that time the brunt of the fighting against Turkey had been borne by the British in Gallipoli, the Sinai peninsula and Mesopotamia. The advent of the new commander put new life into the Russians. He pushed forward an expeditionary force under General Baratov through Enzeli and Hamadan to screen Persia from further German penetration and to establish touch with the British troops in Mesopotamia. He collected guns and stores, raised and trained efficient troops and, in spite of immense difficulties in supply, ably assisted by Generals Yudenich and Prjvalski, occupied in three successful offensives all Armenia, including the fortress of Erzerum, the port of Trebizond and the town of Erzinjan. The revolution of March 12, 1917, found the grand duke still in the Caucasus. The emperor's last official act was to nominate him to be once more supreme commander-in-chief. His journey from the Caucasian headquarters at Tiflis to headquarters at Mogilev was a triumphal procession, patriotic demonstrations and crowds of people greeting him at every station on the way; 24 hours after his arrival at Mogilev he received a telegram from Prince Lvov, chief of the provisional government, cancelling his appointment. He spent the next two years in the Crimea, taking no part in politics. At last, in March 1919, he left Russian soil on the British cruiser "Marlborough," and lived quietly near Paris. He died in Jan. 1929. (A. W. F. K.)

NICHOLAS OF DAMASCUS (NICOLAUS DAMASCENUS) (fl. 1st century B.C.), Greek historian and philosopher of Damascus, whose works included a universal history from the time of the Assyrian empire to his own days. He instructed Herod the Great in rhetoric and philosophy, and attracted the notice of Augustus when he accompanied his patron on a visit to Rome. Later, when Herod's conduct aroused the suspicions of Augustus, Nicholas was sent on a mission to bring about a reconciliation. He survived Herod and it was through his influence that the succession was secured for Herod Archelaus; but the date of his death, like that of his birth, is unknown. Fragments of his universal history, his autobiography and his life of Augustus have been preserved, chiefly in the extracts of Constantine Porphyrogenitus. *(See* CONSTANTINE : *Constantine VII.)*

For fragments *see* L. Dindorf (ed.), *Historici Graeci minores* vol. i (1870). The text of his life of Augustus, with Eng. trans. and commentary, was edited by C. M. Hall (1923). F. Navet, *Nikolaus von Damaskus* (1853), contains an account of his life and trans. of the fragments.

NICHOLAS OF LYRA (NICOLAUS LYRANUS) (*c.* 1265–1349), called by Martin Grabmann "the foremost exegete of the Franciscan-Scotistic school," was born at Lire (now Vieille-Lyre) in Normandy. He entered the Franciscan order at Verneuil about 1300, studied at Paris, became a professor before 1309 and taught for many years in the Sorbonne. From 1319 he was provincial of his order in France and in 1325, as provincial of Burgundy, he founded the College of Burgundy at Paris, where he died in the autumn of 1349.

Nicholas' most important writing is the monumental 50-volume *Postillæ perpetuæ* in *universam S. Scripturam,* a commentary on the whole Bible, first according to the literal sense, then according to a mystical or spiritual exposition. This book, the first commentary printed, soon became a favourite manual of exegesis, and some scholars claim that it exerted an important influence on Luther. The prime significance of the work is the author's insistence, against the allegorical interpretations common in his time, on the literal sense as the foundation for all mystical applications. Nicholas also wrote on the Eucharist, the Beatific Vision and other matters, including a book of devotions. (WM. J. B.)

NICHOLAS, SIR EDWARD (1593–1669), English statesman, was born at Winterbourne Earls, Wiltshire, on April 4, 1593, of a Wiltshire family. He was educated at Salisbury grammar school, Winchester college and Queen's college, Oxford. After studying law at the Middle Temple, Nicholas became in 1618 secretary to Lord Zouch, warden and admiral of the Cinque ports, and continued in a similar employment under the duke of Buckingham. He was M.P. for Winchelsea in 1621 and Dover in 1628. In 1625 he became secretary to the admiralty; then in 1626 extra clerk of the privy council with duties relating to admiralty business; and from 1635 to 1641 he was one of the clerks in ordinary to the council. In this situation Nicholas was concerned with the levy of ship money. He had Charles's confidence, became a privy councillor and a secretary of state in Nov. 1641, attended the king at Oxford and was one of the royal commissioners at the treaty of Uxbridge (Feb. 1645). Nicholas helped to arrange the details of the king's surrender to the Scots, though he does not appear to have approved of the step; and he signed the capitulation of Oxford. He went to France, and after the king's death remained on the continent.

Despite his friendship with Sir Edward Hyde, he had little influence with Charles II and two years after the Restoration he was persuaded to resign his secretaryship. He died at East Horsley, Surrey, on Sept. 1, 1669.

Much of Nicholas' correspondence is printed in *The Nicholas Papers, 4* vol. (1886–97) and in W. Bray (ed.), *The Diary and Correspondence of John Evelyn* (1906). *See* also D. Nicholas, *Mr. Secretary Nicholas* (1955). *(R. B.* WM.)

NICHOLAS, NORTHERN or LENIN **LAND** lies in the Arctic sea, about 30 m. N. of Cape Chelyuskin, extending in a north-easterly direction from 77° 50′ N., 99° E. to beyond 81° N. The small Alexis (Little Taimir) and Starokadomski Islands lie at the eastern end of Alexis strait, which separates Nicholas Land from the mainland. This land was discovered in 1913 by the Russian hydrographical expedition in the "Taimir" and "Vaigach" under B. A. Vilkitski. He took possession for Russia and charted the eastern side. In the following year he returned and charted the southern coast. The northern and western sides are unknown. The east coast is much indented and a deep gulf or strait occurs in about 79° N. In the south there is a low plain covered with tundra, but on the east the land is lofty (1,500 ft.) and flat-topped with large valley glaciers. Both sedimentary and volcanic rocks occur, but details are lacking. Water of over 100 fathoms depth lies close to the eastern side.

See papers in *Petermann's Mitteilungen, 60* (1914); *Geographical Journal* (Dec. 1919), and *Geographical Review* (July 1925).
(R. N. R.-B.)

NICHOLS, JOHN (1745–1826), English printer and author, was born at Islington on Feb. 2, 1745. He edited the *Gentleman's Magazine* from 1778 till his death, and in that periodical, and in his numerous volumes of *Anecdotes and Illustrations,* he made invaluable contributions to the personal history of English men of letters in the 18th century. He was apprenticed in 1757 to "the learned printer," William Bowyer, who took him into partnership in 1766. On the death of his friend and master in 1777 Nichols published a brief memoir, which afterwards grew into the *Anecdotes of William Bowyer and his Literary Friends* (1782). *The Literary Anecdotes of the 18th Century* (1812–1815), into which the original work was expanded, forms only a small part of Nichols's production. It was followed by the *Illustrations of the Literary History of the 18th Century, consisting of Authentic Memoirs and Original Letters of Eminent Persons,* which was begun in 1817 and completed by his son John Bowyer Nichols (1779–1863) in 1858. He died on Nov. 26, 1826.

Nichols's other works include: A *Collection of Royal and Noble Wills* (1780); *Select Collection of Miscellaneous Poems* (1782), with subsequent additions, in which he was helped by Joseph Warton and by Bishops Percy and Lowth; *Bibliotheca Topographica Britannica* (1780–1790); with Richard Gough, *The Progresses and Public Processions of Queen Elizabeth* (1788); and the *History and Antiquities of the Town and County* of *Leicester* (8 vols., 1795–1815).

A full memoir of John Nichols by Alexander Chalmers is contained in the *Illustrations,* and a bibliography in the *Anecdotes* (vol. vi.) is supplemented in the later work. *See* also R. C. Nichols, *Memoirs of J. G. Nichols* (1874).

NICHOLS, ROBERT MALISE BOWYER (1893-1944), English poet and writer, the son of J. B. B. Nichols, also a poet, was born on Sept. 6, 1893, and educated at Winchester and at Trinity college, Oxford. In 1914 he obtained a commission in the Royal Field Artillery, and served in France until 1916. From 1918 to 1919 he was engaged on propaganda work in the United States for the Ministry of Information. From 1921 to 1924 he was professor of English literature at the Imperial college, Tokyo. In addition to his published work, he contributed to *The London Mercury* and other periodicals. Nichols died Dec. 17, 1944.

His published work includes *Invocation,* poems (1916); *Ardours and Endurances* (1917); *The Budded Branch* (1918); *Aurelia* (1920); *The Smile of the Sphinx* (1920); *Guilty Souls,* drama (1922); *Wings over Europe,* drama, with M. Browne (1929); *Fisbo,* a satirical poem (1934); *Such Was my Singing,* poems (1942).

NICHOLSON, JOHN (1822–1857), British soldier and administrator of India, son of Alexander Nicholson, a north of Ireland physician, was born Dec. 11,1822, and educated at Dungannon College. He was presented with a cadetship in the Bengal infantry in 1839 by his uncle Sir James Hogg, and served in the first Afghan War of 1839–42; he distinguished himself in the defence of Ghazni, and was one of the prisoners who were carried to Bamian and escaped by bribing the guard upon General Pollock's successful advance. In Afghanistan Nicholson first met Sir Henry Lawrence, who got him the appointment of political officer in Kashmir and subsequently on the Punjab frontier. In 1847 he was given charge of the Sind Sagar district, and did much to pacify the country after the first Sikh War. On the seizure of Multan by Mulraj, he rendered great service in securing the country from Attock, and was wounded in an attack upon a tower in the Margalla Pass, where a monument was subsequently erected to his memory. On the outbreak of the second Sikh War he was appointed political officer to Lord Gough's force, when he rendered great service in the collection of intelligence and in furnishing supplies and boats.

On the annexation of the Punjab he was appointed deputy commissioner of Bannu. There he became a kind of legendary hero, and many tales are told of his stern justice, his tireless activity and his commanding personality. In the course of five years he reduced the most turbulent district on the frontier to such a state of quietude that no crime was committed or even attempted during his last year of office, a condition of things never known before or since. He would go personally to the scene of a crime or a legal dispute and decide the question on the spot. Every man in his district, whether mountain tribesman or policeman, felt that he was controlled by a master hand, and the natives said of him that "the tramp of his war-horse could be heard from Attock to the Khyber." It is little wonder that the natives worshipped him as a god under the title of Nikalsain.

When the Mutiny broke out in May 1857 Nicholson did more than any other single man to keep the Punjab loyal and to bring about the fall of Delhi. When the news of the rising at Meerut arrived, Nicholson was with Edwardes at Peshawar, and they took immediate steps to disarm the doubtful regiments in that cantonment. Together they opposed John Lawrence's proposal to abandon Peshawar, in order to concentrate all their strength on the siege of Delhi. In June Nicholson was appointed to the command of a movable column, with which he again disarmed two doubtful regiments at Phillaur. In July he made a forced march of 41 m. in a single day in the terrific heat of the Punjab summer, in order to intercept the mutineers from Sialkot, who were marching upon Delhi. He caught them on the banks of the Ravi near Gurdaspur, and utterly destroyed them, thus successfully achieving what hardly any other man would have attempted. In August he had pacified the Punjab and was free to reinforce Gen. Archdale Wilson on the ridge before Delhi.

Before Nicholson's arrival the counsels of the commanders before Delhi, like those at Meerut, suffered from irresolution and timidity. As General Wilson's health declined, his caution became excessive, and Nicholson was especially sent by Sir John Lawrence to put more spirit into the attack. His first exploit after his arrival was the victory of Najafgarh, which he won over the rebels who were attempting to intercept the British siege-train from Ferozepur. After marching through a flooded country scarcely practicable for his guns, Nicholson, with a force of 2,500 troops, defeated 6,000 disciplined sepoys after an hour's fighting and thenceforth put an end to all attempts of the enemy to get in the rear of the British position on the ridge. Nicholson grew fiercely impatient of General Wilson's procrastination and at one time was thinking of appealing to the army to set Wilson aside and elect a successor; but at last, on Sept. 13, he forced Wilson to make up his mind to the assault, and he himself was chosen to lead the attacking column. On the morning of Sept. 14 he led his column, 1,000 strong, in the attack on the Kashmir gate and successfully entered the streets of Delhi. But in trying to clear the ramparts as far as the Lahore gate, he undertook a task beyond the powers of his wearied troops. In encouraging them as they hesitated, he turned his back on the enemy and was shot in the back. The wound was mortal; he died on Sept. 23.

His best epitaph is in Sir John Lawrence's Mutiny report:

> Brigadier-General John Nicholson is now beyond human praise and human reward. But so long as British rule shall endure in India, his fame can never perish. He seems especially to have been raised up for this juncture. He crowned a bright, though brief, career by dying of the wound he received in the moment of victory at Delhi. The Chief Commissioner does not hesitate to affirm that without John Nicholson Delhi could not have fallen.

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NICHOLSON, JOSEPH SHIELD (1850–1927), British economist, son of an Independent minister, was born on Nov. 9, 1850 at Wrawby in Lincolnshire, and educated at Edinburgh university and Trinity college, Cambridge, where he won the Cobden Prize in 1877 (the first award), and again in 1880. After studying at Heidelberg and at London university, he became a private tutor at Cambridge.

In 1880 he went to Edinburgh university as professor of political economy. He wrote more than 20 volumes on economics, of which the chief are: *The Silver Question* (1886), *Money and Monetary Problems* (1888), *Bankers' Money* (1903), *The Tariff Question* (1903), *The History of the English Corn Laws* (1903), *Project of Empire* (1909) and *Principles of Political Economy* (3 vols., 1893, 1897, 1901). In all his economic writings he advocated the principles of Adam Smith. He resigned his chair in 1925 and died in Edinburgh on May 12, 1927.

NICHOLSON, SIR WILLIAM NEWZAM PRIOR (1872–1949), English painter, engraver, theatre designer and illustrator, was born at Newark-on-Trent on Feb. 5, 1872. At Herkomer's school. London, he met James Pryde, with whom he collaborated under the pseudonym "J. and W. Beggarstaff" to produce strikingly bold posters (1893–98). He studied at the Académie Julian, Paris. 1889–90. His illustrations to *An Alphabet, An Almanack of Twelve Sports* and *London Types* in 1898 and the woodcut "Portrait of Queen Victoria" earned him wider recognition. He made sets for *Peter Pan* in 1904. Nicholson's paintings, whether landscapes, portraits or still life, are characterized by solid construction and heavy colour, as in "Girl With the Tattered Glove" (1909, Fitzwilliam museum, Cambridge), "Mushrooms" (1940, Tate gallery, London) and "The Stack, Hoar's Fields" (1925). He was knighted in 1936, and died on May 16, 1949, at Blewbury, Berkshire.

His eldest son, BEN NICHOLSON (1894–), leading English abstract painter, was born on April 10, 1894, at Denham, Buckinghamshire. After studying briefly at the Slade School of Art he traveled extensively in Europe during 1911–18 and held his first one-man show in London in 1922. From 1920, under the influence of Cubism and the De Stijl movement, he began his severe, geometrical designs, notable for an icy brilliance of colour, which culminated in the series of constructions "White Reliefs" of 1935–39 (one of 1935 in the Tate gallery). He was a member of Abstraction-Création, Paris (1933–35), and coedited *Circle* (1937).

See Lillian Browse, *William Nicholson,* with bibliography **(1956)** ; Sir Herbert Read, *Ben Nicholson,* etc., 2 vol. **(1948, 1956)**.

(D. L. FR.)

NICIAS (d. 414 B.C.), a soldier and statesman in ancient Athens, inherited from his father Niceratus a considerable fortune invested mainly in the silver mines of Laurium. Evidence of his wealth is found in the fact that he had no less than 1,000 slaves whom he hired out. He was several times colleague with Pericles in the strategia, and on Pericles' death became the leading advocate of the Periclean policy of pinpricks (*epiteichismoi*) and concentration on the Thraceward region against the offensive policy of the democrats under Cleon. At the amphibious tactics of the *epiteichismos* he was unsurpassed. Having been largely responsible for the "peace of Nicias" (421), he appears in the rather obscure history of the following years as the leader of the peace party, in opposition to Alcibiades. In 415, much against his will, he was appointed leader of the Sicilian expedition with Alcibiades and Lamachus; and the recall of Alcibiades, followed by the death of Lamachus, left him in sole command. Demosthenes came out with reinforcements early in 413 and took charge for a brief space, but at the end the main responsibility for the delay, and so perhaps for the disaster. rests with Kicias. He was put to death during that year by the Syracusans.

NICKEL (symbol Ni), a grayish-white metallic element, hard, tough and markedly resistant to oxidation and corrosion. It is widely familiar because of its use in coinage, but has become more important for its many domestic, industrial and military applications, which during the period 1939–54 consumed more than 250,000,000 lb. of the element each year. The metal itself is well suited for direct use in many kinds of mechanical equipment, but it is more commonly employed in the form of alloys. Use in this form dates from prehistoric times. for early man fashioned some of his implements from meteoric iron, which normally contains 5% to 15% nickel. It was also used in alloy form by the Chinese in ancient days. but nickel itself was not isolated until 1751, when A. F. Cronstedt prepared an impure sample from an ore containing niccolite (NiAs). An ore of this same type had earlier caused copper and silver miners in Saxony considerable trouble because it yielded a brittle unfamiliar product. They came to refer to it as "kupfernickel," after "Old Nick" and his mischievous gnomes, and Cronstedt applied their name to his new element. His results were confirmed in 1775 by T. O. Bergman, and the name nickel soon became generally accepted. About a century elapsed before nickel was mined in quantity for a growing world market.

Occurrence and **Production.**—Nickel is the 24th element in order of abundance, and constitutes about 0.016% of the earth's crust. It is a fairly common minor constituent of igneous rocks but there are singularly few deposits which qualify with respect to concentration. size and accessibility for commercial interest The most important sources of the metal are the mixed sulfide ores containing pentlandite, $(Fe,Ni)S$; nickel-bearing pyrrhotite. Fe_5S_6 to $Fe_{16}S_{17}$; and nickel-bearing chalcopyrite. $CuFeS_2$. Ores of this type are mined on a large scale in Canada (Sudbury, Ont.. and Lynn Lake, Man.), and to a lesser extent in the Petsamo district of Finland, ceded to the U.S.S.R. during World War II. Minor deposits of nickel-bearing sulfide ores occur in Norway, China, India, Alaska and the United States (Missouri), some production being achieved from the last source. Oxide ores ranging from garnierite, $H_2(Ni,Mg)SiO_4$, to nickel-bearing iron oxide have become an increasingly important source of the metal since World War II. They are mined in New Caledonia. Cuba and the United States (Oregon), and also occur in the Philippines, Indonesia, Brazil and Venezuela. Selected production figures in millions of pounds of nickel are summarized in the following table:

Metallurgy.—The extractive metallurgy is fairly complex and costly; it underwent rapid changes during and immediately following World War II. The nickel-bearing sulfide ores of Canada, which are embedded in a matrix of basic rock, are first ground and carried through a series of flotation and magnetic separation processes. In the operations of the International Nickel company, three distinct concentrates are isolated for separate processing: nickel-bearing iron sulfide, copper-bearing nickel sulfide and copper sulfide. The nickel-bearing iron sulfide is desulfurized in a fluid-bed roaster, reduced with carbon monoxide and hydrogen in a rotary kiln and then leached with ammonia-carbon dioxide solution to remove the nickel. The residue from the extraction is sintered (formed into solid mass without completely melting) and sold as iron ore pellets to the steel industry. The nickel is recovered as a basic carbonate when the final solution is treated with steam. The copper-bearing nickel sulfide is partially desulfurized in multiple-hearth roasters *(see* COPPER: *Commercial Production Processes: Roasting),* melted and cooled under specially controlled conditions which allow subsequent magnetic and flotation separations into three concentrates: nickel sulfide. copper sulfide and precious metals. The nickel sulfide is sintered for direct sale to the alloy markets, and for further refining, both electrolytically and by the carbonyl process. *(See* CARBONYLS, METAL.)

Nickel-bearing sulfide ores are also treated to a lesser extent by the Hybinette process which involves selective leaching of the copper with sulfuric acid from a nickel-copper matte derived from a flotation concentrate. The crude products are refined by a combination of electrolytic and cementation techniques *(see* CEMENTATION). Flotation concentrates from nickel-bearing sulfide ores are also leached directly in water or ammonia under aeration at elevated pressures and temperatures. The nickel in the resulting salt solutions is recovered directly as a salable powder by treatment with hydrogen gas at elevated temperatures and pressures.

The silicate ores of New Caledonia are largely treated by a matte smelting process. The ore is fused with calcium carbonate, calcium sulfate and coke to yield a nickel-iron sulfide concentrate which is further refined by smelting to eliminate the iron in a siliceous slag, and yield ultimately fairly pure nickel metal. Some of the New Caledonia ores, as well as those from Oregon in the United States, are treated by electric smelting to yield ferronickel which can be sold directly to the steel industry.

Cuban oxide ores are reduced in multiple-hearth furnaces and then selectively leached with ammonia-carbon dioxide solutions. The ammonia is recovered efficiently for reuse by steaming the solution which results from leaching, while the nickel is simultaneously precipitated as the basic carbonate. The latter is calcined to nickel oxide for direct sale, or for further processing to nickel-oxide sinter or ingot nickel. Extraction of nickel from the laterite ores of Cuba by direct leaching with sulfuric acid, followed by sulfide precipitation and chemical refining, has successfully passed pilot-scale study.

Physical Properties.— Nickel has an atomic number of 28 and occurs in Group VIII of the periodic arrangement of the elements, after iron and cobalt and above palladium and platinum. It resembles iron in strength and toughness but is more like copper, which follows it with atomic number 29, in resistance to oxidation and corrosion. This combination of useful properties accounts for many of its applications. Nickel has an atomic weight of 58.71 and consists of the following stable isotopes:

Mass number	58	60	61	62	64
Per cent abundance	67.76	26.16	1.25	3.66	1.16

Radioactive isotopes with half lives ranging up to about 8×10^5 years have been prepared. Nickel has the following physical constants:

Density, g./cm.^{3}	8.90 (20° C.)
Melting point, °C.	1455
Boiling point, °C.	2900
Specific heat, cal./g./° C.	0.1095 (18° C.) .1340 (1360° C.)
Latent heat of fusion, cal./g.	73
Coefficient of expansion, cm./cm./° C.	0.0000129 (25°–100° C.) .0000135 (375°–1000° C.)
Thermal conductivity, cal./cm.^{2}/sec./° C./cm.	0.142 (18° C.)
Hardness, Brinell number	85 (99.99% Ni, annealed) 210 (99.4% Xi, cold-rolled)
Atomic radius, Å (Angstrom unit $= 10^{-8}$ cm.)	1.24
Ionization potential, volts	7.61 (I), 18.2 (II)
Electrode potential, molal, volts	+0.231 (25° C.)
Electrical conductivity, basis copper = 100%	16%
Resistivity, ohm-cm.	7.8 (20° C.)
Magnetic permeability, μ,	110 (initial) 600 (maximum)
Curie temperature, ° C.	360
Tensile strength, lb./in.^{2}	46,000 (99.99% hTi, annealed) 105,000 (99.4% Ni, cold-rolled hard temper)

Uses of Nickel in Alloys and as the Metal.— More than 50% of the nickel produced is normally incorporated in alloys with iron. Nickel steels (0.5%–10% nickel) possess special properties of strength and toughness and are used in great quantities in the manufacture of automobiles, trucks, buses, ships, airplanes, railway locomotives and cars and special parts for most types of transportation equipment. They are also used in agricultural equipment, machine tools, mining and excavating machinery, oil well and refinery equipment, steel mill machinery, power-generating equipment and many types of steel construction. Stainless steels (2%–26% nickel) are resistant to corrosion, tarnish and stain and are used extensively wherever these properties in association with strength and toughness are required, as, for example, in transportation equipment such as streamlined trains, airplanes and truck tanks; kitchen equipment, tableware and cooking utensils: and in equipment for the chemical and process industries. textile and paper mills and oil refineries. Heat-resistant steels (2%–26% nickel) are used to meet the high-temperature requirements of furnace and other equipment parts for the glass, ceramic, metal and chemical manufacturing industries. Many other alloys with iron such as the nickel cast irons (1%–5% nickel) meet special needs in the manufacture of metal equipment. About 25% of the nickel produced is used in high nickel alloys. Those with copper (65%–70%) have desirable physical properties and are highly resistant to corrosion. They are used in building, chemical and food-processing equipment and in marine and power-generating equipment. Considerable quantities are also incorporated in cupronickel alloys (2.5%–45% nickel), which are used for condenser tubes and salt-water lines, and in heat-resisting alloys (commonly 78% nickel, 14% chromium, the balance iron and minor elements). They retain their strength, toughness and resistance to oxidation and corrosion at high temperatures, and are therefore particularly useful for jet engine parts. Electrical resistance alloys (80%–85% nickel) are used in heating elements, pyrometers, rheostats and other electrical controls. Magnetic alloys (29%–90% nickel), nonmagnetic alloys (8%–27% nickel), permanent magnet alloys (14%–32% nickel), high permeability alloys (45%–80% nickel) and controlled expansion alloys (30%–60% nickel) have been developed for many diverse applications. Nickel coinage (25%–100% nickel) has been adopted in many countries and the so-called nickel silvers (10%–30% nickel, the balance primarily copper and zinc) are used in many familiar articles such as plated silverware stock, slide fasteners, decorative hardware and jewelry. Many other alloys are in current usage and new nickel alloys are constantly being developed for changing industrial needs. *(See* ALLOYS; STEELS, ALLOY.)

About 20% of the nickel produced is normally used directly as the virtually pure metal. It is employed in equipment for the food-processing, chemical and radio industries. Nickel, as well as stainless steel and other nickel alloys, is used to clad steel and provides, in an economical way, a protective coating which is markedly effective against the corrosive action of chemicals. It is similarly used in electroplating, where it is particularly useful to secure protection from atmospheric corrosion and is kept free from tarnish by a thin layer of chromium.

Chemical Properties and Compounds.— The 28 orbital electrons of nickel are distributed as follows: $1s^2$, $2s^2$, $2p^e$, $3s^2$, $3p^0$, $3d^8$ and $4s^2$. The two electrons in the highest energy level ($4s$) are readily yielded to form a stable, doubly charged cation. The electrode potential for this reaction is +0.231 v., placing nickel above hydrogen in the electromotive series in the following position: Co, *Ni*, Sn, Pb, H. The metal reacts slowly with strong acids under ordinary conditions to liberate hydrogen and form Ni^{++}. The salts formed are slightly acid and yield a precipitate of hydrous nickel oxide when the pH of dilute solutions is raised above about 6.7 The metal is uniquely resistant to the action of alkalies and is frequently used for containers to handle concentrated solutions of sodium hydroxide. The element exhibits only a minor tendency to assume the univalent or tervalent states and such ions are not stable in aqueous solution. The third shell contains only 16 electrons, lacking 2 of the stable inert gas arrangement, and many of the compounds involving special valence forces can be attributed to this electronic structure.

Nickelous oxide, NiO, occurs in nature in small quantities as the mineral bunsenite and can be prepared by heating a variety of nickel compounds in air. It can be reduced to nickel by heating with carbon, hydrogen and other reducing gases. It is soluble in strong acids unless it contains impurities or has been sintered, in which case fusion with $KHSO_4$ may be necessary. Nickel oxide is used in the preparation of nickel alloys, in ground-coat enamels for its beneficial effects on adherence and in colouring ceramics and glass. Nickelous hydroxide, $Ni(OH)_2$, is obtained as a light-green precipitate when nickel salts are treated with alkalies. It is readily soluble in acids and ammonium hydroxide, yielding in the latter case complex ammine ions. It may be reduced with hydrogen at sufficiently low temperatures to yield active nickel catalysts and is incorporated in the Edison nickel-iron alkaline storage battery, where it yields higher valent hydrous oxides when the battery is charged. Basic nickel carbonates result from the reaction between nickel salts and alkali carbonates. If a mixture of alkali and hypohalite is used, higher hydrous oxides of variable composition are yielded as black precipitates. These products are all converted to nickelous oxide, NiO, on complete dehydration and yield exclusively the double-charged nickel cation on solution in acids. Nickel forms a related series of compounds with sulfur. In addition to the commercially important mixed sulfide ores already mentioned, such minerals as millerite (NiS) and polydymite (Ni_3S_4) belong to this group of compounds. Nickelous sulfide, NiS, is highly insoluble and is readily precipitated when nickel salts are mixed with alkaline sulfide in aqueous solution. Other sulfides, such as Ni_3S_2, can be obtained by direct reaction of sulfur and sulfur compounds with the metal and its derivatives.

Nickel sulfate is the most familiar salt. It can readily be prepared by dissolving nickel metal or nickelous hydroxide in sulfuric acid. It is quite soluble in water (140 g. Ni per 1,000 ml. water at 0° C., 761 g. at 100° C.) and can he purified by recrystallization, to yield the hexahydrate $NiSO_4.6H_2O$. This salt is widely employed in plating baths and in dips for steel vessels which are to be coated with vitreous enamel and commonly serves as a reagent for the preparation of nickel catalysts. The nickel halides and nickel nitrate can be similarly prepared and purified. Nickel chloride crystallizes as the hexahydrate, $NiCl_2.6H_2O$, and becomes anhydrous when heated above 140° C. Nickel nitrate hexahydrate, $Ni(NO_3)_2.6H_2O$, dissolves in its own water of crystallization at about 57° C., readily dehydrates at higher temperatures and decomposes at about 300° C. to yield NiO in air, or pyrophoric nickel when heated in a reducing atmosphere. It is used in the preparation of special nickel catalysts and powders and, along with the chloride, is also used to some extent in nickel plating. Most nickel salts form double compounds with other salts, and co-ordination complexes with ammonia. Nickel also forms co-ordination complexes with alkali cyanides and in this behaviour exhibits properties similar to those of palladium and platinum.

Nickel readily forms salts with organic acids, either by direct reaction between nickelous hydroxide and the acid or by double decomposition between suitable salts. Nickel formate, $Ni(HCOO)_2$, which is one of the most familiar of these, is unique in that it decomposes at about 240° C. to give off hydrogen and carbon dioxide, leaving a residue of finely divided nickel which is particularly useful as a hydrogenation catalyst. The higher fatty acid salts, such as the stearate and oleate, are water insoluble and exhibit colloidal properties typical of the metal soaps when dispersed in organic liquids.

Nickel forms a series of compounds in which co-ordination or secondary valence forces are involved in addition to those of the usual salt structure. The highly insoluble, striking red derivative with dimethylglyoxime, commonly precipitated in nickel analyses, is a characteristic inner-complex compound involving a chelate ring. This derivative is nonpolar in character, highly insoluble in water, but somewhat soluble in chloroform and other organic solvents. It sublimes without decomposition when heated *in vacuo,* but is readily converted quantitatively to NiO on strong heating in air.

Nickel carbonyl, $Ni(CO)_4$, is an unusual compound in that it contains a neutral nickel atom surrounded by four co-ordinately bound carbonyl groups. It can be prepared by treating finely divided metallic nickel with carbon monoxide; sulfur acts as a catalyst for this reaction. The product is a colourless mobile liquid with a high vapour pressure and is poisonous if inhaled. It boils at 43" C. and begins to decompose at 60° C. or less, depending on the conditions, to metallic nickel and carbon monoxide. A fine nickel powder may be prepared in this manner, or pellets may be built up on nuclei of nickel as in the Mond process. A bright nickel mirror or nickel plate may also be obtained and nickel carbonyl can serve as a source of reactive carbon monoxide in certain organic syntheses. *(See* CARBONYLS, *METAL.)*

Analytical.— Nickel is precipitated in the ammonium sulfide group along with cobalt, manganese, zinc and iron in systematic analyses. The nickel and cobalt sulfides remain as undissolved residue after the precipitate is extracted with dilute hydrochloric acid. Nickel may be identified by its red precipitate with dimethylglyoxime, or its brown borax bead. In quantitative analysis nickel is usually isolated and weighed as the dimethylglyoxime complex. It may also be determined by titration with potassium cyanide solution, electrolysis of a strongly ammoniacal solution, or polarographically.

Uses of Nickel Compounds.— Nickel compounds have been used mainly in electroplating, in the production of nickel catalysts, in ground-coat enamels, in storage batteries of the Edison type and in the production of special nickel powders. Many nickel compounds exhibit insecticidal, fungicidal and bactericidal action, but have not received wide practical use because of the availability of effective cheaper materials. Ingested nickel is relatively nontoxic and any quantities that might be picked up incidentally through the use of nickel or nickel-alloy cooking utensils or in fats hydrogenated over nickel catalysts are considered to be without physiological action.

Nickel Catalysts.— Substantially more than 2,000,000 lb. of the metal were used in catalytic applications each year from 1949 to 1954. Catalytic nickel can be prepared by many different methods. Nickelous hydroxide and basic carbonates, nickel nitrate, formate and various other organic compounds yield, on thermal decomposition at moderate temperatures in a reducing atmosphere, finely divided nickel in a highly active form. Nickel sulfate and other soluble salts are frequently the starting reagent. The precipitates obtained when they are mixed with alkalies in aqueous solution, frequently in admixture with carrier materials such as diatomaceous earth, are washed, dried and reduced. Nickel formate yields active nickel directly when it is decomposed without access to air, such as under oils which are to be treated. Nickel alloys containing a metal which can be selectively dissolved away, such as the nickel-aluminum preparations of M. Raney which yield on treatment with sodium hydroxide soluble sodium aluminate and an active nickel residue, are commonly employed. Nickel catalysts are most frequently utilized in hydrogenating unsaturated organic compounds. The most familiar application is the hydrogenation of fats and oils, in the process known as fat hardening. A fraction of 1% of active, finely divided nickel suffices to catalyze the addition of hydrogen to unsaturated compounds in vegetable, animal and fish oils, converting them from liquids to solids with more desirable physical properties and greatly improved chemical stability. The nickel is recovered by filtration and may be re-used or may be employed in continuous processes. Many millions of pounds of natural oils are treated annually in this manner for use in edible products such as shortenings and oleomargarine, in soaps and numerous industrial preparations. Nickel catalysts are also extensively used in the synthesis of organic chemicals and pharmaceuticals, in petroleum chemistry and gaseous fuel production. Although the quantity of nickel used in chemical operations is dwarfed by the tonnages which go into structural applications, it has become a reagent of great importance in chemical industries

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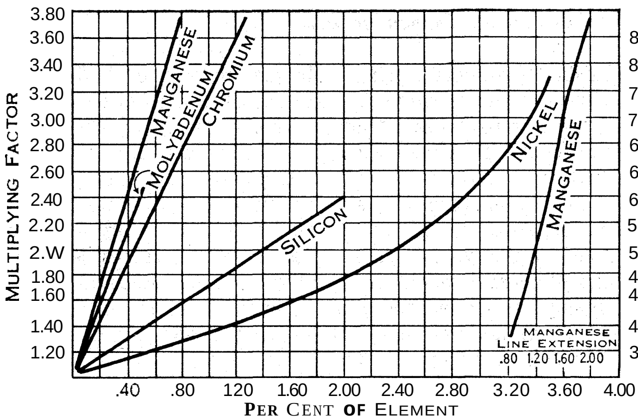
NICKEL-CHROMIUM STEELS, a series of alloys of iron, nickel (1%–4%), chromium (0.40%–1.75%) and carbon (0.05%–0.60%), constitute one of the oldest and most widely used classes of low-alloy steels. (For high-alloy nickel-chromium steels see STAINLESS STEEL.) Nickel, which stabilizes austenite, a noncarbide constituent of steel, is added to steel to increase strength and toughness. with a moderate effect on hardenability. Chromium unites with carbon to form complex carbides and increase hardenability greatly if carbon (above 0.10%) is present.

The effect of nickel, chromium and other elements on the hardenability of steel is illustrated in fig. 1.



BY COURTESY OF AMERICAN IRON & STEEL INSTITUTE

FIG. 1.— HARDENABILITY MULTIPLYING FACTORS FOR A VARIETY OF ALLOYING ELEMENTS

The low-alloy grades of nickel-chromium steels (1.0% to 2.0% nickel and 0.5% to 1.0% chromium) have hardening characteristics similar to those of other low-alloy steels. They are hardened by water quenching up to 0.40% carbon and oil-quenched with higher carbon contents. The higher-alloy grades (3.00% to 4.00% nickel and 0.50% to 2.00% chromium) may be air- or oil-quenched, depending on the composition and size of cross section.

The effect of nickel and chromium on the physical properties of air-cooled, hot-rolled 0 20% carbon steel for a 0.05 to 0.75 in. section is illustrated in fig. 2.

Kickel-chromium steel may be produced in an electric or open-hearth furnace. Nickel is not oxidized in the molten bath and therefore yields 100% recovery (see NICKEL STEEL). Chromium presents a different problem because it is oxidized and enters the slag under normal basic open-hearth operations.

It is, therefore, not recovered from scrap in this operation, and additions must be made in the bath after it is thoroughly deoxidized or to the ladle during the tap. Recovery of chromium is possible, however, in the electric furnace with proper slag manipulation; that is, using a reducing slag or adding silicon or chrome silicide (reducing agents) to the furnace bath following an oxidizing condition to reduce the Cr_2O_3 in the slag to chromium and return it to the metal portion. Nickel-chromium steel may also be made in an acid open-hearth or acid electric furnace, using raw materials free from undesirable elements that cannot be removed by these processes. Nickel-chromium steels may be poured into ingots or castings; and the usual deoxidizer, as in nickel steel, is silicon, which is added in the ladle to about 0.25% of the final chemical analysis of the heat.

Ingots are stripped and placed in soaking pits as soon as they are solidified to prevent cooling cracks.

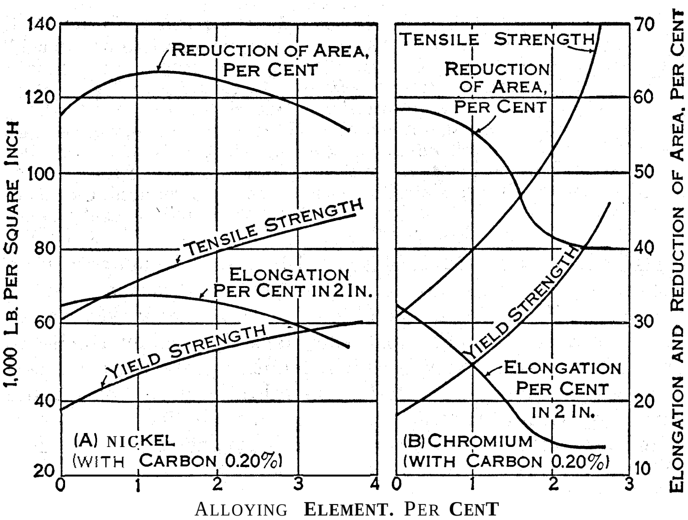


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FIG. 2.— EFFECT OF (A) NICKEL AND (B) CHROMIUM ON THE TENSILE PROPERTIES OF ROLLED CARBON STEELS

Semifinished products, such as blooms, slabs and shapes, are stacked close together to prevent cooling cracks. Nickel-chromium steels are subject to flakes or hair cracks, as are many other air-hardening steels. Thorough deoxidation, slow pouring at correct temperatures and slow heating and cooling assist in avoiding flakes.

Nickel-chromium steels are used for important parts that are to be case-hardened or for highly stressed forgings. They are also widely used for heavy castings, such as those for bridges, locomotives and rolling-mill machinery, and for abrasion-resisting castings, such as power-shovel teeth and impact hammers.

Table I shows a range of about 60 A.I.S.I. and S.A.E. nickel-chromium steels used in the United States.

Table I.—Range of A.I.S.I. and S.A.E.† Standard Nickel-Chromium Open-Heartlz and Electric Furnace Steels*

No. (Series)	C	Ni	Cr	Mo
A.I.S.I. 3100	0.13/0.53	1.10/1.40	0.55/0.90	—
S.A.E. 3200	.10/ .55	1.50/2.00	.90/1.25	—
A.I.S.I. 3300	.08/ .19	3.25/3.75	1.40/1.75	—
S.A.E. 3400	.10/ .55	2.75/3.25	.60/ .95	—
A.I.S.I. 4300	.15/ .43	1.65/2.00	.40/ .90	0.20/0.30
A.I.S.I. 8600	.13/ .65	.40/ .70	.40/ .60	.15/ .25
A.I.S.I. 8700	.18/ .53	.40/ .70	.40/ .60	.20/ .30
A.I.S.I. 9300	.08/ .20	3.00/3.50	1.00/1.40	.08/ .15
A.I.S.I. 9400	.35/ .48	.30/ .60	.30/ .50	.08/ .15
A.I.S.I. 9700	.45/ .67	.40/ .70	.10/ .25	.15/ .25
A.I.S.I. 9800	.38/ .43	.85/1.15	.70/ .90	.20/ .30

*American Iron and Steel Institute
†Society of Automotive Engineers.

Steels of the 3100 series, such as 3115 and 3120, are low-cost carburizing grades used for piston rings, automotive power train gears, oil-well-bit reamer cutters and many other small, case-hardened parts. The S.A.E. 3200 steels containing 2% nickel and 1% chromium are most often used in the high-carbon ranges. These steels are superior to the 3100 series in tensile properties and are used for automobile drive and axle shafts, master connecting rods of radial aircraft engines and many highly stressed keys and pins.

Steels of the A.I.S.I. 3300 series, containing around 0.30% or 0.40% carbon, develop mechanical properties superior to those of the lower alloy content nickel-chromium steels, particularly in sections over $3\frac{1}{2}$ in. They are therefore used extensively for forgings and bars that require rigid mechanical properties, such as large rocker arms and connecting rods. The S.A.E. 3400 series steels exhibit excellent resistance to fatigue, combined with good strength and ductility, which is especially valuable in parts likely to be subject to occasional overstressing from vibration or other causes.

A.I.S.I. 3450 is used for heavy-duty gears of medium section in machine-tool construction.

Many nickel-chromium steels have been developed containing small additions of molybdenum, which are more complex steels (see table) with outstanding properties. The addition of molybdenum increases depth-hardening properties which makes it possible to develop strength and hardness in large sections equal to those secured in small sizes of other steels. Another characteristic of the nickel-chromium-molybdenum steels that contributes to their usefulness is high-hardness-machinability properties. Some compositions may be machined with Brinell hardnesses exceeding 400. These steels also show high resistance to creep up to about 1,000° F., and find application in valves and fittings in steam power plants.

Steels with about 0.55% carbon, 0.65% manganese, 2.00% nickel, 0.90% chromium and 0.20% molybdenum are used for roller bearings where ductility is required along with high hardness and fatigue resistance.

See also Nickel; Alloys; Iron and Steel.

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(N. B. Mr.)

NICKEL SILVER, comprises a range of alloys of copper, nickel and zinc which are silvery in appearance but contain no silver. Its composition varies from 7% to 30% nickel, the alloy most widely used being "18% nickel silver" (18% nickel, 62% copper, 20% zinc). In general the zinc content is lowered as the nickel is increased, the copper content varying between 53% and 63%.

The importance of these alloys lies in their colour, ductility, good mechanical properties and suitability for working in a wide variety of cast, rolled and extruded or drawn shapes. The addition of 1%–2% lead improves machining properties. Such alloys resist corrosion better than does brass but tarnish slowly through the action of sulfur in the air. Their colour ranges from nearly white in the 30% alloy to pale brassy yellow in the alloys with low nickel content.

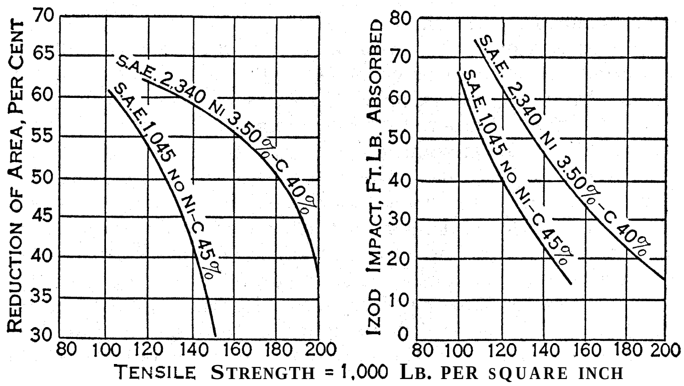
A natural alloy known as paktong (white copper), smelted by the Chinese from copper-nickel ores, was one of the first alloys used by man. It was later improved by the addition of zinc ores and was imported into Europe by the East India company. Not until the 1840s was the alloy made in Europe by mixing the three metals and it was known as German silver until 1914. After an electroplating plant was set up in Birmingham in 1844 German silver was found very suitable as a basis for silver plating.

Nickel silver is used extensively for electroplated table and ornamental silverware (being the base of E.P.N.S.), for jewelry and fancy goods, for architectural and ornamental metalwork, for some food and chemical equipment and for marine and plumbers' fittings.

In hard-rolled strip form it is used for spring elements, especially in electrical and telephone relays. (P. E. G.)

NICKEL STEEL. Nickel steel was first produced by J. F. Hall of England and M. Marbeau of France about 1885, each working independently. The grades commercially used are an alloy of nickel (0.20%–5.00%), carbon (0.10%–0.60%) and the remainder iron. The primary reason for adding nickel to steel is to increase its strength, toughness, depth hardness, and resistance to fatigue. These properties may be gained with small percentages of nickel (often referred to as an austenite former), which lower the eutectoid ratio (1% of nickel = 0.042% carbon) and tend to suppress transformation of austenite during cooling. In effect this results in a full-hardened steel with great strength and toughness, even after slow cooling (see fig. 1), which is not possible with ordinary carbon steel.

Higher percentages of nickel than those specified above are not used commercially in nickel steel (see STAINLESS STEEL) because a martensitic structure, such as 0.40% carbon and 7% nickel, will result which has low elongation and shock-resistant values and is difficult to work and machine.



BY COURTESY OF THE INTERNATIONAL NICKEL CO., INC.

FIG. I.— (LEFT) NICKEL STEELS OIL-QUENCHED; (RIGHT) CARBON STEELS WATER-QUENCHED

Nickel steel may be produced in the electric or open-hearth furnace in the same manner as carbon steel, except that cleaner scrap is generally used and greater control exercised because of the economic risks. Nickel is not oxidized in the molten bath. It is, therefore, completely recovered from nickel-bearing scrap, and nickel may be added to meet specification early or late during the making of the heat.

Nickel steel may be teemed into ingots or castings; and the usual deoxidizer is silicon, which is added in the ladle to about 0.25% of the final chemical analysis of the heat. Ingots are stripped as soon as solidified and placed immediately in soaking pits to prevent cooling cracks.

The hot-working temperatures vary slightly from 2,200° F., depending on the chemical composition. Blooms, slabs, plates and shapes are stacked close together and protected from drafts while cooling. Surface imperfections are removed from nickel steel in the semifinished state and in the finished state if permitted by the user.

Industrial Uses.—By using high-strength steel, structures can generally be lightened in weight; for this reason, nickel steels and other alloy steels are widely used in the automotive and railroad industries. It is estimated that the U.S. automotive industry alone consumes 60% of all alloy-steel bar stock used in the country for the production of gears, shafts, roller bearings. nuts, bolts and various forgings. The weight saving over carbon steel by the use of nickel-alloy steel may be as much as 50%. For example, the weight of the entire rear-end assembly of an automobile may be reduced one-half by using smaller axles, housings and bearings of nickel steel and at the same time be as strong as twice its weight of carbon steel.

In steam locomotives, nickel steel was used for axles, boilers and

TABLE I.—Ejects of Nickel on Hardness and Low Temperature Strength Using a 0.20% Carbon Normalized Steel

Nickel (%)	Brinell hardness	Charpy impact resistance in ft.-lb at	
		Room temperature	-50° F.
0.0	127	80	7
1.0	146	94	30
2.0	155	88	35
3.0	168	88	40
4.0	187	75	50

firebox plates and frame castings. In diesel locomotives it is used for gears, generator roofs and side sheets and frames. In marine propulsion, such steels are used for shafts and in reduction-gear assemblies. In aircraft it is used for landing-gear parts and power-transmitting parts of reciprocating engines. Nickel steel was chosen for the forging of the world's largest supersonic wind tunnel at the air force research centre at Tullahoma, Tenn., with the following composition 0.28% carbon, 0.65% manganese, 2.85% nickel, 0.35% molybdenum and 0.07% vanadium. Nickel steel has also been used in long-span bridges to reduce dead weight and increase the pay load (for example, the George Washington bridge across the Hudson river at New York city and the San Francisco-Oakland bridge).

Although the greater portion of nickel steel is employed for rolled or forged products, a generous quantity is used for castings. Cast-nickel alloys respond to heat treatment and give high values for strength and hardness.

A few uses are railroad passenger-car truck frames, rolling-mill rolls, heavy-cast machinery gears, crusher-jaw castings, impact hammers and power shovels.

One of the outstanding characteristics of nickel steels is resistance to embrittlement at low temperatures, for which reason it is utilized in chemical equipment for subzero operations. This fact, plus the effect of nickel on hardness, is shown in Table I.

Table II illustrates the wide range of these steels used in the United States.

Steel A is an inexpensive water or oil hardening steel for parts of moderate importance, steel B can be oil-quenched direct from the carburizing heat for a tough core and file-hard case; it has good machining properties and is widely used for roller bearings, gears, piston pins and drive shafts. Steel C usually is given a more elaborate heat treatment for a strong, tough core; it is used for gears, shafts, and machine parts requiring extra toughness as well as surface hardness and constancy of dimension. Steel D is hard to work but after proper case hardening gives parts having extreme hardness and resistance to shock; examples are aircraft en-

TABLE 11.—Range of Analyses of Nickel-Bearing Steels

	Low-nickel		Medium-nickel	High-nickel
	A (%)	B (%)	C (%)	D (%)
Carbon	0.10–0.40	0.06–0.43	0.10–0.50	0.09–0.20
Manganese . . .	.30–1.20	.25– .90	.40– .90	.40– .60
Nickel	.20–1.00	1.40–2.00	3.25–3.75	4.50–5.25
Molybdenum . . .	—	.15– .30	None or .20– .30	—

gines, crankshafts, truck, bus and tractor transmission, and differential gears.

Great strides had been made by the 1960s in finding substitutes for nickel in steel. Manganese, boron and nitrogen had been proved possible substitutes. Many high-nickel alloys had been developed containing up to 95% nickel. Some uses of these are lead in wire for light bulbs and electron tubes, thermocouples, low-coefficient-of-expansion material, alloys that resist chemicals and other corrosive mediums and magnets.

See also NICKEL.

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NICOBAR ISLANDS, a group of 12 inhabited and 7 uninhabited islands in the Bay of Bengal, between Sumatra and the Andaman Islands (*q.v.*). The Andaman and Nicobar Islands together constitute a territory of India.

The aggregate area of the Nicobar Islands is 627 sq.mi., Great Nicobar (*Loöng*), the largest and southernmost of any size, covering 333 sq.mi. Principal of the central group of islands are Camorta and Nankauri (Nancoury), between them being a landlocked shelter called Nankauri harbour. Chief island of the northern group is Car Nicobar (Pu), area 49 sq.mi., on which is the headquarters of the administration. Some of the islands have mere flat coral-covered surfaces; others, again, are hilly, the Great Nicobar rising to 2,105 ft. On that island there are considerable and beautiful streams, but the others generally are badly off for fresh surface water. The marine surveys of these islands are still meagre and unsatisfactory. In 1951 the inhabitants of the Nicobar Islands numbered 12,009, Car Nicobar being by far the most densely populated island.

Geology and Climate. — The Nicobars form part of a great submarine chain, of which the Andamans are a continuation. Elaborate geological reports were issued by a Danish scientific expedition in 1846 and an Austrian expedition in 1858. H. Rink of the Danish expedition considered that the islands belong to the Tertiary age. The Baron von Hochstetter of the Austrian expedition classified the most important formations thus: eruptive, serpentine and gabbro; marine deposits, probably late Tertiary, consisting of sandstones, slates, clay, marls, and plastic clay; recent corals. He considered the whole group connected geologically with the great islands of the Malay archipelago farther south. Earthquakes of great violence were recorded in 1847 and 1881 (with tidal wave), and mild shocks were experienced in Dec. 1899.

The climate is unhealthy. The islands are exposed to both monsoons. and smooth weather is only experienced from February to April, and in October. Rain falls throughout the year, generally in sharp, heavy showers. The rainfall varies from 90 to 135 in., and the shade temperature from 64° to 92° F.

Flora and Fauna. — The vegetation of the Nicobars has not been subjected to a systematic examination by the Indian forest department like that of the Andamans, and indeed the forests are inferior in economic value to those of the more northerly group. There are fruit trees, such as the coconut (*Cocos nucifera*), the betel nut (*Areca catechu*), and the Nicobar breadfruit (*Pandanus leram*), a thatching palm (*Nipa fruticans*) and various timber trees of some commercial value, but only one timber tree (*Myristica irya*) would be considered first class in the Andamans. The palms of the Nicobars are exceedingly graceful.

The mammals are not numerous: in the southernmost islands are a small monkey, the crab-eating macaque (*Macaca irus*), a tree shrew (*Tupaia nicobarica*), rats and mice, bats and the Nicobar flying fox. It is doubtful if the wild boar is indigenous; cattle, when introduced and left, have speedily become "wild." The birds, of which there are many kinds, show strong Indian affinities. Notable among those found in the islands are the megapode (*Megapodius nicobaricus*) characteristic of the Australian region, the edible-nest-building swift, the hackled and pied pigeons, a parakeet (*Palaeornis caniceps*) and an oriole. Snakes, lizards and chameleons, crocodiles, turtles and an enormous variant of the edible Indian crab are numerous; butterflies and other insects have not yet been systematically collected. The fresh-water fish are reported to be of the types found in Sumatra.

History. — The situation of the Nicobars along the line of a very ancient trade route has caused them to be reported by traders and seafarers through all historical times. In the 17th century the islands began to attract the attention of missionaries. At various times France. Denmark. Austria and Great Britain all had more or less obscure rights to the islands, the Danes being the most persistent in their efforts to occupy the group, until in 1869 they relinquished their claims in favour of the British, who at once began to put down the piracies of the islanders, and established a penal settlement, which was withdrawn in 1888. Car Nicobar in the north and Camorta in the centre are the principal ports of the group.

In 1942, during World War II, the Nicobar Islands were occupied by Japanese forces, who developed Car Nicobar as a big supply base. In 1945 the islands were reoccupied by the Allies.

(X.)

Ethnology. — The Nicobarese are probably a mixture of Malay and Burmese (Talaing) strains, with a more primitive element now represented by the Shom Pen of the interior of Great Nicobar. They are of relatively short stature (average height of adult male, 5 ft. $3\frac{3}{4}$ in.) and sturdy build; hair may he slightly wavy or curly, scanty on face and body; brachycephaly is usual. The language, which has several dialects, belongs to the Mon-Khmer group.

The political unit is the village. There are hereditary headmen who govern with a council of elders; the power of the headman depends on his personality, and public opinion is the final arbiter. Land is held by the community, but there is private ownership of fruit and coconut trees. The status of women is high; they inherit and own property, and girls have considerable freedom in the choice of a husband. The marriage tie is loose, and separation (which ends the marriage) is frequent. Polygamy is rare and is confined to the rich.

Clothing is scanty. Men wear a belt and a cloth perineal band with a tail behind, perhaps connected with one of their stories of origin — that they are descended from a man who mated with a bitch. Articles of European clothing are now often worn. Houses vary in shape; they are built on piles, with thatched roofs and are reached by a notched pole. Much cooking is done in them on clay hearths, but there are also separate cookhouses. Special houses are built by communal labour for feasts and meetings. The coconut is the main crop and yams and other vegetables are grown; fish, turtles, pigs and fowl are also important in the diet. Crossbows are used for shooting birds, spears for hunting pigs, spears, nets: traps and poison for fish, harpoons for turtles. The dao (half sword, half chopper) is the universal tool. Canoes are single outriggers with dugout hulls.

The concept of a beneficent creator is known, probably due to missionary influence. The indigenous religion consists in belief in a multiplicity of spirits, many of them those of ancestors, who may be friendly (locally) or more frequently malevolent. The latter bring disease and misfortune. There is a class of mediums who can communicate with, and control, the spirits; those causing sickness may be caught and towed out to sea in model boats. Grotesque carvings of aggressive mien are kept in houses to scare away evil spirits. Men can acquire reputations as sorcerers by eccentric behaviour, such as sitting in pig wallows and collecting bristles; they are much feared, and are sometimes killed.

The natives of Chowra act as middlemen for the group. They alone make pottery, with clay obtained from Teressa, and exchange it for canoes made in the southern and central islands, which they trade to the north. Chowra men go to Nankauri to bum shells for lime (used in betel chewing), paying in pots for the privilege.

(B. A. L. C.)

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NICOLAI, CHRISTOPH FRIEDRICH (*1733–1811*), German author and bookseller who, with Lessing and Moses Mendelssohn, was a leader of the German *Aufklarung* ("Enlightenment"). was born on March 18. 1733, at Berlin. son of the well-known bookseller. Christoph Gottlieb Nicolai (d. 1752). In 1749 he went to Frankfurt an der Oder to learn his father's business, finding time also to become acquainted with English literature.

In 1752 he returned to Berlin, where he began to take part in literary controversy by defending Milton against the attacks of J. C. Gottsched. Nicolai's *Briefe iiber den jetzigen Zustand der schonen Wissenschaften in Deutschland*, published anonymously in 1755, were directed against both Gottsched and Gottsched's Swiss opponents. J. J. Bodmer and J. J. Breitinger; his enthusiasm for English literature won him the friendship of Lessing and Mendelssohn. With Mendelssohn he established the periodical *Bibliothek der schönen Wissenschaften* (1757–60); and with Lessing and Mendelssohn *Briefe, die neueste Literatur betreffend* (1759–65); from 1765 to 1792 he edited the *Allgemeine deutsche Bibliothek*. The *Bibliothek* was the organ of the so-called "popular philosophers," who warred against authority in religion, and against what they conceived to be extravagance in literature, and Nicolai showed a complete incomprehension of the new movement of ideas represented by Herder, Goethe. Schiller, Kant and Fichte.

Of Nicolai's independent works, perhaps the only one with some historical value was his *Charakteristischen Anekdoten von Friedrich II* (1788–92). His romances are forgotten. although *Das Leben und die Meinungen des Magisters Sebaldus Nothanker* (1773–76) and his satire on Goethe's Werther, *Die Freuden des jungen Werthers* (1775), had a certain reputation in their day. Between 1788 and 1796 Nicolai published in 12 volumes a

Beschreibung einer Reise durch Deutschland und die Schweiz, which bore witness to the narrow conservatism of his views in later life. He died in Berlin on Jan. 8, 1811.

Nicolai's *Bildniss und Selbstbiographie,* edited by M. S. Löwe, was published in the *Bildnisse jetzt lebender Berliner Gelehrter* (1806).

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NICOLAI, (CARL) OTTO EHRENFRIED (1810–1849), German composer known for his opera on Shakespeare's *The Merry Wives of Windsor.* Born at Königsberg, June 9, 1810, he studied under C. F. Zelter in Berlin. Between 1839 and 1841 he produced four operas in Italy, and from 1841 to 1847 was conductor of the court opera in Vienna, where he founded the Philharmonic concerts for the performance of Beethoven's symphonies. *Die lustigen Weiber von Windsor,* the libretto adapted by S. H. Mosenthal, n-as given in Berlin (March 9, 1849), and still holds its place in Germany as a popular comic opera. It was first given in London as *Falstaff,* in Italian, in 1864. Nicolai died in Berlin, May 11, 1849.

NICOLE, PIERRE (1625–1695), French Jansenist theologian and moralist. was born at Chartres. He studied at Paris, and taught at Port-Royal, for which, with Antoine Arnauld and others. he wrote schoolbooks, especially *Logique de Port-Royal.* From 16jj to 1668 he played a decisive part in writing or editing most of the Jansenist pamphlets (*see* JANSENISM). His special contribution to this controversy was the distinction drawn between the *question de droit* (are the doctrines called Jansenist heretical?) and the *question de fait* (did Jansen teach these doctrines?). By answering the first affirmatively and the second negatively, he enabled the Jansenists to pursue their program without openly breaking with the church. From 1669 Nicole devoted his theological talents mainly to the defense of Roman Catholic dogma against the historical criticism of Protestant writers. But his best, and best-known. work is the *Essais de Morale* (4 vol., 1671–78; 10 more posthumously). in which he discoursed. with some humanity of outlook and great penetration of mind, upon the practice and problems of a rigorously Christian ethic in the world of his day. He had no sympathy with advanced mystical speculations. He died in Paris on Nov. 16. 1695.

See C. A. Sainte-Beuve, *Port-Royal,* 5th ed., vol. iv (1888); M. J. F. R. I. H. Bremond, *Histoire littéraire du sentiment religieux en France,* vol. iv (1920). (N. J. A.)

NICOLL, ROBERT (1814–1837), Scottish poet. was born on Jan. 7, 1814, at the farm of Little Tullybeltane, in the parish of Auchtergaven, Perthshire. At 16 the boy was apprenticed to a grocer and wine merchant at Perth. In 1833 he began to contribute to *Johnstone's Magazine* (afterward *Tait's Magazine*), and in the next year his apprenticeship was canceled. In 1836 he became editor of the *Leeds Times.* He died at the house of his friend William Tait. at Trinity, near Edinburgh. on Dec. 7. 1837. He had published a volume of *Poems* in 183;; and in 1844 appeared a further volume. *Poems and Lyrics,* with an anonymous memoir of the author by Mrs. C. I. Johnstone. The best of his lyrics are those written in the Scottish dialect.

NICOLLE, CHARLES JULES HENRI (1866–1936), French bacteriologist. winner of the Nobel prize for his discovery that typhus fever (*q.v.*) is transmitted by the body louse, was born on Sept. 21, 1866, at Rouen. where his father. Eugène Kicolle, was professor of medicine. After graduating M.D. at Paris in 1893 he became a member of the Rouen medical faculty. and in 1896 was appointed director of its bacteriological laboratory. where he carried out important work on the preparation of diphtheria antiserum. In 1903 he was appointed director of the Pasteur institute in Tunis, and during his 33 years' tenure of that post the institute became a world-famous centre for bacteriological research and for the production of serums and vaccines to combat many of the most prevalent infectious diseases. His researches on the transmission of typhus culminated in 1909 when he made the discoveries for which in 1928 he received the Nobel prize. Later he helped to make a clear distinction between classical louse-borne epidemic typhus and murine typhus, which is conveyed to man by the rat flea. Re also made valuable contributions to the knowledge of rinderpest, Malta fever, measles, scarlet fever, diphtheria and tuberculosis, and was responsible for many innovations in bacteriological technique. Apart from his scientific activities, Kicolle enjoyed a considerable reputation as a philosopher and as a writer of fanciful stories. In 1928 the silver jubilee of his directorship of the Tunis institute was commemorated by a gold medal, and in 1932 he was elected to a chair in the Collège de France. He died in Tunis on Feb. 28, 1936.

(W. J. BP.)

NICOLLS, RICHARD (1624–1672), American colonial governor, was born probably at Ampthill, Eng., in 1624. He commanded a royalist troop of horse during the Civil War and on the defeat of the king went into exile. Soon after the Restoration he entered the service of the duke of York, through whose influence he was appointed in 1664 on a commission to conquer New Netherland from the Dutch and to regulate the affairs of the New England colonies and settle disputes among them. The expedition set sail from Portsmouth on May 25, 1664, and New Amsterdam was surrendered to Nicolls on Sept. 8. Under authority of a commission from the duke of York, Nicolls assumed the position of deputy governor of New Netherland (New York). His policy was vigorous but tactful, and the transition to the new regime was made smoothly and with due regard to the interests of the conquered people. The English system of law and administration was at once introduced into Long Island. Staten Island and Westchester. where the English element already predominated, but the change was made much more slowly in the Dutch sections. A code of laws known as the "duke's laws," drafted by the governor with the help of his secretary. Matthias Nicolls (*c.* 1630–87), was proclaimed in 1665 and continued in force until 1683. Nicolls returned to England in the summer of 1668 and continued in the service of the duke of York. He was killed in the naval battle of Southwold hay, May 28, 1672.

See M. Schuyler, *Richard Nicolls* (New York, 1933).

NICOMACHUS (fl. 4th century B.C.), of Thebes. Greek painter, was a contemporary of the greatest painters of Greece; Vitruvius observes that if his fame was less than theirs. it was the fault of fortune rather than of demerit. Pliny gives a list of his works. among them a "Rape of Persephone." "Victory in a Quadriga," a group of Apollo and Artemis and the "Mother of the Gods Seated on a Lion." Pliny also says that he mas a very rapid worker and used only four colours.

NICOMACHUS, a Keopythagorean philosopher and mathematician whose works had a great vogue. was born at Gerasa in Arabia Petraea (northwest Arabia) and flourished about A.D. 100. Two treatises by him are extant: (1) The *Introductio arithmetica* sets out the elementary theory and properties of numbers. Numbers are no longer denoted by lines as in Euclid, but are written in the ordinary notation; hence general principles can be stated only with reference to particular numbers taken as illustrations. Nicomachus states a rule about cubes that makes it possible to sum any number of forms of the series of natural cubes beginning from 1.

Nicomachus' popularity is shown by Lucian's having a character sap. "You count like Nicomachus." A Latin translation by Apuleius of Madauros (born about A.D. 125) is lost; but Boethius' version survives. The commentators include Iamblichus. Heronas. Xsclepius of Tralles. Joannes Philoponus and Proclus. The Greek text was edited by R. Hoche (1866) and the commentaries of Iamblichus and Philoponus by E. Pistelli (1894) and Hoche (1864 and 1864–67), respectively. There is an English translation by M. L. D'Ooge with essays by F. E. Robbins and L. C. Karpinski (1926). (2) The *Enchiridion Harmonices* (ed. by C. Jan in *Musici Scriptores Graeci,* 1895) is on the Pythagorean theory of music. Nicomachus is said to have written *Theologumena arithmetices* (in two books) on the properties of numbers, of which the *Theologumena arithmeticae* edited by Ast (1817) contains no more than fragments, at most. (T. L. H.; X.)

NICOMEDES I (*c.* 278–248 B.C.), king of Bithynia. He made himself master of the whole country and put to death his brother, who had set himself up as an independent ruler. He enlarged and consolidated the kingdom, founded the city of Nicomedia as the capital and fought successfully with Antiochus of Syria. Nicomedes II, king of Bithynia (149–91 B.C.), mas fourth in descent from Nicomedes I. A popular ruler, he adhered steadily to the Roman alliance. His son, Nicomedes III, ruled until 74 B.C.

NICOMEDES (*c.* 240 B.C.), Greek mathematician, is known only through references to his work by the commentators Pappus (*c.* A.D. 280). Iamblichus (c. A.D. 310) and Proclus (c. A.D. 450). His date is estimated from the fact that he is said to have compared his work with that of Eratosthenes and that he is referred to by Apollonius, these two men being contemporaries.

Nicomedes seems to have been the inventor of the conchoid, a curve that he used in trisecting an angle and in doubling a cube. The use of this curve to solve the problems of trisecting an angle and duplicating a cube should not be interpreted to mean that these problems can also be handled by the Euclidean instruments of the compass and the straightedge, for this is impossible.

See Ivor Thomas (trans. and ed.), *Selections Illustrating the History of Greek Mathematics,* vol. i (1939–42). (V. Sd.; X.)

NICOMEDIA: see Ismid.

NICOPOLIS (Victory City), **ACTIA,** an ancient city of Epirus, founded 31 B.C. by Octavian (Augustus) in memory of his victory over Antony and Cleopatra at Actium. The colony, composed of settlers from many neighbouring towns, succeeded and became the capital of southern Epirus and Acarnania, with the right of sending five representatives to the amphictyonic council. On the spot where Octavian's tent had stood he built a sanctuary to Neptune adorned with beaks of captured galleys and instituted the Actian games in honour of Apollo. The city was restored by the emperor Julian and again (after the Gothic invasion) by Justinian, but in the middle ages it was supplanted by Préveza. The ruins, known as Palaeoprevesa (Old Préveza), lie about 3 mi. N., on a small bay at the narrowest part of the peninsula which separates the Gulf of Arta (Sinus Ambracius) from the Ionian sea. The most conspicuous objects are the acropolis, two theatres and an aqueduct.

NICOSIA, the capital of Cyprus, lies on the Pedieos river in the centre of the plain between the Kyrenia mountains and the Troodos range. Pop. (1956 est.) 48,864.

The town was known in antiquity as Ledra, and under the Byzantines by the Greek name of Lefkosia, corrupted by the Latins to Nicosia. From the 10th century it was the seat of government. The Lusignan kings (*q.v.*) walled the city, which covered a much larger area than that enclosed by the existing Venetian fortifications (3 mi. round). In 1373 it was sacked by the Genoese and in 1426 by the Mamelukes, when the royal palace (a fragment of ahich survives near the Paphos gate) mas destroyed. Nicosia never fully recovered, many of the Latin religious orders leaving the island. Under the Venetians, who occupied Cyprus in 1489, the Greeks again had their cathedral (the ruined Bedestan beside St. Sophia). Work started on the new walls in 1567, but was incomplete when the huge Turkish invasion force landed in 1570, when the town was again plundered. The Turkish governors established themselves in the later palace of the Lusignans, where the law courts now stand. When Cyprus came under British administration in 1878, Nicosia had greatly declined, but during the 20th century building mas extended far beyond the Venetian walls and dry moat. Within these walls the old town was largely rebuilt with only a slight widening of its medieval streets.

Nicosia is the seat of the main government offices and of most of the foreign consulates, and it is the professional and educational centre of Cyprus, There are two chief thoroughfares: Kyrenia street continuing into Ledra street (north and south) and Paphos street (east and west). Ledra street is the business and shopping centre but there is a separate market and a bazaar quarter. The fine Gothic cathedral of St. Sophia, dedicated in 1325, is now Selimiye mosque. The town has several public gardens, in one of which stands the municipal theatre. Near it is the Cyprus museum, erected in 1907.

There are many light industries, mainly serving the local market. Some of the more important manufactures are cotton yarn and textiles, cigarettes, flour, soft drinks, confectionery, footwear and underwear. Nicosia is connected by a good road with Famagusta (38 mi.) and the other chief towns of the island. From Nicosia airport, 5 mi. from the city. there are flights direct to London and Paris and connecting services with New York and the principal airports in Europe and the middle east. (A. H. S. M.)

NICOSIA, city and episcopal see (since 1816). Sicily. Italy, province of Enna. 21 mi. N. of the railway station of Leonforte (which is 49 mi. W. of Catania). 2,840 ft. above sea level. Pop. (1951) 16,955. The town retains a medieval appearance, with a Norman cathedral and other interesting churches, among them S. Maria Maggiore, with a reredos by Antonio Gagini. A Lombard dialect is still spoken there.

NICOTERA, GIOVANNI (1828–1894), Italian patriot and politician, was born at San Biagio on Sept. 9, 1828. Joining the party of Young Italy he was among the combatants at Naples in May 1848 and was at San Pancrazio with Garibaldi during the defense of Rome. After the fall of Rome he fled to Piedmont, where he organized the expedition to Sapri in 1857, but shortly after his arrival there he was defeated and severely wounded by the Bourbon troops. Condemned to death, but reprieved through the intervention of the British minister, he remained a prisoner at Naples and at Favignana until 1860. when he joined Garibaldi at Palermo. Sent by Garibaldi to Tuscany, he attempted to invade the papal states with a volunteer brigade, but his followers were disarmed and disbanded by Ricasoli and Cavour. In 1862 he was with Garibaldi at Aspromonte; in 1866 he commanded a volunteer brigade against Austria; in 1867 he invaded the papal states from the south, but the defeat of Garibaldi at Mentana put an end to his enterprise. His parliamentary career dates from 1860. During the first ten years he engaged in violent opposition, but from 1870 onward he joined in supporting the military reforms of Ricotti. Upon the advent of the left in 1876. Nicotera became minister of the interior, and governed with remarkable firmness. He was obliged to resign in Dec. 1877, when he joined Crispi, Cairoli, Zanardelli and Baccarini in forming the "pentarchy" in opposition to Depretis. but he only returned to power 13 years later as minister of the interior in the Rudini cabinet of 1891. On this occasion he restored the system of uninominal constituencies and resisted the socialist agitation. He fell with the Rudini cabinet in May 1892, and died at Vico Equense, near Naples, on June 13, 1894.

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NICOTIANA, a genus of plants of the nightshade family (Solanaceae), comprising about 60 species of usually sticky herbs and shrubs, native chiefly to tropical America. They are strongly scented annuals or perennials, possessing narcotic-poisonous properties. They have alternate, simple, usually entire but sometimes wavy-margined large leaves, and nhite, yellow,, greenish or purple, very fragrant flowers, with a long, tubular, five-lobed corolla, usually opening at night. Besides *N. tabacum,* important as the source of commercial tobacco (*q.v.*), several other species are cultivated as ornamental plants. About ten species are found in the southern and uestern parts of the U.S., and *N.* glauca (tree tobacco) a slender evergreen shrub native to Brazil, has become widely naturalized on the Pacific coast. N. *rustica,* one of the plants known as wild tobacco, formerly cultivated by the Indians of the eastern states, is of uncertain origin, but is almost certainly the source of the first tobacco taken from Florida to Lisbon and popularized by Jean Nicot, for whom the genus and nicotine were named. Beautiful night-fragrant species for the garden are *N.* alata var. *grandiflora* (jasmine tobacco), three to four feet high, and the somewhat shorter *N. sylvestris,* both tender perennials from South America. Nicotianas. easily grown from seed and root cuttings, are sensitive to frost. They do well in light rich soil in a warm sheltered location and frequently self-sow in the garden; some make good potted plants.

See T. H. Goodspeed, "The Genus Nicotiana," in *Chronica Botanica,* vol. xvi (1954). (N. Tr.)

NICOTINE, a volatile liquid, is the principal alkaloid *(see* ALKALOIDS) of tobacco, in which it occurs to the extent of 4% to 5% along with minute amounts of closely related alkaloids. Nicotine is still used in medicine to a small extent, but the principal demand for it is as a horticultural insecticide. It is prepared by adding lime or caustic soda to a filtered, concentrated. aqueous extract of tobacco (stalk and other tobacco refuse is generally used) and recovering the alkaloid so set free. by extraction with a suitable solvent or by steam distillation. This crude alkaloid is freed from water by a chemical drying agent, such as solid potash, and then fractionally distilled. Pure nicotine, $C_{10}H_{14}N_2$, is a highly poisonous colourless liquid, with an unpleasant odour; it boils at 246°–247° C. and is soluble in most solvents. including water. The dipicrate crystallizes in short, yellow prisms, melts at 218° C. and is characteristic of the alkaloid. Nicotine was synthesized in 1904 by A. Pictet, P. Crepieux and Ritoschy.

NICTHEROY: *see* NITEROI.

NIDAROS: *see* TRONDHEIM.

NIEBUHR, BARTHOLD GEORG (1776–1831), German historian who started a new era in historical studies by his method of source criticism; all subsequent historians are in some sense indebted to him. Niebuhr, the only son of the Danish explorer Carsten Niebuhr (*q.v.*), was born in Copenhagen on Aug. 27, 1776. Up to his matriculation at Kiel university he had a solitary education which perhaps intensified his leaning toward a life of scholarship. But on his father's advice he spent over a year in England and Scotland and then embarked on a career in state service, becoming private secretary to Count Schimmelmann, the Danish minister of finance, and in 1804 director of the national bank. In 1806, at the request of Baron von Stein, the Prussian chief minister, he took up a similar post in Prussia. Two years after Stein's fall (1808), however. disapproving of Prince von Hardenberg's policy, he resigned and became state historiographer. At the same time he became a member of the Berlin Akademie der Wissenschaften and was thereby empowered to lecture at the newly founded university of Berlin. In 1810 he began the series of lectures on Roman history which mere the basis of his great book and which made a sensation in Berlin. In 1816 he went as Prussian ambassador to the Vatican, retiring to Bonn in 1823 where he died on Jan. 2, 1831. Niebuhr's chief work was done while he was employed in public service. His interests were academic (to the fine arts he was wholly indifferent; it has been said that to him Rome was only a collection of unsolved problems) and he never wholly reconciled himself to his official career; yet he held that no one could understand the history of Rome without knowing the state as it is seen by the statesman; and his work, above all his gift for analogy. benefited greatly from his practical life.

Niebuhr's *Romische Gescizichte* (3 vol., 1811–32; Eng. trans. 1828–42) marked an era in the study of its special subject and had a momentous influence on the general conception of history. Niebuhr made particular contributions of value to learning, *e.g.,* his study of social and agrarian problems; on the other hand some of his theories were extravagant and his conclusions mistaken. But his permanent contribution to scholarship was his method. The failings of classical sources were already recognized but it was Niebuhr who evolved what Goethe called *"tatige Skepsis"*—the constructive skepticism which is the root of a scientific method of criticism. It was Niebuhr who showed how to analyze the strata in a source, particularly poetical and mythical tradition; how to discard the worthless and thereby lay bare the material from which the historical facts could be reconstructed. He thus laid the foundation for the great period of German historical scholarship.

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NIEBUHR, CARSTEN (1733–1815), German traveler who was the sole survivor of the first scientific expedition to Arabia and the compiler of its results, was born at Ludingworth, Hanover, on March 17, 1733. He worked as a peasant in his early years, but managed to learn surveying. In 1760 he was invited to join the expedition being sent out by Frederick V of Denmark for the scientific exploration of Egypt, Arabia and Syria. The expedition visited the Nile. Mount Sinai, Suez and Jidda, whence it journeyed overland to Mokha. In hlay 1763 the philologist of the expedition, F. C. von Haven. died, folloned in July by the naturalist. Pehr Forskål Sana. the capital of Yemen. was visited. but the remaining members of the expedition were obliged to return to Mokha. Niebuhr saved his life and restored his health by adopting native dress and food. From Mokha they sailed to Bombay, where the artist and the surgeon of the expedition died, leaving Niebuhr alone. He stayed 14 months in India and then turned homeward by way of Muscat. Persia, Mesopotamia. Cyprus and Asia Minor, reaching Istanbul via Brusa in Feb. 1767 and Copenhagen in the following November. He later held posts in the Danish military service and in the civil service of Holstein. He died at Lleldorf in Holstein on April 26. 1815.

Niebuhr's major works are *Beschreibung von arabien* (Fr. trans., *Description de l'Arabie*) and *Reisebeschreibung nach arabien und andern umliegenden landern* (Eng. trans, *Travels Through Arabia*). He also edited P. Forskål's *Descriptiones animalium, Flora aegyptiaco-arabica* and *Icones rerum naturalium.*

See the anonymous *Life of Carsten Niebuhr* in the "Lives of Eminent Persons" series (1838); and D. G. Hogarth, *The Penetration of Arabia* (1904). (WM. C. B)

NIEBUHR, REINHOLD (1892–), U.S. Protestant theologian and social critic, a pioneer in the "new theology" that has striven to restate the biblical-Christian teaching in a form relevant to the great issues of contemporary life and history. Niebuhr's influence has been widespread, cutting across the lines of the diverse religious communities as well as of the various academic disciplines dealing nith human affairs. The influence of his thinking has been felt alike in theology and in the fields of 'history, political science and international affairs.

Niebuhr was born on June 21. 1892 at Wright City. Mo., the son of a clergyman. He attended Elmhurst college (1910), Eden Theological seminary (1913) and Yale Divinity school (B D., 1914; M A.. 1915). He received a D.D. from Eden Theological seminary in 1930 and numerous honorary degrees from institutions in the United States and abroad. He nas ordained to the ministry of the Evangelical Synod of North America in 1915 and served as a pastor in Detroit from 1915 to 1928. In the latter year he joined the faculty of Union Theological seminary in New York city, serving as associate professor of the philosophy of religion until 1930 and as professor of applied Christianity until 1960, the year of his retirement. He married Ursula Keppel-Compton in 1931.

In his earliest writings, Niebuhr exhibited the quasi-humanistic religious "liberalism" and social idealism that pervaded the theological atmosphere of the time. Increasing experience with the actualities of social life which he encountered in the course of his ministry in a great industrial city, together with his reflections on world affairs. sharply reoriented his thinking in a direction more orthodox theologically and more realistic socially. *Moral Man and Immoral Society,* published in 1932, embodying this new orientation, came as a tract for the times, combining a somber Augustinian emphasis on the involutions of sinful self-love in the individual and corporate structures of life with a social radicalism bordering on Marxism. His Marxist inclinations vanished in the years after World War II, and he in fact became a vigorous critic not only of totalitarian communism but of doctrinaire socialism as well; the original combination of a hardheaded Augustinian doctrine of man nith a lively social concern, however, remained characteristic of his thought.

The most impressive statement of his fundamental theological position Niebuhr developed in his Gifford lectures, published as *The Nature and Destiny of Man* (2 vol., 1941–43). This work is a sustained and systematic attempt to restate, assess and vindicate the essential Augustinian-Reformation teachings on man in the context of an "existentialist" understanding of the human situation, emphasizing at once man's dynamic of self-transcendence, the ambiguities of his creaturely existence and the corruptions of his sinful egocentricity. It was this work that brought Niebuhr closest to continental neo-orthodoxy, although he was throughout very critical of both Karl Barth and Emil Brunner,

In later years Niebuhr's thinking shifted more and more to a concern with the problem of history and an emphasis on man's essential historicity ("Man's being and human society are by nature historical. . ."). *Faith and History* (1949), *The Irony of American History* (1952) and *The Self and the Dramas of History* (1955) mark this new direction. The last-named work is particularly significant for what it owes to the "relational" (or "dialogical") philosophy of Martin Buber, an influence that came late but remained powerful in Niebuhr's thought. His The *Structure of Nations and Empires* (1959) combines this concern with history with his lifelong preoccupation with the problems of political power.

BIBLIOGRAPHY.—Niebuhr's writings and his commentaries on religious, social and political affairs are voluminous. A full bibliography to 1956 may be iound in Charles W. Kegley and Robert W. Bretall (eds.), *Reinhold Niebuhr: His Religious, Social, and Political Thought* (1956), and a collection of his outstanding occasional articles in D. B. Robertson (ed.), *Love and Justice: Selections From the Writings of Reinhold Siebuhr* (1957). Important studies of Niebuhr's thought include Edward J. Carnell, *The Theology of Reinhold Niebuhr* (1950); Georgette Paul Vignaux, *La Thhologie de l'histoire chez Reinhold .Viebuhr* (1957); Gordon Harland, *The Thought of Reinhold Niebuhr* (1960). (W. HE.)

NIEDERWALD, a broad hill in Germany. in the *land* of Hesse, opposite Bingen, forming the southwestern apex of the Taunus range (*q.v.*). Its summit is clothed with dense forests of oak and beech. while its southern and western sides. which descend sharply to the Rhine, are covered with vineyards. On the hill above Riidesheim stands the national monument of the war of 1870–71. Cog railways run up the hill.

NIEL, ADOLPHE (1802–1869), marshal of France, was born at Muret on Oct. 4. 1802. and entered the École Polytechnique in 1821. whence he passed to the engineer school at Metz, becoming lieutenant in the engineers in 1827 and captain in 1833. He served with distinction in Algeria and in the Crimean War. Niel commanded the IV corps in the war against the Austrians. (*See* ITALIAN WARS.) On the field of battle of Solferino he was made a marshal of France. After service in a home command. he became minister of war (1867). He drafted and began to carry out a far-reaching scheme of army reform, based on universal service and the automatic creation of large reserves. He also rearmed the whole of the army with the chassepôt rifle. He died on Xug. 13. 1869, in Paris.

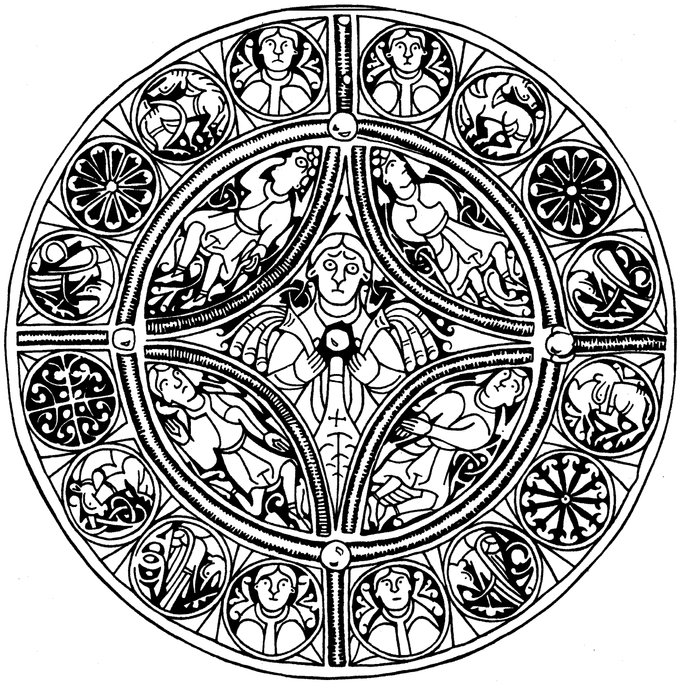
NIELLO (Italian. from Latin *nigellum*, neuter diminutive of *niger,* black), the name given to the black sulphide, or mixture of sulphides, used to inlay ornamental designs engraved in silver, gold or brass. The term has also been extended to include objects so treated, and to prints on paper, made from engraved plates, on which niello is then applied. The art has been practised since Roman times and possibly earlier. It reached a high standard on the European continent, especially in Italy, during the 1jth century, after which it largely disappeared, although it seems to have continued uninterrupted in Russia. particularly at Tula, near Moscow, up to the end of the tsarist regime. It was used to decorate silver in Turkey during the 18th century, and it flourished as late as the 19th century in Malaya, as some fine examples of Chutam and Judam ware testify.

Apart from Pliny. who made a passing reference to a method of blackening silver used by the Egyptians, the first authors to write on the preparation of niello and its application to silver were Eraclius and Theophilus in or about the 11th century and Benvenuto Cellini during the 16th.

According to each of these authors, niello is made by fusing together silver. copper and lead in certain proportions, and then mixing the molten alloy with sulphur. The black product (a mixture of the sulphides of silver, copper and leadj is powdered. and after the engraved metal, usually silver, has been moistened with a flux such as a solution of borax, some of this powder is spread upon it, and the metal strongly heated. whereupon the niello melts and runs into the engraved channels. The excess niello is removed by scraping until the filled channels have been made visible, and finally the surface is highly polished. The success of this method depends on the fusibility of niello at a relatively low temperature. It is important to note in this connection that although, of the individual sulphides that constitute niello, only silver sulphide has a melting point (835° C.) lower than that of silver (960° C.) a suitable mixture of these sulphides will have a melting point several hundred degrees below that of silver, and can therefore be melted upon the silver surface without damaging it.

Although there has always been agreement on the nature of niello, there has been a regrettable tendency to describe all black inlay on metal as niello, without making the proper tests to establish that this is so. In consequence, many objects previously thought to be examples of niello work have been found. on more careful examination. not to contain niello at all. A specific instance of this is the bronze statuette of Nero found at Barking hall, near Suffolk, and now in the British Museum. The "niello" inlay comprises thin strips of copper, the surface of which has acquired, through the passage of time. a thin film of some black substance consisting. in part, of copper sulphide.

An examination of nielli in the British Museum (from which the examples that follow have been chosen), which were selected



REDRAWN FROM A PHOTOGRAPH FROM "DARK-AGE BRITAIN," D. B. HARDEN, ED ; BY COURTESY OF METHUEN AND CO

THE FULLER BROOCH. AN EXCELLENT EXAMPLE OF SAXON NIELLI. A SILVER DISK BROOCH WITH FIGURAL AND FOLIATE DESIGNS. IT IS BELIEVED TO BE THE ONLY REPRESENTATION IN MEDIAEVAL ART OF THE FIVE SENSES. BRITISH MUSEUM. (ABOUT FOUR-FIFTHS ACTUAL SIZE)

to represent periods in the art of niello from the earliest times down to the 19th century has shown that niello made after the 11th century is indeed a mixture of the suiphides of silver, copper and sometimes lead, but that the niello used before that time consists of silver sulphide alone. (This latter is made in the same way as the mixed sulphides. The silver formed at the surface through decomposition [*see* below] is filed away.) This circumstance indicates not only a change in the composition of niello about the 11th century, but also a change in the technique of its application. For although the melting point of silver sulphide in the absence of air is below that of silver, if silver sulphide is heated in air to a temperature near its melting point, it decomposes, and the result of an attempt to fuse silver sulphide would be silver, and not niello. Silver sulphide. however, softens at a temperature far below its melting point. and it is not a difficult task—even if somewhat tedious—to make niello inlays by filling the engraved parts with the powdered sulphide. and. after heating the engraved article in a flame, to "rub in" the powder with a burnisher, thus uniting the powdered grains into a coherent mass. Before about the 11th century a similar technique was almost certainly used: but only a molten niello is capable of filling the finest engraved lines, and so the best work was not achieved until the goldsmiths had mastered the art of working with the readily fusible mixture of sulphides.

Even the rubbing in process demanded by the use of silver sulphide niello required a certain amount of skill. especially in the control of the temperature. Thus the early Roman and Byzantine niello work was not elaborate, consisting of crosses or simple foliate designs on silver bowls and spoons.

Several gold rings of similar workmanship have been preserved. on which the owner's name and ornamental patterns were formed in gold, the background being filled with niello. A well-known example is the ring that belonged to Ethelwulf. king of Wessex and father of Alfred the Great. One of the finest Saxon nielli is the Fuller brooch. a silver disk brooch with figural and foliate designs. believed to be the only representation in mediaeval art of the five senses.

The art of niello was also practised by the Irish metalworkers from the 10th to the 12th century, and among much work that merits attention may be mentioned the niello decoration on croziers and bell shrines, as exemplified by that on the crozier of Kells and the bell shrine of St. Cuillean. In both of these, the decorated parts consist of brass, inlaid with copper, silver and niello. Many fine specimens of 15th-century niello work are to be found in museums in England and on the continent of Europe.

The British Museum possesses a particularly beautiful late 1 jth-century German silver beaker, parcel gilt, and extensively nielioed on the body and cover. (*See* C. H. Read and A. B. Tonnochy, *Catalogue of Silver Plate in the British Museum [Franks Bequest]*, p. 41, London, 1928.) The niello decoration takes the form of scenes from life depicted by boys and cupids, the background and shading being niello.

In Italy during the 15th century the art was brought to perfection. and was practised by all the great artist-goldsmiths, the greatest of whom was Maso Finiguerra (*q.v.*). These artists were employed to illustrate religious scenes by engraving in silver! and their work is well represented in London in the British Museum and in the Victoria and Albert museum as nielloed silver plates used in the decoration of chalices. paxes and knife handles; and in the British Museum as prints and sulphur casts, made from such plates before inlaying with niello.

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NIEM [NYEM, or NIEHEIM], **DIETRICH OF** (*c.* 1345–1418), mediaeval historian, was born at Nieheim. a small town subject to the see of Paderborn. He became a notary of the papal court of the rota at Avignon, and in 1376 went with the Curia to Rome. Urban VI made him an abbreviator to the papal chancery. His chief importance lies in the part he took in the controversies arising out of the Great Schism. He accompanied Gregory XII to Lucca in May 1408, and. having in vain tried to make the pope listen to counsels of moderation, he joined the Roman and Avignonese cardinals at Pisa. He adhered to the pope elected by the council of Pisa (Alexander V) and to his successor John XXIII, resuming his place at the Curia. In view of the increasing confusion in the Church, however. he became one of the most ardent advocates of the appeal to a general council. He was present at the council of Constance as adviser to the German "nation." He died at Maastricht on March 22, 1418.

Niem's most important works are the *Nemus unionis*, a valuable collection of papal documents; and the *De schismate*, giving the history of events from 1376 to 1410, when he completed the work. It was continued in the *Historia de vita Johnnnis XXIII.*

For bibliography *see* Potthast, *Bibl. hist. medii aevi* (2nd ed., Berlin, 1896), p. 1,051, *s.v.* "Theodoricus de Niem"; and generally *see* the article on Niem by Theodor Lindner in *Allgemeine deutsche Biographie* (Leipzig, 1886); and Erler, *Dietrich von Nieheim* (Leipzig, 1887).

NIEMCEWICZ, JULIAN URSIN (1757–1841), Polish scholar, poet and statesman, was born in 1; 57. In the earlier part of his life he acted as adjutant to Kosciusko, was taken prisoner with him at the fatal battle of Maciejowice (1794), and shared his captivity at St. Petershurg. On his release he travelled for some time in America. where he married. After the Congress of Vienna he was secretary of state and president of the constitutional committee in Poland. but in 1830–31 he was again driven into exile. He died in Paris on the 21st of April 1841. Niemcewicz wrote comedies. novels and historical works. but he is best remembered by his *Historical Songs of fhe Poles* (Warsaw, 1816), a series of lyrical compositions in which the chief heroes are of the golden age in Polish history.

His collected works mere published in 12 vol. (Leipzig, 1838–40).

NIERSTEIN, a village of Germany, in the *Land* of Hesse, on the left bank of the Rhine, 8 mi. S. of Mainz by the railway to Worms. Pop. (1950) 5,574.

Nierstein was originally a Roman settlement, and was a royal residence under the Carolingian rulers. Later it passed from the emperor to the elector palatine of the Rhine. It contains an old Roman bath—Sironabad—and sulfur springs. It is famous for its wines.

NIETZSCHE, FRIEDRICH (1844–1900), German philosopher, one of the most influential thinkers of modern times. was born Oct. 15, 1844, at Röcken, in the Prussian province of Saxony, the son of a Lutheran minister and the grandson of two. The religion of his home had a patriotic complexion, and he was named Friedrich Wilhelm after the reigning king of Prussia. Nietzsche later dropped the "Wilhelm," and no major writer has been a more stringent critic of his countrymen or of the religion and morality of his fathers. In the English-speaking world his ideas have sometimes been discounted as a mere reaction against his childhood training, but in Germany and in France the most serious philosophers and psychologists, theologians, novelists and poets have unstintingly acknowledged their debt to him.

Basel and Bayreuth.—Nietzsche attended the universities of Bonn and Leipzig and in 1869 was appointed professor of classical philology at the University of Basel. He became a Swiss subject, but when the Franco-German War broke out in 1870, he requested a leave from his university to serve with the Prussian army as a medical orderly. Soon he returned to Basel, his health badly shattered. He offered courses in Greek literature and philosophy and found further inspiration in his friendship with the composer Richard Wagner, who mas then living at Tribschen. near Lucerne.

Wagner was born in the same year as Nietzsche's father and appreciated Nietzsche as a brilliant apostle and errand boy. Nietzsche's first book, *The Birth of Tragedy From the Spirit of Music (Die Geburt der Tragodie aus dem Geiste der Musik*, 1872) won the composer's enthusiastic approval: the last ten sections were devoted to a rhapsody on Wagner. Of Nietzsche's four essays published as *Untimely Meditations* (*Unzeitgemässe Betrachtungen*, 1873–76), Wagner especially liked the last: *Richard Wagner in Bayreuth*. Wherever Nietzsche showed an independent mind, Wagner showed little sympathy. A break was thus inevitable, and Wagner's removal to Bayreuth merely hastened it. The composer made his peace with the young German empire, which Nietzsche considered a cultural menace, and his ideas became influential. Wagner's chauvinism and anti-Semitism, which had mattered less when he was the lonely genius of Tribschen, were now institutionalized as part of the meaning of Bayreuth. Wagner's *Parsifal*, finally, seemed to Nietzsche a thoroughly insincere obeisance to Christianity, and the philosopher had no sympathy for Wagner's deliberate idealization of "pure foolishness." Wagner's inscribed copy of *Parsifal* reached Nietzsche even as Nietzsche's enlightened *Human, All-Too-Human* (*Menschliches, Allzumenschliches*, 1878), with a motto from Voltaire, reached Wagner; and this book was at least as distasteful to the composer, who did not bother to finish reading it, as the opera was to Iiietzsche. Their break was sealed.

Later Life and Works.—In 1879 Nietzsche resigned from the university, pleading his ill-health. He devoted the next ten years solely to his writing. living very modestly and driving himself relentlessly. Every book represented a triumph over his half-blind eyes, migraine headaches and manifold physical agonies. His major works belong to this period. They were written in utter solitude in various places in Switzerland and Italy (particularly the Engadine and the Riviera) and were ignored by the public until Georg Brandes (Georg Morris Cohen) began to lecture on Nietzsche at the University of Copenhagen in *1888*. Ten years later. Nietzsche was world famous.

In Jan. *1889*, however, Nietzsche suffered a mental and physical breakdown; and he remained insane until he died, at Weimar, on Aug. 25. 1900. His illness never was diagnosed conclusively, but was probably an atypical general paralysis. In that case there must have been a syphilitic infection, which is usually supposed to have taken place during his student days. although he may have infected himself while ministering to sick soldiers during the war. That he generally lived the life of an ascetic is agreed.

Although he proposed marriage to several women, Lou Salomé was the only one who, for a time, deeply moved his heart. His other proposals represented frantic attempts to escape from his desperate solitude. He scarcely knew the women in question and was profoundly relieved when they refused. Lou Salomé, who later wrote several books and became the beloved of Rainer Maria Rilke and, still later, a friend and disciple of Sigmund Freud, meant a great deal to Nietzsche in 1882—much more than he meant to her. To her, and only to her, he spoke of his inmost ideas; and when the intrigues of his envious sister, Elisabeth, disrupted their relationship, he felt lonelier than ever.

It was then that his most popular. most enigmatic and least understood work was born: *Thus Spoke Zarathustra (Also sprach Zarathustra)*. After the aphoristic works of the preceding years, culminating in *The Dawn* (*Morgenröte, 1881)* and *The Gay Science (Die frokliche Wissenschaft,* 1882), this was his first attempt to present the whole of his thought. The first three parts appeared in *1883* and *1884* but found no response, and Nietzsche abandoned the project after the fourth part, although it was at first intended as an intermezzo. After *Zarathustra,* Nietzsche composed *Beyond Good and Evil (Jenseits von Gut und Bose, 1886)* and *The Genealogy of Morals (Zur Genealogie der Moral, 1887)* in a less poetic vein. to clarify his ideas.

Nietzsche's Sister and Last Works.—The *femme fatale* both in Nietzsche's life and for his posthumous reputation was his sister. After his break with Wagner she showed no understanding and little sympathy for his development. She married an anti-Semitic agitator, Bernhard Forster, of whose activities Nietzsche unequivocally disapproved. and moved to Paraguay with her husband to found a colony, "Nueva Germania." After her husband's suicide in the midst of a major financial scandal, she tried to make a national hero of him while salvaging the colony as an island of Teutonic Christianity. Having failed in both attempts. she secured the rights to her brother's literary remains and edited them without scruple or understanding. In an early manuscript, for example, in which Nietzsche mentioned that their father had suddenly become mentally ill and died soon after (in 1849), she erased a few words and published the text as saying that he had become ill after a fall down the cellar stairs. She secured letters which her brother had written to others and suppressed some of them, while publishing his drafts for many of them as drafts for letters to herself, occasionally even erasing address and signature in the notebook manuscripts.

While she gained a wide audience for her misinterpretations, she withheld her brother's self-interpretation, *Ecce Homo,* until 1908. Meanwhile she collected some of his notes under the title *The Will to Power (Der Wille zur Macht)* and presented this work, first as part of her three-volume biography (Leipzig, 1895–1904), then in a one-volume edition (1901) and finally in a completely remodeled two-volume edition *(1906)*. Ever since, the two-volume edition has been widely considered Nietzsche's crowning systematic labour. In fact. he had long used many of these notes in writing his later works, where they are occasionally given unexpected twists, while other notes had not been used by him because they were mere jottings and not acceptable formulations of his views. His later books, moreover, became less and less aphoristic and more and more continuous. Clearly, his projected main work, which he planned for a time to call *The Will to Power*, would have looked completely different even in form from the book that his sister put forward.

In *1888*, after he had dashed off *The Wagner Case (Der Fall Wagner)*, a brief polemic, he abandoned the former title and decided to call his main work *Revaluation of All Values (Umwertung aller Werte)*. He finished the first part, an essay of about 100 pages, and called it *The Antichrist (Der Antichrist, 1888)*. *It* is here and in *Twilight of the Idols (Gotzen-Diimmerung, oder Wie man mit dem Hammer philosophirt)*, written earlier in *1888*, and in *Ecce Homo*, written in the autumn of that year, that we encounter Nietzsche's final views, not in the sister's book which, however, contains many highly interesting notes. His last literary labour was to assemble under the title *Nietzsche contra Wagner* some passages from his earlier books, slightly revised here and there. This is his shortest and perhaps most beautiful book.

Those who have looked to *The Will to Power* as Nietzsche's magnum opus have found him all but incoherent. In any case, his memorable formulations have invited quotation out of context and prompted a great variety of untenable and mutually contradictory interpretations, beginning with those of his sister. It was at her repeated request, furthermore, that Adolf Hitler eventually consented to visit her Nietzsche-Archiv in Weimar, on his way to Bayreuth. Nietzsche had once written to her that it was typical of her to try to reconcile opposites, and this is epitomized in the name that she adopted after her husband's suicide: Forster-Nietzsche. Although the Nazis followed her lead and published some misleading anthologies of Nietzsche's thought, they could draw little comfort from his unexpurgated works. All serious students of the matter are agreed that the Nazi version of Nietzsche represents an utterly unscrupulous perversion of his thought.

Will to Power and Overman.— In the course of his psychological observations. Nietzsche gradually came to the conclusion that all human behaviour could be reduced to a single basic drive, the will to power. This notion is inseparable from his idea of sublimation, and the will to power is first discussed at any length in the chapter "On Self-Overcoming" in *Zarathustra*.

What man and every living being wants more than anything else is, according to Nietzsche, a higher, more powerful state of being in which the thousandfold impotence of his present state is overcome. Man wants to perfect himself, to re-create himself, to become a creator rather than a mere creature. It is only when he fails in this endeavour and resigns himself more or less to this failure that he seeks crude power over others as a substitute. Power is wanted in any case, but "power" in the vulgar sense is wanted only for lack of something better.

The higher state for which man strives, Nietzsche calls the overman (*Übermensch*). The overman is the man who has overcome himself; the passionate man who is the master of his passions; the creator who excels in both passion and reason and is able to employ his powers creatively. Although Nietzsche once remarks in *Zarathustra* that there has never yet been an overman, he says in *The Antichrist* (sec. 4): "Success in individual cases is constantly encountered in the most widely different places and cultures: here we really do find a *higher type*, which is, in relation to mankind as a whole, a kind of overman."[1] The disagreement between the two passages is not profound: it is only a question of either stressing the success of a Leonardo or of a Goethe, or emphasizing that even they were in some respects all too human.

The Last Man.—The overman serves Nietzsche as a contrast to man as he is, to "the last man" and to God. The last man appears in "Zarathustra's Prologue" where it is suggested—and this is confirmed elsewhere, most incisively and vitriolically in *Ecce Homo*—that evolution, biological or social, will lead not to the attainment of the overman but in the direction of the last man, who is an uncreative conformist and a complacent hedonist. "One still loves one's neighbor and rubs against him, for one needs warmth . . . A little poison now and then: that makes for agreeable dreams. And much poison in the end for an agreeable death. One still works, for work is a form of entertainment. But one is careful lest the entertainment be too harrowing. One no longer be-

[1]All quotations are from ***The Portable Nietzsche,*** The Viking ***Press,*** 1954.

comes poor or rich: both require too much exertion. Who still wants to rule? Who obey? Both require too much exertion. No shepherd and one herd! Everybody wants the same, everybody is the same: whoever feels different goes voluntarily into a madhouse."

The contrast between the overman and the last man epitomizes Nietzsche's critique of modern civilization. This critique is worked out in great detail and includes not only a critique of the pleasure principle, both as a norm and as the basis of any psychological monism, but also, and above all, a critique of the Christian religion and of morality.

God and the Eternal Recurrence. — The contrast of overman and God is also formulated in "Zarathustra's Prologue": "Remain faithful to the earth. and do not believe those who speak to you of otherworldly hopes!" Perfection can be hypostatized as existing even now in another world, in God, or it can be presented as a challenge and ideal for every one of us. Instead of resigning ourselves to being all too human and worshipping perfection, we can try to perfect ourselves in this life, on this earth.

The image of eternity is, for Nietzsche, the circle. He believed in the eternal recurrence of the same events at gigantic intervals. This he considered the most scientific of all hypotheses. Granted a finite number of power quanta as the basic constituents of the world, only a finite number of configurations would be possible. No if we do not cling to the Christian belief in creation, there is no beginning of the past, nor has a stable end state been attained by now. The only alternative, Nietzsche supposes, is that the configurations must repeat themselves after enormous periods of time. "And this slow spider, which crawls in the moonlight, and this moonlight itself, and I and you in the gateway . . . must not all of us have been there before? And return . . . must we not eternally return?"

This idea reverts to Stoic speculations. The world is not governed by a purpose; it is an eternally repeated senseless play, and me are condemned to play the same role over and over again. The overman, however, unlike Goethe's Faust, can say to every single moment: abide. thou art so fair — and if this is impossible, at least return eternally!

This conception of the overman does not entail faith in progress, which Nietzsche derided as "merely a modern idea, that is, a false idea" (in a discussion of the overman, Antichrist, sec. 4). For Nietzsche, overman and eternal recurrence belonged together. The idea of the overman is a challenge, not a prediction: it is an antithesis to God, even as the eternal recurrence of the same events is an antithesis to the Christian conception of time and history.

Critique of Christianity. — Nietzsche's opposition to Christianity is not confined to its otherworldliness which he considered a mere symptom. Otherworldliness is motivated by the will to power of the weak who have despaired of fulfillment in this life. They slander this world in favour of another world in which they hope for such power that "we shall judge angels" (I Cor. vi, 2, cited in Antichrist, sec. 4j).

Christianity, according to Nietzsche, is born of weakness and breeds weakness, while making war on those who are better favoured. It is the revolt of failures of every kind: of slaves against masters, of unfree minds against freethinkers, of the mediocre against the exception. Christianity, he says, "has waged deadly war against this higher type of man"; "Christianity has sided with all that is weak and base, with all failures"; "it has corrupted the reason even of those strongest in spirit by teaching men to consider the supreme values of the spirit as something sinful, as something that leads into error — as temptations. The most pitiful example: the corruption of Pascal, who believed in the corruption of his reason through original sin when it had in fact been corrupted only by his Christianity." (Antichrist, sec. 5.)

Dionysus.—Although Nietzsche diagnoses any celebration of the "pure spirit" at the expense of the body as a slander against life, prompted by what he calls ressentiment (resentment), he does not extol the body at the expense of the spirit. Against licentiousness, which is lack of self-control, and against renunciation, whether prompted by a lack of passion or by fear of any kind, he pits his image of Goethe "who might dare to afford the whole range and wealth of being natural, being strong enough for such freedom; the man of tolerance, not from weakness but from strength, because he knows how to use to his advantage even that from which the average nature would perish; the man for whom there is no longer anything that is forbidden — unless it be weakness, whether it be called vice or virtue."

All of Nietzsche's heroes were, like Goethe, men of surpassing intelligence, not irrationalists and least of all "pure fools." With the exception of Arthur Schopenhauer, whom Nietzsche greatly admired in his youth but later criticized, they affirmed this world. To cite the continuation of his portrait of Goethe from *Twilight* of the Idols: "Such a spirit who has become free stands amid the cosmos with a joyous and trusting fatalism . . . *he* does not negate any more. Such a faith, however, is the highest of all possible faiths: I have baptized it with the name of Dionysus."

The "Dionysian" in Nietzsche's early works was contrasted with the "Apollinian": it represented the flood of passion as opposed to the serenity which found expression in Greek sculpture. In his later work, as in the quotation above, it represents passion controlled and creatively employed as opposed to the negation of the passions. of the body and of this world.

"Dionysus versus 'the Crucified One': there you have the contrast. It is not martyrdom that constitutes the difference — only here it has two different senses . . . The tragic man affirms even the harshest suffering: he is sufficiently strong, rich, deifying for this; the Christian negates even the happiest life on earth: he is sufficiently weak, poor, and disinherited to suffer from life in any form. The God on the cross is a curse on life, a pointer to seek redemption from it; Dionysus cut to pieces is a *promise* of life: it is eternally reborn and comes back from destruction" (The Will to Power, note 1,052; written in 1888).

All of Nietzsche's many other criticisms of Christianity are corollaries of the major points here stated; *e.g.,* that most unevangelical sentiments of resentment have been central in Christianity from the beginning, even in the New Testament (though Nietzsche excepts Jesus from this charge); that the religion of Paul and of Catholicism, of Luther and of Calvin is a religion of vengefulness, judgment and negation; that Christianity is deeply antirational and antiscientific; that "the philology of Christianity" as exemplified in its treatment of the Old Testament is profoundly dishonest; that faith in the Christian sense involves self-deception. At bottom the charge is always the same: Christianity is born of weakness, failure and resentment and is the enemy of reason and honesty, of the body and of sex in particular, and of power, joy and freedom.

Slogans. — When Nietzsche took How One Philosophizes With a Hammer as the subtitle of Twilight of the Idols, he explained in his preface that his intention was "the sounding out of idols . . . which are here touched with a hammer as with a tuning-fork." He wanted "to pose questions here with a hammer, and, perhaps, to hear as a reply that famous hollow sound." Yet it has been widely assumed that his "hammer" was a sledgehammer. The slogan is recalled, the text forgotten.

When Nietzsche contrasted "master morality" and "slave morality" it was assumed that he identified himself with the former. In fact, he tried to show the need for "a typology of morals" to replace the prejudice that one's own morality is simply "morality." His cutting analysis of "slave morality" with its central Ressentiment is particularly pointed and original; but in the chapter on "The 'Improvers' of Mankind" in *Twilight* of the Idols he leaves no doubt of his distaste for master morality. He did not believe in the possibility of any universal moral code. Every morality was to him a prescription for living with one's passions, and different people require different prescriptions. A Luther cannot live like a St. Francis, and a St. Francis cannot live like Goethe. "One thing is needful" is the title of a long aphorism in The Gay Science which begins, "'Giving style' to one's character"; and it ends: "For one thing is needful: that a human being attain his satisfaction with himself . . . Whoever is dissatisfied with himself is always ready to revenge himself therefor; we others will be his victims."

That Nietzsche called himself a good European is often forgotten; that he called himself an immoralist is recalled. What he meant was not that he favoured a lack of discipline and letting oneself go. On the contrary, he insisted that without long and hard discipline we should lack all those achievements "for whose sake life on earth is worthwhile; for example, virtue, art, music, dance, reason, spirituality." His "immoralism" was in the main an impassioned nonconformism, and his choice of word was suggested by the fact that "morality" generally designates a social code that equates being moral with conforming.

Influence. — Of those hundreds who have written about Nietzsche, some authors quite deliberately perverted his meaning; others read their own ideas into their subject more or less unconsciously; and the vast majority had never read most of his books from beginning to end. The number of irresponsible interpretations is appalling. On the other hand he also exerted a commanding influence, in various ways, on some of the foremost writers of the 20th century: on Thomas Mann and Hermann Hesse, on Stefan George and Christian Morgenstern, on Rainer Maria Rilke and André Gide, on Karl Jaspers and Martin Heidegger, on Sigmund Freud and Bernard Shaw, on Oswald Spengler and Max Scheler, on André Malraux and Jean Paul Sartre. Freud often expressed his admiration for the profundity of Nietzsche's penetrating self-knowledge and for his insight into psychology. Spengler acknowledged in the preface to *The Decline of the West* that he owed "everything" to Goethe and to Nietzsche. According to Jaspers, Nietzsche belongs with Soren Kierkegaard. Together they determine the situation in which contemporary philosophy must begin. Heidegger sees Nietzsche as the last great metaphysician and the end point of a development begun with Plato. Thomas Mann fashioned the hero of his *Doktor Faustus* after Nietzsche; Malraux included an incident from his biography in *La lutte uvec l'ange;* Albert Camus, like Thomas Mann and Stefan Zweig, wrote an essay on Nietzsche; and Stefan George, two poems. More than half a century after his death, his life and work had lost none of their fascination, and modern philosophy had not yet digested all he had to offer.

Bibliography. — For a comprehensive bibliography, which lists the various editions of Nietzsche's works and letters as well as items not included in any collected edition and the most important works about him, *see* Walter Kaufmann, *Nietzsche: Philosopher, Psychologist, Antichrist* (Princeton, N.J., 1950; London, Toronto, 1951); the revised ed. (1956) omits the long bibliography.

Of the many editions of Nietzsche's works in German the *Musarion-Ausgabe,* 23 vol. (Munich, 1920–29), is the most complete. For an English text see *The Portable Nietzsche,* ed. and trans. by Walter Kaufmann (New York, 1954), containing *Thus Spoke Zarathustra, Twilight of the Idols, The Antichrist* and *Nietzsche contra Wagner* all complete, as well as selections from his other books, from his notes and from his letters in chronological sequence.

For studies *see* Charles Andler, *Nietzsche: sa vie et sa pensée,* 6 vol. (Paris, 1920–31); Erich Podach, *Nietzsches Zusammenbruch* (Heidelberg, 1930), *Gestalten um Nietzsche* (Weimar, 1932); Karl Jaspers, *Nietzsche: Einführung in das Verstandnis seines Philosophierens* (Berlin, 1936); George A. Morgan, Jr., *What Nietzsche Means* (Cambridge, Mass., London, 1941); Martin Heidegger, "Nietzsches Wort 'Gott ist tot' " in *Holzwege* (Frankfurt-on-Main, 1950). (W. Kn.)

NIEUPORT (Flem. Nieuwpoort), a town of Belgium in the province of West Flanders. Pop. (1947) 5,062. It was the port of Ypres, and is situated on the Yser about 10 mi. S. of Ostend. At one time Lombartzyde was the port of the Yser, but in the course of the 12th century mud was silted up, and ships went further south to Sandeshove, where it was more navigable. This place became the *novus portus,* or Nieuport. It was strongly fortified in the middle ages and its siege by the French in 1488–89 is an episode of its heroic period. Under its walls in 1600 Maurice of Nassau defeated the archduke Albert and the Spaniards.

Nieuport contains an ancient cloth market, a fine town hall and an old church, and outside is a lighthouse dating from 1289. More than once in the course of its history, the town has been completely rebuilt, hence its draftsboard plan, preserved even after the wholesale destruction of 1914–18.

Nieuport has one of the main artificial drainage outlets of the low country, the locks of Palingbrug. After World War I they were rebuilt in the form of six locks debouching on the canal of the Yser. They played an important part in the war, being the instrument of the famous flooding of the front on the Yser on Oct. 29, 1914; all that was necessary to submerge a large part of the district, under the enemy's fire,, was to reverse the normal process; *i.e.,* to close the locks to the lower and open them to the higher water, so as to allow the tide to flow inland.

Nieuwpoort Bad, 2 mi. from the town, is a fashionable seaside resort dating from 1869.

NIEVRE, a department of France, formed from the old province of Nivernais with a small part of the Orléanais. It is bounded northwest by Loiret, north by Yonne, east by Côte d'Or, east and southeast by Saône-et-Loire, south by Allier and west by Cher. Pop. (1954) 240,078. Area 2,660 sq.mi. Nièvre falls into three regions. In the east are the granitic mountains of the Morvan, one of the most picturesque parts of France, containing Mont Prénelay (2,759 ft.) and several lesser heights. The north and centre are occupied by plateaus of Jurassic limestone with a maximum elevation of 1,400 ft. The west and southwestern part of the department is a district of plains, composed mainly of Tertiary formations with alluvial deposits: and comprising the valleys of the Loire and the Allier. The lowest level of the department is 446 ft., at the exit of the Loire. Eastern Nièvre belongs to the upper basin of the Yonne, a tributary of the Seine, followed by the southern part of the Nivernais canal; western Nièvre drains toward the Loire, which crosses its southwestern corner and then forms its western boundary.

The principal cereals are oats and wheat; potatoks and various kinds of forage are also largely grown. On the extensive pastures much cattle is fattened. The Nivernais and Charolais are the chief breeds. The rearing of sheep and draught horses is also important. Vines are grown in the Loire valley and near Clamecy. The white wines of Pouilly are widely known. Nibvre abounds in forests, the chief trees being the oak, beech, hornbeam, elm and chestnut. Coal is mined at Decize, and gypsum, building stone and kaolin are quarried. The best-known mineral springs are those of Pougues and St. Honoré. Nièvre is famous for ironworks, the most important being those of Fourchambault. At Imphy there are large steelworks. The government works of La Chaussade at Guérigny make chain cables, anchors, armour plates, etc. There are also manufactories of agricultural implements and hardware, potteries, manufactories of porcelain and fai'ence (at Nevers) and glassworks, tileworks, chemical works, paper mills and sawmills, as well as tanneries, boot and shoe factories, cask manufactories and oil works (colza, poppy and hemp). In the Morvan district the timber industry is important.

Much of the traffic is by water; the canal along the Loire runs through the department for 38 mi., and the Nivernais canal for 78 mi. The chief railway is tliat of the P.L.M. company, whose main line to Nîmes follows the valley of the Loire and Allier. Nibvre is divided into 4 *arrondissements* (Nevers, Cosne, Château-Chinon and Clamecy being their capitals), 25 cantons and 313 communes. It forms the diocese of Nevers under the archbishop of Sens and part of the *académie* (educational district) of Dijon and of the region of the 8th army corps. The chief towns are Nevers, the capital, Clamecy, Fourchambault, Cosne, La Charité and Decize. The appeal court is at Bourges.

NIFO, AGOSTINO (Augustinus Niphus) (1473?–1538 or 1545), Italian philosopher and commentator, was born at Japoli, Calabria. He lectured at Padua, Naples, Rome and Pisa, and was deputed by Leo X to defend the Catholic doctrine of immortality against the attack of Pomponazzi and the Alexandrists. In return for this he was made count palatine, with the right to call himself by the name Medici. He edited (1495) the works of Averroes, with a commentary compatible with his lately acquired orthodoxy. In the great controversy with the Alexandrists he opposed Pomponazzi's theory that the death of the body means the death of the soul. He insisted that the individual soul, as part of absolute intellect: is indestructible, and on the death of the body is merged in the eternal unity.

His principal philosophical works are *De immortalitate animi* (1518 and 1524); *De intellectu et daemonibus; De infinitate primi motoris quaestio* and *Opuscula moralia et politica.* His numerous commentaries on Aristotle were frequently reprinted, the best-known edition being printed at Paris in 1654 in 14 vol,

NIĞDE (Arab. *Nakidah*), the chief town of a vilayet in Turkey, situated on the Kaisarieh-Cilician Gates road. It is remarkable for the beauty of its buildings, dating from almost all ages of the Seljuk period. After the fall of the sultanate of Rum (of which it had been one of the principal cities), Niğde became independent, and, according to Ibu Batuta, ruinous, and did not pass into Ottoman hands till the time of Mohammed II. It represents no classical town, but, with Bor, has inherited the importance of Tyana, whose site lies about 10 mi. S.W. A Hittite-inscribed monument, brought perhaps from Tyana, has been found at Niğde. Pop. (1955) 14,693; of the vilayet, 285,824.

NIGEL (d. 1169), bishop of Ely, head of the exchequer in the reigns of Henry I. and Henry II., was brought into the exchequer in early life (1130). Soon after his uncle Roger of Salisbury secured him the bishopric of Ely, much to the disgust of the monks. Nigel incurred the suspicion of leaning towards the Angevin interest, when Roger of Salisbury and Alexander of Lincoln were arrested by Stephen (Jan. 1139). He attempted to maintain himself in his see by force of arms, but he was forced to fly to the empress at Gloucester. He was reconciled to Stephen in 1142 and restored to his see; but he now quarrelled with Henry of Winchester and was forced to go to Rome. Fortunately, he secured the strong and uniform support of the Roman Curia. At the accession of Henry II. (1154) Nigel was summoned to reorganize the exchequer. He was the only surviving minister of Henry I., and his knowledge of the exchequer business was unrivalled. This was the great work of his life. To the work of his son Richard, the *Dialogus de Scaccario,* we owe our knowledge of exchequer procedure as it was left by Nigel. The bishop took little part in politics, except as an administrator. In 1166 his health was broken by a paralytic seizure.

See F. Liebermann, *Einleitung in den Dialogus & Scaccario* (1875); J. H. Round, *Geoffrey de Mandeville* (1892).

NIGER, a great river of West Africa, inferior only to the Congo and Nile among the rivers of the continent. Rising within 150 m. of the sea in the mountainous zone which marks the northeast frontiers of Sierra Leone and Guinea, it traverses the interior plateaus in a vast curve, flowing northeast, east and south-east. until it enters the Gulf of Guinea through an immense delta Its total length is about 2,600 miles. About 250 m. from its mouth it is joined by the Benue, coming from the east from the mountainous region of Adamawa. From its mouth to the limit of navigability from the sea the Niger is in British territory; above that point it flows through former French territory, which now comprises the newly created African republics. The area of the Niger basin is calculated at 580,000 sq.m. at least.

The source of the Niger lies in 9° 5′ N. and 10° 47′ W.; the most northerly point of the great bend is about 17° N. and the mouth is in 4° 30′ N. 6° E. The river is known locally under various names, the most common being Joliba (a Mandigo word meaning great river) and Kworra or Quorra. By the last name the Niger was known in its lower reaches before its identity with the upper river was established. The Tembi, the stream considered the chief source of the Niger, issues from a deep ravine 2,800 ft. above sea-level where, from a moss-covered rock a spring issues and has made a pool below. The overflow forms the Tembi, which within a short distance is joined by two other rivulets, the Tamincono and Falico, which have their origin in the same mountainous district. After flowing north for about 100 m., the river turns eastward and at its confluence with the Tankisso (a northern tributary), 210 m. from its source, has attained dimensions sufficient to earn for itself the title Joliba. Taking at this point a decided trend northward, the Niger, 100 m. lower down, at Bamako has a depth of 6 ft. with a breadth of 1,300 feet. Seven or eight miles below Bamako the Sotuba rocks mark the end of what may be considered the upper river. Thirty miles below Sotuba are the rapids of Tulimandio; a little lower down is Kulikoro, from which point the bed of the stream for over 1,000 m. is fairly free from impediments.

Middle Niger and Lake Region.—The Niger here turns more directly to the east and increases in volume and depth. Below Sansandig the banks of the river become low and the Niger is split up into a number of channels. Mopti is at the junction of the main stream with a large right-hand backwater or tributary, the Bani-or Mahel Balevel, on which is situated the important town of Jenné. Below Mopti is a swampy and treeless region and the first of a series of lakes (Debo) is reached. These lakes are chiefly on the left of the main stream, with which they are connected by channels conveying the water in one direction or the other according to the season. At high water most of these are united into one general inundation. The largest lake, Faguibini, is nearly 70 m. long by 12 m. broad, has high shores and reaches a depth exceeding, in parts, 160 feet. It is not until Kabara, the port of Timbuktu, is reached, a distance of 450 m. from Sansandig, that the labyrinth of lakes, creeks and back-waters ceases. Below Kabara the river reaches its most northerly point. Here, and for some 500 m. down stream the river is bordered on the north by the Sahara; in places it is desert on both sides, with long lines of sand dunes. At Bamba it is shut in by steep banks, and narrows to from 600 to 700 yd., again spreading out some distance down. At Tosaye (about 250 m. from Timbuktu) the stream turns distinctly south-east and preserves that direction throughout the remainder of its course. Here, just before the bend becomes pronounced, the Baror and Chabar rocks reduce the width of the river to less than 500 ft., and at low water the strength of the current is a serious danger to navigation.

At Ansongo, 430 m. below Timbuktu, the navigable reach of the middle Niger, in all 1,057 m., ends. Four huge flint rocks bar the river at Ansongo and effectually prevent further navigation except in very shallow draught vessels. From Ansongo to Say, some 250 m., the river presents a labyrinth of rocks, islands, reefs and rapids. From Say, where the stream is about 700 yd. in breadth, to Bussa, there is another navigable stretch extending 300 miles. After the desert region is past the Niger receives the waters of the river Sokoto, a considerable stream flowing from the north-east. Some distance below this confluence are the Bussa rapids. These rapids are of a more dangerous character than any encountered between Ansongo and Say. "In one pass, some 54 yd. wide, shut in between two large reefs, a good half of the waters of the Niger flings itself over with a tremendous roar" (Hourst). The rapids extend for 50 m. or more; in a less obstructive form they continue to Rabba.

Lower River and Delta.—A little above Rabba the river makes a loop south-west, at the head of the loop being (right bank) Jebba. Here there is an island in midstream, taken advantage of in the bridging of the river by the railway from Lagos. Sixty miles lower down is the mouth of the (left hand) tributary the Kaduna, a river of some magnitude whose head waters are not far from Kano. In 7° 50′ N. 6" 45′ E. the Niger is joined by its great tributary the Benue. At their confluence the Niger is about $\frac{3}{4}$ m. broad and the Benue rather more than a mile. The united stream forms a lake-like expansion about 2 m. in width, dotted with islands and sandbanks; the peninsula at the junction is low, swampy and intersected by numerous channels. The stream, as far south as Iddah (Ida), a town on the east bank, rushes through a valley cut between the hills, the sandstone cliffs at some places rising 150 ft. high. Between Iddah and Onitsha, 80 m., the banks are lower and the country flatter, and to the south of Onitsha the whole land is laid under water during the annual floods. Here may be said to begin the great delta of the Niger, which, extending along the coast for about 120 m., and 140 or 150 m. inland, forms one of the most remarkable of all the swampy regions of Africa. The river breaks up into an intricate network of channels, dividing and subdividing, and intercrossing not only with each other but with the branches of other streams, so that it is exceedingly difficult to say where the Niger delta ends and another river system begins. The Rio Nun is a direct continuation of the line of the undivided river, and is thus the main mouth of the Niger. From the sea the only indication of a river mouth is a break in the dark green mangroves which here universally fringe the coast. The crossing of the bar—where the depth of water is but 12 or 13 ft—requires considerable care, and as other branches of the Niger afford better access the Nun mouth is now little used. East of the

Nun the estuaries known as the Brass, Sombrero, New Calabar, Bonny. Opobo (or Imo), etc. (with the exception, perhaps, of the first-named), seem to derive most of their water from independent streams West of the Nun all the estuaries up to the Forcados seem to be true mouths of the great river. The Forcados has supplanted the Nun river as the chief channel of communication by water with the interior. The mouth of the Forcados is 2 m wide, the bar, formerly but $\frac{3}{4}$ m. across, had by 1927 grown to $2\frac{1}{4}$ m. across, but the depth of water allowed vessels of 18 ft draught to enter the river; within the bar is a deep water natural harbour of 3 to 4 square miles Five miles up stream is the port of Burutu. From the mouth of the Forcados to the main stream is 105 m , with a minimum depth in the dry season of seven feet. The other western mouths of the Niger have as a rule shallow and difficult bars. The delta is the largest in Africa and covers 14,000 square miles, a larger area than the more famous Nile delta.

The **Benue.**—The Benue is by far the most important of the affluents of the Niger. The name signifies in the Batta tongue "Mother of Waters." The river rises in Adamawa in about 7° 40' N and 13° 1j' E., at a height of over 3,000 ft., being separated by a narrow water parting from one of the head-streams of the Logone, whose waters flow to Lake Chad. In its upper course the Benue is a mountain torrent falling over 2,000 ft. in some 150 miles. With the Chad system it is connected by the Kebbi or Mayo Rebbi, a river which issues from the south-west end of the Tuburi marshes, and eventually joins the Benue The Tuburi marshes occupy an extensive depression in the plateau east of the Mandara hills, and are cut by 10° N , 1j° E The central part of the marshes forms a deep lake, whence there is a channel going northward to the Logone.

Below the Kebbi confluence the Benue, now a considerable river, turns from a northerly to a westerly direction and is navigable all the year round by boats drawing not more than $2\frac{1}{2}$ feet. At Yola, a town some 850 m. by river from the sea and at an altitude of 600 ft., the width of the stream at flood time reaches to 1,000 or 1.500 yd , and though it narrows at the somewhat dangerous rapids of Runde Gilla to 1jo or 180 yd., it soon expands again. About 50 m. above Yola the Benue is joined by the Faro, a river rising in the Adamawa hills. and some 50 m. below Yola the Benue receives, on the right bank, the Gongola, which rises in the Bauchi highlands and after a great curve north-east turns southward. It is over 300 m long, and at flood time is navigable for about half of its course. In its lower course the Benue is joined by several other streams; its valley is bordered by ranges of hills.

As the Niger and the Benue have different gathering grounds, they are not In flood at the same time. The upper Niger rises in June and decreases in December. The middle Niger, however, reaches its maximum near Timbuktu only in January and April–July is the low water season The Benue reaches its greatest height in August or September, begins to fall in October, falls rapidly in November and slowly in the next three months, and reaches its lowest in March and April. The flood rises with great rapidity, and reaches 50, 60 or even 75 ft. above the low-water mark

Below the Benue confluence the Niger is at its lowest in April and May; in June it is subject to great fluctuations; about the middle of August it usually begins to rise; and its maximum is reached in September. In October it sinks, often rapidly A slight rise in January, known as the *yangbe,* is occasioned by water from the upper Niger Between high and low-water mark the difference is as much as 3j ft.

History **and** Exploration.—Vague ideas of the existence of the river were possessed by the ancients. The great river flowing eastward reached by the Nasamonians as reported by Herodotus can be no other than the Niger. Pliny mentions a river Nigris, of the same nature with the Nile, separating Africa and Ethiopia, and forming the boundary of Gaetulia; and it is not improbable that this is the modern Niger. In Ptolemy, too, appears along with Gir (possibly the Shari) a certain Nigir (Νίγειρ) as one of the largest rivers of the interior; but so vague is his description that it is impossible definitely to identify it with the Niger. Arabian geographers, such as Ibn Batuta, who were acquainted with the middle course of the river, called it the Nile of the Negroes At the same time contradictory opinions were held as to the course of the stream. It was supposed by some geographers to run west. an opinion probably first stated by Idrisi in the 12th century. Idrisi gave the Nile of Egypt and the Nile of the Negroes a common source in the Mountain of the Moon. Fountains from the mountain formed two lakes. whence issued streams which united in a very large lake From this third lake issued two rivers—the Nile of Egypt flowing north, and that of the Negroes flowing west (*see* R. Dozy and M J de Goeje's *Edrisi,* Leiden, 1866: Premier Climat, 1st four sections). From Idrisi's description it would appear that he regarded the Shari, Lake Chad, the Benue, Kiger and Senegal as one great river which emptied into the Atlantic. From 1405 to 1413 a Frenchman, Anselme d'Isalguier, lived at Gao. a city on the Niger 400 m. below Timbuktu; the account of his travels was never printed and is lost Knowledge of his adventures, never widely known, was completely forgotten until brought to light by Ch de la Roncière (*see* his *Découverte de l'Afrique au Moyen Âge,* vol. iii., Cairo, 1927) Leo Africanus visited the Niger regions in 1513–15 without settling the question as to the direction of the river. The belief that a western branch of the Nile emptied itself into the Atlantic was held by Prince Henry of Portugal, who instructed the navigators he despatched to Guinea to look for the mouth of the river, and when in 1445 they entered the estuary of the Senegal, the Portuguese were convinced that they had discovered the Nile of the Negroes (*see* Azurara's *Discovery and Conquest of Guinea,* Beazley and Prestage's translation, vol ii., London, 1899, chap lx and lxi, and introduction and notes). The Senegal being proved an independent river and the eastward flow of the Niger assumed, the theory that it ran into the Nile was revived.

That the vast network of rivers on the Guinea coast, of which the Nun was the chief, known as the Oil rivers, formed the delta of the Niger does not appear to have been suspected before the beginning of the 19th century. Consequently it was from the direction of its source that the river was first explored in modern times. In 1795 Mungo Park (*q.v.*), sent out by the African Association, landed at the Gambia, and struck the Niger near Segu on July 20, 1796, uhere he beheld it "glittering in the morning sun as broad as the Thames at Westminster and flowing slowly to the eastward" (*Travels,* 1st ed, *p.* 194). He descended the river some distance. and on his return journey went up stream as far as Bamako. In 1805 Park returned to Africa for the purpose of descending the Niger to its mouth. From Bamako he sailed down the river for over 2,000 miles and on the eve of the successful accomplishment of his undertaking lost his life during an attack on his boat by the natives at Bussa (Nov or Dec. 1805). Park held to the opinion that the Niger and Congo were one river, though in 1802 C. G Reichard, a German geographer, had suggested that the Rio Nun was the mouth of the Niger. Owing to Park's death the results of his second journey were lost, and the work had to be begun afresh. In 1822 Maj. A. G. Laing (who had reached Timbuktu by way of Tripoli) obtained some accurate information concerning the sources of the river, and in 1828 the French explorer René Caillié went by boat from Jenni: to the port of Timbuktu. In 1826 Bussa was reached from Benin by Hugh Clapperton, and his servant Richard Lander On Clapperton's death Richard Lander and his brother John led in 1830 an expedition which went overland from Badagry to the Niger. Canoeing down the river from Yauri—60 m. above Bussa—to the mouth of the Rio Kun they finally settled the doubt as to the lower course of the stream

Heinrich Barth (1851–54) made known to Europe the course of the river from Timbuktu to Say. Later, the extension of French influence throughout the western Sudan led to an accurate knowledge of the river above Timbuktu. From 1880 onwards Col. (afterward General) Gallieni took a leading part in the operations on the upper river, where in 1883 a small gunboat, the "Niger," was launched for the protection of the newly established French posts. In 1885 a voyage was made by Capt. Delanneau past the ruins of Sansandig, as far as Diafarabe. In 1887 the "Niger" made a more extended voyage, reaching the port of Timbuktu.

A more important expedition was that of Lieut. Hourst, who, starting from Timbuktu in Jan. 1896, navigated the Niger from that point to its mouth.

In addition to the main stream, the Niger basin was made known during the last quarter of the 19th century and the early years of the 20th. The journeys of the German traveller G. A. Krause (north from the Gold Coast, 1886–87) and the French Capt. Binger (Senegal to Ivory Coast, 1887–89) first defined its southern limits by revealing the unexpected northward extension of the basins of the Guinea coast streams, especially the Volta and Komoe, a fact which explained the absence of important tributaries within the Niger bend.

The exploration of the Benue dates from the middle of the 19th century. In 1851 Barth crossed the Benue at its junction with the Faro, but the region of its sources was first explored by the German E. R. Flegel (1882–84), who traversed the whole southern basin of the river and reached Ngaundere. The Benue itself had been ascended 400 mi. by the "Pleiad" expedition in 1854 and in 1889 the river was traced to 13½° E., and Kebbi to Bifara by Maj (afterward Sir Claude) Macdonald, further progress toward the Tuburi marsh being prevented by the shallowness of the water.

In 1903, a French officer, Capt. E. Lenfant (who had in 1901 succeeded in navigating the Bussa rapids on the Niger) ascended the Kebbi and discovered the Lata fall, continuing up the river to its point of issue from Tuburi. Crossing the marshes he found and navigated the narrow river leading to the Logone.

From Kulikoro (which is connected by railway with the port of Dakar) downward, the French have undertaken works on the Niger with a view to deepening the channel, and they maintain a regular steamer service to the port of Timbuktu. In 1910 the British began dredging with the object of obtaining in the lower river a minimum depth of 6 ft. of water; however, while there is still a large river traffic the building of railways in Nigeria has deprived the lower Niger and the Benue of their importance as highways of commerce to the far interior.

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NIGERIA, a country of West Africa, occupying the basin of the lower Niger and extensive adjacent territories. Area 339.169 sq.mi. (Korthern region, 264,282 sq.mi.; Eastern region, 29,484; Western region, 45,376; Lagos, 27), excluding the British Cameroons (34,081 sq.mi.) which mas until Oct. 1, 1960, administered through the Federation of Nigeria.

Nigeria became an independent member of the British commonwealth on Oct. 1, 1960.

Nigeria is bounded west by Dahomey, north by Niger, northeast by Lake Chad, east by British Cameroons and Cameroun, and south by the Gulf of Guinea.

PHYSIOGRAPHY

Nigeria is divided into four relief belts each roughly parallel to the coast: (1) the low coastal belt, which includes the Niger delta; (2) a hilly belt rising to more than 1,500 ft.; (3) the valleys of the middle Niger and the Benue, from 250 to 600 ft.; and (4) the wide plateau belt, all more' than 600 ft. above sea level and reaching 6,000 ft. on the Jos plateau.

The main rivers are the Niger (*q.v.*), entering the country in the northwest and flowing first southeast and then south to the Gulf of Guinea; its tributary the Benue, which rises in the Adamawa mountains; and the Cross river (*q.v.*), which flows into a deep estuary east of the Niger delta. Long but intermittent streams drain northeastward from the Jos highlands to form the Komadugu Yobe, which flows into Lake Chad.

The coastal belt is swampy and crossed by numerous creeks into which flow the distributaries of the Kiger and streams draining from the hilly belt behind. Many of these are used to float logs from the timber areas. The tidal swamps are covered by mangrove forests. The inner fresh-water swamps bear some useful timber, and rice cultivation is being encouraged. They are almost entirely under water in times of flood. The swamp belt reaches its greatest breadth (about 50 mi.) at the Niger mouths and narrows rapidly toward Lagos and toward Calabar.

As the land rises gently inland to form the hilly belt it becomes clothed with dense evergreen rain forest to a width averaging 80 mi.. corresponding roughly to the area with an annual rainfall of more than 80 in. East of the Niger the forest has been much impoverished hy clearings made to allow cultivation. The forest is the native home of the oil palm. and as timber trees (obeche, ebony and mahogany) have been cut while oil palms have been preserved, many districts have no covering but oil palm bush. The inland and western sections of the forest, where the dry season is more marked, include many deciduous trees. The valleys of the Benue and the middle Niger form a great arc of lowland from Sokoto in the northwest to Yola in the northeast. The valleys are wide and the rivers slow-flowing to their junction at Lokoja, but from that point to Idah, where they open on the coastal lowland, the banks rise steeply on either side. Savanna woodland covers most of the country from the crests of the hill belt to the plateau. Gallery forest fringes the main rivers.

The plateau section is highest to the southwest and to the west of Jos, where its southern edge has heights of 6,000 ft. and an area 60 mi. by 100 mi. is more than 3.000 ft. above the sea. This high area descends northward by steps to the general plateau level (about 1.500 it.). Most of Bornu (*q.v.*) slopes gently toward Lake Chad at levels between 600 and 1,200 ft. It includes a wide area of swamp in the rainy season. The Jos plateau is open grassland with a belt of deciduous forest along its rainier southern face. The rest of the zone is rather dry savanna country, the trees decreasing northward in number and size. About lat. 12° N. it passes into thorn scrub. interspersed with bare patches of sandy soil in the dry season but carrying good pasture during the rains. Water can be found at shallow depths in parts of the plateau, and wells are being sunk in the more arid areas.

Geology. — The basal crystalline and metamorphic rocks which compose the great African tableland are exposed in all the upland areas of Nigeria: the central plateau area of the Northern region, the hill belt of Ilorin, Oyo and Abeokuta and the Oban hills north of Calabar. also in the mountain country of the Cameroons. Depressions in the surface of the ancient tableland have been partly filled by more recent deposits. In the Benue valley the surface rocks are of Cretaceous age. Tertiary beds cover much of Bornu, the Sokoto basin. the Niger valley from Lokoja to Kontagora and the inner half of the coastal belt. The swamp belt and parts of Bornu adjoining Lake Chad carry thick alluvial deposits. Volcanic rock occurs mainly in the Cameroons.

Tin ore (cassiterite) has long been obtained from eluvial and old alluvial deposits overlying the granites of the Bauchi plateau. Two rare ores. columbite and tantalite, occur with the tin. Coal is mined near Enugu, but the large deposits of lignite near Benin and Onitsha had not been exploited by the latter 1950s.

(T. HER.)

Climate.— The high mean temperatures and high relative humidity found in coastal areas create most trying conditions which have given a bad reputation to the climate of Nigeria. Progress in medical science has however made it possible for Europeans to lead a normal and healthful life in Nigeria provided they take periodical leaves in a cooler climate. Near the coast the seasons are not sharply defined, and temperatures rarely exceed 90° F.; but humidity is high and the general effect is enervating. Inland there are two distinct seasons: a dry season of low humidity with high midday temperatures but with relatively low night temperatures; and a wet season when the humidity rises. though never becoming as high as it is on the coast. On the plateau temperatures are generally lower, and the climate is pleasant for Europeans. The principal winds, which are usually light except during a line squall, are the northeasterly current, known locally as the harmattan, which is hot. dry and dust-laden from its passage over the Sahara desert; and the warm, moist southwesterly current from the southern Atlantic.

Rainfall is heavy in the south. ranging from about 70 in. in the southwest to about 150 in. in the southeast (with as much as 400 in. locally. toward the foot of Cameroon mountain); it decreases rapidly inland to about 20 in. in the extreme north. The rainy season extends from May to October in the south and from June to September in the north. There is usually a break of dry weather in August and in the first half of September in the southwest. The dry season in the north is normally a drought, but some rain may normally be expected to fall every month on the coast. The mean maximum temperature is about 87° F. in the coastal belt and 94° F. in the north. Maximum day temperatures are highest in the latter half of the dry season from February to April and lowest in July and August. Mean minimum temperature is about 72° F. in the south and 66° F. in the north. The mean daily range of temperature is high in the north, averaging 25° (with higher ranges in the dry season). but normally not more than 15° in the south. Near the coast maximum relative humidity lies between 95% and 100%, falling to a minimum, between 70% and 80%, in the afternoon; seasonal variations are slight, though short periods of low humidity occur in January and February. Inland from the coastal belt relative humidity decreases and changes abruptly as the locality comes under the influence of the southwesterly or the northeasterly wind. Violent thunderstorms are common and these generally have been called tornadoes, but they are in fact line squalls and do not have the characteristics of a line tornado. A line squall forms from a dark mass of heavy cloud in the east with thunder and lightning and moves westward; as it passes overhead squalls of up to 50 m.p.h. rise, followed by heavy rain; this gradually dies away in about an hour, leaving clear, cool and refreshing weather.

(G. B. G. C.)

Vegetation.— The vegetation of Nigeria varies from lush rain forest in the south to arid thorn scrub in the far north. Between these extremes broad belts of distinctive vegetation are arranged roughly parallel to the equator.

The coastal vegetation is composed largely of species which also occur on the Atlantic shores of tropical America. Three species of red mangrove (*Rhizophora*) form extensive thickets and forests in the brackish swamps. *Raphia* palms, climbing palms, *Pandanus* and various trees with stilt roots are characteristic of a different type of swamp forest, which occurs behind the mangroves where the water is fresh. Mangroves and fresh-water swamp forest are both particularly well developed in the Niger delta.

The rain forest region, continuous with the great equatorial forests of the Cameroons and of the Congo basin, is honeycombed with villages and their farm lands. and even the valuable forest reserves of the southwest are far from virgin. In the best forests the largest trees, 120–200 ft. in height and 10–20 ft. or more in girth, tower above the main canopy; many of them have buttresses at the base of the clean straight boles. The forests are rich in species. Among the valuable timber trees are several members of the mahogany family (Meliaceae), such as African mahogany (*Khaya ivorensis*), African walnut (*Lovoa trichilioides*), guarea (*Guarea cedrata* and *G. thompsonii*) and sapele (*Entandrophragma cylindricum*). There are also iroko (*Chlorophora excelsa*), obeche (*Triplochiton scleroxylon*), afara (*Terminalia superba*), idigbo (*Terminalia ivorensis*), ekki (*Lophira alata*), opepe (*Nauclea diderrichii*) and abura (*Mitragyna*). Among the numerous smaller trees are species of ebony (*Diospyros*), many species of wild cola (*Cola*). camwood (species of *Pterocarpus* and *Baphia*) and Lagos silk rubber (*Funtumia elastica*). Silk cotton (*Ceiba*) and kapok (*Bombax*) trees grow to great sizes in secondary forest. The oil palm (*Elaeis guineensis*) is abundant in farmed areas. especially in the Eastern region: while small plantations of edible cola nuts (*Cola acuminata* and *C. nitida;* native in West Africa) and the introduced cacao and Para rubber are common in the Western.

Fallow farm land in the rain forest region is soon covered by quick-growing trees: such as the umbrella tree (*Musanga cecropioides*), and by dense tangles of scandent (climbing) shrubs which become large lianes when left to grow up with the developing forest. If tall grass invades the fallows, fierce fires become almost inevitable every dry season and these gradually kill out all the forest species. This is particularly liable to occur near the northern. drier limit of the forest regions where wide tracts previously occupied by forest are now degraded to a savanna type.

The rain forest region reaches only 50 to 150 mi. inland. and the rest of the country is covered with a more open vegetation of tall grass and of deciduous. fire-resisting trees of relatively small stature. At its best the vegetation consists of closed woodland from 20 to 60 ft. high. but grass fires and shifting cultivation have caused the trees to be usually rather widely spaced amid the tall grass. Belts of this vegetation. commonly called savanna, run right across northern Africa between the Sahara and the rain forest regions. In the moister savanna regions of Nigeria tussocky grass from 6 to 12 ft. high and broad-leafed trees predominate; among the latter, *Daniellia oliveri, Lophira lanceolata, Isoberlinia doka* and *I. dalzielii* are very abundant. In the more arid regions shorter feathery grass and fine-leafed thorny trees. especially species of *Acacia,* including the gum arabic (*A. senegal*), are widespread. Narrow strips of more or less evergreen forest vegetation fringe the streams in the savanna regions.

Savanna trees are used mainly as fuel and for rough building poles and for their fruits. The following fruit trees are common in and around towns and villages: the locust bean (*Parkia*), the shea butter (*Butyrospermum*), the baobab (*Adansonia*) and the tamarind (*Tamarindus*). The fan palm (*Borassus*), the doum palm (*Hyphaene*) and species of *Raphia* occur in the savanna regions; the date palm is found only in towns, but a wild relative, *Phoenix reclinata,* is common by streams.

At the beginning of the rainy season the savanna trees come into new leaf, often with vivid tints. fresh green grass grows up from the burned ground and a number of bulbous monocotyledons come into flower. During the rainy season the grass grows apace and the tree canopy thickens. Toward the end of this season the grasses flower and with them many of the Compositae and other dicotyledonous herbs. During the dry season the grass is burned and the vegetation remains charred and bare for a few weeks.

Most of the extreme north of Nigeria is covered by a drift of sand formed during an arid period in early Quaternary times. The climate has since become much moister and the sand has been stabilized by vegetation. Where, however, such ground has been cleared of its natural vegetation the loose sand is easily blown about in the dry season after the crops have been reaped. This has led some people to believe that the Sahara is encroaching into Nigeria. In fact, the northern boundary of Nigeria is separated from the desert by a wide belt of thorn woodland.

Montane vegetation is of limited occurrence in Nigeria. The best examples are seen in the Sonkwala mountains of Ogoja province, outliers of the extensive highlands of the Cameroons. This vegetation has close affinities with that of the mountains of eastern and southern tropical Africa and includes some typically European genera and species. The flora of the Bauchi plateau also has many affinities with that of east and south tropical Africa, but montane vegetation is virtually absent. (R. W. J. K.)

Fauna. — The fauna of Nigeria is rich but varies greatly from one vegetation zone to another. The dense forest is rather sparse in large animals, the outstanding ones being the gorilla, chimpanzee and drill. A number of dwarf antelopes, or duikers, live there, as well as numerous monkeys and many smaller mammals. The manatee lives in suitable rivers and creeks in the south. while the hippopotamus is found in most of the larger rivers and lakes. The pygmy hippopotamus occurs in the Owerri area. The situtunga and the bush cow are found wherever the terrain is suitable. The elephant still inhabits parts of the forest zone, as well as the open country north of the forest which is the home of many antelopes. Giraffe and rhinoceros are now local and scarce in the Northern region. The leopard is found throughout Sigeria and the lion in much of the open zone.

Hundreds of species of birds are common! including such tropical families as parrots, hornbills, touracoes, barbets. weavers and sunbirds. There are ostriches in the extreme north, together with several species of storks and bustards. The most plentiful game birds are guinea fowl, francolins (bush fowl), green pigeons. ducks and geese. The presence of the tsetse fly excludes domestic stock. except for some poor sheep and goats, from the forest zone, but horses, donkeys, camels, cows and pigs, as well as numerous sheep and goats, are kept in the open country. Reptiles are plentiful both in variety and number, with three species of crocodiles, several turtles and tortoises and many lizards and snakes. The most important snakes are black cobras! green mambas, giant vipers and pythons. Nigeria is also rich in amphibians, fish and all forms of invertebrates. (G. S. Ce.)

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HISTORY

Very little is known of the history of Nigeria, least of all the history of the coastal tribes, before the country was first visited by Portuguese navigators in the second half of the 15th century. A number of Negro tribes occupied the swampy coastal areas and the thickly forested lands which lay immediately behind, while the interior, which became the Northern region of Nigeria, was the home of peoples of mixed Arab, Hamitic and Negro blood. The Moslem religion probably was introduced into this northern area as early as the 13th century and profoundly influenced the social as well as the religious life of the inhabitants, although much paganism still survived. There was little intercourse between these northern peoples and the pagan tribes inhabiting the forest country to the south, and until Europeans visited the coast the only contacts of Nigeria with the outer world were with the eastern Sudan and, across the Sahara, with the Moslem states of North Africa.

Bornu and the Hausa Lands. — The principal peoples in the north were the Kanuri. who occupied Bornu (*q.v.*), the Hausa-speaking tribes and the Fulani. The empire of Kanem, of which Bornu was a province, by the end of the 1rth century A.D. extended both east and west of Lake Chad and included the greater part of the Hausa lands. Ton-ard the end of the 14th century the power of Kanem waned and the empire shrank until little was left of it except Bornu. Meanwhile! to the west of Bornu. the fortunes of the Hausa states rose and fell. These states, the most important of which were Kano, Zaria, Daura, Gobir and Katsina, had existed from an early date; each independent of the others, and often fighting for supremacy but joining from time to time in a loose confederacy for mutual defense. Conquered in turn by Kanem and by Askia the Great, king of Songhai (Sonrhaï)—early in the 16th century — they retained their identities under native rulers who acknowledged the suzerainty of the conquerors. When the influence of Songhai declined and the Hausa states recovered their independence, they engaged again in internecine wars and were overrun at different times by the armies of Bornu or of Kebbi, a state to the west of the Hausa lands, which was of importance in the 16th century.

Meanwhile, for several centuries, there had been a steady movement into the Hausa lands of a pastoral tribe. the Fulani (*q.v.*), of whose origin little is known. While most of the Fulani remained with their herds, moving from place to place in search of water and pasturage, a number drifted to the towns and mingled with the Hausa population. Their intelligence and ability quickly established these "town Fulani" in positions of influence.

Such a position had been gained by Usuman (Othman) dan Fodio, a fanatical Fulani sheikh of great reputed sanctity who had made the pilgrimage to Mecca. When, about 1802, Usuman intervened on behalf of a number of Moslems who had been enslaved, the pagan king of Gobir ordered his arrest and Usuman roused his followers to revolt. Recognized as *sarkin musulmi* (Commander of the Faithful), Usuman was supported by the Fulani, and some of the Moslem Hausa and easily defeated the forces of the king of Gobir, later conquering all the Hausa lands in a triumphant *jihad,* which was directed against lax or lukewarm Moslems and pagans. Bornu. a Moslem state, was overrun in 1808 but quickly recovered its independence. Fulani emirs were appointed as rulers of the various states and the Fulani empire was established from Gando in the west to Adamawa in the east. Usuman was succeeded by his son Bello who, as sultan of Sokoto (*q.v.*), was recognized as *sarkin musulmi* and suzerain of all the Fulani emirates.

The courts and the systems of government and taxation, which were based on Koranic law in the Hausa states, were adapted with little change by the new Fulani rulers, and for a time a high standard of justice and administration was maintained. However. gradually the courts became corrupt. the administration extortionate and tyrannical (emirs raiding neighbouring pagan tribes and sometimes even their own subjects to get slaves). This state continued until the British occupation of the country.

When the Bornu armies mere defeated by the Fulani in 1808 and the *mai* (king) was forced to flee before the invaders, the country was saved by the military skill of Lamino (Mohammed al-Amin al-Kanemi), a Moslem sheikh born in Fezzan of Arab and Kanem descent. With a small force of fanatical followers he defeated the Fulani in a number of battles and drove them from Bornu. He restored the *mai* to his throne and allowed him to continue as the titular ruler, but retained all power to himself, governing the country wisely and well; with the title of *shehu* (sheikh), until his death in 1835. The puppet *mai* then attempted to recover his lost power but was defeated and killed by Omar, Lamino's son, who continued to rule Bornu with the title of *shehu.*

In 1893 Bornu was invaded by Rabah Zobeir (*q.v.*), with an army better armed and disciplined than that of Bornu, which he completely defeated, making himself the ruler of Bornu. In 1900, however, Rabah was defeated and killed by the French, who were extending their control over the western Sudan.

The Coastal Tribes. — To the south of Bornu and the Hausa lands there were a large number of tribes having various origins and customs and speaking distinct languages. Of these the largest and most important were the Yoruba and the Beni or Bini (see Benin), who occupied what later became the Western region of Nigeria, and the Ibo, in what later became the Eastern region. The Ibo tribe was divided into several clans speaking different dialects and lacking any central organization. For this reason it has practically no known history and was of little importance until after the British occupation. The same could be said of the numerous small tribes which inhabited the forest area, and the mountainous areas of the north.

The Beni and Yoruba, on the other hand, had long-established states which at various times reached a much higher standard of organization and culture than the other purely Negro peoples. When the first Portuguese ships reached the Nigerian coast in the 1jth century, the Beni had long been an important nation and the ***oba*** (king) of Benin was a powerful monarch whose authority extended over the Yoruba country and even farther west. Friendly intercourse and a certain amount of trade, mainly in slaves, was established between the Portuguese and the Beni, but the tribe gradually declined in power as the ***oba*** came under the influence of a theocracy of fetish priests who maintained authority by the terror created through wholesale human sacrifices. They discouraged intercourse with Europeans, trade dwindled, and by the beginning of the 18th century Berlin had lost influence.

In the meantime the Voruba tribe had risen in importance. Little is known of their origin, but they supposedly came from the northeast and perhaps from Upper Egypt. The first settlement of the Toruba in western Nigeria was probably at Ife, which was to remain the spiritual headquarters of the race. The *alafin* of Oyo was originally the ruler of the whole tribe. but about 1810 the breakup of his kingdom began. each clan, under its own king. becoming practically independent although the nominal suzerainty of the *alafin* continued to be recognized. The country was greatly weakened and suffered from repeated invasions from Dahomey, while the northern province of Ilorin (*q.v.*) fell to the Fulani from the north. The different clans—Oyo, Egba, Ife. Ijebu and others—became involved in internecine wars. the prisoners being sold at Lagos as slaves.

The Slave Trade.— The slave trade established by the Portuguese proved so lucrative that other nations were soon in competition and the slave ships of several European nations flocked to the Guinea coast. British ships were visiting the coast of Nigeria by the 17th century. Much of the trade was with minor chiefs and tribes in the Xiger delta and on the banks of other rivers. the slaves being obtained by these middlemen from the interior. Most of the slaves were prisoners of war or criminals, or were more brutally obtained by organized raids. In many cases payment was made for them by the European traders in potable spirits. arms arid ammunition, which encouraged intertribal warfare and further debased an already barbarous people. Throughout the long period of unrestricted slave trade no European nation attempted to bring any part of Nigeria under its control.

Feeling in Great Britain against the horrors of the slave trade resulted in the passing of an act in 1807 making the trade illegal for British subjects. but the trade was scarcely affected as ships of other nations continued to carry cargoes of slaves across the Atlantic. A British naval squadron was then stationed on the West African coast to intercept the slavers. British merchant ships continued to visit the estuaries of the Nigerian rivers and began a legitimate trade. buying palm oil and other products. This fact and the activities of the naval squadron greatly increased British influence among the coastal tribes.

Exploration.— At that time little was known of the interior of Africa and it was not even appreciated that the numerous streams of the Xiger delta were in fact the mouths of a great river. Existence of such a river had long been known, but its general direction and outlet were matters for speculation. Several explorers failed before Mungo Park, in 1796, established the fact that the general course of the upper Niger was easterly. Park lost his life at the end of 1805 or early in 1806 in an attempt to follow up his first discovery. It was not until 1830 that the brothers Richard and John Lander ascertained that the Niger flowed into the Gulf of Guinea, through the delta which had been known to Europeans for more than 300 years. (See SIGER.)

Other explorers reached northern Nigeria by travelling across the Sahara from Tripoli. In 1823 Dixon Denham and Hugh Clapperton (*qq.v.*) reached Bornu, where they were received by the mui and by the *shehu* Lamino. They then visited Sokoto and met Sultan Bello, returning safely to England in 182j. Clapperton died near Sokoto in 182; on a second journey made from the Bight of Benin. Another extensive exploration was carried out by the German, Heinrich Barth (*q.v.*), on behalf of the British government. He crossed the Sahara in 1850, visited Bornu and the Hausa lands and returned safely across the desert in 1855.

Meanwhile an attempt had been made to follow up the discovery of the Lander brothers by a trading venture on the Niger, to provide an alternative to the slave trade. A company was formed by a Liverpool merchant. Macgregor Laird (*q.v.*), who went in 1832 with two small steamers to a point above Lokoja, but disease decimated the crews and the expedition was abandoned.

In 1841 a large party, including missionaries, n-as sent by the British government in four ships, under the command of naval officers. to explore the Niger and to try to make treaties for stopping the slave trade. In two months there were 48 deaths out of 145 Europeans in the ships. while a number of others became seriously ill, and this enterprise also was abandoned.

It was not until 1854 that a single ship. commanded by W. B. Baikie (*q.v.*), n-ith a crew composed largely of Africans, nas able to explore the Xiger and the Benue and to do a certain amount of successful trading, without any loss of life, the success resulting from the prophylactic use of quinine.

The Beginnings of British Rule.— By that time the trade in palm oil. which the coastal Xfricans found remunerative. had greatly increased, while the slave trade declined in the Niger delta and on the Oil rivers to the east of it. although it was not until about 1840 that slave ships stopped visiting these rivers. To assist legitimate trade it was decided in 1849 to appoint a British consul for the Bights of Biafra and Benin. with his headquarters at Fernando Po. Selected for this post was John Beecroft who had resided at Fernando Po for many years as superintendent of the naval base there.

Beecroit was soon engaged in negotiations with King Kosoko of Lagos, then the principal port in West Africa from n-hich slaves were shipped. with a view to stopping the trade; but these were unsuccessful. and in 1851 the town was attacked by a naval force and captured after heavy fighting. Kosoko fled. and his uncle Akitoye, the legitimate ruler, mas placed on the throne and signed a treaty providing for the abolition of the slave trade and of human sacrifice and for the protection of missionaries. A British consul was appointed to Lagos with the king's consent.

In 1861 as Akitoye's successor Dosumu appeared unable to govern effectively or to prevent the revival of the slave trade, he was required to sign a treaty ceding his possessions to the British crown in return for a pension, and Lagos was annexed as a British colony. For a time the existence of this colony, which effectively stopped the slave trade and provided a haven for runaway slaves, was strongly resented by the Yoruba in the hinterland of Lagos and especially by the Egba, who closed the trade routes and expelled all missionaries and European traders. At a later date. however. British influence increased in the Toruba country through the efforts of the governor of Lagos to bring to an end the civil wars which had raged for so many years among the Voruba. In 1888 a treaty with the *alafin* of Oyo placed the whole of the Voruba country under British protection.

After his successful voyage in 1854 Baikie had established himself at Lokoja under the protection of the emir of Nupe and maintained his more or less official settlement from trading profits. A number of European companies also began to trade on the Niger, but several of their ships were attacked and some of their trading stations were looted and destroyed by the riverain tribes. In 1879 George Goldie-Taubman (later known as Sir George Goldie, *q.v.*), who was interested in one of the companies, arranged a merger of all the British firms trading on the Niger; and a few years later he was able to buy out the rival French companies. Treaties were made with the chiefs of tribes inhabiting the banks of the Niger and the Benue and with the Fulani sultan of Sokoto. and at the Berlin conference of 1884–8j it was possible to claim that British interests were supreme on the Xiger and the Oil rivers. This claim was admitted by the conference and a British protectorate was then declared over the Xiger districts, which included the Oil Rivers area and the hinterland.

Notwithstanding the proclamation of this protectorate. the British government was reluctant to incur additional expenditure on the proper administration of the territories. In the south. the vague authority of the consul had gradually increased in the Oil Rivers area, and courts of equity, composed of the leading African and European traders on the different rivers, had been established. In 1872 an order of the queen in council had regularized the judicial and administrative position of the consul, but he had for a time little means of enforcing his authority. In 1887, however, Chief Jaja of Opobo was removed and deported in consequence of his interference with trade and defiance of the consul. In 1891 a commissioner and consul general was appointed to the Oil Rivers. with his headquarters at Calabar, and in 1893 the territory was renamed the Niger Coast protectorate.

The Royal Niger Company. — In 1886 a royal charter was granted to the company organized by Sir George Goldie, which later was called the Royal Niger Company, Chartered and Limited. The company was authorized to administer the delta and the country on the banks of the Niger and the Benue together with the hinterland. but was forbidden to establish any monopoly of trade. The company at once set up courts of justice and the usual administrative services and raised an armed constabulary. Most of the Fulani empire was beyond its control; but in 1897, after a short campaign, the company's troops mere able to subdue Ilorin and Nupe and to compel the emirs of these states to abandon slave raiding and recognize the suzerainty of the company.

Meanwhile, on the coast, the people of Brass. who were included in the Niger Coast protectorate and excluded (except on payment of prohibitive dues) from trading in their former markets on the Niger which lay within the company's territory, became increasingly hostile. In 1895 they raided the company's establishment at Akassa, killing many of the African employees of the company and carrying off others as prisoners, some of these being killed and eaten. This outrage was punished by a naval force.

Benin. — Another naval force, assisted by the protectorate constabulary, had captured (1894) Brohemie, on the Benin river, the headquarters of the Jekri chief Nana. who had traded in slaves extensively. Nana was captured, tried and deported.

The principal centre of the slave trade in the Niger Coast protectorate was then the city of Benin, which was also notorious for wholesale human sacrifices. King Overami of Benin had failed to implement a treaty he had signed in 1892 for the abolition of human sacrifice and of the slave trade. and the acting consul general, J. R. Phillips. suggested that he should visit Benin to discuss the matter. The king replied that he would be willing to receive Phillips in a few months' time: but Phillips was not prepared to wait and decided, in spite of warnings, to go at once to Benin. He so informed the king, assuring him that his party would be unarmed; in reply Overami promised to send guides to meet the party. On Jan. 3, 1897, Phillips and his party landed at Gwato, where a friendly welcome was received through messengers sent by the king. The next day the party started for Benin and within a few hours it was attacked and massacred, only two of the Europeans, badly wounded, and a few Africans escaping. Phillips and six of his European companions and more than 200 Africans perished.

A naval force was at once sent to the Benin river: and sailors and marines, with troops of the protectorate constabulary, captured Benin after severe fighting, about six weeks after the massacre. The state of Benin when it was entered by the British justified its being styled "the City of Blood." Everywhere there mere altars covered with human blood, bodies crucified on trees and other remains of innumerable human sacrifices. After a judicial enquiry those who were directly responsible for the massacre were executed and Overami was deported.

Northern and Southern Nigeria. — The whole of the southern part of Nigeria was then more or less under control and the company's successes against Nupe and Ilorin had strengthened its position in the north. There were, however, international difficulties. On the western frontier. disputes with France (which were to be embittered in 1898 by the Fashoda incident at the opposite end of the Sudan) nearly led to war, and an imperial force of African soldiers with British officers. the West African Frontier force. was raised in 1897 and placed under the command of Frederick (later Lord) Lugard (see LUGARD, FREDERICK JOHN DEALTKY LUGARD, 1ST BARON). For a time the situation was critical, but the dispute was finally settled without fighting. (See BORGU.)

These international difficulties and the complaint of the Brass people against the Royal Niger company led to the revocation of the company's charter, the British government assuming direct control of the company's territories on Jan. 1, 1900. The land in the delta and along the lower reaches of the Niger, which had been included in the company's territories. was added to the Niger Coast protectorate, which was renamed Southern Nigeria. On May 1, 1906, the Lagos territories were amalgamated with Southern Nigeria, the whole country being styled the Colony and Protectorate of Southern Nigeria, with Lagos as the seat of government.

The northern part of the company's territories became the Protectorate of Northern Nigeria. with Sir Frederick Lugard as the first high commissioner. The Fulani emirates still retained their independence, and slave raiding continued; but the principal slave raiders, the emirs of Kontagora, Nupe and Adamawa, were removed from office in 1901, and Bauchi and Bornu were brought under control the following year. The sultan of Sokoto refused friendly overtures. In spite of this the British administration was steadily extended, and a small garrison was stationed at Zaria. As the emir of Kano threatened to attack this garrison and refused to surrender the murderer of a British official. a force of about 700 African soldiers, with British officers, advanced against the mud-walled city of Kano, which was taken with little difficulty on Feb. 3, 1903. There was subsequently severe fighting against the main Kano army and the army of the sultan of Sokoto, who fled before the battle. Sokoto was then occupied, and the chiefs nominated a new sultan. whose appointment was approved by the high commissioner.

The sultan and emirs who accepted British rule were installed with full ceremonial after agreeing to abolish slave raiding and to be guided by the advice of British officials. In return they were promised their religion would not be interfered with and that the existing system of Moslem law would be retained. Most of these emirs remained loyal and proved efficient administrators under British supervision. A rising of a few fanatics against the sultan of Sokoto in 1906 was suppressed by protectorate troops, and there was some fighting against the pagan tribes who resisted the enforcement of law; otherwise there was little serious trouble. and British administration was quickly made effective throughout Northern Nigeria. Slave raiding was suppressed and the legal status of slavery was abolished, although many slaves remained voluntarily with their masters.

In the administration of Northern Nigeria, Lugard used the indigenous authorities. the emirs and other chiefs, in what became known as indirect rule. The native administrations had their own treasuries and received a proportion of the tax. Prevented by supervision from relapsing into past corrupt practices they proved to be capable of efficient local government.

The Amalgamation of **Nigeria.**—Lugard ceased to be high commissioner in 1906 but returned to Nigeria in 1912 as governor both of Northern and Southern Nigeria, charged with the duty of amalgamating the two territories. This amalgamation was effected on Jan. 1, 1914, the whole country being known thereafter as the Colony and Protectorate of Nigeria.

Seven months later, in Aug. 1914, World War I broke out, and Nigerian forces were soon in action against German troops in the Cameroons (*q.v.*). After some initial reverses on the frontier, a combined Franco-British invasion of the Cameroons resulted in the conquest of the country by the beginning of 1916. In 1922 a small part of the Cameroons was mandated by the League of Nations to the United Kingdom and was attached for purposes of administration to Nigeria. Before the end of the war Nigerian soldiers had also taken part in the fighting in East Africa. In recognition of the gallantry and discipline of the West African troops the king became their colonel in chief, and their title was altered to Royal West African Frontier force. Throughout the war the loyalty of the Nigerians was generally quite marked, chiefs and people alike helping in every way. The same must be said of them in World War II, when Nigerian troops again served overseas (in East Africa against Italians and in Burma against Japanese) and added to their military laurels.

Constitutional Changes. — Following the amalgamation of 1914 and particularly after the end of World War II, there were a number of territorial and constitutional changes in Nigeria. In 1914 the country was divided into three main areas, namely the Colony of Nigeria (corresponding to the former Colony of Lagos) and two groups of provinces in the protectorate, the Northern and Southern provinces. The Southern provinces were later divided into two groups, the Eastern and the Western provinces. In 1951 these groups of provinces were officially renamed as the Northern, Eastern and Western regions.

In 1914 a legislative council for the colony alone had been set up. affairs of the protectorate being beyond its purview. but in 1923 a larger legislative council was established which for the first time included a limited number of elected members.

A radical change was made in the constitution of Nigeria in 1947. Houses of assembly for the three groups of provinces were set up. and there was also a house of chiefs for the Northern provinces. In each of the houses of assembly nonofficial members were in a majority over *ex-officio* members. In addition there was a central legislative council for the whole of Nigeria, and in this body also there was a nonofficial majority.

Public opinion was still not satisfied, and a fresh constitution. introduced in 1951. provided for a central legislative house of representatives. Resulting friction between central and regional legislatures caused the introduction of yet another constitution (the third in eight years) ·in 1954. This set up the Federation of Tigeria, comprising the Northern. Eastern and Western regions. the Southern Cameroons (part of the trust territory) and the Federal Territory of Lagos. After a constitutional conference in 1957–58 the office of federal prime minister was created and full internal self-government was achieved by the Eastern and \Test-ern regions in 1957 and by the Northern in 1959. It was agreed that Nigeria would welcome the Southern Cameroons as a self-governing part of the federation. The British government then announced its n-illingness to grant independence to the federation on Oct. 1. 1960. and on the request of the Nigerian federal legislature this undertaking n-as implemented by the United Kingdom parliament. British Cameroons remained in its status as a Trust Territory, administered by the United Kingdom.

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POPULATION

The vast majority of the inhabitants of Nigeria is Xegro, the purest Negro stock being in the south in the forest country, where races migrating irom the north were unable to advance. Because of the extensive intermingling of stock that has taken place it is impossible. except in very few cases, to draw lines of ethnic demarcation. The Fulani (*q.v.*), who are widely but thinly distributed north of the forest zone. and the Shuwa Arabs. who within Nigeria are confined to the neighbourhood of Lake Chad. are of nidely different stock who may be roughly classified as Mediterranean and Semitic respectively. There are few left of pure Fulani stock.

The term "tribe" is commonly used ior convenience in Nigeria to describe groups distinguished from each other by language rather than as descriptive of a unit having political unity, but it is possible that these language groups had at one time. in the distant past, a real political unity. In the majority of cases. however, traditions are localized and the belief in a single derivation, if it ever existed. has disappeared. Within the major language groups there are often many diiierent dialects, and among the Ibo there is the greatest variety. A complete list of the tribes in Nigeria would run into hundreds. The most widely-diffused languages are Hausa, Ibo and Yoruba. In the emirates of the north the official language is Hausa. but elsewhere it is English. With the spread of education and trade English is widely spoken, particularly in the south.

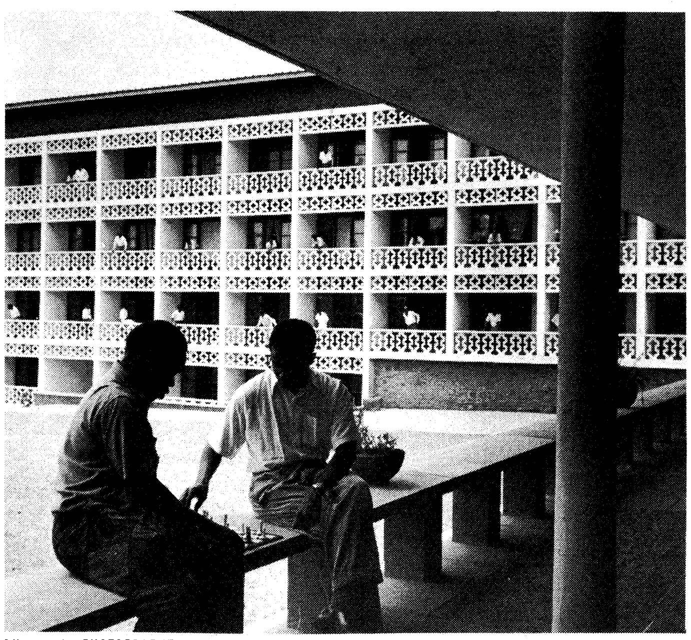
In the southwest the Yoruba (*q.v.*), who occupy the country behind the coastlands irom Dahomey to Benin and who have a considerable tradition, are the chief tribe. In the Niger delta and in the forest zone, besides the Beni of Benin, are the Itsekiri, living in the lower part of the Benin river, the Ijaw (*q.v.*), living in the delta on both sides of the main mouth of the Niger, and the Ibo (*q.v.*), the largest of the southern tribes. occupying a wide tract of country just above the delta and extending east from the Niger to the Cross river. On the Cross river the most important peoples are the Ihibio. Efik and Ekoi. The secret society known as Ekpe (Ekkpé) (Egbo) was an Ibibio institution which spread to the Ibo and the Ekoi. The Christian missions have extended a wide influence over these areas since mid-19th century, particularly in the field of education, and Moslem missionaries have also obtained notable influence, though mainly in the southwest.

In northern Nigeria the inhabitants are of more mixed blood. as a consequence of the invasion of Fulani. Berber and Arab or Arabized people. But the bulk of the people are Negro. The most important are the Hausa (*q.v.*) among whom the superior classes adopted Mohammedanism in the 13th and 14th centuries. The Hausa are keen traders and make excellent soldiers. The Fulani, besides providing the ruling families in many of the Hausa states. include a separate group of nomadic cattle raisers. In the uplands. mhere Moslem influence is weak. there are many pagan tribes, often of fine type: of these the Tiv on both sides of the middle Benue are a particularly powerful tribe. In Bornu the population consists of Berber or Kanuri. the ruling race containing a mixture of Berber and Negro blood. with many lesser indigenous tribes.

Census for the component parts of the Federation of Nigeria was taken between July 1952 and June 1953. At the census of July 1952 the population of the Norther11 Region, including the northern areas of the British Cameroons trust territory. was 16.840.-479 160 per square mile); at the census of Dec. 1952 the population of the Western region was 6.092.310 (134 per square mile). excluding the Lagos municipal area. subsequently the federal capital territory. with an African population of 267,407 (9.904 per square mile). At the census of June 1953 the population of the Eastern region was 7.217.829 (245 per square mile) and of the Southern Cameroons 753,358 (45 per square mile). On the basis of these figures the population of the country in 1953 was 31.171.388.

The census of 1952–53 revealed only 48 towns with a population of more than 20.000; rather less than 10% of the total lives in towns. Most of the largest cities are in the Yoruba country: Ibadan (*q.v.*) had 459.196 inhabitants in 1952; Lagos (*q.v.*), 267,-307: Ogbomosho, 139.535; Oshogbo. 122,746; Ife, 110,790: Iwo, 100.006. In the Eastern region there are few towns: Onitsha, 76,921 inhabitants in 1953; Enugu. the capital, 62.764. In the Northern region, towns were: Kano, 93,016; Sokoto, 47,643; Kaduna. the administrative capital. 6.095 (township).

Education and Welfare.—.\part from the Koranic schools of the Moslem north, the spread of education was largely the work of Christian missionaries, who were also pioneers in the establishment of medical services. After World War II. however, the ten-year plan for development and welfare was inaugurated in 1946 (see below). In 1951, halfway through the plan. there were 9.477 primary schools (1,002,533 pupilsj. 110 secondary schools (21.425) and 120 schools for training teachers (4,522) as well as University



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COURTYARD OF MEN'S DORMITORY AT UNIVERSITY COLLEGE, IBADAN college opened in 1948 at Ibadan (346). In the years remaining before the completion of the plan further provision was made for education, special emphasis being placed on the technical side. A college of technology was opened at Ibadan in 1952; there was also the Technical institute at Yaba and "trade centres" at Yaba, Kaduna, Enugu and Ombe River. Medical services were likewise developed under the ten-year plan: in the mid-1950s the government and the native administrations were running 70 general hospitals and nursing homes, 248 maternity hospitals and homes and 4 other special hospitals, 894 dispensaries. corresponding figures for private establishments being 72 general, 171 maternity and 226 dispensaries. Though the incidence of disease had been greatly reduced, smallpox, leprosy, malaria, sleeping sickness, yams. parasitic infections and other tropical afflictions still took a heavy toll.

See C. K. Meek, *The Northern Tribes of Nigeria,* 2 vol. (London, 1925); P. A. Talbot, *The Peoples of Southern Nigeria,* 4 vol. (London, 1926); C. D. Forde and G. I. Jones, *The Ibo and Ibibio Speaking Peoples of Southern Eastern Nigeria* (London, 1950); and C. D. Forde, The *Yoruba-Speaking Peoples of South-Western Nigeria* (London, 1951); K. M. Buchanan and J. C. Pugh, *Land and People in Nigeria* (London, 195j). (G. B. G. C.)

GOVERNMENT AND ADMINISTRATION

Under the federal constitution of 1954 *(see* above, *History)* there is a governor for each of the regions (Northern, Western and Eastern) and a commissioner for the Southern Cameroons, with a governor general for the federation. The house of representatives for the federation consists of 184 representative members, of whom 92 are elected in the Northern, 42 in the Eastern and 42 in the Western region, 6 in the Southern Cameroons and 2 in Lagos; and there are 3 *ex-officio* members. The council of ministers for the federation consists of the governor general, who presides, three *ex-officio* members and 10 others chosen by the governor general from among the representative members of the regional legislatures or the legislature of the Cameroons. Both the federal and all the regional governments have established Nigerians as their commissioners in London.

In each region and in the Cameroons there is a house of assembly, and in the Northern and Western regions there are also houses of chiefs. In each region there is an executive council, presided over by the governor, consisting of the premier of the region, who is appointed by the governor and a number of other ministers appointed on the recommendation of the premier. There is also an executive council for the Southern Cameroons.

The names and boundaries of the provinces of which the regions are composed have been changed from time to time. In the mid-1950s the composition was: Northern region (including the northern areas of the Cameroons), 12 provinces, Adamawa, Bauchi, Benue, Bornu. Ilorin, Kabba, Kano, Katsina, Niger, Plateau. Sokoto and Zaria; Western region, 8 provinces, Abeokuta. Benin, Colony, Delta (Warri), Ibadan, Ijebu, Ondo and Oyo; Eastern region, 5 provinces, Calabar. Ogoja, Onitsha, Onerri and Rivers; the Southern Cameroons, the Cameroons province and Bamenda. (A. C. Bs.)

Judiciary. — The constitution provides for the establishment of a federal supreme court; and there is a high court in each of the three regions. in the Southern Cameroons and in the Lagos federal territory. There are also magistrates' courts, with chief magistrates and magistrates of first, second and third grades; and native courts administering native and customary law, their jurisdiction being quite extensive in the north but more limited in the Eastern and Western regions.

Defense. — The Nigeria regiment of the Royal West African Frontier force has British and Nigerian officers and noncommissioned officers, other ranks being recruited locally. Regimental training follows the pattern of the British army, with special facilities for the training of the Nigerian officers.

ECONOMY

The great majority of the people of Nigeria are peasant proprietors whose holdings usually cover two or three acres: the greater part of the country's agriculture and forestry is in their hands. The main concern of the farmer at one time was to produce food for himself and for his family — to speak broadly. he needed cash merely to purchase simple luxuries. This generalization, however, lost much of its force after World War II, when conditions began to change rapidly. Demand for education and for European styles of dress and ways of life, symptoms of a progressive and ambitious outlook: created a need for cash which stimulated production for export by modern, efficient and competitive methods. Fertilizers do much to increase the yield of Nigerian farms and are extensively used where they can be supplied economically. Cattle. sheep and goats are found everywhere, but it is in the north and in parts of the Cameroons where large herds and flocks are tended for the production and distribution of meat. There are several government stock farms for the improvement of breeds and development of a disease-resisting stock.

The largest groups of employed persons are in government service (the Nigerian government employs about 100,000 persons including 5.000 established civil servants) and employees of the European importing firms and mining industries (employing about 63,000 in 1950). There are no native industries organized on a large scale; but leather working in the north (for "Morocco" leather) and fishing in the delta are activities of economic importance. Heavy industries such as mining, engineering and the production of timber and plywood have been developed by Europeans, but Nigerians are increasingly taking up such activities.

In general. the products of southern Nigeria are palm oil, palm kernels, cocoa and rubber; those of the middle belt, benniseed and other oil seeds; those of the north, peanuts, hides and skins, cattle and cotton. With tin and timber these products form the principal exports. Coal is mined under the control of a statutory corporation at Enugu. but the output (636,000 tons in 1954) is such that little is available for export after local needs have been met.

Communications. — As the railway and the rivers of Nigeria serve only limited areas: with inadequate cross-country connections: transport is mainly by road. Roads are usually from 10 to 14 ft. wide; most of the bridges allow for single-line motor traffic only; and a number of routes still depend on ferry crossings over the rivers. Motor traffic, however, has superseded the old method of transport on the heads of bearers; the Niger and Benue rivers are crossed at Jebba and Makurdi by combined road and rail bridges. In 1955 there were 31,184 mi. of motorable road (inciuding 2,200 mi. bitumen surface). The extension and improvement of the system was a major feature of the ten-year development plan. The Nigerian railway, begun in 1896, has 1,7jo mi. of 3 ft. 6 in. gauge running from Lagos and from Port Harcourt in the south to Kano and thence to Nguru in the north; with branches from Kafanchan to Jos and from Zaria to Kaura Namoda and a light railway of 2 ft. 6 in. gauge (133 mi.) from Zaria to Jos. Goods trains operate on all lines. Freight handled amounted to 2,602,000 tons in 1954–5j. The railway serves the cattle. peanut and cotton areas of the north, the tin mines of the plateau, the palm forest and the coal mines of the east and provides the main distributing system for goods unloaded at Lagos and Port Harcourt. Passenger services run three times weekly in each direction from Lagos and Port Harcourt to Kano and to Jos. A road motor-feeder service operated by the railway serves large areas under peanuts and cotton-in Sokoto province.

Lagos (*q.v.*) is the chief port of entry; the other ports are Port Harcourt! Burutu, Calabar. Warri and Sapele. The draught at Lagos bar is 27 ft. Previously inaccessible to large ships because of the sandbar, the port has been improved by extensive harbour works. Port Harcourt, on the Bonny river 41 mi. upstream, has a depth of 21 ft. at the bar. Both at Lagos and Port Harcourt ocean-going vessels can lie alongside railway docks. Burutu port: on the Forcados river, is operated by the Cnited Africa Company Ltd. Calabar, 48 mi. up the Calabar river, has no bar, but the maximum advised draught is 20 ft. Warri, on the Warri river. and Sapele. on the Benin, are governed by the changing condition of the Escravos bar (minimum 11 ft.).

There is regular steamship service by several lines between Europe. America and South Africa and Tigerian ports. The principal passenger and mail service is by the Elder Dempster line from Liverpool to Lagos, the voyage taking 13 days. There are direct cable and radio communications with Europe and South Africa.

Commerce. — The coastal peoples since the 15th century have traded directly with European merchants, but intercourse with the interior was prevented by the dense forest belt and the disease-ridden swamps, which prevented Europeans from investigating the courses of the rivers. Up to mid-19th century the trade of northern Nigeria was with the other countries of the Sudan and across the Sahara with the Mediterranean. Direct trade between the Guinea coast and the north followed the British expeditions up the Niger and Benue. Modern developments date from the founding of the Royal Niger company and the pacification of the Fulani emirates. There is an extensive internal trade for which no statistics are available.

Whereas palm oil was produced almost wholly by primitive methods beiore World War II, a large proportion of the export in the 1950s was produced by means of presses and mills, with consequent improvement in quality, so that lowest-grade oils were no longer exported. In 1953 the quantity of palm oil exported was 201,000 tons, the value £12,980,000; corresponding figures for palm kernels were 403,000 tons and £22,185,000. Cocoa plantations were started in Nigeria early in the 1900s when less than 1,000 tons were exported annually; after reaching 121,000 tons in 1951, the quantity was 104,671 tons, worth £24,858,000, in 1953 (energetic measures were undertaken to combat the swollen-shoot disease threatening this crop). Exports of raw cotton amounted to 17,707 tons in 1953. Cultivation of peanuts in northern Nigeria, where soil and climate are well suited, has grown rapidly, with annual exports reaching 378,320 tons in 1949 and 327,000 tons, worth £24,928,000, in 1953. Marketing boards for these crops are responsible for the purchase and sale of the products, also for price stabilization, research and development. They have contributed large amounts to promote the interests of the producing areas. The tin mining industry was developed by Europeans and the tinfields are worked by private enterprises, mostly for companies registered in London — exports amounted to 12,136 tons in 1953. The columbite found with the tin is particularly valuable, Kigeria providing 95% of the world's supply. Timber cutting for exports is an industry in which Nigerians take a considerable part; 11,821,000 cu.ft. were exported in 1953, mainly mahogany, cedar and walnut. Textile manufactures constitute the most valuable import, followed by iron and steel manufactures, foodstuffs (notably fish and salt), tobacco, beverages and petroleum.

Finance. — The expansion of the Nigerian budget since World War II, and the growth in the revenue has been spectacular, but the fact of its being in part a consequence of increases in the world prices of the country's primary products brought with it a measure of inflation. Moreover, increased development depended largely upon grants from the United Kingdom. Substantial grants were made under the Colonial Development and Welfare act (1945) and irom commonwealth funds. The International Bank in 1954 recommended the eventual doubling of government expenditure on development. In 1960 it was decided that the Colonial Development and Welfare assistance would continue by agreement, and on May 17, 1960, a commonwealth assistance loan of £12,000,000 ($33,600,000) was made, to be available after independence. On April 4, 1960, the federal minister of finance presented a "stability budget," designed to maintain confidence in the country's economic position. The Central Bank of Nigeria was opened in July 1959, and through it a national currency was issued, linked by statute with sterling. In the same year Nigeria's first investment company (ICON) was set up, with an authorized capital of £12,000,000. *See* also Index references under "Nigeria" in the Index volume. (G. B. *G.* C.)

NIGER TERRITORY (NIGER, REPUBLIC; REPUBLIQUE DU NIGER), the easternmost of the eight former French overseas territories, which constituted French West Africa (*q.v.*), and which in 1958 was proclaimed an independent republic, member state of the French Community. The area is 489,206 sq.mi., bounded on the west by the Sudanese Republic and Upper Volta, north by the Saharan departments and Libya, east by Chad, and south by Nigeria and Dahomey. The country consists mainly of a plateau at an average elevation of 1,000 ft. above sea level, but the isolated granitic massif of Aïr (Azbine) reaches 5,905 ft. The climate is excessively hot and the southern zone, being part of the Sahel, has a three to four months rainy season (July to Oct.) and a vegetation of scrub with occasional clusters of trees; the north belongs entirely to the Sahara desert region. The Niger river flows through the southwest. Fauna is plentiful, gazelles being particularly numerous, and Niger is a favourite resort of big game hunters.

The population, estimated at 2,556,211 in 1959, comprised Tuareg (about 22%) in the Sahara and Negroes in the south, the latter being divided among the Jerma in the western areas: the Hausa in the central and the Manga in the eastern. The principal towns, with 1959 populations (est.), are: Niamey, the capital, on the Niger, 30,030; Zinder (*q.v.*) in the south-central part of the republic, 14,891; Maradi, 11,762; Tahoua, 11,629; Konni, 6,494; Illella, 6,279. Agadez (Agadès), in the Sahara, numbers 4,531. Millet is raised for local consumption, as well as minor quantities of corn, cassava and rice; peanuts are raised for export. Cattle numbered more than 2,000,000 head in the late 1950s and sheep and goats numbered nearly 6,000,000 head. (Hu. DE; X.)

NIGHT BLINDNESS (NYCTALOPIA) is a condition in which the sight is good by day or with good illumination but deficient at night or with reduced illumination. When a normal person leaves a lighted room and enters the dark, he initially fails to see clearly. Gradually his sensitivity to light improves, however. and after being in the dark for approximately an hour his eyes will have reached their maximum sensitivity to light. During this time visual purple has been built up in the retina. The vitamin A-deficient person makes visual purple more slowly, and since his eyes do not become accustomed to dim lights in the normal way he remains night blind even though in the dark for long periods of time. Visual purple is one of the pigments found in the rod cells of the retina. When light falls on the retina, visual purple or rhodopsin is bleached. and in the dark it regenerates. The accumulation of visual purple in the rods in dim light is the chemical basis of dark adaptation, during uhich the human eye becomes 10,000 times more sensitive to light than when it is light adapted.

Night blindness may be inherited or acquired. Acquired night blindness may be due to ocular defects, such as degeneration of the peripheral parts of the retina, especially the pigment layer of the retina. It is encountered in myopia, in detachment of the retina and in inflammations and degenerations of the optic nerve. Malnutrition associated with vitamin **A** deficiency is known to result in night blindness. Liver disease may produce it. It has been described following the ingestion of drugs such as quinine and carbon sulfide compounds. There are instruments capable of testing dark adaptation. *See* also VISION: *Adaptation;* EYE. HUMAN; VITAMINS. (I. H. L.)

NIGHTHAWK, a name applied to certain American birds of the genus *Chordeiles*. Unrelated to true hawks, they belong to the nightjar or goatsucker family, Caprimulgidae, and live on insects, caught as the bird flies about nith its capacious, whisker-bordered mouth open. The common nighthawk (C. minor) inhabits most of North America, migrating south in winter. Less exclusively nocturnal than other nightjars, it often flies about and migrates all day. Two protectively coloured eggs are laid among gravel or on flat gravel roofs. In courtship the nighthawk plunges toward the earth and pulls out of the dive with a loud "zoom" of air through its quills. It also utters a nasal *peent*. *See* also NIGHTJAR. (DN. A.)

NIGHTINGALE, FLORENCE (1820-I~IO), English nurse, generally accepted as the originator and founder of modern nursing, whose achievements in public health were almost equally important, was born in Florence, Italy, on May 12, 1820, the second daughter of wealthy and cultured parents. Her socially ambitious mother intended that she should make a brilliant marriage, but such ambitions were vain. In 1837, at the age of 17, Miss Nightingale heard, as Joan of Arc had heard, the voice of God calling her to service. A period of perplexity followed as to the form of service she was to undertake, but by 1844 her vocation had become clear: she was to nurse the sick.

A desperate struggle with her family ensued. Nursing at that time was disreputable, and nurses frequently were drunken prostitutes. In spite of the furious opposition she met, Miss Nightingale would not be turned from her determination. When Richard Monckton Milnes, later Lord Houghton, repeatedly pressed her to marry him, she refused, even though he was "the man I adore." Everything had to be sacrificed to her vocation. Years passed in misery and frustration, and it was not until 1851 that she was allowed to gain her first nursing experience, with the Protestant deaconesses at Kaiserswerth in Germany, and not until 1853 that she left home to take her first post, the reorganization of a small hospital in Harley street, London, the Institution for the Care of Sick Gentlewomen in Distressed Circumstances.

The reorganization mas a brilliant success, and it was her work in Harley street that led Sidney Herbert, secretary of war in the British cabinet, to invite her to undertake a mission to the Crimea. War with Russia had been declared in March 1854; by October England was ringing with the horrible state of the British military hospitals revealed by the special correspondent of the *Times* (London). Florence Nightingale sailed for the Crimea with 38 nurses on Oct. 21, 1854, and within a month found that she had more than 5,000 men in her charge. The so-called hospitals were vast dilapidated buildings, filthy, bare, not merely lacking medical equipment but destitute of every convenience for common decency. By superhuman efforts she brought order out of chaos, working day and night. often on her feet for 20 hours at a stretch and hindered at every turn by official jealousy and intrigue. Every night she made a personal inspection of the vast wards. But she did more than make the hospitals sanitary; she revolutionized the treatment of the private soldier, and the army regarded her with something approaching worship.

When the story of her achievements reached home, a great outburst of enthusiasm made her a national heroine, and £45,000 was raised by public subscription as a testimonial and placed at her disposal. But when she returned from the Crimea she insisted on going into retirement. She had dedicated her life to the welfare of the private soldier, and she believed that her popularity would prejudice the government against her. She retired so completely that when in 1907 she was awarded the Order of Merit the announcement came as a surprise; most people thought she had died half a century before.

In fact, however, with Sidney Herbert's help, she had embarked on a movement for army reform, and in 18j7 encouraged by Queen Victoria. she obtained a commission to inquire into the sanitary condition of the army. For the first time in history the food, housing and health of the soldier in peacetime were scientifically examined. In 1858 she published an immense volume, *h7Otes on Matters Affecting the Health, Efficiency and Hospital Administration of the British Army*. In 1859 a commission was set up to inquire into the sanitary condition of the army in India, and in 1863 its report was submitted to Miss Nightingale. Work for the army had become only a part of her activities. Military hospitals had led her to civil hospitals, military nursing to civil nursing, military health to public health. In July 1860, with the sum subscribed as *a* testimonial, she opened the Nightingale training school for nurses at St. Thomas's hospital. From that date modern nursing may be said to begin. Every probationer entering the school was interviewed by Miss Nightingale and remained under her close supervision. The strain of this, however, was too great, and her health: shaken by her enormous exertions in the Crimea, gave way. Though an invalid: she continued to work, nevertheless, and became a ruthless taskmaster to others. The war office leaned on her advice, all sanitary papers were sent to her, she drew up regulations, framed warrants: reported on barrack plans. She was an acknowledged authority on India, though she had never been there, and viceroy after viceroy came to her for his "Indian education." As the years went by thousands of nurses came under her control; after 1862 district nursing was developed under her guidance; the work involved in that alone would have occupied the whole time of an ordinary woman. Not until 1872, when she "went out of office," did the fury of her work slacken. Then she became interested in mysticism, assisted Benjamin Jowett in the translation of the dialogues of Plato and compiled a book of extracts from the Christian mystics. Personal relationships, especially with young people became of increasing importance and she enjoyed a tranquil old age, darkened only by the gradual loss of her sight. She died on Aug. 13, 1910. By her express wish the offer of a national funeral and burial in Westminster abbey was refused and her coffin was carried to the family grave in the little country churchyard of East Wellow, Hampshire, by six sergeants of the British army.

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(C. W.-SH.; X.)

NIGHTINGALE, the bird celebrated beyond all others for the vocal powers which, contrary to usual belief, it exercises at all hours of the day and night during several weeks after its return from its winter quarters in the south. The song itself is indescribable, though many attempts, from the time of Aristophanes to the present, have been made to express in syllables the sound of its many notes. Poets have descanted on the bird (which they nearly always make of the feminine gender) leaning its breast against a thorn and pouring forth its melody in anguish. But the cock alone sings, and there is no reason to suppose that the cause and intent of its song differ in any respect from those of other birds' songs (*see* SONG-BIRD).


ERIC HOSKING
EUROPEAN NIGHTINGALE (LUSCINIA MEGARHYNCHOS)

In contrast with the nightingale's voice is the inconspicuous coloration of the bird's plumage, which in both sexes is of a reddish brown above and dull grayish white beneath, the breast being rather darker and the rufous tail showing the only bright tint.

No nightingale (genus *Luscinia*) is found in America, but it is closely related to the American thrush (*q.v.*) and a member of the same family, the Turdidae. The European nightingale, *Luscinia megarhynchos,* is abundant in Great Britain in suitable localities to the southeast of a line stretching from the valley of the Exe, in Devonshire, to York, but it does not visit Ireland, Wales or Scotland. On the continent of Europe it does not occur north of a line stretching irregularly from Copenhagen to the northern Urals, and it is absent in Brittany. Over south Europe otherwise it is abundant. The nightingale reaches Iran, and is a winter visitor to the Arabian peninsula, Sudan, Ethiopia, Algeria and as far south as Ghana. The larger eastern *L. philomela,* russet brown in both sexes, is a native of eastern Europe. *L. hafizi* of Iran is probably the Perso-Arabic bulbul of poets. The nightingale reaches its English home about the middle of April, the males (as is usual among migratory birds) arriving several days before the females.

Poets and novelists are apt to command at will the song of this bird, irrespective of season. If the appearance of truth is to be regarded, however, it is dangerous to introduce a nightingale as singing in England before April 15 or after June 15. The "early nightingale" of newspaper paragraphs is generally a thrush. On the cocks being joined by their partners, the work for which the long and hazardous journey of both was undertaken is speedily begun. and before long the nest is completed. This is of a rather uncommon kind, being placed on or near the ground, the outworks consisting chiefly of a great number of dead leaves ingeniously applied together so that the plane of each is mostly vertical. In the midst of the mass is wrought a deep cuplike hollow, neatly lined with .fibrous roots, but the whole is so loosely constructed, and depends for lateral support so much on the stems of the plants among which it is generally built, that a very slight touch disturbs its beautiful arrangement.

In this nest four to six eggs of a deep olive colour are laid and the young subsequently hatched. The nestling plumage of the nightingale differs much from that of the adult, the feathers above being tipped with a buff spot, just as in the young of the European robin (*Erithacus rubecula*), hedge sparrow and redstart, thereby showing the natural affinity of all these forms. Toward the end of summer the nightingale disappears to its African winter haunts.

The name nightingale has been applied to several other birds. The so-called Virginian nightingale is a species of grosbeak (*q.v.*); the Pekin nightingale or Japanese nightingale is a small babbler (*Liothrix luteus*) of the Himalayas and China, found also in Hawaii.

The nightingale holds a place in classical mythology. Procne and Philomela were the daughters of Pandion, king of Attica, who in return for aid in war rendered him by Tereus, king of Daulis in Thrace, gave him the first named in marriage. Tereus, however, being enamoured of her sister, pretended that his wife was dead, and induced Philomela to take her place. On her discovering the truth he cut out her tongue to hinder her from revealing his deceit. But she depicted her sad story on the robe she sent to Procne, and the two sisters then contrived a horrible revenge for the infidelity of Tereus, by killing and serving to him at table his son Itys. Thereupon the gods interposed, changing Tereus into a hoopoe, Procne into a swallow and Philomela into a nightingale, while Itys was restored to life as a pheasant, and Pandion (who had died of grief at his daughter's dishonour) as a bird of prey (see OSPREY). The fable has several variants. Ovid's version may be found in the sixth book of his Metamorphoses.

NIGHTJAR (GOATSUCKER), *Caprimulgus europaeus,* a bird erroneously believed since very ancient days to have the habit implied by its second name. It is characterized by its flat head, wide mouth fringed with bristles, large eyes, soft plumage and consequently noiseless flight. It arrives in Europe from Africa late in the spring, returning in the early autumn. Its food consists of .insects, chiefly moths and cockchafers. which it catches on the wing at night.

ERIC HOSKING

EUROPEAN NIGHTJAR (CAPRIMULGUS EUROPAEUS)

When resting on a bough the nightjar sits along its length. In this position the cock bird utters his curious burring note. The two eggs are laid on the ground; the young are clad in dark-spotted down, rendering them, like their parents, exceedingly difficult to see when crouching on the ground.

A second species, C. rujicollis, the red-necked nightjar, is very similar to the common nightjar in appearance, but has a reddish buff collar and white throat patch and is somewhat larger. It occurs in Spain and Portugal. C. aegyptius, the Egyptian nightjar, closely resembles the common nightjar. Others are found throughout the old world.

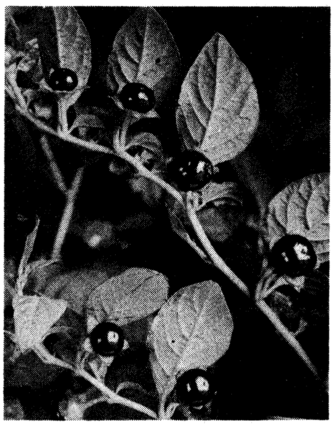
In America their place is taken by the allied genus, Antrostomus, one member of which, A. *vociferus,* is the whippoorwill (*q.v.*). The nighthawk (*q.v.*) is another common American species, with a voice quite different from that of the whippoorwill. The family (Caprimulgidae) is almost cosmopolitan, but is not represented in New Zealand and Polynesia.

NIGHTSHADE, a general term for plants of the botanical genus *Solanum,* of the nightshade family (Solanaceae). The species to which the name of nightshade is commonly given in North America and England is *Solanum dulcamara,* also called bittersweet or woody nightshade. It is a native of Europe, North Africa and temperate Asia and is widely naturalized, being a common plant in damp hedgebanks and thickets, scrambling over underwood and hedges, all over eastern and central North America and throughout England.

It has slender slightly woody stems, with alternate lanceolate leaves, more or less heart shaped, with two leafy lobes at the base. The flowers are arranged in drooping clusters and resemble those of the potato (to which it is related) in shape, although they are much smaller. The flower clusters spring from the stems at the side of, or opposite to, the insertion of a leaf. The corolla is wheel shaped, of a lilac-blue colour with a green spot at the base of each segment, or sometimes white, and bears the yellow stalkless anthers united at their margins so as to form a cone in the centre of the flower.

The flowers are succeeded by egg-shaped scarlet berries, one-half inch long. Both the berries and the foliage are poisonous, due to the presence of solanine, sometimes causing convulsions and death if ingested in large doses. The plant derives its names of bittersweet (not to be confused with false or climbing bittersweet [*q.v.*] or waxwork, Celastrus scandens, highly prized for its decorative coloured fruit) and dulcamara from the fact that its taste is at first bitter and then sweet.

The black nightshade, *S.* nigrum, also poisonous, differs from S. dulcamara in having white flowers in small umbels and globose black berries. It is a common and almost cosmopolitan weed in gardens and waste places, growing about 12 or 18 in. high, and has ovate, entire or sinuate, or toothed leaves. The plant is common in eastern North America. From the black nightshade have been derived the garden huckleberry (*S.* intrusum) and the wonderberry (*S.* burbanki), both with edible fruit.



JOHN MARKHAM

FRUITING BRANCH OF DEADLY NIGHTSHADE (ATROPA BELLADONNA)

Deadly nightshade, dwale or belladonna (Atropa belladonna) is a tall bushy herb of the same plant family. It grows to a height of four or five feet having leaves of a dull green colour, with a black, shining, berry fruit, about the size of a cherry, and a large tapering root.

The plant is a native of central and southern Europe, extending into Asia, and is found locally in England, chiefly on chalk and limestone, from Westmorland and southward. Since it is highly poisonous, deadly nightshade is not a garden subject; it is cultivated chiefly in southern Germany, Switzerland, France and the U.S. for the medicinal atropine (*q.v.*) derived from its leaves and roots. (See also SOLANUM; SOLANACEAE; HORSE NETTLE.)

The name enchanter's nightshade is applied to weak-stemmed plants of the genus *Circaea,* of the evening primrose family (see ONAGRACEAE). Malabar nightshade refers to twining herbaceous vines of the genus *Basella.* (N. TR.)

NIGRA, COSTANTINO, COUNT (1828–1907), Italian diplomatist, was born at Villa Castelnuovo, in the province of Turin, on June 11, 1828. During the war of 1848 he interrupted his studies to serve as a volunteer against Austria, and was wounded at the battle of Rivoli. On the conclusion of peace he entered the Piedmontese foreign office; he accompanied Victor Emmanuel and Count Camillo Benso di Cavour to Paris and London in 1855, and in 1856 he took part in the conference of Paris by which the Crimean War was brought to an end. After the meeting at Plombières between Cavour and Napoleon III, Nigra was sent to Paris as an agent of Cavour. After the breach with Napoleon he was secretary of state to the prince of Carignano, viceroy of the Neapolitan provinces. When Napoleon recognized the kingdom of Italy in 1861, Nigra returned to France as minister resident, and for many years played a most important part in political affairs. In 1876 he was transferred to St. Petersburg with the rank of ambassador. in 1882 to London, and in 1885 to Vienna. In 1899 he represented Italy at the first Hague peace conference. In 1904 he retired, and he died at Rapallo on July 1, 1907. He was created count in 1882 and senator in 1890.

NIHILISM is a philosophy of skepticism that originated in 19th-century Russia during the early years of the reign of Alexander II and was most clearly expressed in the literary criticism of D. I. Pisarev. The term (from the Latin *nihil,* "nothing") was first used by Nikolai I. Nadezhdin in an article in the Messenger of Europe, and it later was popularized by Ivan Turgenev in his celebrated novel Fathers and Sons (1862).

The philosophy of nihilism has often been associated erroneously with regicide and the policy of terror employed by a clandestine political organization against the imperial administration. Fundamentally nihilism represented a philosophy of negation of all forms of aestheticism; it ,advocated utilitarianism and scientific rationalism. The social sciences and classical philosophical. systems were rejected entirely. Nihilism represented a crude form of positivism and materialism. a revolt against the established social order; it negated all authority exercised by the state, by the church or by the family. It based its belief on nothing but scientific truth; science became the cure-all for social problems. All evils. nihilists believed. derived from a single source: ignorance. which science alone would overcome. Prince Petr Kropotkin. the leading Russian anarchist. defined nihilism as a struggle against all forms of tyranny. hypocrisy and artificiality in favour of individual freedom. It was a revolt of an adolescent generation that cherished infinite faith in scientific truth.

The thinking of nihilists was profoundly influenced by such men as Ludwig Feuerbach. Charles Darwin. Henry Buckle and Herbert Spencer. Since nihilism denied the duality of man as a combination of body and soul, of spiritual and material substance, it came into violent conflict with ecclesiastical authorities. Since nihilists questioned the validity of the divine right doctrine. they came into similar conflict with secular authorities. Since they scorned all social bonds and family authority. the conflict between fathers and sons was equally immanent, and it is this therne that is best reflected in Turgenev's novel. A comparison between Turgenev's hero, Bazarov. and Leonid Andreyev's Savva. created during the early 20th century, reveals the deterioration of nihilist philosophy. which changed from a faith in science into a justification of destruction. (A. G. M.)

NIIGATA, the chief town and capital of the prefecture of Niigata, Japan. Pop. (1960) 314.528. It occupies an area of about 27 sq.mi., and its plan consists of five long parallel streets intersected by cross streets. which in most cases have canals running down the middle and communicating with the river. so that the internal traffic of the city is mainly carried on by water. The town has been brought within the railway circuit, and the production of petroleum has been developed in the district. There is a large manufacture of lacquer ware in the town. and since 1931 modern industries have been developed. Area of prefecture of Niigata, 4.855 sq.mi.; pop. (1960) 2.442.037.

NÍJAR, a town of southeastern Spain. in the province of Almería; on the southern slope of the Sierra Alhamilla. and on the small river Artal, which flows into the Mediterranean sea 6 mi. S.W. Pop. (1950) 10.577 (mun.). Lead. iron and manganese are mined near by: the fertile plain watered by the Artal yields an abundance of wheat, fruit. olives and esparto grass: fine porcelain and woolen and cotton goods are manufactured there.

NIJHOFF, MARTINUS (1894–1953), Dutch poet and critic whose work had great influence on modern Dutch poetry, was born April 20, 1894, at The Hague. He studied law at Amsterdam and literature at Utrecht. and was for many years editor of the old-established literary periodical. *De Gids.* He died at The Hague. Jan. 26. 1953.

Nijhoff began his literary career with *De Wandelaar* (1916), a collection of symbolical poems expressing an essentially modern anguish and despair in traditional poetic forms. It was followed by *Pierrot aan de lantaren* (1919), a poetic dialogue between Harlequin and Pierrot. His best-known collection. *Vormen,* appeared in 1924. He returned to more serious themes in *Nieuwe Gedichten* (1934) and *Hrt uur U* (1941). In Nijhoff's poetry simple everyday words are charged with power, and this makes his work almost untranslatable. In his prose sketch. *De pen op papier* (1927), he deals playfully with the process of poetic creation. He also wrote plays—*De Vliegende Hollander* ("The Flying Dutchman") (1930), written for an open-air performance by undergraduates, and a biblical trilogy. Het *heilige hout* (1950)—and translated both classical and modern works.

See T. de Vries, *M. Nijhoff, wandelaar in de werkelijk heid* (1946). (GD. W. HS.)

NIJINSKY, VASLAV (WASLAW) (1890–1950), Russian dancer. whose remarkable performances with the Diaghilev ballet brought him an almost legendary fame. Born in Kiev. Feh. 28. 1890. Nijinsky studied under Legat and Oboukhov in the Russian Imperial Ballet school. St. Petersburg, graduating in 1908. Almost immediately. Sergei Diaghilev selected him as leading dancer of the company he presented in Paris in 1909. Diaghilev deeply influenced Nijinsky's entire career. Endowed with phenomenal technique and a genius for characterization, Nijinsky scored triumphs in *Petrouchka, Carnaval, Scheherazade* and *Le Spectre de la Rose,* all of which were created by Michel Fokine. A daringly original choreographer, Nijinsky created *L'Aprés-midi d'un Faune, Le Sacre du Printemps, Jeux* and *Till Eulenspiegel* (the latter produced in America without Diaghilev's personal supervision). all for the Diaghilev ballet. In 1913 Nijinsky married Romola de Pulzky. His brief career was terminated in 1917 by the threat of insanity. which shadowed the rest of his life. He died in London on April 8. 1950.

Sijinsky's sister. Bronislava Nijinska (1891–), became a distinguished choreographer.

See Romola Nijinsky, ***Nijinsky*** (1934). (LN. ME.)

NIJMEGEN, or NIJMWEGEN, a residential town in the province of Gelderland. the Netherlands, on the left bank of the Waal, $24\frac{1}{2}$ mi. S.E. of Tiel by rail. Pop. (1957 est.) 122.963 mun. It has regular steamboat communication with Rotterdam, Cologne and Arnhem, and is very prettily situated on the slopes of five low hills rising from the riverside. Steps are necessary to lead to the higher portions of the town. In 1877–84 the old town walls were demolished, a promenade and gardens taking their place. and subsequently a new quarter grew up on the south side with a fine open place called the Emperor Charles's plain. On the east of the town is the beautiful park called the Valkhof, which marks the site of the old palace of the Carolingian emperors. The palace was ruined by the French bombardment of 1794, and only tno portions of it remain. These are a part of the choir of the 12th century palace-church. and a 16-sided baptistry originally consecrated by Pope Leo III in 799 and rebuilt in the 12th or 13th century. Close by is the lofty tower of the Belvedere, dating from 1646. The *Groote Kerk* of St. Stephen forms with its tall square tower one of the most striking features of the town. Originally built about 1272, it dates in its present condition mainly from the 1jth and 16th centuries. The interesting Renaissance town hall was built in 1554 (restored in 1879). There is also an interesting museum of antiquities. Other buildings of note include the old weighhouse and Flesher's hall. probably built in 1612 and restored in 1885. Nijmegen is the seat of a Roman Catholic university.

Beer. Prussian blue, leather, tin, pottery, cigars and gold and silver work are the chief industrial products. The town was occupied by Germany during World War II.

NIJNI-NOVGOROD (now called GORKI'). chief town of Gorki *oblast*, Russian S.F.S.R., *U.S.S.R.*. at the confluence of the Oka and Volga rivers in 56° 24′ N.. 44° E. Pop. (1959) 942.-000. The city owes its importance to its position at the junction of the navigable rivers between which. to the west of it. was the flourishing Moscow region. though the development of its trade. at first mainly in furs. was much hampered by Tatar raids, which did not cease until the second half of the 16th century. After the last raid in 1536 it became a depot for goods brought from the southeast. and the conquest of Kazan in 1552 and of Astrakhan in 1556 opened free navigation on the Volga. The thick forests of the district provided material for shipbuilding and a yearly "caravan" of boats under military protection began to carry the products of Moscow and the north to the Caspian and to return laden with the products of the south and east.

The Fair.—From remote antiquity Russian merchants were accustomed to meet in summer with those from the east at different places on the Volga between the mouths of the eastward flowing Oka and the westward flowing Kama, the fair changing its site with the increasing or decreasing power of the nationalities which struggled for the possession of the middle Volga. Bolgari. Nijni-Novgorod, Kazan and Vasilsursk have been successively the site of the fair since the 10th century. From 1641 its seat was at a monastery 55 mi. below Nijni and close to hlakaryev; this situation later proved inconvenient, and after the destruction of the shops by fire, the fair was transferred to Nijni in 1517.

The long distances in Russia. the poor network of communications, the seasonal nature of production and river transport, the dependence of the peasant on handicrafts as a supplement to agriculture, the links between Russia and the orient are some of the factors which tended to preserve the importance of fairs as a medium of exchange and barter until modern times. In the more industrialized regions of the south and west, with their better railway facilities and higher level of literacy, fairs gradually disappeared, but in other regions they continued to be of great importance for home trade. The state granted special customs exemptions to goods destined for the Nijni fair and gave cheaper transport facilities and special credits to traders.

Until the 1880s Russian manufacturers depended largely on barter trade in tea from Kiakhta, and its price at the fair regulated output. Later the price of raw cotton and madder from Asia at the fair influenced the output of the growing textile industry of the central productive region. The owners of the iron works in the Ural district sent "caravans" of boats laden with iron goods to Nijni, where the purchases of iron made for Asia and middle Russia determined the amount of credit on which they could depend for the next year's work. Similarly the corn and salt trade of the south and the general trade of Siberia and Turkistan depended on the prices prevailing at the fair.

The fair reached its highest development between 1880 and 1884. During the 1914–22 uar and civil war, the trade of Nijni was interrupted, and when the fair reopened in 1923, conditions had altogether changed. Private trade, though not entiiely suppressed, had been markedly reduced and the various state trading departments and local goods exchanges had taken over much of the regulation between supply and demand.

Trade with the Ural metal region via the Kama, with Siberia and with the corn, salt. wine and naphtha regions of the Caspian revived. The duration of the fair was fixed for Aug. 1 to Sept 1 j

In addition to its trading activities the town has shipbuilding and repair yards and manufactures machinery. telephones, chemicals. sewn goods, matches. bricks flour, confectionery and alcoholic beverages The town has railway links through Vyatka with Perm and Sverdlovsk, and also with Kotlas, Moscow and, by a branch line to Arzamas. with the trans-Siberian railway. There is also a short branch to Pavlov Steam navigation on the Volga began in 1821 and developed rapidly after 184j. An air service between Moscow and Nijni-Novgorod was established, with daily services during the period of the fair.

The Town consists of three parts. The upper city is built on three hills on the right bank of the rivers (490 ft.). On one of them is the ancient citadel or Kremlin. first erected as a palisaded fort in the second half of the 14th century, and rebuilt in the early 16th century. with a wall 2,300 yards long, 65 to 95 ft high and having 11 towers. Within it are the law courts. the former governor's residence, the arsenal. barracks. etc.. a museum and the Preobrazhensky and Archangel cathedrals, dating from 1225 and 1222 respectively. but much spoiled by later restorations. Kozma Minin Sukhorukov, a cattle-dealer of the town, who organized the army that saved Moscow from Polish dominion in 1612. is buried in the Preobrazhensky cathedral, and a square in the Kremlin contains a monument to Minin and Pozharsky erected in 1826. The view from the Kremlin of the broad Volga with its low-lying and far-spreading left bank is very striking. Near the Kremlin are two monasteries, the Pechersky, built in the first half of the 16th century to replace one founded in 1330 and destroyed by a landslip in 1596, and the Blagovyeshchensk (1370, rebuilt 1647). Five descents lead to the lower town, the Nijni bazaar, built on the alluvial terrace 30 to 35 ft. above the banks of the Oka and Volga The climate is harsh and continental, average January temperature 10.6° F., July 64° F., extreme readings −40° F. and +104° F.

History.— The confluence of the Oka and the Volga, inhabited in the 10th century by Mordvinian tribes, began to be coveted by the Russians as soon as they had occupied the upper Volga, and as early as the 11th century they established a fort. Gorodets, 20 mi. above the mouth of the Oka. In 1221 the people of Suzdal. under Yuri Vsevolodovich, prince of Vladimir, erected a fort on the hill now occupied by the Kremlin. Until the beginning of the 14th century Nijni-Novgorod, which greu rapidly as the Russians colonized the banks of the Oka, remained subject to Suzdal; it enjoyed, however, almost complete independence, being ruled by its popular assembly. Until 1390, it elected its only princes. Poorly protected by its palisaded walls, it was plundered in 1377 and 1378 by the Tatars, supported by the Mordvinians.

In 1390 Prince Vasili of Moscow, in alliance with Toktamish, khan of the golden horde of the Mongols, took Nijni and established his own governors there; in 1417 it was definitely annexed to Moscow, becoming a stronghold for the further advance of that principality toward the east. It was fortified in 1508–11, and was able to repel the Tatars in 1513, 1520 and 1536. In 1606–11 the trading classes took an active part in the expeditions against the revolted serfs. A Nijni cattle-dealer, Sukhorukov, helped to deliver Moscow from the Poles in 1612. In 1667 the city withstood an attack by Stenka Razin. During the 17th century the country became the seat of a vigorous religious agitation, and in its forests the Raskolniks established hundreds of their monasteries and communities, those of the Kerzhenets playing an important part in the history of Russian nonconformity.

Nijni-Novgorod had some part in the literary movement of the end of the 18th century; its theatre also was of some importance in the history of the Russian stage. It has a growing university and a Workers' Scientific institute opened since the 1917 revolution. The city was renamed Gorky in 1932 after the writer Maxim Gorky, born there on March 16, 1868.

NIKE, the goddess of victory (Gr. *νίκη*, Lat. *Victoria*). She does not appear personified in Homer. In Hesiod (*Theog.* 384) she is the daughter of the giant Pallas and Styx, and is sent to fight on the side of Zeus against the Titans. Nike does not appear to have been the object of a separate cult at Athens. She was at first inseparably connected and confounded with Pallas Athena, the dispenser of victory, but gradually separated from her. As an attribute of both Athena and Zeus she is represented as a small figure carried by those divinities in their hand. Athena Nike was always wingless, Nikē alone winged. In works of art she appears carrying a palm branch or a wreath (sometimes a Hermes staff as the messenger of victory) erecting a trophy or recording a victory on a shield, or, frequently, hovering with outspread wings over the victor in a competition, since her functions referred not only to success in war but to all other human undertakings. In fact, Nikē gradually came to be recognized as a sort of mediator of success between gods and men.

At Rome Victoria was worshipped from the earliest times. Evander was said to have erected a temple in her honour on the Palatine before the foundation of Rome itself (Dion. Halic. i, 32, 33). She was identified with the obscure Sabine goddess Vica Pota and others. Special games were held in her honour in the circus, and generals erected statues of her after a successful campaign. She came to be regarded as the protecting goddess of the senate, and her statue (originally brought from Tarentum and set up by Augustus in memory of the battle of Actium) in the Curia Julia (Dio Cassius li. 22; Suetonius, *Aug.* 100) was the cause of the final combat between Christianity and paganism towards the end of the 4th century. Victoria had altars in camp, a special set of worshippers and colleges, a festival on Nov. 1, temples at Rome and throughout the empire. Representations of Nikē-Victoria in art are very numerous. cf. GREEK ART (fig. 3).

See L. R. Farnell, *Cults of the Greek States*, i (1896); G. Wissowa, *Religion und Kultus* (2nd ed. 1912) (bibl.); Roscher's *Lexikon*, arts. "Niké," "Victoria."

NIKISCH, ARTHUR (1855–1922), Hungarian conductor, was a precocious child, making a public appearance as a pianist at eight years old. He studied at the Vienna Conservatoire from 1866 to 1873, and while there he composed a symphony and other works. In 1877 he began as assistant conductor at the Leipzig opera and two years later became chief conductor. His brilliant success in Leipzig gave him a world-wide reputation. Nikisch was conductor of the symphony orchestra at Boston, U.S.A., from 1889 to 1893; and subsequently, after having been director at the Budapest opera, at the Leipzig Gewandhaus. He died in Leipzig on Jan. 23, 1922.

See F. Pfohl, *Arthur Nikisch* (Hamburg, 1925).

NIKKO, a small town in Tochigi prefecture. One of the chief centres of pilgrimage and sightseeing in Japan, it lies 91 mi. N. of Tokyo by rail, in a valley below the range called Nikko-Zan (Mountains of the Sun's Brightness). Its natural beauties and the splendour of its monuments gave rise to a popular saying: "Do not say 'splendid' (*Kekkō*) until you have seen Nikko." A Shinto shrine seems to have existed from time immemorial and in 767 its first Buddhist temple was founded by Shōdō Shōnin (the subject of many legendary adventures); but the main celebrity of the place is due to the sepulchres and sanctuaries of Iyeyasu and Iyemitsu, the first and third shoguns of the Tokugawa dynasty. Iyeyasu was buried with amazing pomp in 1617, and Iyemitsu, his grandson, was slain in 1650 while visiting his tomb. From 1644 to 1868 the "abbots" of Nikko were always princes of the imperial blood; thirteen of them are buried within the sacred grounds.

NIKOLAEV, a seaport of the Ukrainian S.S.R., U.S.S.R., situated a little above the confluence of the Ingul and Bug rivers! at the head of the Bug estuary in 46° 58′ N., 31° 58′ E. Pop. (1959) 224,000. Vessels have to pass the bar of the Dnieper t~ reach the Ochakov channel, and dredging has been carried out to a depth of 25 ft., so that vessels of 24 ft. draught can pass without lightening their loads. Two icebreakers are now working so as to keep the estuary of the Dnieper and the channel of the Bug open for navigation from the Black sea to Nikolaev all the year round. There is a government commercial quay and a harbour for coasting vessels. The Varvarovka jetty was damaged during the civil war. There are floating elevators and a railway grain elevator. The chief imports are cement, iron, steel, machinery and general merchandise, and the exports are grains, oilseeds, sugar, wool, iron ore, manganese and timber.

In common with other Black sea ports, Nikolaev suffered from the effects of the civil war and the war of intervention and from the decrease in Black sea trade due partly to change of frontiers and partly to war damage and loss of ships and the cessation of repairs and construction until 1923. The town has ship yards where steamers for the admiralty and for the commercial fleet are built, the construction of armoured ships and torpedo boats dating back to 1870. and being carried out mainly along the bank of the Ingul river. Ochakov and Kimburn are potential forts to protect the double estuary in case of attack. The industrial enterprises of Nikolaev include the manufacture of machinery. ploughs, nails, glass, footwear, macaroni, tobacco and alcoholic drinks.

The town is linked by rail with the general railway net to the north. and also has a branch to Kherson.

The remains of the Greek colony Olhia have been discovered close to the confluence of the Ingul with the Bug. 10 mi. S. of Nikolaev. After the fall of Ochakov. Prince Potemkin established (1789) a wharf on the Ingul which received the name of Nikolaev.

NIKON [NIKITA MININ] (1605–1681), 6th patriarch of Moscow, Russian reformer and statesman, son of a peasant farmer named Mina, was born on May 7, 1605, in the village of Valmanovo, 90 versts from Nijni-Novgorod. Misery pursued the child from his cradle, and prematurely hardened a character not naturally soft; he ran away from home to save his life from an inhuman stepmother. He took orders, and became a popular preacher in Moscow, then, seeing in the loss of his three little children a providential warning to seek the higher life, he first persuaded his wife to take the veil, and then withdrew himself first to a desolate hermitage on the isle of Anzersky on the White Sea, and finally to the Kozhuzersky monastery, in the diocese of Novgorod, of which he became abbot in 1643. On becoming a monk he took the name of Nikon. In his official capacity he had frequently to visit Moscow, and in 1646 made the acquaintance of the pious and impressionable Tsar Alexius, who fell entirely under his influence. Alexius appointed Nikon archimandrite, or prior, of the wealthy Novospassky monastery at Moscow, and in 1648 metropolitan of Great Novgorod. Finally (Aug. 1, 1652) he was elected patriarch of Moscow. It was only with the utmost difficulty that Nikon could be persuaded to become the archpastor of the Russian Church, and he only yielded after imposing upon the whole assembly a solemn oath of obedience to him in everything concerning the dogmas, canons and observances of the Orthodox Church.

Ecclesiastical reform was already in the air. A number of ecclesiastical dignitaries, known as the party of the protopopes (deans), had accepted the responsibility for the revision of the church service-books inaugurated by the late Patriarch Joasaf, and a few other very trivial rectifications of certain ancient observances. Nikon was bolder and more liberal. He consulted the most learned of the Greek prelates abroad; invited them to a consultation at Moscow; and finally the scholars of Constantinople and Kiev opened the eyes of Nikon to the fact that the Muscovite service-books were heterodox, and that the ikons actually in use had very widely .departed from the ancient Constantinopolitan models, being for the most part imitations of later Polish and Frankish (West European) models. He at once (1654) summoned a properly qualified synod of experts to re-examine the service-books revised by the Patriarch Joasaf, and the majority of the synod decided that "the Greeks should be followed rather than our own ancients." A second council, held at Moscow in 1656, sanctioned the revision of the service-books as suggested by the first council, and anathematized the dissentient minority, which included the party of the protopopes and Paul, bishop of Kolomna. Heavily weighted with the fullest oecumenical authority, Nikon's patriarchal staff descended with crushing force upon the heterodox. His scheme of reform included not only service-books and ceremonies but the use of the "newfangled" ikons, for which he ordered a house-to-house search to be made. His soldiers and servants were charged first to gouge out the eyes of these "heretical counterfeits" and then carry them through the town in derision. He also issued a *ukaz* threatening with the severest penalties all who dared to make or use such ikons in future. This ruthlessness goes far to explain the unappeasable hatred with which the "Old Ritualists" and the "Old Believers," as they now began to be called, ever afterwards regarded Nikon and all his works.

From 1652 to 1658, Nikon was not so much the minister as the colleague of the tsar. Both in public documents and in private letters he was permitted to use the sovereign title. Such a free use did he make of his vast power, that some Russian historians have suspected him of the design of establishing "a particular national papacy"; and he himself certainly maintained that the spiritual was superior to the temporal power. He enriched the numerous and splendid monasteries which he built with valuable libraries. His emissaries scoured Muscovy and the Orient for precious Greek and Slavonic mss., both sacred and profane. But his severity raised up a whole host of enemies against him, and by the summer of 1658 they had convinced Alexius that the sovereign patriarch was eclipsing the sovereign tsar. Alexius suddenly grew cold towards his "own familiar friend." Nikon thereupon publicly divested himself of the patriarchal vestments and shut himself up in the Voskresensky monastery (19th of July 1658). In February 1660 a synod was held at Moscow to terminate "the widowhood" of the Muscovite Church, which had now been without a pastor for nearly two years. The synod decided not only that a new patriarch should,be appointed, but that Nikon had forfeited both his archiepiscopal rank and his priest's orders. Against the second part of this decision, however, the great ecclesiastical expert Epifany Slavenitsky protested energetically, and ultimately the whole inquiry collapsed, the scrupulous tsar shrinking from the enforcement of the decrees of the synod for fear of committing mortal sin.

For six years longer the Church of Muscovy remained without a patriarch. Every year the question of Nikon's deposition became more complicated and confusing. At last the matter was submitted to an oecumenical council, which opened its sessions on Nov. 18, 1666, in the presence of the tsar. On Dec. 12 the council pronounced Kikon guilty of reviling the tsar and the whole Muscovite Church, of deposing Paul, bishop of Kolomna, contrary lo the canons, and of beating and torturing his dependants. His sentence was deprivation of all his sacerdotal functions;

henceforth he was to be known simply as the monk Nikon. The same day he was sent as a prisoner to the Therapontov Byelozersky monastery. Yet the very council which had deposed him confirmed all his reforms and anathematized all who should refuse to accept them. Nikon survived the tsar (with whom something of the old intimacy was resumed in 1671) five years, expiring on Aug. 17, 1681.

See R. Nishet Bain, *The First Romanovs* (1905); S. M. Soloviev, *History of Russia* (Rus.), vol. x (1895, etc.); A. K. Borozdin, *The Protopope Avvakum* (Rus.) (1898); V. S. Ikonnikov, New *Materials concerning the Patriarch Nikon* (Rus.) (Kiev, 1888); William Palmer, *The Patriarch and the Tsar* (1871–76). (R. N. B.)

NIKOPOLI or NICOPOLIS (Bulgarian *Nikopol*), the chief town of a subprefecture in the district of Plevna (Pleven), Bulgaria. Pop. (1956) 5,763. Nikopoli is picturesquely situated on the south bank of the Danube, where it receives the Osem. The chief industries are tanning and fishing. As a military post the town has for centuries been important. A ruined castle still dominates the place, and fortifications stretch down to the river.

Nikopoli occupies the site of the ancient Asamus, but by some mediaeval confusion bears the name of Nicopolis ad Istrum, which was founded by Trajan several miles down the river. at the inflow of the Iatrus or Yantra, at the spot still called Nikup. The following are the chief points in the modern history of the place: — capture of the fortress by Sigismund of Hungary in 1392 and 1395; defeat of Sigismund and his hosts in 1396 by Bayezid I; siege of the town by King Ladislaus I of Hungary in 1444; defeat of the Turks by Bathori in 1595 and by Michael of Walachia in 1598; capture of the town by Pasvan-oglu in 1797; occupation of the fortress by the Russians under Kamensky in 1810; destruction of the Turkish flotilla by Govarov in 1829; capture and burning of the town by the Russians under Kriidener. June 1 j, 1877.

NIKŠIĆ, a romantically situated town of Montenegro, Yugoslavia, in the valley of the Zeta, which forms the main source of communicatidn between north and south Montenegro. Pop. (1961) 20,165. Wheat, maize. rye and potatoes are cultivated. and there are two breweries, cloth and cotton mills in the town. which is an important mart for timber, hides! farm produce and livestock. The chief road, to Podgorica (*q.v.*), is entered by a long viaduct, the gift of Russia, to obviate the flooding which formerly often rendered it impassable. The town, of white houses, is built round a square with four radiating streets, and is dominated by the pale yellow cupola of the Byzantine cathedral. another gift from Russia. Close by stands a royal palace and on one of the heights are the ruins of an old Turkish fortress.

Nikšić was occupied by Italian troops in 1941. About 12 mi. S.E. is the famous shrine of Ostrog (*see* MONTENEGRO).

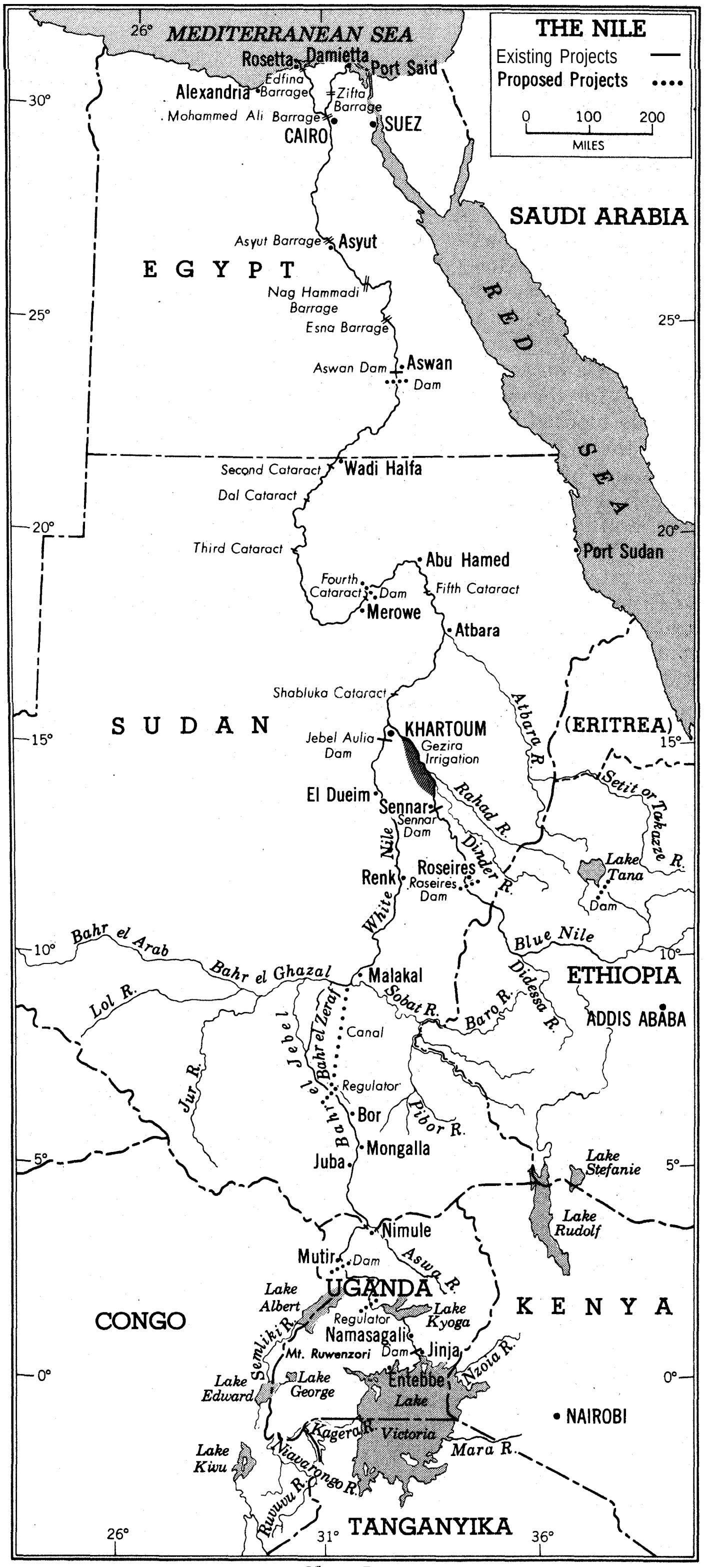
NILE, an African river whose basin is the dominant feature of the northeastern quarter of the continent. Its length as the water flows from its most distant source to the entry of the Rosetta branch into the Mediterranean is about 1,157 mi. This source is the head of the Luvironza in lat. 3° 50′ S. and about 40 mi. E. of Lake Tanganyika. There is a probability that the Nile may be the longest river in the world. The Mississippi-Missouri was once taken to be the longest, but the U.S. army engineers later gave the length from the most remote source of the Missouri to the sea as 3,891 mi. There is reason to think that the Amazon is more than 4,000 mi. long, but its length is taken from maps on a scale of 1:1,000,000, while the Nile has been measured from maps on scales ranging from 1:100,000 to 1: 250,000. More detailed maps of the Amazon on a larger scale would be likely to increase its estimated length because of the effect of sinuosity. The name Nile comes from the Latin *Nilus* and Greek *Neilos,* whose origin is unknon-n. *Aiguptos* in the Odyssey is the name of the Nile (masc.) as well as of the country of Egypt (fem.) through which it flows and survives both in the name Egypt and in the name Copt (*gupti* in the Arabic of Upper Egypt). At the present time the Nile in Egypt and in the northern Sudan is called en-Nil, or el-Bahr ("the river"), or el-Bahr en-Nil.

General Account. — The basin covers approximately 1.812.500 sq.mi. or about one-tenth of the area of Africa. Politically it includes Uganda, parts of Kenya, of 'Tanganyika and of the Republic of the Congo (formerly Belgian Congo), most of the Sudan, part of Ethiopia and the cultivated portion of Egypt. Its rapidly increasing population was estimated as roughly 40.000.000 in 1954. of whom more than half live in Egypt It is possible to travel by car in the dry season over most of the basin; but south of lat 15° N over the plains of the Sudan motor transport is not usually possible from May to November In the higher country leading up to the Lake plateau and the Nile-Congo watershed and on the Lake plateau there are all-weather roads.

Three principal streams form the Nile. The largest in volume is the Blue Nile which draws practically all its water from Ethiopia and contributes four-sevenths of the total supply of the main stream. Next comes the White Nile, which is the longest branch and supplies two-sevenths of the total; its headstreams flow into Lakes Victoria and Albert; and lower down in the Sudan it receives the Sobat. which obtains its water mainly from Ethiopia. The White Nile and Blue Nile join at Kllartoum. Lastly there is the Atbara, draining the northwestern part of Ethiopia and joining the main stream zoo mi. N. of Khartoum, and contributing the remaining one-seventh. The Blue Nile and Atbara are both muddy streams in flood time and bring down the soil which has made the cultivable land of Egypt and is still adding to it. From the Atbara junction to within a few miles of the Mediterranean there is not enough rain to produce any crops, and so this area depends entirely on irrigation by Nile water. The river is navigable from the sea to Wadi Halfa (about 951 mi), and the Aswan dam and the barrages are passed by locks Between Halfa and Khartoum the river is broken up by the cataracts, and ordinarily navigation is only possible in short stretches From Khartoum the White Nile is navigable for 1,104 mi to Rejaf, 100 mi from the Uganda border. the Jebel Aulia dam (25 mi. S of Khartoum) being passed by a lock From Rejaf to the Uganda border the river is again beset with rapids. but there is navigation from Nimule on the border into Lake Albert and up the Victoria Nile to the foot of the Murchison falls. Between Lakes Albert and Victoria there are two successions of rapids with a navigable stretch which includes Lake Kyoga (Kioga) between them. 'The Blue Nile is navigable during flood for 385 mi. as far as Roseires. though it is interrupted by the Sennar dam which has no lock. During the flood season the Sobat is navigable up to Gambela and the Bahr el-Ghazal up to Wau. Regular air services operate on important routes throughout the Nile basin, including Ethiopia.

The White Nile.—'The main stream of the White Nile begins on the Lake plateau of East Africa, where there are two separate river systems, the Victoria Nile and the Lake Albert system. Most of this country lies 4,000 ft. or more above sea level and on this account enjoys a pleasant climate. Two rivers, the Niavarongo (Nyawarongo) and Ruvuvu, may justly be considered the headwaters of the White Nile, since they join together to form the Kagera, the most important tributary of Lake Victoria. The Kagera is a stream 510 mi. long from the source of the Luvironza to its mouth and 70 m. wide near its mouth. Of the other tributaries of Lake Victoria the largest from the point of view of discharge is the Nzoia in the northeast. which has rather less than half the discharge of the Kagera and is torrential: with only a small flow in the dry season; it draws its water from Mount Elgon and the high country to the northeast of Lake Victoria. The lake has an area of 26,828 sq.mi. inclusive of islands and is like a small sen insomuch as it is subject to considerable storms. The Nile leaves Lake Victoria by the Ripon falls, which are now submerged because of the dam at the Owen falls a mile or more lower down.

At this point the supposed connection between the level of Lake Victoria and sunspots may be mentioned. From 1896 to 1927 maximum and minimum lake levels coincided with maximum and minimum sunspot numbers. thus giving rise to the theory of a connection. Later, however. this regularity disappeared. Moreover on theoretical grounds the connection is unlikely. so the coincidence in the first part of the records must be considered as accidental. Indeed. by the middle of the 20th century no connection between sunspot activity and any portion of the Nile had yet been established. The river below the lake, known as the Victoria Nile,



FROM A MAP COMPILED BY THE SURVEY OF EGYPT

is first beset with rocks and rapids but becomes navigable just above Namasagali (50 mi. from the lake). Soon it crosses the mouth of Lake Kyoga. the centre of an important district whose products are collected by steamers navigating the lake. Lake Kyoga is a shallow piece of water with many swampy arms, having an area of open water of about 1,710 sq.mi. (4,429 sq.km.). Many of the arms are practically filled with swamp vegetation, and parts of the open lake are covered with water lilies whose stems go down to the bottom a metre or more below. Below Kyoga the Nile is navigable until it turns westward, after which there is a series of rapids finishing with the Murchison falls. Here the Nile passes through a narrow cleft in the rock and falls a distance of about 140 ft. A short distance from the Murchison falls the Victoria Nile enters Lake Albert. Lake Albert is at the tail end of another river system which starts from near some of the Kagera sources but on the northern side of the Mfumbiro volcanoes. The principal headstream of this system is the Ruchuru river, which runs along the Rift valley northward to Lake Edward. Lake George, which is much smaller, is joined to Lake Edward by a broad channel. The Semliki river, a fair stream, connects Lake Ednard with Lake Albert. It flows in places through thick forest along the western side of Ruwenzori, of which it receives the drainage. Lake Albert lies between the high escarpments of the Rift valley, which in places come down abruptly to the water. It has an area of 2,046 sq.mi. Below Lake Albert the river is known as the Albert Nile or Bahr el Jebel (river of the mountains), by which name it is known in the Sudan For about 140 mi. the Bahr el Jebel is a placid stream, often with snampy edges abounding in mosquitoes; but at Nimule on the Sudan-Uganda boundary it ceases to be navigable for nearly 100 mi. as it descends from the plateau to the Sudan plains. Just below Nimule are the Fola rapids, a fine sight, where the river rushes through a confined channel between rocks. After its arrival in the plains of the Sudan the country is flat except for rare rocky hills outcropping from the plain. Between Lake Albert and the plains the river receives some tributaries of a torrential nature, of which the principal is the Aswa from the southeast. The principal feature of the Bahr el Jebel when it reaches the plain is the large swamps of the Sudd region, where half its water is lost. Through these swamps the river winds between walls of high vegetation, papyrus, reeds and elephant grass, which except for lagoons and side channels extend from the river to the dry ground on either side, which may be miles away. Very few people are seen when once the river enters the swamps since only occasionally does it touch the higher ground. The country on the edge of the swamps provides good grazing, which lasts into the dry season, as the river, when high, floods a lot of country that is not permanent swamp. Most of the tribes of these southern plains, Nuers, Dinkas and Shilluks, are cattle-owning people living in a very primitive fashion. In the 19th century the Bahr el Jebel was frequently closed by vegetation. A block (Arabic *sudd*) is formed by masses of floating vegetation uprooted from the shallow lagoons by strong winds and blown into the main stream, where they may collect at a bend until they stretch across the uhole river. More floating islands of vegetation come down and some get sucked under the surface block to constrict the channel still further. Ultimately the block becomes a solid mass over which even elephants can cross. Sometimes the pressure of the rising water carries it away, sometimes the river breaks auay sideways to form a fresh channel. Between 1899 and 1904 the river, which had been completely blocked over long distances, was cleared. Since navigation became regular and frequent these blocks have only very rarely been formed in the main stream, though less-frequented streams are occasionally blocked. About halfway through the swamps a separate channel, known as the Bahr el Zeraf ("river of giraffes"), has been formed near the edge of the dry ground on the east and follows an independent course to the White Nile. In former times it was sometimes connected with the Bahr el Jebel, and a permanent connection has been made by means of two cuts dug by a dredger where the two streams are close together. At the tail end of the swamps the Bahr el Jebel is joined by the Bahr el Ghazal from the west and the two together flow eastward as the White Nile, being joined later by the Zeraf. The Bahr el Ghazal ("river of gazelles") is formed by the junction of a number of torrents coming from the southwest and west. The main stream is the Jur. which is navigable in flood up to a point south of Wau, the capital of the Bahr el Ghazal province. Next to the Jur in size is the Lol, into which a number of tributaries flow. It ends in swamps to the west of the Jur; other streams end in swamp to the east. The effect of the swamps is that very little water flows out of the mouth of the Bahr el Ghazal into the White Nile. In the southern part of the Bahr el Ghazal basin the principal tribe is that of the Azande, who came originally from the Congo and are agriculturalists and craftsmen.

The Sudd region and country of large permanent swamps ends at the junction of the Bahr el Ghazal and the Bahr el Jebel, although there is some swamp fringing the White Nile nearly as far as the mouth of the Sobat. The Sobat draws the greater part of its water from the Ethiopian plateau, though a little comes from the south. It is formed of two main streams, the Baro flowing from east to west and the Pibor from the south. From the Ethiopian mountains to the White Nile the country is flat grass plain liable to be flooded in the rains and in parts waterless in the dry season. The Sobat is in flood from July to October on its headwaters and, as a result of the inflow from flooded areas, remains high at its mouth until December. It is navigable in flood to Gambela on the Baro and to Pibor Post on the Pibor, but the journey for the greater part is monotonous. The Pibor is occasionally blocked by vegetation. From the Sobat mouth to Khartoum the White Nile is a wide placid stream with a very small slope and often a narrow fringe of swamp. After Jebelein the country gradually becomes more arid and savanna forest gives place to thorn scrub, until near Khartoum it is almost desert. At Kosti the railway from Khartoum that follows the Blue Nile southeastward to Sennar and then turns southwestward on its way to El Obeid crosses the White Nile on a bridge with an opening span. Twenty-five miles from Khartoum is the Jebel Aulia dam, containing a lock, which forms a reservoir the effect of which, when full, extends beyond Renk, 280 mi. upstream.

Between Malakal and Khartoum end the regions of Negro people speaking their own languages—Bantu in the far south and then Sudanic—and begins a region where the people are of mixed Arab and Negro descent and speak Arabic. Actually Arabic is understood by riverside people and people on the main routes all over the southern Sudan, while in Uganda and East Central Africa the *lingua franca* is Swahili.

The Blue Nile.—The Blue Nile is the source of nearly 70% of the Nile flood. The reputed source of the Blue Nile is a spring to the south of Lake Tana in Ethiopia, from which flows the little Abai or Xbbai, the principal tributary of the lake. The lake is in a basin at an altitude of about 6,000 ft. (1,840 m.), but with high mountains at no great distance. It has an area of about 1,222 sq.mi. (3,165 sq.km.) and is shallow. The Blue Nile leaves the lake over a series of rapids and very soon drops into a deep gorge in places 4,000 ft. below the general level of the plateau. Tracks descend to the river at places where at low stage there are fords. It is usually a two days' journey with mules to descend, cross the river and climb up the other side of the canyon. Tributary streams have cut similar ravines, and the scenery is magnificent both in its scale and in its ruggedness. The actual course of the river has not been followed as it is not possible to travel along the bottom of the gorge and its course is continually interrupted by rocks and rapids. There is a bridge at Shafartak where the road from Addis Ababa to Gojjam used to cross the river by a ford. Only a small portion of the Blue Nile water comes out of Lake Tana; by far the greater part is from tributaries, some of which are important streams, for example the Bashilo, Jamma, Guder, Didessa, Dabus, Balas, Dinder and Rahad. The water is derived from the rain which falls on the Ethiopian plateau and not from melting snow as has sometimes been stated. The highest mountains in Ethiopia reach 15,000 ft. but snow falls on them only occasionally and quickly disappears.

Halfway between Roseires and Khartoum is the Sennar dam, by means of which an area of 1,000,000 ac. in the Gezira between the Blue and the White Niles is irrigated. The water is impounded in flood and used in February and March. It is a good example of co-operation—originally between the government, a foreign company holding a concession and the native African tenants, then, after the concession had terminated, between the government and the tenants only. The scheme is well planned, and irrigation is based on careful measurement by weirs and other devices of the quantities of water entering the feeders from the main canal. The principal crops are cotton, millet and *lubia* (a kind of bean). Between Sennar and Khartoum the Blue Nile receives two tributaries: the Dinder and the Rahad. These, like the Blue Nile, are torrential but unlike the Blue Nile, dry up entirely except for pools (though both are considerable streams in floodj.

The Main Nile and the **Atbara.**—The main Nile from Khartoum northward flows between deserts with a narrow strip of vegetation on either side. Where the soil permits, the banks and neighbouring flat land are cultivated by the use of Nile water and support a small population. These conditions continue as far as a little distance north of Aswan. In this stretch the Nile receives its last tributary, the Atbara, which in flood is a large muddy river and in the dry season is a string of pools. Its principal tributaries are the Setit or Takazze (Takkaze) and the Bahr es Salaam. From Abu Hamed onward the valley is often rocky and desolate, particularly in the neighbourhood of the Fourth cataract and for more than 100 mi. S. of Wadi Halfa, where the country is known as the Batn el-Hagar (belly of stones). Wadi Halfa is just below the Second cataract and is within the area affected by the heightened Aswan reservoir, which ponds water up as far back as the cataract. The Aswan dam, which had been heightened twice, had in the late 1950s a height of nearly 53 m. (174 ft.) and a length of 2 km. ($1\frac{1}{4}$ mi.) and stored 5,300,000,000 tons of water.

From Aswan northward to Cairo the river is bordered by a flood plain of alluvium gradually increasing to a maximum width of about 12 mi. which is cultivated by irrigation. Outside this is the desert. At the beginning of the 20th century basin irrigation was practised up to the head of the delta. In this system the land is watered by short canals, which can only receive water when the river is in flood. These deliver the muddy water on to the land, which is divided into compartments or basins by cross banks running from the river bank to the higher desert edge. The water is held in these basins to a depth of several feet for some weeks and deposits its mud. During this time the land is well soaked, the river falls, and the remaining water is then returned. After this seeds are planted in the mud to produce the single annual crop, which gets only such extra water as can be lifted from wells. This system was in use for thousands of years without any deterioration of the soil; but with an uncontrolled river the area that could be watered was variable and liable to be reduced in a low flood, with the possibility of famine. In perennial irrigation as distinguished from flood irrigation much smaller quantities of water are run on to the land every two or three weeks and two or three crops are grown in the year. This began to develop on a large scale from canals in the time of Mohammed Ali Pasha, toward the middle of the 18th century. A necessary feature is the barrages or low dams which have been built across the Nile at various points to enable its level to be raised so that it can flow at all times into main canals, whose heads are just above the barrages. From the main canals there are branch canals! and these again divide into smaller canals called distributaries, which deliver the water to irrigation ditches and so to the land. By the end of the 19th century cultivation in the delta itself was all perennial, depending on the Mohammed Ali barrage (below Cairo at the head of the delta), above which the three main canals of Lower Egypt begin. During the 20th century barrages were built at Asyut and Nag Hammadi in Upper Egypt, by means of which a large part of Upper Egypt was converted to the perennial system; and another barrage at Esna improved basin irrigation. During the time of low supply, when all the water is needed for irrigation, the Rosetta branch is closed at the barrage and the Damietta branch nearly so, while both are completely closed near the sea—the first by the Edfina barrage with its sluices, the second by an earth bank built each year by February and washed away by the rising flood in August (during this time waterborne traffic in the delta follows the canals). The crops grown during the low stage of the river are cotton, rice, sugar cane, groundnuts, sesame and millet. In the flood season the principal crop is maize; and in the winter the crops are wheat, barley, clover, beans, flax, onions and lentils. Cotton is the most valuable crop and occupies more than one-quarter of the total cultivated area. It is also Egypt's principal export. The Nile from Aswan to the sea is controlled in the interests of irrigation, though control is not complete in flood time.

Climate and Health. — In Egypt the months May to October are hot in the daytime, but there is a considerable drop in temperature after sunset. The winter months usually have clear bright days with cool or even cold nights. The climate of the northern Sudan is similar except that the temperatures are higher. Upper Egypt and the northern Sudan are characterized by low humidities, and the region from Halfa to Xtbara is one of the driest in the world. In the central Sudan from Khartoum to Renk or Roseires during the months of December, January and February the days are not unduly hot, and the nights are cool, while at the same time the humidity is low; then the temperature increases until May or June, after which the onset of the rains causes it to drop; September and October are liable to be oppressive months. In the southern Sudan the average temperature is lower than further north and varies less through the year; the highest temperatures occur from January to April and the lowest are in July and August. The climate of the high country of Ethiopia and central Africa is temperate, and above 5,000 ft. the nights are cold. Round Lake Victoria the temperature does not vary very much through the year.

The principal features of the rainfall are as follows. (1) There is a little rain on the Mediterranean coast (from 150 to 200 mm. annually) and over the delta: but this decreases rapidly with distance from the sea. being only 30 mm. in Cairo: it falls usually in the months from November to March. (2) A region extending from just south of Cairo to just north of Atbara is practically rainless. (3) There is next a steady increase of rainfall southward of the rainless region. (4) Regions of fairly heavy rainfall are found on the Ethiopian and Lake plateaus. where a total of more than 1,600 mm. is reached in places. the average rainfall of both plateaus being about 1,200 mm. or 50 in. On the whole the rainfall of the Nile basin is scanty, and hence for the size of its basin the discharge of the Nile is small. From Khartoum southward over the Sudan plain and in Ethiopia the maximum of rainfall is in July and August, but the rainy season is increasingly long toward the south and as the altitude of the country increases. On the Lake plateau there is no month when rain may not fall. There are two minima and maxima? the minima being in January and June-July.

In order to keep in good health in the Nile basin it is necessary to take precautions against diseases and, in the case of visitors and foreign residents, particularly against those prevalent in hot countries. In the southern and central parts of the basin malaria is a common disease and is carried by anopheline mosquitoes. All over the basin dysentery and typhoid fevers are common. The parasites which cause these are usually taken in food. while water and flies are also a means of carrying the infection. In Egypt and some other parts oi the basin bilharziasis and ankylostomiasis, diseases due to microscopic worms, are common. They are either contracted by drinking infected water or by wading or bathing in it. In certain districts relapsing fever occurs, transmitted by the bite of a tick that lives in cracks in the ground and in native houses and comes out at night. Sleeping sickness occurs over a wide area of the southern Nile basin and was formerly responsible for the deaths of great numbers of people. Now. however. as a result of stringent measures of control, it has practically disappeared from many districts in which it was formerly a serious danger. It is carried from one person to another by the bites of species of tsetse flies. Flies of the same genus carry trypanosomiasis of animals and so cause mortality among cattle, horses and donkeys.

Vegetation. — The desert region outside the Nile valley extends from the Mediterranean to about the latitude oi Atbara. Much of this area is almost rainless, and there is no vegetation except in favoured places such as the oases, where underground water comes to the surface, or along drainage lines where after rain the subsoil may remain moist for a long period. As regions of scanty but regular rainfall are reached, the country becomes dotted with small thorny shrubs, mostly acacias. These begin about the latitude of Xtbara and grow increasingly thick toward the south. After rain the country becomes green with grasses and small herbs but these rapidly dry up after the rain ceases.

South of this are types of savanna country. The first is thorny savanna containing small thorny trees and after the rains grass and herbs. This covers much of the central Sudan from latitude 10° to 15° N.

South of this is found true savanna country, consisting of open grass plains on which trees are rare except in a few places near the rivers. and on which the grass may grow from 6 to 10 ft. high. During the rains these plains are often swampy. True savanna covers a good deal of country from Malakal to Bor and from the Bahr el Jebel to the foothills of the Ethiopian plateau. During the dry season, which lasts about half the year, the grass dries, and over all the southern Sudan and parts of the Lake plateau it is burned every year. This kills many species of trees and so limits the vegetation and moreover stunts the growth of the remainder. In the savanna zone the rivers are often fringed nith reed swamp, more particularly the Bahr el Jebel in the Sudd region from Lake No to Bor and also the lower Bahr el Ghazal. In this swamp grow papyrus. bulrushes, tall bamboolike grasses, "um soof" (*Vossia cuspidata*), the thorny tree called "ambatch" (Herminiera *elaphroxylon*), whose wood is like pith. and floating vegetation such as the water lettuce (Pistia stratiotes). Papyrus swamps are also found in the valleys of the Lake plateau.

The true savanna country changes into savanna forest, which fringes the Blue Nile near Roseires and southward and covers the western slopes and parts of the plateau of Ethiopia. the southern parts of the Bahr el Ghazal basin and large areas of Uganda, the Lake plateau and its slopes. Savanna forest consists of trees of medium height casting little shade, while the ground is covered with grass and perennial herbs. Tropical rain forest does not exist in great quantity in the Nile basin, but it is found in river valleys along the File-Congo divide and in patches on the Lake plateau and in Ethiopia. Rain forest is characterized by a large number of species and several stories of vegetation, so that practically all the space is utilized and a wonderful luxuriance of plant life results.

History of Exploration. — The earliest traces of man are stone implements found in many parts of the basin, some of which were made perhaps 100,000 years ago. The most recent in Egypt are found with early pottery and come down to *c.* 4,J00 B.C. The historical period begins c. 3,400 B.C. and follows a period known as predynastic in which metal instruments began to be used as well as those of stone. When the early flint-implement people lived, the climate of North Africa was warm and humid. Lakes and rivers existed in what is now desert and the country was covered with vegetation and inhabited by animals now only found in tropical Africa. The mildness of the climate allowed men to live in shelters made of reeds or branches and did not force them to live in caves. as in northern countries, where traces of their occupation would have been preserved. Consequently the only remains of these early men are their durable flint instruments which are widespread over northeastern Africa. Gradually the climate became drier. the rivers shrank and ultimately. perhaps 20,000 years ago, desert conditions were established as they are at present. The result of this change was to concentrate people on the edges of the Nile valley. In the valley itself the river probably covered rnost of the land when in flood and left huge marshes when it fell again and retired to its trough. In these marshes primitive people living on the edges of the valley hunted hippopotami. water-loving antelopes and wild fowl. As the rainfall over North Africa decreased and the country became arid, the File shrank to something like its present volume, and the beginnings of agriculture probably started on the edges of the valley.

Actual history in the basin begins in Egypt 5,000 or 6,000 years ago and is based on deductions from pottery and utensils found in tombs. Later there are the inscriptions, pictures and carvings on the monuments which record contemporary events, and so down through ancient Egyptian, Greek: Roman and Arab times to the present. Little. is known of the early history of the Nile basin outside Egypt and this comes from the excavations in the northern Sudan and occasional references on Egyptian monuments to people farther south. It seems likely that the ancient Egyptians. although they traded down the Red sea as far as Somaliland and up the Nile beyond Khartoum, knew nothing of the source of the river. Herodotus. who visited Egypt c. 460 B.C. and travelled up to Aswan, has left some account of the country and a little about what lay to the south as far perhaps as the beginning of the Sudd region. By the 1st century A.D. trade down the Red sea to India and the east coast of Africa was well established, and this must have led to trade with the interior. It was probably due to this that rumours of snow-capped mountains and great lakes in the interior reached the Mediterranean. Because of the difficulties of travel in the Sudan it seems unlikely that the connection of the Nile with these was actually established: it n'as probably an intelligent guess. Strabo about the beginning of the era says that it was well known that the annual rise of the Kile was due to rain on the high mountains of Ethiopia. Claudius Ptolemaeus, who lived in Alexandria in the 2nd century A.D. and wrote treatises on astronomy and geography, thought that the White Nile came from the high snow-covered mountains in central Africa, called the Mountains of the Moon. and passed through two lakes. His map corresponds in a general way with what actually exists and must have been a collation of information then current as travellers' tales.

With Portuguese expeditions to Ethiopia in the 15th and 16th centuries more definite knowledge was obtained. and the first European to see the source of the Blue Kile was Father Pedro Paez, a Portuguese Jesuit. who visited it in 1613. Later. about 1770, James Bruce spent some time near Lake Tana and the head waters of the Blue Nile and then returned from Gondar to the Blue Kile at Sennar and so down the Nile to Cairo.

Modern exploration of the Nile basin begins with the conquest of the northern and central Sudan by Mohammed Ali Pasha and his sons from 1821 onward. As a result of this the Blue Nile was known as far as its exit from the Ethiopian foothills. arid the White Nile as far as the Sobat mouth. During his last visit to the Sudan about 1837 Mohammed Xli gave orders for the exploration of the While Nile so as to solve the problem of its origin. which had interested the civilized world for 2.000 years. Three expeditions under a Turkish officer. Selim Bimbashi, were made between 1839 and 1842 and two got to the point about 20 mi. beyond the present port of Juba, where the country rises, and rapids make navigation very difficult. These expeditions were accompanied by Georges Thibaut (Shawki Ibrahim). Jacques Pons d'Arnaud (Arnaud Bey) and Ferdinand Werne who published accounts of their journeys. After these expeditions traders and missionaries penetrated the country and established stations in the southern Sudan. From an Austrian missionary. Ignaz Knoblecher, in 1850 came reports of lakes farther south. In the 1840s the missionaries Johann Ludwig Krapf, Johannes Rebrnann and J. Erhardt travelling in East Africa saw the snow-topped mountains Kilimanjaro and Kenya and heard from traders of a great inland sea which might be a lake or lakes.

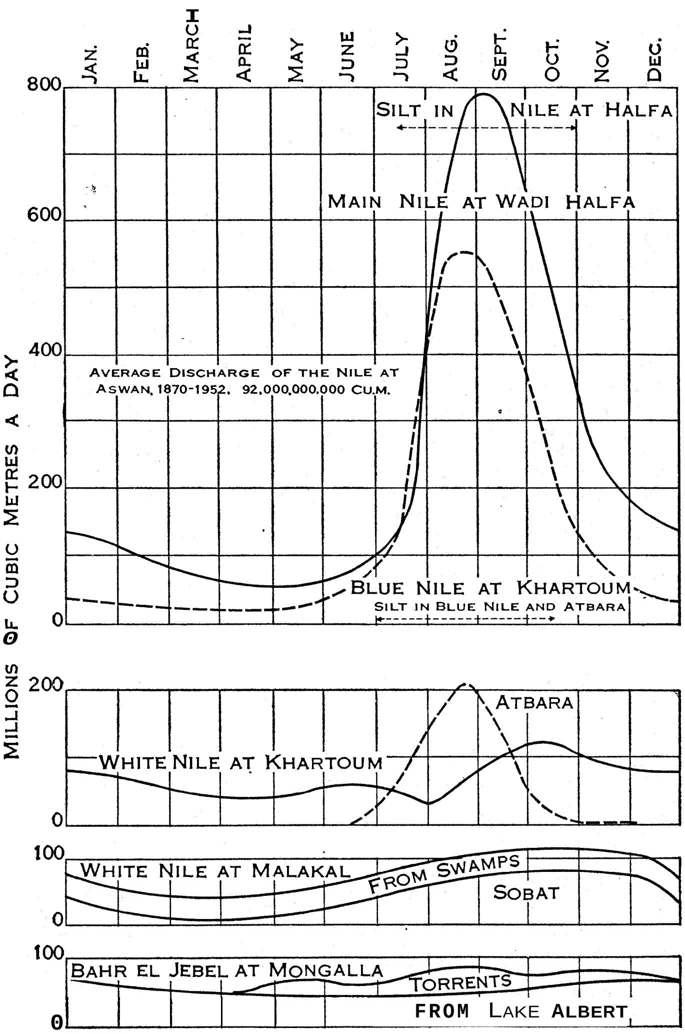
These reports led to fresh interest in the Nile source and to an expedition by Richard Burton and J. H. Speke, who followed a trade route of the Arabs from the east coast and reached Lake Tanganyika. On the return journey Speke went north and reached the southern end of Lake Victoria! which he thought might be the origin of the Nile. This was followed in 1860 by another expedition by Speke and J. A. Grant under the auspices of the Royal Geographical society. They followed the previous route to Tabora and then turned toward Karagwe, the country west of Lake Victoria. Here they saw the high Mfumbiro mountains 100 mi. to the west (they thought that they might be the Mountains of the Moon) and discovered the Kagera river. From the information that he was able to collect Speke thought that the Kagera must be the principal tributary of the lake. Continuing around the lake he finally reached the Ripon falls (1862), at which point he wrote "I saw that old Father Nile without any doubt rises in Victoria Nyanza." Speke then made his way northward with Grant, for part of the way along the Nile. until they reached Gondokoro, nearly opposite the present Juba. They heard rumours on the may of another large lake to the west but were unable to visit it and passed the information on to Sir Samuel Baker. who met them at Gondokoro, having come up from Cairo. Eaker then continued his journey south and discovered Lake Albert. Neither Speke nor Baker had followed the Nile completely from the Ripon falls to Gondokoro, and Baker, who saw the northern half of Lake Albert, was told that it extended a very long way to the south. The discoveries of Speke and Baker are now commonly held to have settled the origin and course of the Nile, but at the time the unexplored gaps and the very elementary state of the science of hydrology led people to think that there was still an element of doubt. The question was settled when, between 1874 and 1877, Gen. C. G. Gordon and his officers followed the river and mapped part of it. In particular Lake Albert was mapped and Col. Charles Chaillé-Long, an American, discovered Lake Kyoga. In 1875 H. M. Stanley travelled up from the east coast arid circumnavigated Lake Victoria. His attempt to get to Lake Albert was riot successful, though he travelled up the Katonga swamps and got as far as the escarpment above Lake George, from which he was forced to turn back by threat of war. Finally he marched to Lake Tanganyika and travelled down the Congo to the sea. In another memorable journey in 1889 to relieve Emin Pasha. Stanley travelled up the Congo and across to Lake Albert. where he met Emin and persuaded him to evacuate his Equatorial province. which had been invaded by the Khalifa's forces. They returned to the east coast by way of the Semliki valley and Lake Edward, and Stanley saw the snowy peaks of Ruwenzori for the first time.

Thus by 1890 the main features of the Nile basin were known! though there still remained much to be explored and also the business of map-making, which 60 years later was still not fully complete in detail. Since 1900 the expansion of perennial irrigation in Egypt and its commencement in the Sudan have created demands for more water when the river is low. These have led to hydrological studies and surveys, whose results are described below.

Hydrology.—Nile studies map be said to have begun at a very early date. as the ancient Egyptians recorded river levels on Nilometers some of which still remain. However. before the 20th century there was very little detailed knowledge about the Nile water supply and its origin, and the greatest developments took place after World War I. The levels and discharges of the principal tributaries and of the main stream are now measured at many points from the Kagera, beyond Lake Victoria, to the sea, with the exception of the Blue Nile beyond the Sudan boundary. Between 1901 and 1904 Sir William Garstin made a hydrological reconnaissance of the White Kile from Lake Victoria to Khartoum. and C. E. Dupuis examined the Atbara and also the Rahad and the Dinder (tributaries of the Blue Nile) and visited Lake Tana. The results of these reconnaissances. with recommendations for the improvement of Egypt's water supply. were published in 1904 in a report on the basin of the upper Nile. In 1906 Sir Henry Lyons published his Physiography of *the Nile Basin,* in which was collected all the information from travellers and scientific explorers available at the time. In the previous year the Sudan branch of the Egyptian Irrigation service had been formed, which with the Physical department was to continue studies of the upper Nile. In 1925 the Sudan formed an Irrigation service, and in 1947 Uganda started a hydrological survey.

The principal feature of the Nile regime is the annual flood. The river at Wadi Halfa, where it enters Egypt. usually begins to rise in June, reaches its maximum at the beginning of September and then falls away at a decreasing rate. It is low from February to the middle of July. and during this time its natural supply is insufficient for the irrigation requirements of Egypt. Although the flood is a fairly regular phenomenon it varies both in volume and in date. These variations are important, since a very high flood brings danger of flooding in Egypt and the northern Sudan, and a low one may mean a shortage of irrigation water later.

The flood is caused by the Blue Nile and Atbara. whose water comes from rainfall on the Ethiopian highlands and brings down mud washed off the land surface into the many small streams which it forms. The Blue Nile and Atbara come down in flushes, which are gradually smoothed as they travel down the river. The average flows of the river and its principal tributaries are shown in the accompanying figure. It is clear that the greatest part of the total flow is contributed by the Blue Nile and the least by the Atbara. but at the low time of the year the White Nile is the most important stream. The White Nile also receives some water from the Ethiopian highlands, which altogether produce 84% of the Nile supply, while the remaining 16% comes from the Lake plateau of central Africa. When the Blue Nile is rising rapidly it holds up the White Nile discharge. and only when the rise slows down does the White Nile's discharge begin to increase. The effect of the Blue Nile is therefore to make a natural reservoir of



FROM MINISTRY OF PUBLIC WORKS, EGYPT

AVERAGE DISCHARGES OF THE NILE

the White Nile, and this effect is now produced artificially on a greater scale by the Jebel Aulia dam, situated some little distance up the White Nile, which adds 2,000,000,000 cu.m. to Egypt's low-stage supply. The Atbara draws its supply from the northern part of the Ethiopian plateau, but little is known of the hydrology of its tributaries. The rainfall that causes its flood comes from the same source as that falling in the Blue Nile basin, and this is probably the South Atlantic (see below). In flood its level fluctuates rapidly like that of the Blue Nile, and after the flood it soon ceases to flow. The Blue Xile receives two tributaries in the Sudan. both coming from Ethiopia. the Rahad and the Dinder. They are strong streams in flood but, like the Atbara, are reduced to pools later. When at their maximum, they produce together about 10% of the Blue Nile's discharge. Of the tributaries of the Blue Nile outside the Sudan practically nothing is known from a hydrological point of view. Lake Tana has been studied and only produces about 7% of the discharge of the Blue Nile. The lake is important because it offers the possibility of an economical reservoir for the joint use of the Sudan and Egypt, where excess evaporation losses would be small.

About half of the discharge of the White Nile is provided by the Sobat, about half by the Bahr el Jebel and an insignificant portion by the Bahr el Ghazal. The Sobat is formed by two main streams, the Baro coming from Ethiopia and the Pibor coming from the south, though its main tributaries also come from Ethiopia. Flushes occur on the headstreams of the Sobat, but when they reach the plains they overflow and flood large areas of country. The effect of this is to smooth out all the peaks and to delay the arrival of the maximum at the mouth by a couple of months. The Sobat, like the Blue Nile and Atbara in flood time, brings down mud from Ethiopia, though only a small amount gets into the main Nile. The figure shows the average contributions of the Sobat and Bahr el Jebel (called Swamps) to the White Nile. It will be noticed that the Bahr el Jebel's discharge varies very little throughout the year. This is due to the regulating effect of the large swamps of the Sudd region on the Bahr el Jebel. When a rise occurs upstream of the swamps, most of it flows out of the river into the marshes and only a very small part of the increase is left at their tail. As large areas are below the river level, the water which enters them is lost by evaporation and by transpiration from the luxuriant vegetation, with the result that the Bahr el Jebel loses nearly half its water in the swamps. In the case of the Bahr el Ghazal, which drains a large area having a fair rainfall, the tributary streams in their upper courses carry considerable volumes of water in flood (from July to October) although they are practically dry from January to April. Of this quantity which drains into the tributaries, estimated to be rather more than the discharge of the Sobat, only a trickle reaches the mouth of the Bahr el Ghazal. The Bahr el Jebel derives its water mainly from the equatorial lakes, but there is in addition a contribution averaging about 17% of the total from torrential tributaries joining between Lake Albert and Mongalla, which rise and fall quickly. During the dry season their contribution is negligible. The Bahr el Jebel immediately below Lake Albert does not fluctuate rapidly, since it is entirely controlled by the lake, which because of its size can only change its level slowly. Lake Albert receives supplies from two main sources, the Victoria Nile and the Semliki. The latter comes from Lake Edward and receives on its way the drainage from the western side of Ruwenzori and some small streams from the Belgian Congo. The Victoria Nile comes from Lake Victoria through Lake Kyoga and provides about 80% of the inflow into Lake Albert. There is a small amount of drainage-from swampy valleys into the Victoria Nile and Lake Kyoga, which in seasons of heavy rain may be considerable; but on the average the system is a source of loss.

Lake Victoria has an annual average outflow of 21,000,000,000 cu.m. A water balance sheet for the lake shows that rainfall and evaporation are approximately equal and about five times the outflow by the Victoria Nile or inflow from tributaries, The approximate equality of rainfall and evaporation makes the large lakes of central Africa valuable as potential storage reservoirs. Lake Victoria has been made into a reservoir (1954) by the Owen Falls dam on the Victoria Nile, just below its outfall from the lake. In this the surplus discharges of high years can be stored to meet the deficit of low ones. The fall from the lake is used for a hydroelectric scheme to provide power for industries in Uganda.

Origin of the Nile Flood.—It has already been said that the greater part of the Nile water comes from rainfall in Ethiopia. The development of meteorology in the 20th century made it clear that the causes of such phenomena as the Indian monsoon and other tropical rains must be sought in the general circulation of the atmosphere. In 1910 J. I. Craig put forward the theory that the Ethiopian rainfall is caused by a current of moist air coming from the South Atlantic across Africa. The following is the evidence. The possible sources of rain in Abyssinia are the Mediterranean sea, the Red sea, the Indian ocean and the South Atlantic ocean. The Mediterranean and Red seas are ruled out because of intervening deserts and the fact that there is no stream large enough to reach the sea on the eastern side of the highlands. On the whole the winds of the rainy season blow across Africa from the Gulf of Guinea to Ethiopia. The rainfall is heaviest over the coast and the Congo basin, falls off over the Sudan plains and is again fairly heavy on the Ethiopian plateau. South and east of the plateau, rainfall is scanty and large areas are desert or semi-desert.

Periodicity and Prediction.— Much work has been devoted to the search for periodicities in natural phenomena and the long series of records of the Roda (Cairo) Nilometer have afforded valuable material. The most complete portion extends, with gaps, from A.D. 622 to A.D. 1522 and gives maximum and minimum levels. In spite of uncertainties due to repairs and renewals of the gauge, to changes of the river channel, to vagaries of gauge observers and to defects in the records, much useful information can be extracted from them. When the maximum levels are plotted in order the principal feature is the occurrence of terms of years when, on the whole, floods are above the average and of others when they are below; but there is no obvious regularity about their occurrence. Low floods may occur among high ones and vice versa. For example in the latter half of the 19th century a very low and a very high flood occurred in successive years. with a difference at Aswan of 9 ft. between their peaks. Many people have analyzed the records, and periodicities have been found varying from 2 to 240 years in length, but all of them have small amplitudes of the order of 10 cm. The largest so far found has an amplitude of 17 cm., or 34 cm. between minimum and maximum floods. These periodicities are completely masked by irregularities such as the one already mentioned and, although they may have theoretical importance, are of no use for the practical business of attempting to forecast the flood. Forecasts of the river, when they can be made, are of considerable value in the practice of irrigation. Attempts to relate the flood discharge to the general circulation of the atmosphere have been partially successful, and relations have been found between the volume of the flood and temperatures in Alaska and Samoa, and the pressure at Port Darwin in Australia. On these a formula can be based which will account for rather less than half the variation of the flood; the rest results from causes outside the formula. By the middle of the 20th century this was about as far as such statistical research could go. If the flood could be traced to two or three causes which could be measured, a fairly exact formula could be deduced. So far, however, only symptoms of such causes had been found.

Two other types of forecast are successful and in regular use. The first depends on the time taken by rises or falls of the river to travel downstream and on the flattening that they undergo as they proceed. Past records of river levels have been analyzed, and from this analysis curves and tables have been made showing how long a well-marked change of level takes to travel over the various reaches of the river and how much is lost on the way. This varies with the height of the river. For example the time from Roseires on the Blue Nile to Aswan, a distance of 1,540 mi., varies from 10 days at the top of the flood to 3j days at the lowest levels. This type of forecast is very useful when the Blue Nile and Atbara begin to rise, and plans must be made for the sowing of crops. The amount of these depends on the amount of available water: of which some must be retained in the Aswan reservoir so that it is not empty before the natural supply of the rising river is sufficient for the crops. If the flood is a high one, this type of forecast is again useful to predict the height to which the river is likely to rise in Lower Egypt, so that suitable measures can be taken to prevent breaches of the river banks. The other successful type of forecast is based on the fact that when the rains in Ethiopia are over, usually by the end of October, the Blue Nile falls regularly in much the same manner each year. Consequently the discharge in one month influences those in the following months, and a forecast can be made in November for the following months up to May or even June. This forecast is extremely useful as it gives an idea of the water which will be available for summer crops and whether the prospects are favourable for a large area under rice.

Utilization of the Water and Irrigation **Projects.**—In Egypt in 1955 just over 6,000,000 ac. were cultivated by irrigation, of which 1,000,000 were on the basin system of flood irrigation. In the Sudan about 1,000,000 ac. were irrigated in the Gezira by water taken into a canal just above the Sennar dam; about 300.000 ac. were irrigated by pumps drawing from the river; and an area in the Northern province, varying from 10,000 ac. in poor years to 100,000 in good ones, was watered by flooding. Elsewhere in the basin of the Nile cultivation by irrigation is practically nonexistent.

The division of water between Egypt and the Sudan was the subject of the Nile Waters agreement of 1929 between Great Britain and Egypt. This defined the amount of water that could be taken by the Sudan without interference with the amount used by Egypt in the past; if more water was to be taken for the Sudan, Egypt's preliminary consent was to be obtained. Egypt moreover was not to undertake conservation works without first agreeing; on measures to safeguard the interests of the Sudan. Subsequent agreements were made for Egypt to build the Jebel Aulia dam (1932) and a dam at the Fourth cataract (1952), that the amount stored in the Sennar reservoir might be increased and that Egypt and the Sudan should share equally in the cost and benefit of the project for a dam at Lake Tana.

The irrigation year may be divided into two parts, which are roughly from August to January when the river supply is in excess of requirements, and from February to July when it is necessary to add to the natural flow of the river by water stored from the previous time of excess. The storage of water in the Jebel Aulia reservoir begins in August when there is definitely an excess in Egypt. This is White Nile water, which is free from silt, and it is used ior irrigation in Egypt as soon as the natural river is insufficient. The Sennar dam is in use from the middle of July to the end of March. Its reservoir is first of all filled to the level required to supply the Gezira canal and later to full storage level. During February and March the canal takes only water previously stored in the reservoir, since at this time Egypt has a right to all the natural flow. Further water is stored ior Egypt in the Aswan reservoir from October, and this is drawn upon after thr supply from the Jebel Aulia reservoir is exhausted. At the height of the flood the silt content of Nile water averages about 2,500 parts per 1,000,000 by weight, and ior the whole flood period from July to October about 1,600 parts per 1,000,000. This is much less than is carried by many other rivers, for example the Colorado, the Missouri and the Indus. Most of this has passed by the time that the Aswan reservoir begins to be filled. It occasionally happens, however, that the reservoir is partially filled at the top of a high flood to reduce the maximum levels in Egypt. So iar only an insignificant amount of mud has been deposited in the reservoir by this procedure. Nile water contains on the average about 170 parts per 1,000,000 of dissolved salts. This is not a great amount and is only about hali that in the Thames, but more than in many other British rivers.

By the middle of the 20th century the rapidly increasing populations in Egypt and the Sudan had made further conservation works on the Nile urgent. Proposals for these were made in 1946 in The *Nile Basin*, vol. vii, by H. E. Hurst. R. P. Black and Y. M. Simaika and were accepted as the policy of 'the Egyptian government in 1949. They involved as a main principle over-year storage, the theory of which mas worked out by Hurst *(Trans. American* Society of Civil *Engineers* [1951] and Proceedings, Institution of Civil Engineers [London, 1955–56]). Over-year storage was essential, since in 1913–14, for instance, the whole discharge of the river had been less than the requirements of Egypt and the Sudan were in the middle of the 20th century.

The projects comprised, in the first place, a large reservoir in Lake Victoria, produced by the Owen Falls dam, which would form the main reservoir for over-year storage and would also provide hydroelectric power for use in Uganda; by means of this reservoir water would be stored in good years to supplement the supply of bad ones. An adjunct to this reservoir was to be a regulator or low dam near the outlet of Lake Kyoga; by keeping this partially filled an increased discharge from Lake Victoria could be passed on immediately (instead of gradually as Lake Kyoga filled to the required level), thus avoiding a delay of two or three months. Thirdly, a reservoir in Lake Albert was required to control (1) both water from the Semliki river and the large quantity coming in seasons of unusually heavy rainfall from the tributaries of Lake Kyoga and (2) the amount of water sent down to the Sudan and Egypt. Fourthly, in view of the losses of water in the swamps of the Bahr el Jebel, as it mas obviously useless to provide large storage reservoirs if half their outflow would be lost, the Jonglei diversion canal was designed to by-pass the swamps; this would leave the Bahr el Jebel at Jonglei below Bor and join the White Nile between the mouths of the Bahr el Zeraf and the Sobat; a regulator would divert about half the discharge down this canal, and the remainder would flow down the Bahr el Jebel at a level that mould reduce the losses to normal, so that there would be a gain of water in addition to the regulated distribution produced by the Lake reservoirs. The Jebel Aulia reservoir was to continue to act as it already did and to store water mainly from the Sobat flood. Fifthly, a projected dam at the outlet of Lake Tana, if the lake could be used to its full capacity, would provide water for the increase of cultivation in the Sudan, a measure of over-year storage and also a reserve in case of emergency in Egypt, such as might be caused by a very low flood. Finally a large dam on the main Nile below the Atbara would provide a reservoir for flood protection with, in addition, some stored water from all floods except the low ones, for use in the following low stage.

Since the above proposals were accepted the project for a reservoir in the Wadi Rayan, a depression in the desert-south of the Fayum, was restudied and the Sudan completed a iar-reaching investigation into the effect of the Equatorial Nile projects on the country. The pressure of the rapid increase of population in all countries of the Nile basin led to the discovery of large areas of land in the south which could be cultivated, or where crop yields could be increased by irrigation. In Egypt it is possible to irrigate certain desert areas by pumping ii cheap power is available. Altogether it was known that there was more potentially cultivable land in the basin than could be watered by the average flow of the Nile. It was thereiore necessary to use the Nile waters as fully as possible.

The Equatorial Nile project would make almost the maximum use of the water of the Bahr el Jebel and the only considerable resources remaining were the flood waters of the Blue Nile and Atbara, which flowed to the sea. This excess was variable and could onlv be made available by over-year storage on these streams or on the main Nile. In 1946 this was not considered possible partly because of the silt in the flood waters which would deposit in reservoirs and reduce their capacity, and partly because there was no known site or sites with sufficient capacity. Later surveys showed that the valley upstream oi Aswan had a large enough capacity to include in addition to usable storage ior irrigation and flood protection a volume large enough to hold the silt deposits of several hundred years. A proposal (first made by A. Daninos) ior the construction of a high dam (Sudd el-Aali) about 4 mi. S. of the present Aswan dam was studied and was adopted in 1954 as the policy of the Egyptian government. This was not an alternative to the Equatorial Nile projects, but an addition to them to secure the maximum control possible of the Nile waters. It would store part in some years, and in many years all of the excess waters of the flood, thus providing a measure of over-year storage as well as protection for Egypt against high floods, and mould replace and extend the functions of the annual storage reservoir on the main Nile proposed in the 1946 projects. It would also produce large quantities of power for the development of industry. The Sudan proposed to build an annual storage dam at Roseires for the extension of cultivation in the Gezira. Work on the Aswan high dam was begun in 1960 after agreement between Egypt and the Sudan was reached regarding sharing of water and indemnities to the Sudan for flooded lands.

The Sudd el-Aali proposal as presented was to make a rock-fill dam to hold up water to a maximum level of about 60 m. above the maximum level of the reservoir. The capacity at this level is approximately 130,000,000,000 cu.m. oi which the lowest 30,000,000,000 would act as a silt trap, 70,000,000,000 would he ior over-year storage and 30,000,000,000 for annual working and flood protection. At its maximum level the reservoir would extend 90 mi. into Sudan territory upstream of Wadi Halia. and a large area mould be inundated including Wadi Halia itseli. There would be no sluices in the dam and the river would pass through tunnels in the granite outside the river channel. The head on the dam would be used to generate large quantities of power for industry in Egypt.

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NILE, BATTLE OF THE, was fought between the British and French fleets in Abukir bay, near Alexandria, on Aug. 1, 1798.

The British government, having heard that a large-scale expedition was to sail from Mediterranean ports under the command of Napoleon Bonaparte, ordered the earl of St. Vincent, the commander in chief of the main British fleet, which was at that time based on Lisbon. to detach ships under Rear Admiral Sir Horatio Nelson to reconnoitre off Toulon and to watch enemy movements. But Nelson's own ship, the "Vanguard," was dismasted in a storm on May 20, 1798, and his frigates, dispersed, returned to Gibraltar. Meanwhile, St. Vincent had sent him a further detachment which joined Nelson on June 7, bringing his strength up to 14 ships of the line and one brig.

The French expedition eluded the British warships, sailed first for Malta, which was seized early in June, and established a garrison at Valletta. After a meek at the island Bonaparte sailed with his armada for his main objective, Egypt. Finding Toulon empty, Nelson was left to guess the French purpose. He guessed right but, having no frigates for reconnaissance, missed his quarry, reached Egypt first, found the port of Alexandria empty, and impetuously returned to Sicily, where he revictualed. Then, baffled but determined, he made for Egypt once more and on Aug. 1 at last descried the main French fleet of 13 sail of the line and 4 frigates under Adm. F. P. Brueys at anchor in Abukir bay.

Although there were but a few hours before nightfall, and although Brueys, with his ships securely ranged in a sandy bay flanked on one side by a battery mounted on Abukir island, was in a strong defensive position, Nelson gave orders to attack at once and to concentrate on the French van. He left full initiative to his subordinates with great success. Captain Thomas Folev in the "Goliath" led in and, when he saw how the French were disposed, decided to risk finding sufficient depth of water to get his ship round the head of the French line and thus inside and behind their position. He succeeded, and was followed by Samuel Hood in the "Zealous," by Davidge Gould in the "Audacious" and by Sir James Saumarez, Nelson's second-in-command, in the "Orion." Nelson himself, in the "Vanguard." was the first to attack the French from the seaward side and he was followed by each succeeding ship except the unlucky "Culloden" which struck on a shoal. Thomas Troubridge, her captain, was able to signal a safe course to the "Alexander" and the "Swiftsure," which were the last to come into action, after nightfall.

For some hours the battle was fierce, Nelson himself being wounded in the head. The climax came about 10 P.M. when Brueys' 120-gun flagship "L'Orient," by far the biggest ship in the bay, blew up with most of her ship's company, the admiral included. Shortly afterward the fight was resumed and it continued for the rest of the night.

Only two French ships of the line, "Le Généreux" and Rear Admiral Villeneuve's flagship "Le Guillaume Tell," escaped capture or destruction. Together with two frigates, they beat out of the bay during the morning of Aug. 2, no British ship being then in a condition to dispute their passage, though none, not even the "Culloden," had actually sunk. Nelson's losses were 218 killed and 677 wounded. The French lost about ten times that number. "Victory," said Nelson, "is not a name strong enough for such a scene."

The eifect of the battle of the Nile was manifold. It heartened Europe to resist French expansion and isolated Bonaparte's army in Egypt, ensuring its ultimate disintegration. It also ensured that Malta would in due time be re-taken from the French, and restored British prestige throughout the Mediterranean. Nelson himself was rewarded with a peerage.

See Oliver Warner, *The Battle of the Nile* (1960). (*O. M.* W. **W.**)

NILGAI ("blue bull"), the largest antelope (Boselaphus *tragocamelus*) found in India. where it represents the kudu and eland group of Africa. Only the bulls have horns, and these are short. Old bulls are bluish-gray, but younger bulls and cows are browner. It is about the size of a mule (see ANTELOPE).

NILGIRIS, (NILGIRI HILLS, "blue mountains"), a hill system in south India, giving its name to an administrative district of Madras. The Nilgiris form a plateau at a general elevation of 6,500 ft., rising abruptly from the plain, except on the north where their base rests upon the Wynaad and Mysore uplands at about 2,000–3,000 ft. The general aspect of the higher parts is grassy and downlike, interspersed with shola or woodland. The Wynaad (partly included in the administrative district) and the Ochterlony valley comprise broken valleys, once wholly forested, now dotted with tea and coffee plantations, whose output provides the chief commerce of the district. Cinchona is cultivated by the government to supply its quinine factory. The timber forests include teak; and eucalyptus and Australian wattle have been planted extensively on the higher Wynaad country. The Nilgiris are detachrd from the main Deccan plateau by the deep Moyar river valley. Other streams are the Bhavani, the Paikara and the Calicut; none is navigable. Archaeological monuments abound.

The Nilgiris are increasing in importance for hydroelectric power. The Paikara scheme (70.200 kw. installed capacity) and the Moyar valley power station (36,000 kw.) are the main plants.

NILGIRIS DISTRICT is the smallest in Madras; area 984 sq.mi.; pop. (1951) 311,729. The administrative headquarters are at Ootacamund (pop.. 1951, 41,370), at the terminus of a branch line, 41 mi. N.N.W. of Podanur junction on the main Southern railway (Madras to the west coast). The line is rack metre-gauge from Mettupalaiyam, 30 mi. below Ootacamund. "Ooty," as it is popularly called, is the chief summer resort of south India, and the summer residence of the governor of Madras. It has a fine artificial lake at 7,220 ft., dominated to the southeast by Dodabetta (8,640 ft.), the highest peak of the Nilgiris. It is a centre for fishing, shooting and hunting. The annual mean temperature is 58° F. (January min. 38°; May max. 76°); there are night frosts in December-January above 6,000 ft., at only 11° from the equator. The mean annual rainfall is 49 in.

NILOTES, certain peoples of the Sudan, of whom the Shilluk and Dinka, best known representatives of these tall "black"-skinned dolichocephals, have an average stature of about 1.78 m. (70 in.) or perhaps a little more, and a cephalic index which varies around 72. In these tribes, as in the Nuer and Anuak, there is an Hamitic element, and although the majority have coarse features, with broad noses, among the Shilluk and probably the Anuak men with shapely features, including thin lips, long, relativelp high-bridged, narrow noses, and well modelled foreheads are not uncommon.

The languages of the Nilotes form a subgroup of the family of languages called by Meinhof "Sudanic," characterized by the absence of inflection and grammatical gender and by the use of tone rather than accent, while typically each word consists of one syllable (see AFRICAN LANGUAGES). Shilluk so closely resembles Anuak that the two peoples can understand one another, and the same probably holds for Dinka and Nuer.

Mode of Life.—The Nilotes are essentially pastoral and largely riverain, their interest in their cattle being so far predominant that they usually grow scarcely enough grain to supply themselves till the next harvest. For the most part the men go absolutely naked, the women wear a pair of leather aprons reaching from waist to knee. The forehead is often scarred, and the lower incisors are generally removed. The skin is commonly smeared with the ash of wood and cattle dung. Ivory armlets are worn and the hair may be worked into elaborate head-dresses. Cannibalism is unknown and human sacrifice is almost entirely absent. The number of cattle constituting the bride price is a matter of great importance, and this is usually paid in instalments. Certain iron-making groups of Dinka living near the Nile-Congo Divide, having few or no cattle, pay for their wives in iron. Widows are inherited by their husband's heirs, the children that they bear being counted as children of the first husband. Psychically the Nilotes, especially the Dinka, are distinguished from all other groups in their extreme aloofness and pride of race. showing absolutely no desire for European clothes or trade objects.

The social organization of the Shilluk is into a number of exogamous groups, but whether these are totemistic must be left for future investigation. Among the Dinka, who consist of a congeries of independent tribes, there are typical totemistic clans with descent in the male line, the totem being an animal, plant or even a natural object such as a meteor or fire. Almost all the clans whose totem is an animal derive their origin not from the animal itself but from a man born as one of twins, his fellow twin being an animal of the totem species, though sometimes the association is not quite so close, as when the totem animal lays certain commands upon members, offering in return certain privileges.

Religion.—Among the Dinka and Shilluk, the only two Nilotic tribes of whose religious ideas there is definite knowledge, the king (Shilluk ret) or chief (Dinka *baiñ*) is the rain-maker and belongs to the class of rulers called by Sir James Frazer Divine Kings, *i.e.*, there is immanent in each a divine spirit upon which depends the fertility and well-being of the universe. Such divine kings are not allowed to go to battle and were formerly killed ceremonially with their own consent when they showed signs of ill-health, or sometimes even of diminishing strength, lest the decline in vigour of their body—the living shrine of the divine spirit—should entail the weakness of the latter, when the cattle would sicken and fail to bear their increase, the crops would rot in the fields, and men, stricken by disease, would die in ever increasing numbers. The Shilluk king is indeed the classical example of the divine king, and two stages of his treatment can be traced; the earlier, preserved alone in folklore, refers to a time when anyone could kill the king and become his successor until he in turn was killed by a stronger, while in more recent times the killing of the king has become a ceremonial affair, the leading part being assigned to certain families called the Ororo.

In the case of the Shilluk the divine spirit incarnate in each king is Nyakang, the historic founder of the Shilluk kingdom and their culture hero. Like so many divine or semi-divine characters he did not die but vanished in a great storm. He has ten cenotaph tombs, the most sacred perhaps being that of Fenikang, the village in which he lived for a great part of his life. It is the presence of the divine spirit of Nyakang in the ruling king which enables the latter to move the High God, Juok, to send rain.

See W. Hofmeyer, *Die Shilluk* (1925); C. G. Seligman, "The Cult of Nyanking," *Fourth Report of the Wellcome Laboratory*, 1911, Vol. B. (C. G. S.)

NIMBUS: *see* GLORY.

NÎMES, a city of southern France, capital of the *département* of Gard, 174 mi. S. by W. of Lyons. Pop. (1954) 72,274.

Nimes, the ancient *Nemausus,* was named from the sacred wood in which the Volcae Arecomici (who surrendered to Rome in 121 B.C.) held their assemblies. Strabo states that it was the metropolis of a'district containing 24 dependent towns and that it was independent of the proconsuls of Gallia h'arbonensis. Constituted a colony of veterans by Augustus, and endowed with numerous privileges, it built a temple and struck a medal in honour of its founder. Agrippa built the public baths, the temple of Diana and the aqueduct of the Pont du Gard. The city walls were erected by Augustus. Hadrian on his way back from Britain erected at Nimes two memorials of his benefactress Plotina. In the very height of its prosperity the city was ravaged by the Vandals; the Visigoths followed and turned the amphitheatre into a stronghold. which at a later date was set on fire along with the gates of the city when Charles Martel drove out the Saracens. Nîmes became a republic under the protection of Pippin the Short; and in 1185 it passed to the counts of Toulouse. who enclosed it with ramparts, less extensive than that of Augustus. still to be traced in the boulevards. The city took part in the crusade against the Albigenses in 1207. Under Louis VIII it received a royal garrison into its amphitheatre; under Louis XI it was captured by the duke of Burgundy, and in 1420 was recovered by the dauphin (Charles VII). On a visit to Nimes Francis I enriched it with a university and a school of arts. By 1558 about three-fourths of the inhabitants had become Protestants. and in 1567 a massacre of Catholics took place on St. Michael's day. From the accession of Henry IV till the revocation of the edict of Nantes (1685) the Protestant community devoted itself to active industry, but after that disastrous event great numbers went into exile or joined the Camisards. Louis XIV built a fortress (1687)- to keep in check the disturbances caused by the rival religious parties. Nimes passed unhurt through the storms of the Revolution; but in 1815 Trestaillon and his bandit followers pillaged, burned, plundered and massacred the Bonapartists and Protestants.

Nîmes lies at the foot of the Garrigues, a range of barren hills on the north and west. The most prominent of these is the Mont Cavalier, on the summit of which is the Tour Magne, a ruined Roman tower. To the south and east the town overlooks the plain of the Vistre, largely used for the vine. The central and oldest part of the town consists of low buildings and is encircled by boulevards, which occupy the site of the old fortifications. Here are to be found the majority of the Roman remains for which Nimes is remarkable. The most celebrated is the amphitheatre, the best preserved in France. It dates from the 1st or 2nd century A.D. and was used as a fortress for some time during succeeding centuries. Occupied during the middle ages by a special quarter. with a church, it was cleared in 1809. It is built of large stones fitted together without mortar. Originally designed for gladiatorial shows, naval spectacles, chariot races. wolf or boar hunts, the arena has in recent times been used for hull-fights. The celebrated Maison Carrée, a Roman temple, is a famous monument, and according to an inscription is dedicated to Gaius and Lucius Caesar, adopted sons of Augustus, and dates from the beginning of the Christian era. It contains a collection of antique sculptures and coins. The so-called temple of Diana, which adjoins the Fountain gardens, was probably connected with the baths of which remains are visible near by. Two Roman gates. the Porte d'Auguste, consisting of two large archways flanked by two smaller ones and dating from A.D. 16. and the Porte de France remain. The Tour Magne is the oldest monument of Nîmes. but its use is not clear. Near the Tour Magne was discovered the reservoir from which the water brought by the Pont du Gard (*see* AQUEDUCT) was distributed.

With its capital, the temple of Augustus, the basilica of Plotina erected under Hadrian, the temple of Apollo, the baths, the theatre, the circus. constructed in the reign of Nero, the Campus Martius and the fortifications built by Augustus, Nîmes must have been one of the richest of the Roman cities of Gaul.

At the close of the middle ages the industries of Nîmes received an impetus from a colony from Lombardy and Tuscany, and maintained their importance. so that before the revolution about half of the whole community was engaged in manufactures, chiefly that of silk. Industries later included the manufacture of upholstery materials, shawls, carpets. hosiery, leather products, clothes and machinery. Nîmes is. besides, a great market for wine and brandy. Quarries of hard limestone are in the vicinity.

NIMITZ, CHESTER WILLIAM (1885–), U.S. naval officer. commander of the U.S. Pacific fleet in World War II, was born in Fredericksburg. Tex., on Feb. 24, 1885. He graduated from the U.S. Naval academy, Annapolis, Md., in 1905, and during World War I served as chief of staff to the commander. U.S. Atlantic submarine force. Appointed chief of the bureau of navigation of the U.S. navy in 1939, he became commander in chief of the Pacific fleet following the Japanese attack on Pearl Harbor in Dec. 1941.

Nimitz' command of the Pacific ocean areas, with headquarters at Pearl Harbor, complemented the Southwest Pacific area command of Gen. Douglas MacArthur (*q.v.*) and brought land as well as naval forces under his authority. Under his direction and that of his subordinates, Admirals William F. Halsey, Marc A. Mitscher (*qq.v.*), Richmond K. Turner, Raymond A. Spruance (*q.v.*) and Thomas C. Kinkaid (*q.v.*), were fought the battles of Midway (1942); the Solomons (1942–43); the Gilbert Islands (1943); the Marshalls, Marianas, Palaus and Philippines (1944); and Iwo Jima and Okinawa (1945). Nimitz participated for the United States in the Japanese surrender aboard his flagship, the U.S.S. "Missouri," in Tokyo bay on Sept. 2, 1945. From Dec. 1945 until 1947 he served as chief of naval operations.

Subsequently Nimitz headed Pres. Harry S. Truman's commission on internal security and individual rights, was named a UN commissioner for India and Pakistan and served as a regent of the University of California. In 1947. in answer to interrogatories by German Adm. Karl Dönitz, on trial for war crimes. Nimitz gave his justification for the unrestricted nature of U.S. submarine warfare in the Pacific during World War II.

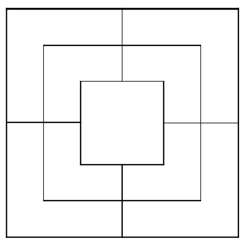
NIMROD (in the Douai version of the Bible, NEMROD) is described in Gen. x. 8–12 as "the first on earth to be a mighty man. He was a mighty hunter before the Lord." Apart from I Chron. i, 10, which quotes this description, the only other reference to Nimrod in the Old Testament is Mic. v, 6, where Assyria is called the land of Nimrod. Unlike the other names in the Genesis context which are names of peoples, Nimrod is that of an individual. The beginning of his kingdom is said in Genesis to be Babel, Erech and Accad in the land of Shinar. Babel is Babylon; Erech is an ancient Sumerian city of Mesopotamia (modern Warka, in southeastern Iraq); and Accad (Akkad or Agade), the royal city of Sargon I, was the capital of a district of the same name in Mesopotamia. Shinar, which the Old Testament sometimes identifies with Babylonia, was, as Egyptian and Hittite records show, a distinct country, probably in northern Mesopotamia, which was prominent c. 1500–1200 B.C. Nimrod is said to have built Nineveh, Calah (an old Assyrian town on the left bank of the Tigris, south of Nineveh), Rehoboth-Ir and Resen, the latter two unknown. It is in accordance with historical truth that Assyria was developed from Babylonia. The description of Nimrod as a "mighty hunter before the Lord" is an intrusion in this context, but probably, like the historical notices, derived from some old Babylonian saga; the Assyrian kings were noted for their prowess in hunting.

Though one may feel reasonably sure that the Nimrod traditions were derived from Babylonian sources, no equivalent of the name has yet been found in the cuneiform records. In character there is a certain resemblance between Nimrod and the hero Gilgamesh (*q.v.*). (W. L. W.; X.)

NINEBARK, any shrub of the genus *Physocarpus* of the rose family (Rosaceae). One of the best known is *P. opulifolius,* native from Quebec to Manitoba. south to Georgia and Kansas, and commonly planted for ornament. It grows from five to ten feet high, with strong, recurving stems, exfoliating bark and small, white or pinkish flowers. in umbellike clusters: followed by clustered, inflated, reddish follicles. There are variegated and dwarf varieties.

NINE MEN'S MORRIS, a game played with counters on a board. also known as Muhle (Germany and Austria), Marelle (France), Mylla (Iceland), Siegen Wulf Myll (Poland) and The Mill, Morelles, Merry Peg, etc., in England.

The board (*see* diagram) comprises three concentric squares and several transversals, making 24 points of intersection. Two players. each provided with nine counters of his own colour, lay pieces alternately upon the points, the object being to get three in a row upon any line. On doing so. the player is entitled to remove from the board one adverse counter, but not one that is in a "mill." a row of three. Having placed all their counters, the players continue moving alternately. with the same object. A "mill" may be opened by moving one piece off the line; returning the piece to its original squares counts as a new 'hill." The player who first captures all the adverse pieces wins. A move is limited from one point to the next along a line, but the rule is often made that when a player has only three pieces left he may move them from any point to any point regardless of the lines. In modern play the diagonal lines of the board are usually omitted, to lessen the advantage of the first player.



THE MILL BOARD
In modern play the diagonal lines are usually omitted

The mill game was often played by shepherds with stones upon a diagram cut into the turf. Shakespeare alludes to this practice in *Midsummer Night's Dream* (act ii, scene i):

> The nine men's morris is fill'd up with mud,
> And the quaint mazes in the wanton green
> For lack of tread are indistinguishable.

"Morris" (*i.e.,* Moorish) is the name of a square dance to which the game bears a fanciful resemblance. (G. MH.; X).

NINETEENTH-CENTURY ARCHITECTURE: see MODERN ARCHITECTURE.

NINETEENTH-CENTURY ART. The 19th century was remarkable for a medley of artistic styles and attitudes. If the broad tendencies can be loosely contained within the categories of classicism and romanticism, the characteristic spirit which informed the significant art of the whole century was a militant and creative individuality.

Classicism.—In the opening years. the classical tendency was in the ascendant. In France. out of the Revolution. came a rigid and conscientious neoclassicism with J. L. David as its chief exponent. This resurgence was. on the one hand, the culmination of a prevailing vogue for Greek and Roman antiquities and, on the other, an active repudiation of the Arcadian frivolities of rococo. At the same time, neoclassical pictures fulfilled the purpose of Revolutionary propaganda by relating the solid virtues of republican Rome with those of the nevi republic of France. When Napoleon became emperor in 1804, David was designated first painter and the concept of imperial majesty, ever present in the emperor's mind, became David's ruling obsession. His influence was decisive, not only in painting, but in the formulation of appropriate styles of décor and furniture, of which the so-called Empire style became popular throughout Europe and even in the United States. *(See* NEOCLASSICAL ART.)

In architecture, Napoleon's hankerings for Roman grandeur, satisfied by the work of P. F. L. Fontaine and C. Percier, were consummated in J. F. Chalgrin's design for the Arc de Triomphe de l'Étoile. For the most part, however, the 19th century's attempts to create a style consisted of quotations from the Greek. In Germany the Greek revival was a wholehearted and enthusiastic movement which produced some distinguished classical adaptations by L. von Klenze and K. F. Schinkel. In England, Sir John Soane's Bank of England had commendable originality and John Nash created an *architecture parlante,* a style for every occasion, classical for the Regent's park and Regent street frontages. Hindu for Brighton pavilion, Gothic for his own country house. *(See* MODERN ARCHITECTURE.)

Romanticism. — David's direction was generally sustained by his pupils J. A. D. Ingres, A. L. Girodet-Trioson, F. Gérard and A. J. Gros. but with the fall of Napoleon, David was exiled. The neoclassical movement, deprived of both leadership and propagandist significance, was confronted with fiercely critical attacks by the romanticists on the grounds that it was sterile and repetitive. By the end of the first quarter of the century, romanticism had spread through Europe like an epidemic, emerging as a reaction from the repressive nature of 18th-century rationalism. As such, it offered an escape for the emotion from an insistent cult of reason and a release for the personality from disciplined compliance with convention. The first aim of the romantic artist was self-expression and his typical expression tended to be evocative of more than it stated. The movement, literary in origin and character, exploited a repertoire of constantly recurring themes, such as the feelings of the artist in the presence of nature, nostalgia for an irretrievable past, the whole gamut of emotional states and every aspect of liberty. In England. romanticism was innocently present in the verse and graphic work of William Blake, dramatically apparent in the apocalyptic visions of John Martin and the macabre nightmares of Henry Fuseli. gently appealing in the Shoreham period (1826–35) of Samuel Palmer. In Germany, there were the brilliant romantic writings of Friedrich Schlegel, the folklore researches of Jacob and Wilhelm Grimm. and the pictures of K. F. Schinkel, C D. Friedrich and P. O. Runge. In France, T. Géricault depicted the terror. pity and horror of the wreck of the frigate "Medusa" and E. Delacroix glorified freedom and expressed wide-eyed admiration for Lord Byron in his "Massacre at Chios."

Tomard the middle of the century the Gothic style revived with more animation in England than elsewhere. Victorian Gothic was a romantic expression both of a partiality for medievalism and of a revulsion from an insistent and pervasive industrialism. John Ruskin, its advocate, genuinely believed that the Gothic style would be an inspiring liberation from the enslavement of classical traditions. Yet its revival was only further proof that architectural design had become an incoherent sham. Industrial design exemplified by the Great exhibition of 1851 had reached its nadir *(see* DESIGN, NINETEENTH-CENTURY). Artists like the Pre-Raphaelites attempted to escape from the hideous present. Others sought self-justification in the comfortable theory of art for art's sake. William Morris witnessed their withdrawal. A hater of machinery, he maintained that the artist must once again become a craftsman and the craftsman an artist, that art must be made by and for the people. "What business have we with art at all," he asked, "unless all can share it?" *(See* ARTS AND CRAFTS MOVEMENT, THE.) However, the absence of any organized patronage had given rise to the 19th-century notion of the artist inevitably in conflict with his own age. With no specific social function, the painter worked prophetlike in isolation. The general public were his patrons; the salons and academies. each dictating their own preferences and prejudices, were his showrooms. The tremendous popularity of works by Sir David Wilkie, Sir Edwin Landseer and W. P. Frith was indicative of the average level of appreciation.

Realism. — The classical and romantic movements had one area of common ground: both were idealist in their refusal to accept the world as they found it. Midway between both, a realist tendency was in evidence throughout the 19th century. F. Goya, with his uncompromising assessments of man and his behaviour, was its starting point. His unflinching observation mas later matched by that of H. Daumier, who invested the capacity with a kindlier derisiveness. Last of the great realists was G. Courbet, who chose to paint only what he could see and what he saw was the rich variety of his immediate world.

Impressionism. — The final significant movement of the 19th-century was Impressionism and the approach to Impressionism was by way of landscape painting. Early in the century, J. M. W. Turner and J. Constable had anticipated the work of J. B. Corot and the Barbizon school by a wholly new conception of landscape painted in the open air and based on natural vision. Impressionism was the direct consequence of this innovation. Of the Impressionists, C. Monet was unique in pursuing his analysis of colour and light to its furthest conclusions. P. Cézanne's comment, "Monet is only an eye. But, my God, what an eye!" was a shrewd summary of the Impressionists' shortcomings and achievements. But, by the 1880s, the very brilliance of their accomplishment had pushed representational painting into a cul-de-sac along which progress seemed impossible. Furthermore, the development of photography had undermined any assumption that the future of painting would be concerned with the imitation of appearances. The response to this situation emerged in Cézanne's methodical "constructions after nature," in the acutely personal romanticism of V. Van Gogh and the decorative symbolism of P. Gauguin. At the close of the century, largely on the foundation of their work, the modern movement began and developed. *See* also PAINTING; SCULPTURE.

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NINEVEH. The ancient capital of the Assyrian empire lay on the right bank of the Tigris opposite the modern city of Mosul. It consists of two great mounds, Kouyunjik and that on which is the reputed tomb of the prophet Jonah (Nebi Yunus). The river has shifted a short distance to the west so that the mounds are isolated from the present bed, although in ancient times the city abutted on the river. The city is situated on the northwest corner of a plain about 25 by 15 mi. in extent, formed by the Tigris and its tributaries, the Khosr on which Nineveh was built, which bounds the plain on the northwest, the Gomal, which forms the northeastern boundary, and the Upper Zab on the southeast. The west and south flank is protected by the Tigris itself. The whole plain slopes gently to the Tigris and provides a strong position, protected by the foothills and the Gomal on the northeast side, and on the south and west by the Tigris and the Upper Zab. The Khosr, although impassable enough when flooded, forms at other times no barrier to attack. The position of Nineveh therefore astride this stream at its confluence with the Tigris is of great strategic importance. The Khosr was used to supply water to fill the protective works of the city and elaborate measures of river conservancy were taken to protect the plain against its most destructive inundations. Although the country is fertile and prosperous wheat land (which no doubt accounts for the many ancient cities so close to one another) because of the slope of the plain the city itself is badly supplied nith water and Sennacherib mas compelled to build water conduits to conduct water from the hills into the Khosr and its canal system. The city then, as is its modern descendant Mosul the centre of a rich district, was suited particularly to military efficiency.

The city was surrounded by immense walls. which enclosed an irregularly shaped space, about 3 mi. long and about 1 mi, broad at the north where the walls mere double. narrowing to about ¾ mi. at the southern end. The walls nere pierced by 15 gates. As in so many walled cities the actual dwellings did not occupy all of the space nithin the walls, there were parks watered by the elaborate aqueducts nhich brought water from the Khosr and other open spaces. The two mounds formed two great fortified strongholds, joined together by a wall. part of which formed the west mall of the city. The mound of Kouyunjik. explored by R. Campbell Thompson on behalf of the British museum contains an important series of buildings: on the north lay the palace of Assurbani-pal; south, the temple of Nabu.

On this spot a rectangular building was found. 100 × 80 ft. which probably included part of the temple buildings and of the courtyard. Directly south of this again is a broad pit which may possibly represent the site of the temple of Ishtar which is known to have existed on the mound. To the east is a building of Sennacherib, nhose purpose does not seem to have been identified. Finally at the southnestern extremity of the mound is the palace of Sennacherib This palace is of great architectural magnificence and is especially remarkable for the bas-reliefs which have so far been discovered. On the other mound Sennacherib built a military depot; his son Esar-Haddon built himself a palace on this mound. which has not at present been fully explored.

Although the greatness of Kineveh covers a comparatively short period there are indications that the city was Sumerian in origin, and early pottery and obsidian flakes have been found on the site. It has been suggested that possibly the Sumerians occupied this nhole area before migrating south. The true history of Nineveh. however, begins at a comparatively late date. Hammurabi restored a temple of Ishtar, probably in Nineveh and Shalmaneser I, nearly 1.000 years later, about 1300 B.C. restored the temple again but although Sennacherib states that some of his ancestors were buried there the city was small and unimportant. He built the great building and nalls, which have been described, and made a great triumphal may. His son Esar-Haddon rebuilt the temple of Ashur but started to rebuild Babylon, and did not carry out Sennacherib's purpose of making Kineveh the capital city of the Assyrian empire. Assur-bani-pal enriched the city with some of its greatest treasures, including a great library of clay tablets. In 612 B C. the men of Kineveh were defeated by the Medes and the city was looted and destroyed. It seems probable that Mespila, referred to by Xenophon in the Anabasis refers to this site, and if so the spot was deserted at this time, but the name of Kineveh nas applied to the site even in the middle ages, so an ancient tradition must have existed as to the location of the tonn. The site however did not become of any importance again until the time of the Arab conquest, nhen it lay on the opposite bank of the Tigris. (For later history see MOSUL.) The site has been attacked by numerous excavators from Layard on. In 1903–05 it was excavated by L. W. King and Thompson.

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NINGPO (formerly Yin Hsien or Ninghsien), the name of a district and of its administrative seat, commonly called Ning-po shih (city), an important port near the mouth of Hangchow bay in northeastern Chekiang province of China. The city (pop. [1953] 237 500) is about 12 mi. above the mouth of the Yung Chiang at the confluence of the Fenp-hua and Yuyao tributaries. The old walled city lies betneen these. but suburbs have been built across both tributaries nhich are bridged. Hills rise in back of the fertile plain in which the city is situated The river is navigable to vessels up to 20 ft. draft and 350 ft. length as far as the anchorage opposite Ningpo. The old foreign settlement was situated on the left bank of the Yung Chiang across the Yuyao from the walled city. Chenhai is an outport for Ningpo at the mouth of the Yung and is protected from sea storms by Tinghai and other islands.

Ningpo is an ancient seat of learning and Buddhist religion. It has occupied its present site since A.D. 713 and was one of the earliest sites of European settlement in China. The Portuguese arrived there in 1520. but were driven out by the Chinese 25 years later because of their illegal activities. Subsequent restrictions made foreign trade with Ningpo virtually impossible. During the Chinese-British war of 1840–42, British warships blockaded Kingpo, but in 1842 the treaty of Nanking opened the port to foreign trade. However, the superior situation of Shanghai at the gateway to the Yangtze valley greatly restricted Ningpo's commercial hinterland. On the seaward side. Ningpo acts as the market centre for the Chou-shan Islands, and a national fish market was established at Ningpo in the 1950s for the productive sea fisheries in the area. After the outbreak of the Chinese-Japanese war in 1937 Ningpo mas one of the few ports to remain open until after 1940. The city exports cotton grown in neighbouring districts; other products shipped include native drugs, tea, reed mats and fish, most of these going to Shanghai. Kingpo imports large quantities of sugar, largely from Fukien province, and textiles and other manufactures from Shanghai. The value of its foreign trade normally has been under U.S. $1,000,000, most of it in imports. Its domestic trade is far more important. Ningpo manufactures cotton and silk yarns and cloth, electrical supplies, canned goods, knitwear, candles and soap. The city has canal. railroad and highway connections with Hangchow in the west. The railroad was destroyed during World War II, but restored in 1955, and extended about 25 mi. E. to the town of Ts'ai-ch'iao. A dirt highway leads southward to Chekiang coastal towns. (H. J. Ws.)

NINGSIA (Kinghsia), former province of China. in western Inner Mongolia. Upon its abolition in 1954, the province was merged with Kansu (*q.v.*). In 1956, most of former Ningsia, settled by Mongols, passed to the Inner Mongolian autonomous region (Kei Mengku Tzu-chih Ch'u). The rest of former Ningsia, inhabited largely by Hui (Chinese Moslems). was constituted in 1958 as the Ningsia Hui Autonomous region, equivalent to a province (capital, Yinchwan; area 30,000 sq.mi.; pop. 1,728,000, of whom one-third were Chinese Moslems). (T. SD.)

NINIAN, ST., a Briton, probably from Strathclyde, who was trained at Rome and founded a church at Whithorn on the west side of Wigtown Bay. Whithorn has been identified with the Leukopibia of Ptolemy, but this is uncertain. Bede. writing three centuries after Ninian, ascribes the name Ad Candidam Casam to the fact that the church of Ninian was built of stone. Bede tells that St. Ninian dedicated his church to St. Martin of Tours, who died between 397 and 400, but Ailred of Rievaulx is the only authority for the statement that St. Martin supplied him with masons. The legends of his work in Ireland probably arise from the influence exercised in that country by the church of Whithorn. The date of Ninian's death is given by Archbishop Ussher as 432, but there is no authority for this statement.

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NINUS, in Greek mythology, the eponymous founder of the city of Nineveh; also the name of the city itself. He was said to have been the son of Belos or Bel; to have conquered in 17 years the whole of western Asia with the help of Ariaeus, king of Arabia; and to have founded the first empire. During the siege of Bactra he met Semiramis, the wife of one of his officers, Onnes, whom he took from her husband and married. The fruit of the marriage was Ninyas; *i.e.,* "the Ninevite." After the death of Ninus, Semiramis. who was accused of causing it, erected to him a temple tomb nine stades high and ten stades broad near Babylon. The legendary aspects of this story were disproved in 1910. For the historical aspects, see SEMIRAMIS.

Another Ninus is described by some authorities as the last king of Nineveh, successor of Sardanapalus.

NIOBE, in Greek mythology, daughter of Tantalus and Dione, wife of Amphion, king of Thebes. Proud of her sons and daughters (numbers variously given by different authors), she boasted of her superiority over Leto, mother of only two children Apollo and Artemis. As punishment, Apollo slew her sons and Artemis her daughters. Their bodies lay for nine days unburied, for Zeus had changed the people to stone; on the tenth day they were buried by the gods. Out of pity for her grief, the gods changed Niobe into a rock on Mt. Sipylus in Phrygia, in which form she continued to weep. The tragic story of Niobe was a favourite in literature and art. Aeschylus and Sophocles wrote tragedies upon it; Ovid described it at length in his *Metamorphoses*.

NIOBIUM (symbol Nb), a hard, silver-white metal, was named columbium (symbol Cb) by Charles Hatchett, who first extracted the oxide in 1801; it was renamed niobium by the German chemist Heinrich Rose in 1844 and this latter name was adopted officially in 1949.

The pure metal has few commercial uses except in the manufacture of electron tubes, where it is sometimes used to absorb residual gases remaining in the tube after evacuation. As an alloy material. niobium has become important in stainless steels intended for use under high-temperature conditions, as in nuclear power rea'ctors. Its presence reduces the precipitation of carbides within the metal, a condition that can lead to serious corrosion, resulting eventually in leakage or breakdown of piping and containers. Niobium has found application also in "cermets," ceramic-metallic compounds used in high-altitude rockets and jet engines.

Niobium occurs chiefly in columbite, a mineral composed of about 85% combined niobium and tantalum oxides and about 15% iron and manganese oxides. It is also found in such rare minerals as pyrochlore, fergusonite and samarskite.

Pure compounds of niobium are required for preparation of the metal, which formerly was obtained by electrolysis of molten, fused fluoride salts. This method has been largely superseded by one in which niobium is prepared by heating a mixture of the carbide and the oxide in a vacuum. The metal so obtained is reduced to a powder, pressed into bars and sintered in a vacuum. In pure form, it has a specific gravity of 8.75 and a melting point of 2,415° C. It resists chemical corrosion, is not acted on by nitric acid up to 100° C., but is not the equal of tantalum for use in hydrochloric acid, aqua regia or dilute sulfuric acid. It is attacked rapidly by hydrofluoric acid, hot concentrated sulfuric acid and concentrated alkalies, and the hot metal reacts with all of the common gases.

Niobium has the atomic number 41; its atomic weight is 92.91. One stable form of the element, Nb^{93}, is known, and ten radioactive isotopes (89, go, 91, 92, 94. 95, 96, 97, 98 and 99) have been prepared. The electron arrangement in the outer unfilled orbits (N and 0) is: $4s^2$, $4p^6$, $4d^4$, $5s^1$.

See C. A. Hampel (ed.), *Rare Metals Handbook* (1954); *C. H.* Mathewson (ed), *Modern Uses of Nonferrous Metals* (1953).

NIOBRARA, the largest river in northern Nebraska, U.S., rises near Lusk. Wyo , flows east across the High Plains, the northern fringe of the Nebraska sandhills and the low eastern plains to join the Missouri river at Niobrara. The name is of Indian origin and means "running water" or "spreading water." Both designations are apt: the Niobrara has a more uniform flow than do most plains streams, because of steady ground-water contributions from tributaries in the sandhills; in its lower course it is wide and shallow. It is 447 mi. long, drains 12,000 sq.mi. and has an annual flow of 1,100,000 ac.ft., with a peak in late spring and summer. In the late 1950s, about 24,000 ac. in the river basin were irrigated, mainly in the western reach where Box Butte reservoir served 12,000 ac. at Mirage flats. Ranching, concentrated in the sandhills, has traditionally been the most important activity in the Niobrara basin. Additional sources of farm income have been hogs, corn and wheat. ***See*** also NEBRASKA: *Physical Geography; The Economy.* *(D. S. ST.)*

NIORT, a city of France, chief town of the *département* of Deux-Sèvres, 42 mi. E.N.E. of La Rochelle. Pop. (1954) 30,199.

Up to the 7th century the Niort plain formed part of the Gulf of Poitou, and the mouth of the Sèvre lay at the foot of the hills now occupied by the town which grew up round the castle erected by Henry Plantagenet in 1135. The place was captured by Louis VIII in 1224. By the peace of Brétigny it was ceded to the English, but its inhabitants revolted against the Black Prince and most of them were massacred when his troops recovered the town by assault. In 1373 the French regained the town. Protestantism made numerous proselytes at Niort, and Gaspard de Coligny made himself master of the town, which successfully resisted the Catholic forces after the battle of Jarnac but surrendered without striking a blow after that of Moncontour. Henry IV rescued it from the league. It suffered severely by the revocation of the Edict of Nantes. Niort is on the Sèvre Niortaise.

The tower of the church of Notre-Dame (15th and 16th centuries) has a fine stone spire and a north doorway with a carved balustrade. The old Renaissance hôtel de ville contains a collection of antiquities. Near Niort are the feudal remains of the fortress of Coudray-Salbart. Niort is the seat of a prefect and a court of assizes. Industries include tanning, chamois dressing, making of gloves, brushes and boots.

NIPIGON, a lake and river of Thunder Bay district, Ont. The lake, area 1,870 sq.mi., is the largest in Ontario exclusive of the Great Lakes. It is 30 mi. N. of the bay of the same name on Lake Superior, at an altitude of 852 ft. above sea level. It is roughly elliptical in shape, 72 mi. long and 50 mi. wide. more than 500 ft. deep and contains more than 1,000 islands. It has a much-indented shore line measuring about 464 mi. The name is an Indian word meaning "deep, clear-water lake."

The river, ahich drains the lake, drops 250 ft. in its 30-mi. course; it is the largest stream flowing into Lake Superior. Power stations on the river at Pine Portage, Cameron and Alexander develop a total of 312,000 h.p. The entire Nipigon region is noted for fishing and hunting. (F. A. CK.)

NIPISSING, a lake in Ontario (elevation 643 ft., area 330 sq.mi., length 45 mi., width 9 mi.), situated midway between Georgian bay and the Ottawa river. It was discovered early in the 17th century and became a major *voyageur* route west. It discharges its water by the French river into Georgian bay, and is separated by a low watershed (former portage) from Trout lake, source of the Mattawa river, tributary of the Ottawa. This route has been suggested as a possible canal route linking Lake Huron with the Ottawa valley.

North Bay, a city of 21,020 inhabitants (1956), serves as a wholesale and retail distributing centre on the north shore of the lake. Small local industries and recent important mining operations have begun on Manitou Island. North Bay is the hub of a large tourist industry; a daily steamer service connects the city with the French river vacation area. (F. A. CK.)

NIPPON, the Japanese pronunciation of the Chinese name of Japan. "sun origin." *See* JAPAN.

NIPPON GINKO: *see* JAPAN, BANK OF.

NIPPUR, an ancient sacred city of Mesopotamia. Nippur lay on the bank of the old course of the Euphrates in 32° N., 45" E. The old bed of the river is represented by present Shatt-al-Nil, whose dry bed now separates the two main groups of ruins. The city lies in the very heart of Sumeria, between the northern cities of Kish, Cutha and Babylon, to nhich it is nearest in position, and the cities of the south. It was the centre of the national cult of the god Enlil, and no doubt because of its position was the ecclesiastical rival of the southern cities, especially Eridu. The possession of Nippur was an essential for every great dynasty, because the rulers of all the cities throughout the whole of Sumer and Akkad ultimately derived their authority from Enlil, and it is essential in studying the ancient geography of hlesopotamia to remember that the monarchy of the region took its rise from prince-priests. and that even the most powerful monarchs could never afford to separate themselves from the powerful and dominant priesthood. Nippur, therefore, although probably never a lay capital except possibly in later times, throughout its long history always played a very prominent part in Mesopotamian history, and, because of the passion exercised by the priests for recording every transaction, however minute, on clay tablets, has left us a most complete record both of its life and of the part which it played in national politics. To-day the wide gap between the two rivers has made the irrigation problem a very difficult one but in ancient times the twin rivers approached one another more closely. The narrow strip between the rivers, scarcely more than thirty miles, could be irrigated by water run from the Euphrates to the Tigris and the land between the Euphrates on which there lay a string of cities and the Tigris was of great agricultural value. Nippur, therefore, apart from its sacred position was a land of great wealth.

The prehistoric city was built on the west bank of the Euphrates, and was grouped about the temple of the earth god. The mound now lies on the east bank of the Shatt al Nil. Extensive remains of cremation have been found in all the earlier pre-Sargonic periods and as a matter of comparison it is interesting to note that in the earliest graves at Ur cremation appears to be a purely ritual survival, and that so far at Kish, even in the earliest graves, no signs of cremation have been found. Painted pottery was also found. In the period of Ur-nina, that is, the end of the fourth millennium B.C., the temple area was enlarged and a great rectangular terrace of plano-convex bricks was built. This terrace extended far beyond the temple area and was large enough to include both the temple and its stage tower (*ziggurat*) at the southern end. There were also store houses, cloisters and priests' rooms on the terrace and a large court north of the temple. This building had an inner court, which was surrounded by thick walls and included rooms in which the temple archives were stored.

The restoration of the original form of the city, especially in later times, is made possible by the discovery of a tablet of the Kassite period, now unfortunately lost, which had upon it a sketch plan of the city. It shows part of the city east of the river and enclosed within its own walls, like the forbidden city of Peking, which lies within its own walls and surrounded by the city itseif. This inner city formed an irregular square, with sides about 900 yards long and was surrounded by canals, with quays along the walls. The inner city was itself also divided into two by a canal. The temple enclosure was oriented, its angles pointing towards the cardinal points of the compass. The tower of the pre-Sargonic period was on the north side of the inner court. On the east side, next to the tower, was the temple of Ekur, with its chapels and other buildings.

All the important kings held this temple in great veneration and considered its repair and reconstruction as a very necessary pious duty. Under the Semitic occupation Naram-sin rebuilt the temple and the city walls. His building was partly destroyed by Ur-Engur, whose restoration gave the area the form in which we have it recorded. His terrace of sundried bricks covered an area of about eight acres. The ziggurat at the northwestern edge was approached by an inclined plane on the south-east side and was made of crude bricks faced with burnt bricks, set in bitumen. It contained three stages. The city walls built by Ur-Engur followed the general lines of the walls built by Naram-Sin.

The whole sanctuary was later restored by Assur-bani-pal of Assyria in the 7th century. The city had previous to this time been allowed to fall into comparative decay, partly owing to the' predominance of Marduk, the god of Babylon, when that city was politically dominant, hut it enjoyed a period of renewed splendour under the Kassite dynasty, but this was only a temporary respite. Assur-bani-pal's restoration however gave it a form in some ways more magnificent than it had ever enjoyed, his great ziggurat measuring 128×190 feet. This was the end of Nippur's glories.

It gradually fell into decay. In the Seleucid period it became a fortress, and was used as such until the close of the Parthian period. in the middle of the third century A.D. From this time onwards the city ceased to be of any importance. It degenerated into a mere village. while some of the old sacred area was used, as in so many Sumerian cities as a cemetery. In the tenth century A.D. the site again became of some importance as a Jewish settlement. although it is possible that there may have been Jews settled on the site even earlier, possibly at the time of the exile. In the 12th century it was the site of a Christian bishopric.

The condition of the ruins is thus described by Langdon: "They are not so extensive as Kish but more compact and massive. . . . The grandeur of these lofty unbroken lines of mountainous ridges, whose concealed buildings lie deep beneath the plain level, cannot be described to conjure sufficiently the imagination of the reader. They do not belie the fame of Nippur in cuneiform inscriptions."

ANCIENT DOCUMENTS

The excavators of the site were particularly fortunate in the number of ancient documents discovered. The ancient temple library and its archives were not in the temple itself but in a mound to the south. West of the temple there was a commercial and residential quarter, and here, separated from the temple by a canal, were found the important archives of the Kassite kings and business houses of the Neo-Babylonian and Persian periods.

These archives show that the district was a great centre of the cattle industry. Cattle and sheep were driven to Nippur for the different feast days and careful records of every transaction were kept. The details are so full that an issue is recorded of barley porridge to such humble members of the temple staff as the dogs. There were three main sources of revenue for the temple. First there were a series of tolls or dues of various forms. Secondly the temple was a great owner of property and received considerable revenues as rent. Thirdly cattle breeding was carried on. Kippur under the Kassites was an administrative centre, possibly even a capital city. The taxes, which were paid in kind, were either stored here or at the chief city of the district. The record of these taxes is instructive for the side lights thrown on the economic geography of Mesopotamia nearly four thousand years ago. The products which were paid included wheat, sesame, oil, dates, flour and live stock.

The majority of these temple archives of Nippur have been found at Tal Duraihim (Drehem) a city site about six miles south of Nippur, and three miles S.E. of the modern village of Afaj. This city apparently served as the collecting place for the animals used for sacrifices at Kippur. These animals formed part of the taxes payable under the kings of the third dynasty of Ur, and the records are therefore of the greatest value in giving lists of the towns at the time and their assessable value. The ruins of this site consist of a large crescent-shaped mound, some 300 feet from north to south, and 200 feet in width, while the height above the plain is about 40 feet. Langdon is of opinion that whatever the building under this mound may prove to be it is certainly not a temple.

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NIRVANA, in Buddhist dogmatics, means literally "blowing out," *i.e.,* the blowing out or extinction of the fire of passion in one who attains release. Whether such a person became extinct at death is classed in the Scriptures among the questions which the Buddha refused to answer. The term is probably originally Buddhist, but it is also found in Vedānta to express union with Brahma. (*See* BUDDHISM.)

NISH, the capital of the Nish department of Serbia. Yugoslavia. Pop. (1961) 81,076, comprising Serbs, Turks, Albanians. Bulgars, Greeks and Jews. The city is not only important commercially. hut also strategically since (1) it commands the only two valleys affording easy access from central Europe to the Aegean, (2) it is the meeting-point of several of the chief Balkan highways, and (3) it is the junction on the Belgrade-Nish railway for both Sofia and Salonika, and fortunately, in this respect, is within easy reach of good coal supplies. The town during World War II was one of Yugoslavia's main defense areas and was a principal fortress. the perimeter of the entrenched camp being about 30 mi. with outlying modern works. The surrounding heights were fortified after 1886. The Turkish town, on the N. bank of the Nishava, contains the citadel and many mosques and picturesque old houses among its winding alleys.

The ancient Roman city *Naissus*, which probably superseded a Celtic settlement, was mentioned as an important place by Ptolemy of Alexandria, and the old fortress on the right bank of the river is believed to have been erected on its site. Under its walls in A.D. 269 the Emperor Claudius destroyed the army of the Goths: and within it, in A.D. 274, Constantine the Great was born. The town was destroyed by the Huns under Attila in the 5th century, and restored by Justinian. In the 9th century the Bulgarians conquered it, but ceded it to the Hungarians in the 11th century, from whom the Byzantine emperor Manuel I took it in 1173. Toward the end of the 12th century the town was in the hands of the Serbian prince Stephen Nemanya, who there received hospitably the German emperor Frederick Barbarossa and his crusaders.

In 1375 the Turks captured Naissus from the Serbians. In 1443 the Hungarians and the Serbians retook it from the Turks, but in 1456 it again came under Turkish dominion. In the first Serbo-Turkish rising, the Serbians, defending the approach to Nish in 1809, fired their magazine and destroyed themselves and the enemy. The Turks built a brick tower in which they embedded 900 Serbian skulls. In the Russo-Turkish war (1877–78) the Serbians captured Nish and the town was ceded to them by the treaty of Berlin (1878). Here the National Assembly, before the constitution of 1901, was regularly held.

During World War I the government withdrew to Nish (1915) when Belgrade was occupied by the enemy, but it was not able to stay there.

NISHAPUR, a town in the ostan of Khurasan in Iran, 3,920 ft. above sea level. 50 mi. W. of Meshed in one of the most fertile districts of Iran. which produces much grain and cotton. Pop. (1956) 25.849. Pottery making is a special industry.

Nishapur in the old Persian is *Nev-shapur-nev*. The second element of the name is that of its traditional founder Shapur (A.D. 241–272). It was once one of the four great cities of Khurasan (*q.v.*), rivaling Rai (Rhages), but the population in 1956 was 25,-849. It was an important place in the 5th century, for Yazdajird (438–457) resided there mostly. During the later Sasanids it is seldom mentioned and when the Arabs came to Khurasan (641–642) it was of so little importance that, as the historian Tabari relates, it did not even have a garrison. But under the Tahirids (820–872) it became a flourishing city and rose to importance during the Samanids (874–999). Toghrul, the first Seljuk ruler, made Nishapur his residence in 1037. In 1153, the Ghuzz Turkmans overran the country and partly destroyed it. In 1208 most of the town was destroyed by earthquake and was hardly rebuilt when it was again destroyed by the Mongols. It was rebuilt, suffered again at the hands of the Mongols (1269) and from another earthquake in 1280. and never rose again to its former greatness.

A few miles to the east stands a fine domed mausoleum, the Gadam Gar (1643). Expeditions of the Metropolitan Museum of Art, New York (1934–40) disclosed rich and significant architectural and artistic remains of both Seljuk and pre-Seljuk times. Four mi. S.E. of the town, adjacent to the mosque of the Imamzadeh Mahruk (a Moslem saint of the 8th century), is the tomb of the astronomer-poet Omar Khayyam. Nearby is the grave of the celebrated poet and mystic Farid ud Din Attar. At Madan, 32 mi. N.W. of Nishapur, are the famous mines which have supplied the world with turquoises for at least 2,000 years.

NISHINOMIYA, Japanese city of Hyōgo prefecture, located midway between Kōbe and Osaka in the continuous urban-iadustrial belt along the eastern Inland seacoast of Honshū. Pop. (1960) 262.608. It occupies a narrow lowland between Osaka hay and interior Mt. Rokkō. Nishinomiya is famed for its fine sake (rice wine) and produces 30 different brands. Its coastal sections are assigned to industry (metals, machinery, chemicals, rubber goods, soap, cosmetics and beer) and to bathing resorts. It has a large professional baseball stadium and excellent railway and road connections with adjacent eastern and western urban areas.

(J. D. EE.)

NISIBIS (NUSAYBIN), a frontier fortress and trading town of Turkey on the Syrian border about 130 mi. N.W. of Mosul, Iraq. It lies on the borderland between the mountains and the plain in 37° N. 41° E. at the point where the Yaghyagha (called in ancient times the Mygdonius) passes through a narrow canyon and enters the plain. During the Assyrian empire it formed a frontier fort against aggressions from the north, and occupied a similar position in Seleucid times. From the middle of the 2nd century B.C. until the early years of the Christian era it was the residence of the kings of Armenia. Owing to its strength the fortress was of considerable importance during the struggle between Rome and Parthia. It became in early Christian times a religious centre. Under the Caliphs it was a frontier fortress and the scene of continuous fighting. Finally it lost most of its prosperity owing to internal troubles, and according to the Arab chroniclers, the compulsory substitution of wheat for fruit crops. It is probable that an insufficient control of the Bedouins of the desert was responsible for much of Nisibis' lost prosperity. Pop. (1960) 5,008.

NISI PRIUS, in English law, a term used to denote generally all actions tried before judges of the king's bench division. For the history and meaning of this term see ASSIZE. In the United States a trial at *nisi prius* is a trial of a civil action in a court of record before a judge and jury.

NISUS, the name of two figures in classical mythology and literature.

1. Nisus, in Greek mythology, was a son of Pandion, king of Megara, and is eponymously connected with the Megarian port of Nisaea. Nisus had a purple lack of hair with magic power: if preserved, it would guarantee him life and continued possession of his kingdom. When Minos (*q.v.*) besieged Megara, Nisus' daughter Scylla fell in love with Minos or was bribed; she betrayed her city by cutting off her father's purple lock. Nisus was killed or killed himself and became transformed into a sea eagle. Minos despised Scylla and brought about her death either by dragging her, tied, after his ship or by abandoning her, so that she desperately swam after him and drowned. Scylla then changed into a sea bird (Gr. *keiris*, Lat. *ciris*), possibly a heron, constantly pursued by the sea eagle. The story appears as early as Aeschylus, but the most famous accounts occur in the Ciris, often attributed to Virgil, and in Ovid's *Metamorphoses*, 8, 1 ff.

2. Nisus in Virgil's *Aeneid* is a Trojan, son of Hyrtacus, close friend of Euryalus. In the funeral games, when he slips and falls, he helps Euryalus win the foot race by tripping the leader (*Aeneid* 5, 315 ff.). Later, fighting the Italians, he sacrifices himself vainly to rescue Euryalus from the enemy, but earns poetic immorality (*Aeneid* 9, 176 ff.). (WM. S. A.)

NITERÓI, a city and port of Brazil, and capital of the state of Rio de Janeiro, is located on the eastern side of the entrance to Guanabara bay opposite the city of Rio de Janeiro, with which it is connected by ferry. Pop. (1960) 228,826. Like Rio de Janeiro, this city is located on low ground at the heads of the numerous bays that indent the shore. The several sections of the city are separated by steep rocky ridges that extend into the water. Niterói is separated from the open ocean by the steep slopes of the main ridge running parallel to the coast.

In addition to serving as capital of Rio de Janeiro state since 1835 (except for the period 1894–1903 when Petropolis mas the capital), Niterói is also a residential suburb of Rio de Janeiro city. The best residential districts include Icarai and São Francisco, both of which are bordered by fine beaches. In and around Niterói there are important manufacturing industries, including Brazil's chief shipbuilding and repairing yards and metal industries which use steel manufactured at Volta Redonda (*q.v.*). There are textile mills and food processing plants; other manufactures include flat glass, matches, tobacco products, furniture, chemicals, explosives and pharmaceuticals. There is a large cement plant nearby. The central business district is in the part of the city known as São Lourenço.

The first settlement on the eastern side of the bay was made by the Portuguese in 1671. At this time a chapel was built in Praia Grande near an Indian village, not far from one of the present ferry terminals. The settlement became a village in 1819 when it was named Villa Real da Praia Grande. In 1834 the city of Rio de Janeiro and the federal district were separated from Rio de Janeiro state; the following year Praia Grande became the capital of the state. In 1836 it became a city and was renamed Niterói, a name derived from the Indian word *Nyterõi*, "hidden water." In spite of the new residential suburbs and industrial districts, Niterói remains even more characteristically Portuguese than its neighbour across the mouth of the bay; the narrow irregular streets and the architecture of the buildings are little changed. The name of the city was formerly spelled Nictheroy. (P. E. J.)

NITHARD (d. 844), Frankish historian, was the illegitimate son of Angilbert, the friend of Charlemagne, by Bertha, a daughter of the great emperor. He was educated at the imperial court and became abbot of St. Riquier *in commendam,* never taking the vows. He fought for Charles the Bald at Fontenoy in June 841 and died as the result of wounds received while fighting against the Northmen near Angoulême. The date of his death was probably June 14, 844.

In the 11th century his body, with the fatal wound still visible, was found in the grave of his father, Angilbert. Nithard's historical work consists of four books on the history of the Carolingian empire under the turbulent sons of the emperor Louis I, especially during the troubled period between 840 and 843. This *Historiae* or *De dissensionibus filiorum Ludovici pii,* dedicated to Charles the Bald, is valuable for the light which it throws upon the disintegration of the Carolingian empire.

The *Historzae* has been printed several times. Perhaps the best edition is in Band ii of the *Monumenta Germaniae historica: Scriptores;* it has also been edited by A. Holder (1882). It has been translated into German by J. von Jasmund (1851; new edition by W. Wattenbach, 1889) and into French in tome iii of Guizot's *Collection des mémoires* (1824).

NITHSDALE, WILLIAM MAXWELL, 5TH EARL OF (1676–1744), Jacobite leader, was a member of the family of Maxwell (*q.v.*), being a son of Robert, the 4th earl (d. 1696), and a collateral relation of Robert Maxwell (d. 1646). who was created earl of Kithsdale in 1620. His wife was Winifred, daughter of William Herbert, 1st marquess of Powis.

After becoming earl in 1698 he served the exiled house of Stuart in secret and was suspected as a Jacobite conspirator. In 1712 he resigned his estate to his son William (d. 1776), reserving a life rent to himself. When the Jacobite rising took place in 1715 he joined his friends in the north of England and was taken prisoner at Preston, being sent to London for trial.

The countess of Nithsdale, who was at Terregles when she heard of the capture of her husband, followed him to London, making part of the journey on horseback in bitter winter weather. The earl and the other Jacobites were brought to trial in Westminster hall on Jan. 19, 1716, and condemned to death on Feb. g. The execution was fixed for Feb. 24.

The countess presented a petition to George I which he refused to receive, and when she knelt before him and took hold of the skirts of his coat he dragged her half across the room before he could break away. Finding that no pardon could be obtained, the countess laid a plan to rescue her husband from the Tower of London. With the help of two Jacobite ladies she cleverly extricated her husband from his cell on the night before the day fixed for the execution by disguising him as a woman.

The earl escaped from England and was followed by his wife after she had gone back to Scotland to rescue important legal papers which proved the transfer of the estate to their son. After a short stay in France the earl and countess went to Rome, where they lived in poverty and obscurity. The earl died on March 20, 1744, and the countess in 1749.

NITON: *see* RADON.

NITRE, naturally occurring potassium nitrate, or saltpetre; "cubic nitre," or Chile saltpetre, is sodium nitrate. A source of nitrogen compounds, nitre was employed in the earliest recorded preparation of nitric acid *(see* NITRIC ACID AND NITRATES) and was used in the manufacture of gunpowder, fireworks, etc. It occurs as crusts on the surface of the earth, on walls, rocks, etc., and in caves. It forms in certain soils in Spain, Italy, Egypt, Iran and India. It occurs with sodium nitrate in Chile, and in the United States it has been found in caves in the Mississippi valley. The colour is white and it has a vitreous lustre. The composition is KNO_3, with 46.5% K_2O (potash) and 53.5% N_2O_5. *See* also POTASSIUM: *Potassium Nitrate.*

NITRIC ACID AND NITRATES. Nitric acid. HNO_3, an important mineral acid, was one of the earliest of the nitrogen compounds to be prepared and used. Its preparation by the distillation of a mixture of nitre (potassium nitrate), alum and blue vitriol is reported in *De inventione veritatis,* ascribed to Geber (*q.v.*). A similar method was described by Albertus Magnus in the 13th century and by Raimon Lull, who prepared the acid by heating nitre and clay and called it *eau forte.*

In 1648 J. R. Glauber devised the process in common use for many years, viz., by heating a nitrate with concentrated sulfuric acid. The true nature of nitric acid was not determined until the 18th century when A. L. Lavoisier (1776) showed that it contains oxygen. In 1784 H. Cavendish synthesized it by passing a stream of sparks through humid air, proving that nitrogen is also a constituent. J. L. Gay-Lussac and C. L. Berthollet established its exact composition in 1816. Nitric acid has been known as *aqua dissolutiva, aqua prima, spiritus acidus nitri, spiritus nitri fumans Glauberi* and aqua fortis.

Free nitric acid. formed in moist air by the discharge of atmospheric electricity (lightning), is found to a very slight extent in rain water and is also formed in the soil by the oxidation of nitrogenous organic matter. It is neutralized by the basic substances in the soil to form nitrates, principally saltpetre, KNO,, and Chile saltpetre, $NaNO_3$, the latter being found in greater abundance and concentrations.

Physical Properties.—Pure 100% nitric acid is a colouriess liquid whose specific gravity at 25° C. relative to water at 4° C. is 1.50269, melting point —41.59° C., and boiling point 86° C. at one atmosphere of pressure. It fumes strongly on contact with moist air and is miscible with water in all proportions.

A water solution containing 68% of the acid, which is the approximate composition of the concentrated acid of commerce, is a constant-boiling or azeotropic mixture at atmospheric pressure with a boiling point of 120 5° C. and a specific gravity of 1.41. A solution containing less than 68% nitric acid may be separated by distillation at atmospheric pressure into the constant-boiling mixture and a distillate of more dilute acid; one with more than 68% nitric acid yields a residue of the constant-boiling mixture and a distillate of the more concentrated acid.

The very concentrated or pure acid undergoes decomposition when boiled and, with the water formed, may be converted to the constant-boiling mixture by repeated distillation. The composition of the constant-boiling mixture varies with the pressure at which it is distilled.

Chemical Properties.—Pure nitric acid or its concentrated solutions decompose slowly into water, nitrogen dioxide and oxygen: $4HNO_3=2H_2O+4NO_2+O_2$; the rate of the decomposition is increased by light and by higher temperature. The concentrated acid is therefore usually coloured yellow due to the presence of the nitrogen dioxide, some of which remains in the solution. Nitric acid forms two compounds with water in the solid phase, the monohydrate, $HNO_3.H_2O$, melting point —37.68' C., and the trihydrate, $HNO_3.3H_2O$, melting point $-18.47°$ C.

Nitric acid may be considered to be the hydrate of nitrogen pentoxide although it is almost never prepared by hydration of the oxide. Conversely the pentoxide is normally prepared by dehydrating the concentrated acid with phosphorous pentoxide: $2HNO_3+P_2O_5=N_2O_5+2HPO_3$. Nitrogen pentoxide is a white solid which sublimes at 32.4° C. and which decomposes readily into nitrogen dioxide and oxygen.

Nitric acid is a strong acid; in dilute water solutions it is almost completely ionized to hydrogen ions, $H+$, and nitrate ions, NO_3^-. Its salts with strong bases are not hydrolyzed in aqueous solution and are neutral to indicators. It neutralizes hydroxide bases and salts of weak acids to form nitrates *(see* below). Due to its strong oxidizing properties, a dilute solution of the acid does not yield hydrogen when treated with metals, but is reduced to one of the oxides of nitrogen, to nitrogen or to ammonium ion. However, with very active metals (magnesium, for example), some hydrogen is liberated along with the other reduction products.

Most of the nitric acid produced is consumed in the manufacture of fertilizers, explosives, plastics, lacquers, synthetic fabrics and dyes by the reaction of the acid on organic compounds. Fuming nitric acid is used as an oxidizer in rocket propellants.

In one type of reaction, organic nitrates and water are formed when alcohols and other compounds containing OH groups react with the acid. Glycerol trinitrate. commonly called nitroglycerin, is made by the treatment of glycerin with a mixture of concentrated nitric and sulfuric acids: $C_3H_5(OH)_3+3HNO_3=C_3H_5(NO_3)_3+3H_2O$. The sulfuric acid combines nith the water, increasing the concentration of nitronium ion (NO_2^+), a powerful nitrating agent. Cellulose in the form of cotton or wood fibres is similarly treated to obtain cellulose nitrates. The extent of nitration (*i.e.*, the number of nitrate radicals combining with a unit of the cellulose) is controlled to produce either guncotton (smokeless powder) or, with less nitration, the base for pyroxalin lacquers and plastics and certain types of fibres. In the organic nitrates the nitrogen atom is bonded to an oxygen atom which in turn is linked to a carbon. Another type of reaction of nitric acid and organic compounds involves the formation of nitro compounds in which the nitrogen atom of the group $-NO_2$ is bonded directly to the carbon atom.

Methyl benzene (toluene) reacts with nitric acid in the presence of concentrated sulfuric acid to form trinitrotoluene, more commonly known as TNT: $C_6H_5CH_3 + 3HNO_3 = CH_3C_6H_2(NO_2)_3 + 3H_2O$. (*See* EXPLOSIVES.)

Nitric acid is a powerful oxidizing agent; it oxidizes nearly all of the metals except platinum, rhodium, iridium. tantalum and gold. Most metals yield nitrates, but with tin, arsenic, antimony, wolfram and molybdenum the oxides of the metals are formed. The behaviour of the acid as an oxidizing agent is complex because of the number of possible reduction products which may be obtained. The oxidation or valence number of the nitrogen in nitric acid is +5; it may be reduced to nitrogen dioxide, NO_2 (+4), nitric oxide, NO (+2), nitrogen, N_2 (0), or to ammonium ion, NH_4^+ (−3), depending upon the temperature, the concentration of the acid, the presence of catalysts and the activity of the metal or other reducing agent involved.

In general. the more concentrated the acid the less the change in the oxidation number of the nitrogen. For example, copper reduces the concentrated acid to NO_2: $Cu+4HNO_3$ (concentrated) $=Cu(NO_3)_2+2NO_2+2H_2O$, and the dilute acid to NO: $3Cu+8HNO_3$ (dilute) $= 3Cu(NO_3)_2+2NO+4H_2O$. A stronger reducing agent may cause a greater change in the oxidation number of the nitrogen, as:

$$4Zn + 10HNO_3 \text{ (dilute)} = 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$$

wherein the reduction product is ammonium nitrate.

On the other hand, the concentrated acid may oxidize the metal or nonmetal to a higher valence stage than does the dilute acid, as:

$$S + 6HNO_3 \text{ (concentrated)} = H_2SO_4 + 6NO_2 + 2H_2O, \text{ and}$$
$$3S + 4HNO_3 \text{ (warm, dilute)} = 3SO_2 + 4NO + 2H_2O$$

When iron. copper or chromium is placed in contact with concentrated nitric acid it becomes inactive or passive to the acid and to certain other substances with which it normally reacts; passive iron reduces neither hydrogen ion nor cupric ion, and passive copper does not reduce silver ion. Passivity may be destroyed by scratching the surface, by the action of reducing agents, or by the effect of a strong magnetic field. It was thought at mid-20th century that the formation of an oxide film on the surface of the metal was the cause of the phenomenon.

Nitric acid is highly toxic if taken internally, producing a widespread gastroenteritis, burning pain in the esophagus and abdomen, and bloody diarrhea. Death may occur from collapse or from secondary destructive changes in the intestinal canal. On the skin a characteristic yellow staining appears. due to the formation of xanthroproteic acid. Copious quantities of water and mild bases such as sodium bicarbonate solution will assist in neutralizing the effects of internal and external exposures.

Manufacture. — In the laboratory pure anhydrous nitric acid is prepared by gently heating an equimolal mixture of pure concentrated sulfuric acid and pure sodium nitrate under vacuum and condensing the evolved gaseous acid at a temperature near or below its melting point. The reaction is $H_2SO_4+NaNO_3=NaHSO_4+HNO_3$ (gas).

Commercially. nitric acid is manufactured by three processes. The older method, practically obsolete at mid-20th century, is similar to the laboratory method. Chile saltpetre. a commercial form of sodium nitrate, is heated with an equimolal amount of concentrated sulfuric acid under reduced pressure in iron retorts. Nitric acid boils out of the reaction mixture and is condensed in glass containers. An attempt to bring about a reaction between another molecule of sodium nitrate with the second hydrogen in the sulfuric acid molecule results in decomposition of the nitric acid because of the high temperatures necessary to make the reaction go.

The second and most common method of manufacturing nitric acid is by catalytic oxidation of ammonia. Ammonia can be synthesized as cheaply per pound of nitrogen as Chile saltpetre can be mined and purified, and as a result it largely supplanted the latter as a source material. A mixture of 10% ammonia and 90% air is heated to 300° C. and passed over a platinum gauze catalyst which is heated initially to 900°–1,000° C. Heat liberated in the reaction is sufficient to maintain the catalyst temperature. About 90% of the ammonia is oxidized to nitric oxide: $4NH_3+5O_2=4NO+6H_2O$. From the catalyst the gases pass into absorption towers where two reactions take place: $2NO+O_2=2NO_2$ and $3NO_2+H_2O=2HNO_3+NO$.

The third method of nitric-acid manufacture involves the direction union of atmospheric oxygen and nitrogen in an electric arc: $N_2+O_2=2NO$. followed by the last two reactions of the ammonia process. Equilibrium in the arc reaction favours formation of nitric oxide only at very high temperatures. For example, at 3,900° C. the reaction is only 10% complete at equilibrium. However, if the reaction mixture is quenched quickly to a temperature below 1,000° C. it may be frozen at the high-temperature equilibrium proportions. Under the most favourable conditions, the yield of nitric oxide is only about 2.5%. The process is not commercially competitive with the ammonia oxidation process even in locations where electric power is cheap. See NITROGEN, FIXATION OF.

Nitrates. — Inorganic nitrates are chemical compounds with the type formula $Me(NO_3)_n$, where Me represents a metal atom and n may be one, two, or more depending on the valence of the metal. Nitrates are crystalline solids at ordinary temperatures. They may be white or coloured, depending on the metallic constituent. As a group they are the most water soluble of all metallic salts. Nitrates are prepared by reaction of the desired metal, its oxide or its carbonate with nitric acid.

Nitrates of base metals decompose according to the equation $2NaNO_3=2NaNO_2+O_2$, when heated, whereas nitrates of the less active metals are converted to oxides under the influence of heat: $2Cu(NO_3)_2=2CuO+4NO_2+O_2$. When heated to high temperatures, nitrates are strong oxidizing agents comparable to nitric acid.

Many nitrates are hygroscopic; *i.e.*, they absorb atmospheric moisture if left unprotected. Potassium nitrate is an important exception. Some nitrates contain water of crystallization when precipitated from aqueous solution; one or more water molecules per nitrate molecule forming an integral part of the crystalline structure of the solid material. The amount of water varies with the substance and the temperature. Heating the hydrated salts causes partial to complete conversion to oxide, depending on the metallic constituent. Nitric acid is driven off as a gas.

The nitrate ion has the structure of an equilateral triangle, with oxygen atoms surrounding the central nitrogen atom. Nitrates are determined qualitatively by reduction with ferrous ion. Fe^{++}, to nitric oxide and subsequent formation of $FeNO^{++}$, a complex ion with a characteristic deep-brown colour. The reaction takes place in the presence of concentrated sulfuric acid, which is added to a solution of the unknown and ferrous sulfate in such a way that the two solutions do not mix. A brown layer at the interface indicates the presence of nitrate ion. Quantitative determination of nitrate ion is usually accomplished by reduction to ammonia by aluminum in alkaline solution. distillation of the ammonia into excess standardized sulfuric acid and back titration with standardized sodium hydroxide solution. Nitrate ion forms an insoluble salt with nitron (1.5-diphenylanilodihydrotriazol nitrate), permitting the gravimetric determination of nitrates. For other nitrogen compounds see NITROGEN.

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NITRIDES are binary compounds of nitrogen with the elements. They apparently do not occur in nature: although F. A. Bannister reported the presence of titanium nitride, TiN, in the mineral osbornite. found in the Busti, India, meteor. The simple nitrides may be regarded as derivatives of ammonia in which the hydrogen atoms are replaced by a metallic or nonmetallic element. Their composition may be represented by formulas corresponding to the normal valence (oxidation number) of the elements based upon their position in the periodic classification: for example. Group I, Li_3N; Group II, Mg_3N_2; Group III. AlN; Group IV, Si_3N_4. Where an element is capable of existing in several oxidation states, corresponding nitrides may be capable of existence; for example, PN and P_3N_5.

In addition to these simple nitrides, compounds with nitrogen are formed by such transition elements as chromium, iron and cobalt, whose structure and composition are more complex and do not conform to valence rules.

Reference is also made to three classes of binary nitrogen compounds which differ markedly from the simple nitrides: (1) the hydronitrogens, compounds of hydrogen and nitrogen which formally resemble the hydrocarbons (*see* AMMONIA); (2) compounds with the more electronegative elements such as oxygen, sulfur and the halogens which are discussed under the respective elements and (3) the trinitrides, containing the N_3 radical which are derivatives of hydrazoic acid, one of the hydronitrogens (see HYDKAZOIC ACID).

Preparation.— Many of the nitrides can be prepared by direct combination of the elements with nitrogen, but such reactions take place much less readily, and then usually only at higher temperatures, than the corresponding oxidation reactions. A few elements, notably lithium, magnesium and the alkaline earth metals. burn in air to give mixtures of the oxides and nitrides. Nitride formation is aided by use of active nitrogen. by reducing the elements to a fine state of subdivision, by employing the amalgams (see MERCURY) and by use of catalysts, as lithium nitride. Nitride formation by direct combination has been observed to take place with the following elements: Mg, Ca, Sr. Ba, Li, Be, B, Al, La. Ce, Pr, Nd, Ti, Zr. Th, V, Cb. Ta, Cr, Mo, W. U, Mn, Fe, Co, Ni. Si, Ge and P. Despite their high reactivity, sodium, potassium, rubidium and cesium do not appear to form nitrides by direct combination. In general, elements of the B subgroups of the periodic classification show little inclination to react directly with nitrogen.

Nitrides may also be prepared by indirect methods, of which the folloning are the more important:

1. Mixtures of the oxides nith carbon can be converted to nitrides by heating in a nitrogen atmosphere. This procedure is used for the preparation of aluminum nitride in accordance with the equation $Al_2O_3+3C+N_2 \rightarrow 2AlN+3CO$ and constitutes the basis for the Serpek process for the fixation of atmospheric nitrogen (see NITROGEN, FIXATION OF). In some cases carbides can be heated directly with nitrogen as in the production of beryllium nitride: $Be_2C+2N_2 \rightarrow 2Be_3N_2+C$.

2. Gaseous ammonia may serve as the nitriding agent for conversion of certain metals, oxides, sulfides and. in some instances, halides into nitrides. Cuprous oxide reacts with ammonia at 300° C. to yield some cuprous nitride, Cu_3N; at 600° C. zinc is converted into zinc nitride, Zn_3N_2.

3. Amides and imides of many elements undergo thermal decomposition to yield the nitrides. Nonmetallic halides, in particular, react with gaseous or liquid ammonia at ordinary temperatures to give the amides or imides which may be heated to effect deammonation (removal of ammonia, analogous to dehydration by which hydroxides are converted to oxides), eventually to give the nitrides. Thus, treatment of boron trichloride with ammonia gives first the diboron tri-imide, $B_2(NH)_3$, which on heating loses ammonia to form the nitride. BN.

$$BCl_3 \xrightarrow{NH_3} B_2(NH)_3 \xrightarrow[125^\circ \text{ C.}]{\text{above}} BN$$

The amides of such metallic elements as magnesium, calcium, strontium. barium. zinc, cadmium. nickel and cobalt precipitate when potassium amide is added to solutions of their salts in liquid ammonia. These products likewise undergo deammonation at higher temperatures.

$$M^{++} \xrightarrow{KNH_2} M(NH_2)_2 \xrightarrow{\text{heat}} M_3N_2$$
(where M = Mg, Ca, Sr, Ba, Zn, Cd, Ni, Co)

The amides of the alkali metals, with the exception of lithium, do not give nitrides on heating.

4. Reaction of certain metallic salts with potassium amide in liquid ammonia as the solvent medium affords a procedure whereby nitrides may be obtained which are unstable at the temperatures required to effect direct combination of metal with nitrogen. The following nitrides are precipitated from liquid ammonia solution under these conditions: mercuric nitride, Hg_3N_2, thallous nitride, Tl_3N, and bismuth nitride, BiN.

$$\left.\begin{matrix} Hg^{++} \\ Tl^{+} \\ Bi^{+++} \end{matrix}\right\} \text{ in liquid } NH_3 + NH_2^- \text{ (from } KNH_2) \rightarrow \begin{matrix} Hg_3N_2 \\ Tl_3N \\ BiN \end{matrix}$$

(See also AMMONIA; SOLUTIONS.)

5. Aqueous ammonia converts the oxides of silver, gold and the platinum metals into highly explosive compounds which are assumed to be nitrogen compounds, possibly nitrides. These are often referred to as the fulminating metals.

6. Careful decomposition of the alkali and alkaline-earth azides by heating gives mixtures of nitrides with the respective metals. (See HYDRAZOIC ACID.) A large number of nitrides have been described in the chemical literature. These may be listed conveniently on the basis of type formula with M representing the element with which nitrogen is combined.

Nitrides of the Elements

Type formula	Where M represents
MN	B, Al, Se, Y, La, Ce, Pr, Nd, Sm, Er, Ga, In, Si Te, Zr, P, As, Sb, Bi, V, Ta, Cb, Cr
MN_2	V, W
M_2N	Cb, Cr, W, Fe
M_3N	Li. Na. K. Rb. Cs. Cu. Tl
M_3N_2	Be, Mg, Ca, Ba, Sr, Ra, Zn, Cd, Hg, Ge, Zr, Cr, Mo, Mn. Co, Ni
M_3N_4	C, Si, Te, Zr, Th, Ge, U
M_3N_5	P, Cb, Ta

A number of other nitrides have been described, but the identity of some of these is questionable: Si_2N_3, U_5N_4, U_5N_2, W_2N_3, Mu_5N_2, Mn_7N_2, Fe_8N and Fe_4N.

Properties and **Uses.**—Nitrides, like oxides, vary considerably in their stability and reactivity.

The nitrides of the noble metals (for example, Hg_3N_2 and BiN) decompose explosively into the elements on heating, whereas the nitrogen compounds of boron, silicon, titanium. zirconium, vanadium, tantalum and molybdenum (as examples of the nitrides of Groups III, IV, V and VI) are characterized by their remarkable stability at high temperatures.

Most nitrides react with water to liberate ammonia, as, for instance, $Mg_3N_2+6H_2O \rightarrow 3Mg(OH)_2+2NH_3$, although the tendency to do so depends not only on the specific nitride but also on the method of preparation and the subsequent thermal history of the compound.

Thus, many of the nitrides prepared at lower temperatures by deammonation of the amides or imides hydrolyze rapidly; if these same nitrides are sintered by heating to a high temperature, they become relatively inert to attack by chemical agents (*e.g.,* boron nitride, BN). Structural changes to highly polymerized aggregates are involved. High-temperature treatment in some instances changes the composition of the nitrides to products of lower nitrogen content; *e.g.*, trititanium tetranitride, Ti_3N_4, is converted into titanium nitride, TiN.

Certain nitrides such as those of boron, BN, silicon, SiN, titanium, TiN, zirconium, ZrN, and tantalum, TaN, are extremely refractory materials with melting points near or above 2,500° C. Where this property is combined with chemical inertness such nitrides have found use in the manufacture of equipment which must withstand chemical action at high temperatures. Crucibles of titanium nitride are especially resistant to attack by various molten ferrous metals. The nitrides of titanium, zirconium and tantalum are furthermore characterized by their extreme hardness and are used either alone or in admixture with borides and/or carbides for hard-metal alloys and abrasive compositions.

Boron nitride has long been known to form hexagonal crystals that resemble graphite in structure and physical properties. Special experimental techniques entailing application of very high pressures (85,000 atm.) and high temperatures (1,800° C.) result in formation of the cubic form, known as "Borazon," which is as hard as the diamond but is more stable toward oxidation. (The patent literature must be consulted for specific disclosures concerning compositions used for such purposes.?

Formation of interstitial or metalliclike nitrides is involved in the nitriding process in which steel and its alloys are heated in an atmosphere of ammonia above 800° C. to produce a surface film possessing great hardness and resistance to wear and to chemical attack.

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NITRIDING, a process for the surface hardening of steel. It consists in heating special alloy steels in contact with ammonia at temperatures below the transformation range for steels, usually between 950° F. and 1,050° F., for periods of from 5 to 100 hr. depending upon the depth of hardened "case" desired. The steels used must contain nitriding-forming elements (such as aluminum. chromium or molybdenum) dissolved in the iron. During the nitriding cycle nitrogen from the ammonia diffuses into the steel and forms alloy nitrides, which are precipitated along the crystal planes of the iron. This precipitation causes an increase in hardness; which is dependent upon temperature and the amount and nature of the nitride-forming elements in the steel. Aluminum is the most effective hardening element. A steel containing approximately 1% aluminum and 1% chromium nitrided at 975° F. will have a surface hardness of approximately 1,100 Vickers-Brinell.

The advantages of nitriding compared with other methods of surface hardening are as follows: (1) A much harder and more wear-resistant case is produced. (2) Distortion is low primarily because the process is carried out below the transformation range. (3) The resistance to fatigue failures, particularly notch fatigue, is greatly increased because nitriding results in surface compressive stresses which resist crack formation. The disadvantages of the process are: (1) An alloy steel must be used, which is more expensive than plain carbon steels. (2) The time required to produce a case is long compared with other methods such as carburizing, cyaniding or induction hardening. (C. F. F.)

NITROBENZENE, the simplest aromatic nitrocompound, $C_6H_5NO_2$, was first isolated in 1834 by E. Mitscherlich and is prepared commercially by the action of a mixture of concentrated nitric and sulfuric acids upon benzene at a temperature of 50°–55° C. The oily product. which separates. is washed with alkali and then distilled. It is a yellowish liquid possessing a strong smell similar to that of oil of bitter almonds. It boils at 210.9° C. and melts at 5.7° C. The products of its electrolytic reduction vary with the conditions: in 50% sulfuric acid solution it yields *p*-aminophenol (L. Gattermann, 1893); in alkaline solution it yields azoxyhenzene, azobenzene. hydrazobenzene or aniline, depending upon the material of which the cathode is constructed, upon the solvent, upon the applied voltage and current density and upon the total amount of current allowed to pass through the solution; in an approximately neutral aqueous or alcoholic solution, it yields β-phenylhydroxylamine; and, in acid alcoholic solution, it yields some benzidine together with other products. With chlorine. in the presence of iodine or antimony chloride, it yields meta-chloronitrobenzene. It occasionally acts as an oxidizing agent, as in the preparation of quinoiine and fuchsine (magenta, *q.v.*). It is used commercially for the preparation of aniline (*q.v.*) and of benzidine (*q.v.*), and in perfumery (oil of mirbane). (G. W. WD.)

NITROCELLULOSE (or cellulose nitrate) is the name given to the nitric esters of cellulosic materials, in practice largely cotton linters and wood pulp.

T. J. Pelouze discovered in 1838 that cotton could be converted into a violently inflammable substance by the action of concentrated nitric acid. C. F. Schonbein in 1846 demonstrated the use of this material as an explosive and improved the manufacturing method by adding sulfuric acid to the nitric acid. Nitrocellulose began to be used as an ingredient of gunpowders (bulk powders) in the 1860s; gelatinized nitrocellulose propellants were introduced in the 1880s. E. A. Brown discovered in 1868 that dry and even moist nitrocellulose could be exploded by a detonator, thus starting the use of the substance as a high explosive.

The history of its uses is punctuated by many disastrous explosions, caused largely by the failure to appreciate that nitrocellulose is an unstable material and is subject to catalytic decomposition caused by its own decomposition products. This reaction, if not checked in time, results in explosions. Sir Frederick Abel demonstrated in 1868 that the then prevalent methods of washing nitrocellulose after nitration were inadequate and that the residual acid was causing high instability. The introduction of the pulping process and other changes in the washing procedure led to significantly improved nitrocellulose. However, explosions of smokeless powder magazines continued; and in modern practice, which goes back to the researches of Paul Vieille, special stabilizers are added to nitrocellulose; the function of these is to neutralize catalytically active decomposition products. The results of this are the modern stable and reliable propellants.

Cellulose molecules consist of thousands of anhydroglucose units, $C_6H_{10}O_5$, linked into chains; therefore the nitration process may be schematically represented by the equation:

$$C_6H_{10}O_5 + xHNO_3 = C_6H_{10-x}O_{5-x}(NO_3)_x + xH_2O$$

Here x is a variable quantity which depends on the composition of the nitrating mixture and on the time and temperature of nitration. Theoretically x can reach the value of three. corresponding to 14.14% nitrogen in the product; but with mixtures of sulfuric and nitric acids such a high degree of nitration is seldom achieved.

The manufacture of nitrocellulose. in principle if not in practice, is a relatively simple process. Cotton linters or sulfite-process wood pulp are dipped into a large excess of nitric-sulfuric acid mixture; after a prescribed length of time, the product is separated from the bulk of the acid, for instance by centrifuging. The nitrocellulose is then "drowned" quickly in excess water and is subjected to boiling in acidified water to eliminate unstable byproducts of nitration.

The next step consists in pulping to disintegrate the fibres and to facilitate a subsequent washing, in which the last traces of acid must be removed. Cotton linters were for a long time preferred for the manufacture of gun propellants; but, starting in World War I. wood pulp became more and more accepted. A high content of alpha-cellulose in wood pulp appears to be essential to ensure high quality of smokeless powders.

Nitrocellulose is a fluffy, white substance, retaining some of the fibrous structure of untreated cellulose. It is rather unstable to heat and even carefully prepared samples will ignite on a brief heating to temperatures in excess of about 150° C.

Xitrocellulose is insoluble in water and in hydrocarbon solvents. It is soluble in acetone, in ethyl acetate, etc. Only the material with a low content of nitrogen is soluble in alcohol or ether, but intermediate grades are soluble in ether-alcohol mixtures.

Collodion or pyroxylin nitrocellulose, with a nitrogen content not in excess of 12%, is used chiefly for lacquers and celluloid plastics. Materials with a nitrogen content in the neighbourhood of 11.5% were used once, after denitration, as artificial silk, but have been replaced in this role by other materials, such as viscose rayon. This same material continued to be used for the manufacture of photographic films, although the use of safety film, made of cellulose acetate plastics, undermined its popularity.

Collodion nitrocellulose with 12% nitrogen finds much use in the manufacture of propellants and of gelatin dynamites. The highest degree of nitration which still gives a product soluble in mixed alcohol-ether solvents is 12.6%. This material, discovered by Dmitri Mendeleyev and known as pyrocellulose, is extensively used for the manufacture of propellants. Guncotton, with more than 13% nitrogen and soluble in acetone only, is also used for propellants, either alone or in combination with lower grades of nitrocellulose. Moist guncotton was once widely used as a high explosive, but it has been replaced by safer materials.

The nitration of cellulose is accompanied by a varying degree of depolymerization of the large molecules. For the manufacture of gun propellants the depolymerization is largely avoided, but with materials intended for the manufacture of lacquers it is deliberately encouraged since depolymerized nitrocellulose gives solutions of low viscosity which are desirable for this application. *See* EXPLOSIVES; PROPELLANTS.

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NITRO COMPOUNDS. Organic compounds in which one or more hydrogen atoms are replaced by the nitro (NO,) group are called nitro compounds. Two main classes are recognized: aromatic and aliphatic.

Aromatic Nitro Compounds.—Aromatic hydrocarbons are substances which contain only carbon and hydrogen and which have at least one benzene ring of six carbon atoms; the parent member of this group is benzene, C_6H_6. Replacement of a hydrogen atom by a nitro group produces an aromatic nitro compound; *e.g.,* from benzene, C_6H_6, nitrobenzene, $C_6H_5NO_2$, is obtained. Substitution of two or more hydrogens by a corresponding number of nitro groups is also possible. An important example is the replacement of three of the hydrogens of toluene, C_7H_8, which gives trinitrotoluene (TNT), $C_7H_5(NO_2)_3$.

Replacement of a hydrogen atom by a nitro group is known as nitration and is most commonly effected by treating the aromatic compound with a mixture of concentrated nitric and sulfuric acids. The equation for the nitration of benzene is

$$C_6H_6 + HONO_2 \longrightarrow C_6H_5NO_2 + H_2O$$

For a long time it was thought that the sulfuric acid facilitated nitration by combining with the water formed, but this is now known not to be the case. Instead, the sulfuric acid, by reacting with the nitric acid, converts it into the nitronium ion, NO_2^+, and this is the actual nitrating agent.

Nitrations are carried out on a commercial scale in large cast-iron vessels equipped with devices through which cooling water can be circulated to remove the heat of reaction. As much as 1,000 gal. of benzene is nitrated at one time. As successive nitro groups are introduced into an aromatic compound, more drastic conditions must be employed. Thus, the preparation of TNT (*q.v.*) is usually carried out in three successive steps in each of which higher temperatures and stronger acids are used.

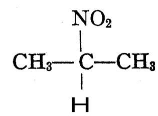
Many aromatic nitro compounds cause pronounced physiological reactions and care should be taken to avoid breathing their vapour and also to avoid contact with the skin. Aromatic nitro compounds are heavier than water and practically insoluble in it. Most are solids, although a few, including nitrobenzene, are liquids. Commercial preparations of nitrobenzene, trinitrobenzene and TNT usually have a yellowish colour, but the highly purified substances are colourless.

Nitrobenzene was first prepared in 1834 by Eilhardt Mitscherlich. Because of its characteristic odour it was called artificial oil of bitter almonds and was formerly employed as a flavouring principle and as an adulterant of oil of bitter almonds. It is highly toxic and such uses have been discontinued. Nitrobenzene was also used as a solvent for shoe dyes because it penetrates leather, but poisoning resulted by absorption of the vapours through the skin. Such formulations are now prohibited in most countries. Nitrobenzene is an excellent solvent for a wide variety of organic compounds.

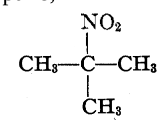
A number of polynitro aromatic compounds are used as explosives; *e.g.,* N,2,4,6-tetranitroaniline (tetryl), TNT and the ammonium salt of picric acid (2,4,6-trinitrophenol). In peacetime, by far the major fraction of aromatic nitro compounds produced is converted into various derivatives. Aromatic nitro compounds are the starting point in the manufacture of many commonly used dyes. Derivatives of aromatic nitro compounds are also widely used as pharmaceuticals and to some extent as photographic chemicals and as chemicals used in the manufacture of rubber articles.

The most characteristic reaction of aromatic nitro compounds is reduction. A variety of reducing agents convert nitrobenzene, $C_6H_5NO_2$, into the aromatic amine aniline, $C_6H_5NH_2$. By use of milder reducing agents and control of the acidity or alkalinity of the reaction mixture, it is possible to stop the reduction at various intermediate stages. Consequently. a variety of compounds, in addition to amines, is readily available by controlled reduction of aromatic nitro compounds.

Aliphatic Nitro Compounds.—Aliphatic hydrocarbons contain only carbon and hydrogen and may be considered as derived from methane, CH,. Replacement of a hydrogen atom by a nitro group gives aliphatic nitro compounds (commonly called nitroparaffins). Typical examples are: nitromethane, CH_3NO_2; 1-nitropropane, $CH_3CH_2CH_2NO_2$; 2-nitropropane,



and 2-methyl-2-nitropropane,



In contrast to the other hydrogen atoms, those hydrogen atoms attached to the carbon atom holding the nitro group are somewhat acidic; *i.e.,* they are removed under the influence of bases. The resulting salts are highly reactive and many of the characteristic reactions of nitroparaffins proceed via these salts.

Nitroparaffins are classified as primary, secondary or tertiary. Primary nitroparaffins have two (or three) hydrogen atoms attached to the carbon holding the nitro group; *e.g.,* 1-nitropropane, nitromethane and nitroethane, $CH_3CH_2NO_2$. Secondary nitroparaffins have but one hydrogen atom on the carbon holding the nitro group, *e.g.,* 2-nitropropane, while tertiary nitroparaffins have no hydrogen atoms attached to the carbon holding the nitro group; *e.g.,* 2-methyl-2-nitropropane. Tertiary nitroparaffins do not react with bases and, hence, they fail to exhibit many of the common reactions of primary and secondary nitroparaffins.

Aliphatic hydrocarbons are much more resistant to direct nitration than the aromatic hydrocarbons, and because of this it was not until 1940 that nitroparaffins were produced commercially. The nitration of aliphatic hydrocarbons employs nitric acid alone and relatively high temperatures (300°–500° C.) are required. A mixture of products results. For example, when propane, C_3H_8, is nitrated the products 1-nitropropane, 2-nitropropane. nitroethane and nitromethane are all formed. While satisfactory for the production of these simple nitroparaffins, the aliphatic nitration process is not suitable for the synthesis of higher members of the nitroparaffin series.

The reaction by which aliphatic nitro compounds were first prepared in 1872 is useful only for the synthesis of primary nitroparaffins. The synthesis of 1-nitrodecane is illustrative:

$$\underset{\text{1-bromodecane}}{CH_3(CH_2)_9Br} + \underset{\text{silver nitrite}}{AgNO_2} \rightarrow \underset{\text{1-nitrodecane}}{CH_3(CH_2)_9NO_2} + \underset{\text{silver bromide}}{AgBr}$$

In 1955 it was discovered that, contrary to the accepted view, if sodium nitrite ($NaNO_2$) is employed in place of silver nitrite then the reaction is valuable for the production of primary and secondary nitroparaffins.

Tertiary nitro compounds are best obtained by oxidizing the corresponding amines with potassium permanganate ($KMnO_4$):

$$(CH_3)_3C.NH_2 + KMnO_4 \rightarrow (CH_3)_3C.NO_2 + H_2O$$

The lower nitroparaffins are colourless liquids of mild odour. In contrast with the aromatic nitro compounds the nitroparaffins have about the same toxicity as petroleum naphtha. The nitroparaffins are only slightly soluble in water. Boiling points of the four lowest members are: nitromethane, 101.2° C.; nitroethane: 114° C.; 2- and 1-nitropropane, 120.3° C. and 131.6° C.

The aliphatic nitro compounds are excellent solvents. They have also found use as fuels and as starting materials in synthesis.

A sensitized form of nitromethane is used as an explosive. Chloropicrin. $Cl_3C.NO_2$, is a grain fumigant, being especially effective against weevils. Chloropicrin is also a powerful lachrymator and this leads to its use as a tear gas and as a warning agent for other fumigants. Tetranitromethane, $C(NO_2)_4$, a colourless liquid. when mixed with organic compounds is liable to produce a violent explosion.

Nitroparaffins are readily reduced to amines; *e.g.*, nitroethane, $CH_3CH_2NO_2$, gives ethyl amine. $CH_3CH_2NH_2$. This reaction greatly extends the utility of the nitroparaffins by making numerous aliphatic amines readily available.

See also BLASTING; EXPLOSIVES; NITROGLYCERIN; TNT.

(N. KM.)

NITROGEN is a colourless! odourless, tasteless gas, which is incombustible, does not support combustion or respiration, and is one of the most widespread elements. It occurs free in the atmosphere and in various compounds, some of which are found in the proteins of plants and animals and others of which constitute important drugs. dyes and other chemicals. Symbol N, atomic number 7, atomic weight 14.008. The free element consists of nitrogen molecules, N_2. Its existence was first recognized by K. W. Scheele (1772), who showed that common air is a mixture of two gases, which he called "foul air" (nitrogen) and "fire air" (oxygen). He obtained the foul air by removing the fire air in combination with various combustible or oxidizable materials, and showed that the residue would not support combustion or respiration.

Nitrogen was also, independently, discovered by Joseph Priestley and Daniel Rutherford about the same time. Antoine Lavoisier named the gas "azote," from its inability to support life, and recognized that it is an element. The name nitrogen was introduced by J. A. C. Chaptal (1790) to indicate that the element is a constituent of nitre.

Nitrogen occurs in the atmosphere to the extent of approximately 78% by volume and 75.5% by weight, and serves to dilute the oxygen. Free nitrogen is also found in many meteorites, in volcanic gases and gases in mines and from some mineral springs; its presence in the sun and in certain stars and nebulae is shown by the spectroscope. In combination, it is found in nitre or saltpetre (potassium nitrate), Chile saltpetre (sodium nitrate), ammonia and ammonium salts in the atmosphere, in rain, soil and guano, and as complex organic compounds (proteins), with an average of 16% of nitrogen, in living organisms.

Preparation and Uses.—Nitrogen may be prepared (1) from atmospheric air by removal of the oxygen, or (2) from its compounds. Atmospheric nitrogen contains about 1% of inert gases (argon, etc.).

1. The oxygen is removed from air by exposure to phosphorus at ordinary temperature (burning phosphorus is not so effective), to moist iron filings, an alkaline solution of pyrogallol, an acid solution of chromous chloride or cuprous chloride, or metallic copper id presence of hydrochloric acid or ammonia, or by passing air over red-hot copper.

On the large scale, nitrogen is made almost entirely by the fractional distillation of liquid air, in which process, since it has a lower boiling point than oxygen. it tends to evaporate first. The gas is marketed in gray cylinders under a pressure of about 120 atm. This gas contains most of the helium and neon present in air (see ATMOSPHERE), but the argon. which has nearly the same boiling point, mostly remains with the oxygen.

2. Pure nitrogen is made from its compounds: (a) by passing chlorine into ammonia solution. $2NH_3+3Cl_2=N_2+6HCl$; (*b*) by heating a solution of ammonium nitrite (or a mixture of sodium nitrite and ammonium chloride), $NH_4NO_2=N_2+2H_2O$; (*c*) by heating ammonium dichromate, $(NH_4)_2Cr_2O_7=N_2+Cr_2O_3+4H_2O$; (d) by passing a mixture of nitric oxide and ammonia gas over red-hot copper, $6NO+4NH_3=5N_2+6H_2O$; (e) in a very pure state by heating sodium or barium azide in a vacuum, $Ba(N_3)_2=Ba+3N_2$. The gas may be collected over water.

Nitrogen gas is used in filling the larger or cheaper kinds of electric bulbs (argon [*q.v.*] is used for the smaller, more expensive ones) to prevent blackening of the bulb by volatilized metal from the filament. which can thus be run at a higher temperature. High-temperature mercury thermometers may contain compressed nitrogen. Large quantities of nitrogen are used to make synthetic ammonia and other nitrogen compounds (such as nitric acid) which are needed in the production of dyes, drugs, explosives and fertilizers.

Properties.—Nitrogen gas is only slightly soluble in water, but one volume of liquid oxygen dissolves about 450 vol. of the gas. On strong cooling under pressure, nitrogen forms a colourless liquid, boiling at −195.84° C., at which temperature its specific gravity is 0.8042 g. per millilitre. The critical temperature is −147.13° C. and the critical pressure 33.49 atm. On rapid evaporation under reduced pressure the liquid freezes to a colourless solid melting at −210.02° C. The density of nitrogen gas at 0° C. and 760 mm. pressure is 1.25051 g. per litre when gravity acceleration= 980.66; $cm./sec.^1$

The element has two stable isotopes with masses 14 and 15, enrichment in N^{15} being achieved by an exchange reaction between ammonia gas and ammonium sulfate solution. Rutherford showed that the nitrogen atom is disintegrated by the impact of swift α particles, and protons (hydrogen nuclei) are expelled from its nucleus. Radioactive isotopes N^{13} and N^{16} are formed artificially in various ways; *e.g.*, N^{13} by bombarding carbon with deuterons, C^{12} (d, n) N^{13}.

Nitrogen gas is somewhat inert, since the heat of dissociation of the nitrogen molecule into atoms is large (170, or 225, kg.cal. per mole), but it can unite directly under certain conditions with several elements, including hydrogen, oxygen, boron, silicon, lithium, magnesium, calcium, barium, titanium, vanadium, tantalum, tungsten and manganese. The compounds with metals (nitrides) may be decomposed by water under various conditions, with evolution of ammonia.

Active Nitrogen.—When a current of nitrogen gas containing a trace of oxygen or other impurity is exposed at low pressure to a high-tension electric discharge, the gas beyond the discharge glows with a yellow light and is more active chemically than ordinary nitrogen (Lord Rayleigh, 1911). It does not react with molecular hydrogen or oxygen but forms ammonia with atomic hydrogen, combines with sulfur, phosphorus and several metals, forming nitrides, decomposes nitric oxide into oxygen and nitrogen, and forms hydrocyanic acid with acetylene. The nature of this so-called active nitrogen is still uncertain, but it probably contains nitrogen atoms, both normal and excited. In a bulb coated with metaphosphoric acid, the glow persists for several hours.

The Nitrogen Cycle.—Animals derive the nitrogen of their tissue proteins partly from animal proteins and partly (sometimes wholly) from vegetable proteins of food. Plants synthesize their proteins from inorganic compounds in the soil and to some extent from free nitrogen in the atmosphere. Daniel Berthelot found that sterilized soils do not take up nitrogen from the air, hence he concluded that microorganisms are concerned with the assimilation.

Leguminous plants such as peas, beans and clover can utilize atmospheric nitrogen by the action of a bacterium *Rhizobium* (or *Pseudomonas radicicola)*, of which there are several strains. The process takes place through the root hairs and involves the production of nodules on the roots, which contain Y-shaped associations of bacteria that are called bacteroids. Free-living anaerobic bacteria in the soil which are able to fix nitrogen are *Clostridium pasteurianum* (S. Vinogradsky, 1893) and *Azotobacter chroococcum (M*. W. Beijerinck, 1901). Certain algae also fix nitrogen and are of importance in tropical soils. The amount of nitrogen fixed by bacteria increases by 30% if certain protozoa are present in the soil, although protozoa feed on bacteria.

Ammonium salts in the soil are oxidized to nitrates by the agency of microorganisms, the process being called nitrification (S. Vinogradsky, 1890). They are first oxidized to nitrites by organisms belonging to the genera *Nitrosomonas,* and the nitrites are then oxidized to nitrates by another bacterium called *Nitrobacter.* The processes depend on free aeration and a neutral or alkaline reaction in the soil. The nitrate is assimilated but is reduced in the plant to ammonia.

Other kinds of bacteria decompose nitrogen compounds in the soil and, by this process of denitrification, return free nitrogen to the air. The combined nitrogen content of cultivated soil is generally enriched and renewed by means of nitrogenous fertilizers such as nitrates and ammonium salts.

Nitrogen is also fixed in the form of oxides by electrical discharges in the atmosphere, and conveyed to the soil in the form of nitric and nitrous acids by rain, these acids forming nitrates and nitrites in the soil. Altogether about 250,000 tons of nitric acid are said to be formed in this way in 24 hours. Some observations show, however, that the combined nitrogen content of rain does not increase during a thunderstorm.

Compounds of Nitrogen and Hydrogen. — Nitrogen forms three compounds with hydrogen, ammonia (*q.v.*), NH_3; hydrazine, N_2H_4; and hydrazoic acid or azoimide, HN,. Ammonia and hydrazine normally function as bases and form secondary compounds, N_4H_4 and N_5H_5, respectively, with hydrazoic acid. With alkali metals, ammonia and hydrazine form compounds in which part of their hydrogen is replaced by a metal.

Hydrazine (*q.v.*), N_2H_4, with the structure $H_2N.NH_2$ (diamide), was originally obtained by T. Curtius (1887) from organic compounds containing two nitrogen atoms linked together. It is made commercially by a process devised by Friedrich Raschig (1907). Sodium hypochlorite solution is mixed with a small quantity of glue and warmed with excess of concentrated ammonia. An intermediate compound called chloramine, NH_2Cl, is formed. which reacts with the excess of ammonia to form hydrazine. After addition of sulfuric acid and cooling, hydrazine sulfate, $2N_2N_4,H_2SO_4$, crystallizes. When this is distilled under reduced pressure with concentrated potassium hydroxide solution, a colourless fuming liquid, called hydrazine hydrate, is obtained. From this, anhydrous hydrazine is obtained by distilling with solid sodium hydroxide or barium oxide (which remove water) under reduced pressure. It is a colourless liquid, boiling point 113.5° C., which freezes to a white crystalline solid, melting point 2° C. Hydrazine decomposes on heating, $3N_2H_4=N_2+4NH_3$, and reacts violently with halogens, forming nitrogen and halogen hydracids, $N_2H_4+2I_2=N_2+4HI$. Hydrazine rapidly destroys cork and rubber and when hot attacks glass. It is a weaker base than ammonia, forming two series of salts; *e.g.*, N_2H_4, HCI and N_2H_4, 2HCl. Hydrazine and its salts are poisonous. They are very powerful reducing agents, precipitating many metals from solutions of their salts.

Hydrazoic acid (*q.v.*), HN_3, also discovered by Curtius (1890), is formed by the action of an oxidizing agent; *e.g.*, nitric acid, on hydrazine, $3N_2H_4+5O=2HN_3+5H_2O$. The sodium salt is formed on passing nitrous oxide over heated sodamide, $NaNH_2+N_2O=NaN_3+H_2O$. Pure hydrazoic acid is a colourless liquid (boiling point 37" C., melting point −80° C.), with a very unpleasant odour. It is very dangerously poisonous and explosive, decomposing with a blue flash on heating. The solution is acid and dissolves many metals forming salts called azides, which, especially those of the heavy metals, are explosive; lead azide is used as a detonator instead of mercury fulminate. In its action on metals nitrogen is evolved (not hydrogen, except a trace with magnesium), and part of the acid is reduced to ammonia. With ammonia and hydrazine it forms the colourless crystalline compounds NH_3,HN_3 (or N_4H_4) and $N_2H_4HN_3$ (or N_5H_5). The group $-N_3$ in hydrazoic acid behaves like a halogen; azides give a white precipitate of AgN_3 with silver nitrate. From X-ray spectra it is shown that the three nitrogen atoms in the group are in a straight line, not, as formerly supposed, in a ring.

Oxides of Nitrogen. — The oxides of nitrogen are: nitrous oxide, N_2O; nitric oxide, NO; dinitrogen trioxide, N_2O_3; nitrogen dioxide, NO_2, and its polymer, dinitrogen tetroxide, N_2O_4; dinitrogen pentoxide, N_2O_5; and an unstable higher oxide of uncertain formula, perhaps NO_3.

Nitrous oxide, N_2O, was discovered by Joseph Priestley (1772) by exposing "nitrous air" (NO) to iron or alkali sulfides, when the gas diminished in volume and became a better supporter of combustion than common air. It was studied by Sir Humphry Davy (*q.v.*) (1799), who called it nitrous oxide and prepared it by heating ammonium nitrate, $NH_4NO_3=N_2O+2H_2O$, the method now used. He showed that it has anesthetic properties, in some cases preceded by peculiar effects which led to its name "laughing gas." Nitrous oxide can be synthesized from its elements only with difficulty and under special conditions (D. L. Chapman, R. A. Goodman and R. T. Shepherd, 1926). It is produced by the reduction of nitric acid under certain conditions; *e.g.*, by the action of zinc on the dilute acid. In the pure state it is made by the action of hydroxylamine hydrochloride on sodium nitrite in equimolecular proportions in solution, hyponitrous acid being an intermediate product. $NH_2OH+HNO_2=N_2O+2H_2O$. It is formed in special circumstances by the oxidation of ammonia.

Nitrous oxide is a colourless gas with a pleasant sweetish odour and taste, density 1.9777 g. per litre, $1\frac{1}{2}$ times that of air. At 15° C. one volume of water dissolves 0.7778 vol of nitrous oxide, forming a neutral solution. It is more soluble in alcohol (3.268 vol. at 15° C.). Nitrous oxide supports combustion better than common air (it kindles a glowing chip, like oxygen), because it decomposes into a mixture of one volume of oxygen and two volumes of nitrogen at a fairly low temperature (beginning at 520° C.). It is an endothermic compound; *i.e.*, contains more energy than its elements and can be decomposed into oxygen and nitrogen by the explosion of a detonator. The molecule is linear, the two nitrogen atoms being adjacent. On cooling or under pressure (50 atm. at 15° C.) it forms a colourless liquid, boiling point −88.7" C., on rapid evaporation of which a white solid, melting point −90.8° C., is formed. The critical temperature is 36.5° C. and the critical pressure 71.66 atm.

The chief use of nitrous oxide is as an anesthetic in operations of short duration, but prolonged inhalation of the pure gas causes death. About 22 1 is required to produce insensibility, and oxygen is usually administered as well. A very pure gas must be used; it is made by the decomposition of ammonia nitrate by heat, the temperature being carefully regulated to avoid the formation of ammonia and nitric oxide, and minimize the formation of nitrogen. The gas is washed with solutions of ferrous sulfate and potassium hydroxide, and with milk of lime, and the gas is dried and liquefied by pressure in steel cylinders. One kilogram of ammonium nitrate gives 182 1. of the gas. Nitrous oxide may be used in making artificially whipped cream, being dissolved in the cream under pressure and liberated in small bubbles when the pressure is released.

Nitric oxide, NO, which is formed from its elements by the action of electric sparks or a high temperature, $N_2+O_2=2NO$, was first obtained by J. B. van Helmont about 1620, and R. Boyle (1660), but was more carefully studied by Priestley (1772), who called it "nitrous air," and obtained it by the action of dilute nitric acid on copper or mercury, $3Cu+8HNO_3=3Cu(NO_3)_2+2NO+4H_2O$. Copper turnings and a mixture of equal volumes of nitric acid and water may be used. The gas so prepared contains nitrogen and nitrous oxide. The pure gas is obtained by shaking a mixture of nitric acid and concentrated sulfuric acid with mercury, or by dropping a solution of sodium nitrite and potassium ferrocyanide into dilute acetic acid, $Fe(CN)_6^{---}+NO_2^-+2H^+ \rightarrow Fe(CN)_6^{--}+NO+H_2O$, or by the action of sodium nitrite solution on an acidified solution of potassium iodide, $2NO_2^-+2I^-+4H^+ \rightarrow I_2+2NO+2H_2O$. The colourless gas may be collected over water, or, if required pure, over mercury. It has a density of 1.3402 g. per litre, slightly greater than that of air. At 15° C., one volume of water dissolves only 0.051 vol. of the gas. It is not easily liquefied and has a boiling point of $-151.7°$ C. and a melting point of $-163.6°$ C. The liquid and solid are distinctly blue. The critical temperature is $-96°$ C. and the critical pressure 64 atm. The molecule contains an odd electron in its structure, and nitric oxide is paramagnetic, its susceptibility being half that of oxygen.

Nitric oxide, although it is endothermic, is the most stable oxide of nitrogen, being dissociated into its elements only to about 3.5% at 1,000° C. Consequently. burning substances continue to burn in the gas only if they have previously attained a high temperature. A taper, burning sulfur or feebly burning phosphorus is extinguished, but brightly burning phosphorus burns brilliantly in the gas. A mixture of nitric oxide and carbon disulfide vapour burns with a brilliant lilac-coloured light, very rich in actinic rays. Nitric oxide combines rapidly with oxygen to form the dioxide, NO_2, which appears as red fumes when nitric oxide is exposed to air. The reaction involves three molecules, $2NO+O_2=2NO_2$, and slows down appreciably in its later stages, so that a short time of contact is necessary for complete oxidation, and with dilute gases several minutes may be needed. This is important in technology (see NITROGEN, FIXATION OF). Nitric oxide dissolves to form a black liquid in cold ferrous sulfate solution, but is expelled again on warming. The best solvent is a slightly alkaline solution of sodium sulfite, when the compound $Na_2(NO)_2SO_3$ is formed. At the temperature of liquid oxygen, it reacts with fluorine to form *nitryl* fluoride, $4NO+F_2=2NO_2F+N_2$, a halogen derivative of nitric acid (melting point $-166°$ C., boiling point $-72.4°$ C.). The compounds NO_3F and NO_2Cl are also known. Nitric oxide and all higher oxides of nitrogen are poisonous.

Dinitrogen trioxide (nitrous anhydride), N_2O_3, was obtained by J. R. Glauber (1648). When nitric acid (56%) is distilled with arsenious oxide or starch, and the red vapour cooled in a freezing mixture, dark-blue liquid N_2O_3 is obtained, $2HNO_3+As_2O_3=N_2O_3+H_2O+As_2O_5$. On evaporation, the liquid decomposes almost completely into nitric oxide and nitrogen dioxide, but these recombine on liquefaction by cooling: $N_2O_3 \rightleftarrows NO+NO_2$. Although the gas is mainly a mixture of nitric oxide and nitrogen dioxide: only about 2% of N_2O_3 being present at 1j° C., it is absorbed by solutions of alkalies with formation of nitrites, and by concentrated sulfuric acid with formation of nitrososulfuric acid ("chamber crystals"), thus behaving as if it consisted of N_2O_3. As absorption proceeds, the equilibrium is displaced to the left in the above equation. Only traces of nitrous acid are formed by the action of water, since the acid is unstable and decomposes, partly into dinitrogen trioxide (to which the blue colour of the solution is due) and water, and partly into nitric oxide and nitric acid: $3HNO_2=HNO_3+2NO+H_2O$. According to H. B. Baker and M. Baker (1900), when liquid dinitrogen trioxide is dried by long exposure to phosphorus pentoxide, the vapour formed from it consists of N_4O_6 molecules, but other workers could not repeat this experiment.

Sodium nitrite, $NaNO_2$, an important salt used in many organic preparations (*e.g.*, of dyestuffs), is mostly manufactured by absorbing higher oxides of nitrogen formed by the oxidation of ammonia in alkali solutions. Older methods of preparation are by heating molten sodium nitrate with metallic lead, $NaNO_3+Pb=NaNO_2+PbO$, or by adding sulfur to fused sodium nitrate and sodium hydroxide: $3NaNO_3+S+2NaOH=3NaNO_2+Na_2SO_4+H_2O$. Nitrites are reducing agents, forming nitrates, usually in acid solution, but they also liberate iodine from acidified potassium iodide, being reduced to nitric oxide (see above).

The chloride of nitrous acid, *nitrosyl* chloride, NOCl, is a yellow gas formed by the direct combination of nitric oxide and chlorine, by the action of phosphorus pentachloride on sodium nitrite, by heating nitrososulfuric acid with sodium chloride, or (together with chlorine) by heating a mixture of concentrated nitric and hydrochloric acids (aqua regia): $HNO_3+3HCl=NOCl+Cl_2+2H_2O$. It has been used for bleaching flour.

Nitrogen dioxide, NO_2, and dinitrogen tetroxide, N_2O_4, exist in equilibrium in varying proportions as a red gas, the mixture being sometimes called "nitrogen peroxide." The gas is formed by the direct. union of nitric oxide and oxygen (see above). Nitrogen dioxide is usually prepared by heating dry lead nitrate, $2Pb(NO_3)_2=2PbO+4NO_2+O_2$, and condensing the nitrogen dioxide to a liquid in a tube cooled in a freezing mixture, the oxygen passing on. A very pure gas is made by warming nitrososulfuric acid with potassium nitrate: $SO_2(OH).O.NO+KNO_3=KHSO_4+2NO_2$, or by adding fuming nitric acid and phosphorus pentoxide to liquid dinitrogen trioxide, and distilling: $N_2O_3+N_2O_5=2N_2O_4$. Dinitrogen tetroxide in a good freezing mixture solidifies to nearly colourless crystals (the liquid supercools), melting at $-9.04°$ C. to a honey-coloured liquid. Both these forms consist mainly of N_2O_4. On warming, the liquid becomes red, because of formation of nitrogen dioxide molecules, $N_2O_4 \rightleftarrows 2NO_2$, and boils at 21.9° C. to form a red vapour. On heating, the colour of the gas deepens, because of further dissociation, and at 140° C. it is nearly black, dissociation being then complete. At still higher temperatures, nitrogen dioxide dissociates into nitric oxide and oxygen, this being complete at 620° C., when the gas is colourless, $2NO_2=2NO+O_2$. On cooling. all these changes are reversed. Since the volume increases, the extent of dissociation may be calculated from the density of the gas. At atmospheric pressure it varies from about 15% at the boiling point to 89.3% at 100° C., and 100% at 140° C.

The gas kindles a glowing chip and supports the combustion of brightly burning phosphorus. A mixture with hydrogen is reduced to ammonia when passed over heated platinum. With water, the liquid, or gas, forms nitric and nitrous acids, $2NO_2+H_2O=HNO_3+HNO_2$, and the nitrous acid decomposes (see above). With ice-cold water, blue liquid dinitrogen trioxide separates.

In the absorption of nitrous fumes in water, as in the preparation of nitric acid by the oxidation of ammonia. the evolution of nitric oxide necessitates adequate oxidation space for its reoxidation to nitrogen dioxide. Alkalies absorb the gas with formation of nitrite and nitrate. $2NO_2+KOH=KNO_2+KNO_3+H_2O$, the process being somewhat slower than in the case of dinitrogen trioxide. The liquid forms a violently explosive mixture with gasoline or other hydrocarbons: which has been used for aerial bombardment. The gas diluted with air is used in bleaching flour.

Dinitrogen pentoxide (nitric anhydride), N_2O_5, was discovered by E. H. Sainte-Claire Deville (1849) by the action of dry chlorine or warm silver nitrate, $4AgNO_3+2Cl_2=4AgCl+2N_2O_5+O_2$. It is best prepared by adding phosphorus pentoxide to a cooled concentrated nitric acid, then distilling the product in a current of ozonized oxygen, drying the gas with phosphorus pentoxide and condensing in a receiver cooled in solid carbon dioxide and ether: $2HNO_3+P_2O_5=N_2O_5+2HPO_3$.

It is also iormed by passing ozonized oxygen into cooled liquid dinitrogen tetroxide: $N_2O_4+O_3=N_2O_5+O_2$. The colourless crystals are stable below 0° C.. but are very hygroscopic. On warming they sublime, but if not quite pure they melt with some decomposition into nitrogen dioxide and oxygen, and also decompose on exposure to light. Rapid heating causes explosion. Phosphorus and potassium burn in the liquid on warming, and charcoal burns if previously ignited. With water, nitric acid is formed.

Trinitrogen tetroxide, N_3O_4, is said to be formed as a greenish solid by passing nitric oxide into liquid oxygen, or by the action of air on solid nitric oxide at the temperature of liquid air. It decomposes into dinitrogen trioxide and nitric oxide above the temperature of liquid air (R. L. Hasche. 1925). A higher oxide of nitrogen, perhaps NO_3, is apparently formed by the action of an electric discharge on a mixture of nitrogen and oxygen, and has a characteristic absorption spectrum.

Hyponitrous acid, $H_2N_2O_2$, with the structure HO.N‖N.OH, is formed by the action of nitrous acid on hydroxylamine *(see* above), but is best obtained as a salt by the reduction of a solution of sodium nitrite with sodium amalgam: $2NaNO_2+4Na+2H_2O=Na_2N_2O_2+4NaOH$ (Edward Divers. 1871). The free acid is obtained in colourless crystals, which at once decompose with feeble explosion, $H_2N_2O_2=N_2O+H_2O$, by the action of dry hydrogen chloride in ether on silver hyponitrite, and evaporation at room temperature. The acid and its salts are reducing agents. An isomer of hyponitrous acid is *nitramide,* perhaps with the formula NH_2NO_2. *Oxyhyponitrous acid* (hyponitric acid, or nitrohydroscylamine), $H_2N_2O_3$, is known in the form of salts.

Nitrogen **Halides.**—*Nitrogen trifluoride,* KF_3. is a colourless gas. melting point −208.5° C., boiling point −129° C., formed by the electrolysis of ammonium hydrogen fluoride (O. Ruff and L. Staub, 1928). *Nitrogen trichloride,* NCl_3, is a yellow, very explosive oil, formed by the action of chlorine on ammonium chloride solution, or the action of excess of chlorine on ammonia (P. L. Dulong, 1811): $NH_3+3Cl_2=NCl_3+3HCl$. In the last reaction, two intermediate compounds are formed, viz., *monochloramine,* NH_2Cl, which has been obtained pure in colourless crystals, melting point −66° C., and *dichloramine,* $NHCl_2$, known only in solution, iormed by acidifying monochloramine solution. Nitrogen trichloride boils at 71° C., but easily decomposes with violent explosion on heating or shock. The vapour has a pungent smell and attacks the eyes and mucous membranes. The liquid explodes on exposure to bright light, and in contact with turpentine and with many solids. It is decomposed by ammonia. A solution in benzene is fairly stable. The vapour is used in bleaching flour (agene process).

Nitrogen tribromide, NBr_3, and the compounds NH_2Br and $NHBr_2$ have been reported. *Nitrogen iodide* was obtained by B. Courtois (1812) as a black powder by the action of ammonia solution on iodine, and drying at room temperature on filter paper. Its formula is NI_3NH_3 (F. D. Chattaway, 1900). It is very explosive, detonating when gently pressed, with evolution of violet fumes of iodine. It is an oxidizing agent. *Nitrogen tri-iodide,* NI_3, is a black powder obtained by the action of ammonia gas on potassium iodobromide, $KIBr_2$, washing with water, and drying (H. W. Cremer and D. R. Duncan, 1930). (*See* also AMMONIA; HYDRAZINE; HYDRAZOIC ACID; HYDROXYLAMINE; NITRIC ACID AND NITRATES; NITROGEN, FIXATION OF.)

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NITROGEN, FIXATION OF. The term "fixation of nitrogen" has been given to any chemical process whereby "free" nitrogen, one of the elements, is caused to combine chemically with other elements to form nitrogen compounds. The atmosphere is a great reservoir of nitrogen, this element accounting for nearly four-fifths of the volume.

Nitrogen is chemically inert, and, under ordinary conditions, does not react with other elements. A number of rather drastic processes have been discovered for "fixing" nitrogen (*i.e.,* causing it to enter into chemical combinations) but these are processes one would not expect to find operative in nature. Yet, nitrogen in combined form is found in all fertile soils, in every living thing, in many foodstuffs, in silk, wool and feathers: in coal and in such naturally occurring chemicals as saltpetre and ammonia. Fixed nitrogen is found in the basic substance of living matter, the protoplasm; it is present in the nucleus of every living cell.

During the early decades of the 19th century, Nicolas Théodore de Saussure. Jean Baptiste Boussingault, Justus von Liebig and others demonstrated that growing plants obtain their fixed nitrogen from the soil. Animals, in turn, secure their fixed nitrogen through the consumption of plants or of other animals which use plants as food. The astonishing fact was discovered, however, that when crops were removed from a field, the decrease in the fixed-nitrogen content of the soil was less than the amounts accounted for by the crop removals. Liebig rightly concluded that the fixed-nitrogen supply of the soil was replenished from the atmosphere, but he contended that the process did not involve any fixation of free atmospheric nitrogen. Since he knew that rain water always contains traces of dissolved nitrogen compounds, and that both animal and vegetable matter release ammonia during decay. Liebig postulated that the released ammonia was returned to the earth in rain water. This "ammonia cycle," from earth to atmosphere and return to earth. does occur, but it accounts for only a small part of the fixed nitrogen that the soil receives from the atmosphere. Not until 1886 was it known that certain microorganisms are able to fix atmospheric nitrogen and thus replenish the soil's supply. Of these, the most important are the *Rhizobium* genera of bacteria and the *Azotobacter*. The former are found on the roots of leguminous plants and the latter live independently in the soil. The process by which these bacteria fix nitrogen mas not known at mid-20th century. It was virtually certain that bacteria do not use known chemical methods for the fixation of nitrogen. Although Liebig and his contemporaries did not arrive at a correct explanation as to the source of fixed nitrogen in the soil, they did make clear the importance of fixed nitrogen in agriculture. Nitrogenous materials long had been used as fertilizers without understanding of the reason for the beneficial effects. As a result of the new knowledge, ammonia released in making coke from coal was recovered and utilized as fertilizer, as was sodium nitrate from deposits in Chile. Wherever agriculture was practised intensively there developed a demand for nitrogen compounds to supplement the natural supply of the soil.

In addition to the demand for fixed nitrogen in agriculture, there were other urgent and growing needs for nitrogen compounds. The increasing quantity of saltpetre used in the manufacture of gunpowder led to a world-wide search for natural deposits of this nitrogen compound. Industrial demands and the advent of high explosives called for an ever larger supply of fixed nitrogen. By the end of the 19th century it was clear that recoveries from the coal-carbonizing industry and the importation of Chilean nitrate could not meet future agricultural and industrial demands. Moreover. it was obvious that in the event of a major war a nation cut off from the Chilean supply soon would be unable to manufacture munitions in adequate amounts. It appeared that the fixation of atmospheric nitrogen offered the only solution. During the final decade of the 19th century and the opening decade of the 20th century, intensive efforts culminated in the development of commercial nitrogen fixation processes.

Fixation of Nitrogen as the Oxide.—Air is essentially a mixture of one volume of oxygen with four volumes of nitrogen. Both gases are in the free, or elemental, condition and do not react with each other under ordinary conditions. If, however, air or any other mixture of oxygen and nitrogen is heated to a very high temperature, a small portion of the mixture reacts to form the gas nitric oxide. On allowing the gas mixture to cool slowly, the nitric oxide decomposes almost completely into oxygen and nitrogen. At any given temperature there exists a dynamic equilibrium among the three gases. This may be expressed chemically thus:

$$O_2 + N_2 \rightleftarrows 2NO - 43{,}200 \text{ cal.}$$

The arrows indicate that the reaction may proceed in either direction as conditions change. Although all chemical reactions are of this sort in theory. conditions are often such that the reaction proceeds almost exclusively in one direction. The chemical expression may then be written as an equation. In the reaction now under consideration, both the forward and reverse reactions must be taken into account. Change of pressure has no effect on the equilibrium, but when the temperature is increased the equilibrium shifts to the right; *i.e.,* a larger proportion of nitric oxide is formed. At ordinary temperatures practically no nitric oxide is present, but at the temperature of an electric arc a small percentage of nitric oxide is formed. Inasmuch as the nitric oxide decomposes into its elements on cooling, it would appear that an "arc" process could not serve as a commercial method of nitrogen fixation. It can serve as a practical process, however. when advantage is taken of the rates of the reactions involved. The chemical expression given above is for an equilibrium. It reveals nothing as to the time required to establish the equilibrium. It is well known that most chemical reactions are greatly accelerated as the temperature of the reactants is increased and, conversely, are retarded as the temperature is decreased. In the present case, equilibrium is reached quickly at the very high temperature of the arc. If the mixture of gases then is cooled rapidly, the rate of the reverse reaction drops to nil; *i.e.,* the decomposition of the nitric oxide virtually ceases, and the high-temperature equilibrium is, so to speak. "frozen."

The nitric oxide does not remain long as such in the cooled gas mixture but begins to react with the free oxygen present when the temperature falls below about 600° C., thus:

$$2NO + O_2 \rightleftarrows 2NO_2$$

The indicated reaction proceeds from left to right until nearly all the nitric oxide has been converted to the dioxide, NO_2. The latter polymerizes partially to set up another equilibrium, thus:

$$2NO_2 \rightleftarrows N_2O_4$$

And. when the $NO_2-N_2O_4$ mixture is brought into contact with water, nitric acid (*q.v.*) is formed.

The foregoing facts form the basis for a practical process of nitrogen fixation.

In 1772 the English chemist Joseph Priestley observed that the passage of an electric spark through a small volume of air confined over water brought a decrease in gas volume, and that the water became acidic. Priestley did not interpret this result correctly and two years elapsed before the correct interpretation u-as given by another English chemist, Henry Cavendish. Thus was discovered what later became known as the "spark" or "arc" method of nitrogen fixation. At that time, however, electrical energy was far too costly to permit the use of such a process.

By the end of the 19th century, mechanical means of generating large quantities of electric energy had been evolved, and the use of water power to drive electric generators finally brought the cost of electric energy down to a range where nitrogen fixation by the spark or arc method became economically feasible. Many experimenters then turned attention to the problem, and by 1902 Charles S. Bradley and D. R. Lovejoy had a small plant using a spark process in operation at Niagara Falls, N.Y. This venture failed commercially, however. In 1904 Christian Birkeland of Oslo, Nor., and Samuel Eyde, an engineer, used an arc method in a srnall plant that was the forerunner of large and commercially successful plants. In 1908 a large arc process plant was established at Notodden. Nor. In the Birkeland-Eyde process an electric arc was spread into a disk of flame by means of a magnetic field. Air was blown through the disk and then mixed immediately with cold air. thus "freezing" the high-temperature equilibrium.

Several modifications of the arc process were developed in the first two decades of the 20th century, and small plants were built in countries other than Norway. The arc process was, however, inherently inefficient in the use of energy, and the absorption towers required for the reaction of the nitrogen oxides with water were large and costly. Better methods of fixing nitrogen were soon discovered and the process was eventually abandoned.

In the decade 1940–50 new interest was aroused in the fixation of nitrogen as the oxide through the use of the high temperature and rapid heat exchange and heat economy possible in a "Royster stove." This piece of equipment is a modification of the heat-exchange stoves long in use on blast furnaces, the essential difference being the substitution of small pieces of highly refractory material for the usual brick checkerwork in the stoves. In the process two or more Royster stoves are used. The refractory filling in one such stove is brought up to a high temperature by burning gas therein. Air is then passed through the stove and, at the high temperature prevailing, a small portion of nitric oxide is formed. The high-temperature equilibrium is then "frozen" by passing the hot gas into an unheated stove. The nitric oxide in the cool gas issuing from the second stove may then be recovered. When most of the heat in the first stove has been transferred to the second stove, the direction of air flow through the two stoves is reversed. Inasmuch as the heat transfer between the two stoves cannot be quite complete without disturbing conditions necessary in the process, one stove must be reheated occasionally with gas.

Fixation of Nitrogen as a Cyanide.—Another chemical method of fixing nitrogen was discovered about 1828 by Desfosses, who observed that potassium cyanide was formed when a stream of nitrogen was passed through a red-hot mixture of potash and carbon in an iron tube. In 1842 a small plant using the cyanide method was built in France and was operated for a few years. Many other attempts were made to find a practical process based on cyanide formation. the latest during World War I, but no commercially successful cyanide process had been adopted at mid-20th century.

Fixation of Nitrogen as a Nitride.—At high temperatures nitrogen will combine directly with some metals to form their nitrides (*q.v.*), most of which can be hydrolyzed to form the metal hydroxides and ammonia. During the decade 1909–19, unsuccessful attempts were made to apply a nitride process developed by O. Serpek in which nitrogen, aluminum oxide and carbon were heated together to form aluminum nitride.

Fixation of Nitrogen as a Cyanamide.—During the period 1895–98, Adolph Frank and Nikoden Caro conducted investigations directed toward the improvement of methods for producing cyanides. In the course of this work they discovered that crude calcium carbide and nitrogen would react at 1,000° C. to form calcium cyanamide rather than a cyanide. The chemical reaction may be written thus:

$$CaC_2 + N_2 = CaCN_2 + C$$

Pure carbide reacts slowly, if at all, but the reaction is catalyzed by alkalies or alkaline earths. Calcium fluoride is the catalyst commonly used. Crude calcium cyanamide may be used directly as a fertilizer.

A large calcium cyanamide plant was built in Italy in 1907. Within the next five years, large plants were built in Germany, Dalmatia. France, Switzerland, Norway, Canada and Japan. The cyanamide process was the first nitrogen fixation process to be so widely used. During World War I the United States government built a very large cyanamide plant near Wilson dam, Alabama.

Calcium carbide and nitrogen are the raw materials for the cyanamide process. The nitrogen may be obtained by the partial liquefaction and fractional distillation of air. The carbide is made by the heating of coke and high-grade lime in an electric furnace, the chemical reaction being:

$$CaO + 3C = CaC_2 + CO$$

The carbon monoxide gas escapes from the furnace. The carbide is drawn off in molten form, cooled, ground and then heated to 1,000° C. and treated with nitrogen. The nitrifying reaction is exothermic and continues spontaneously once started. The resultant mass of crude cyanamide is cooled, ground and granulated for use as a fertilizer, or the cyanamide may be hydrolyzed and the fixed nitrogen liberated as ammonia: $CaCN_2+3H_2O=CaCO_3+2NH_3$.

The cyanamide process is an elaborate one. The electric energy required to produce the necessary carbide is relatively large per ton of fixed nitrogen finally obtained, although it is not so large as the energy required in the arc process.

The development of new manufacturing processes has been rapid during the 20th century. Within a decade after the erection of the first plant using the arc process, that process was fast becoming obsolete, and the cyanamide process was also to become obsolete within a decade after its development. Subsequent to World War I, no new cyanamide plants were built, although some of those then extant were still in operation at the beginning of World War II.

FIXATION OF NITROGEN AS AMMONIA

The direct synthesis of ammonia from elemental nitrogen and hydrogen has proved to be the most economical method discovered for the fixation of nitrogen. This method is being utilized in many countries and has become one of the largest and most basic processes of chemical industry the world over.

During the closing decade of the 19th century and the early years of the 20th century many investigators studied the gaseous system nitrogen-hydrogen-ammonia. Among those prominent in this work in the period 1904–08 were F. Haber. G. van Oordt, R. LeRossignol. W. Nernst. F. Jost and K. Jellinek.

The research of Haber and his associates convinced the Badische Anilin- und Sodafabrik that it was economically feasihle to manufacture ammonia. The German firm then threw its great engineering and technical resources into the project and in 1910 a pilot plant was put into operation. This was the forerunner of a commercial plant which came into production in 1913 with a capacity of 7.000 tons of fixed nitrogen per year.

It was well known when Haber and his associates began their research on ammonia synthesis that no ammonia is formed when nitrogen and hydrogen are brought together under ordinary conditions of temperature and pressure. It was known that a trace of ammonia is formed when a silent electric discharge is passed through a mixture of nitrogen and hydrogen. It had also been observed that complete decomposition of ammonia cannot be effected by heat. Regardless of these clues to the existence of a true equilibrium, such as represented by the expression:

$$N_2 + 3H_2 \rightleftarrows 2NH_3 + 24{,}000 \text{ cal.}$$

several investigators of note contended that no such equilibrium could be found. The situation was. therefore, one of coniusion until Haber and his co-workers clearly demonstrated the existence of the equilibrium and measured the concentrations of the gases under several conditions of temperature and pressure.

Inasmuch as the foregoing expression of equilibrium indicates that one volume of nitrogen and three volumes of hydrogen combine to form two volumes of ammonia, it follows, according to the Le Chatelier principle (see LE CHATELIER, HENRY LOUIS), that the higher the pressure on the system the larger the proportion of ammonia at equilibrium; that is, the equilibrium is shifted toward the smaller volume. It will be recalled that this effect of pressure is different from the case of the nitrogen-oxygen-nitric oxide equilibrium, on which a change in pressure had no effect. The effect of temperature on the equilibrium in the two cases is reversed. In the nitrogen-oxygen-nitric oxide equilibrium the higher the temperature the larger the proportion of nitric oxide, whereas in the nitrogen-hydrogen-ammonia equilibrium the higher the temperature the smaller the proportion of ammonia.

The table shows the effect of temperature and of pressure on the percentage of ammonia formed at equilibrium when one volume of nitrogen and three volumes of hydrogen are caused to react.

Percentage of Ammonia at Equilibrium
(Data obtained *by* the U.S. Fixed Sitrogen Research Laboratory)

Temperature °C.	Pressure in atmospheres						
	10	30	50	100	300	600	1,000
200 . . .	50.66	67.56	74.38	81.54	89.94	95.37	98.29
250 . . .	28.34	47.22	56.33	67.24	81.38	90.66	96.17
300 . . .	14.73	30.25	39.41	52.04	70.96	84.21	92.55
350 . . .	7.41	17.78	25.23	37.35	59.12	75.62	87.46
400 . . .	3.85	10.15	15.27	25.12	47.00	65.20	79.82
0 . . .	2.11	5.86	9.15	16.43	35.82	j3.71	69.69
500 . . .	1.21	3.49	5.56	10.61	26.44	42.15	57.47
550 . . .	0.76	2.18	3.45	6.82	19.13	31.63	41.16
600 . . .	0.49	1.39	2.26	4.52	13.77	23.10	31.43
650 . . .	0.33	0.96	1.53	3.11	9.92	16.02	20.70
700 . . .	0.23	0.68	1.05	2.18	728	12.60	12.87

From the table it is apparent that an ammonia synthesis process should be carried out at a temperature as low and at a pressure as high as may be practical and economical. Again, the rates of reaction toward equilibrium must be taken into account. At ordinary temperatures the rate of reaction is virtually zero and is negligibly low even at 500° C. unless a catalyst is used. Obviously. the use of a catalyst in ammonia synthesis is extremely important in permitting the reaction to be carried out at a lower temperature than would be practical with no catalyst. In commercial plants temperatures in the range 450° C. to 500° C. are used. The best catalyst known is prepared from pure iron plus small proportions of alumina and potash.

The decision as to the pressure at which to carry out the ammonia synthesis is an economic matter. Plants have been built to operate at pressures as low as 100 atm. and as high as 1,000 atm., but most of the plants use pressures in the range 200 to 350 atm.

Steps in the Synthetic Ammonia Process. — Four major steps are involved in the synthetic ammonia process as it is carried out in large commercial plants. The initial step comprises the preparation of nitrogen and hydrogen or a mixture of these two gases. Where natural gas is available at relatively low cost. this material is used as a source of hydrogen. Most of the plants, however. use air, steam and coke to obtain a mixture of nitrogen and hydrogen along with carbon monoxide. carbon dioxide and other impurities. This mixture is then further processed with steam to convert most of the carbon monoxide to hydrogen and carbon dioxide. A few plants obtain hydrogen through the electrolysis of water. and a few others use coke-oven gas as a source of hydrogen. In all plants the necessary nitrogen is obtained from air.

In the second step of the process. the gas mixture is coinpressed and then freed from undesired gases by means of an elaborate system of equipment, leaving a purified mixture of nitrogen and hydrogen in the correct proportion for the ammonia synthesis.

In the third major step the nitrogen-hydrogen mixture is passed through a bed of catalyst at a temperature of about 500° C. and at a pressure from 100 to 1.000 atm. Some ammonia is thus formed, the proportion depending on the temperature and pressure used, the activity of the catalyst and time of contact of the gases with the catalyst.

In the fourth and final step the ammonia is removed. usually by refrigeration. That part of the gas mixture which remains uncombined is then recycled through the catalyst bed after the addition of sufficient fresh nitrogen-hydrogen mixture to compensate for the ammonia removed from the system.

Although the synthetic ammonia process may seem to be one of relative simplicity, it actually represents engineering achievement in the usage of materials and in construction unknown before the 20th century. Nevertheless, the process assures ample supplies of ammonia. which has become the cheapest form of fixed nitrogen available to industry and to agriculture, and is the raw material from which numerous nitrogenous chemicals are manufactured.

The success of the synthetic ammonia plants built in Germany during World War I led to a rapid expansion of the industry and the construction of plants in many countries other than Germany. The initial plant at Oppau. Ger.. was expanded to a capacity of 120,000 tons per year during World War I and a second large plant built at Leuna, near Merseburg. Various modifications of the original Haber or Haber-Bosch process were devised, such as the Claude process in France, the Casale process in Italy, the American and the Nitrogen Engineering processes in the United States. During World War II ten new synthetic ammonia plants were built in the U.S. to meet an anticipated demand for ammonia in the production of munitions. The output of some of these plants was diverted to the production of agricultural fertilizer in the form of ammonium nitrate. At the close of World War II most of the German synthetic ammonia plants lay in ruins; the Cnited States had become the world leader in ammonia production. with a fixed nitrogen capacity of more than 1.000.000 tons per year. (H. A. Cs.)

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NITROGEN HARDENING: see NITRIDING.

NITROGLYCERIN, an explosive first obtained in 1846 by A. Sobrero by treating glycerol (*see* GLYCERINE) with a mixture of concentrated nitric and sulphuric acids at ordinary temperature.

This reaction is strongly exothermic, and precautions must be taken that it does not get out of control, particularly in large-scale operations. Nitroglycerin is an ester of nitric acid, having the systematic name of glyceryl trinitrate and the formula is $CH_2(ONO_2)–CH(ONO_2)–CH_2(ONO_2)$.

It is an oily substance which is colourless when pure, but which is usually of a pale yellow colour, of specific gravity 1.60 at 15° C. Its melting point is 13.2° C., but the liquid is easily supercooled. Nitroglycerin is scarcely soluble in water and in glycerol, fairly soluble in ethyl and methyl alcohols and is miscible in all proportions with ether, acetone, benzene, etc. It dissolves and swells nitrocellulose and is therefore used as an ingredient in double-base propellants. It is used either alone or in mixtures with other ingredients as an explosive. Liquid nitroglycerin is extremely sensitive to shock and should be regarded as a hazardous substance. Evidence as to whether crystalline nitroglycerin is less or more hazardous is conflicting. However, for the prevention of freezing of nitroglycerin on storage in cold places, more use is being made of the so-called "low-freezing" nitroglycerin, which is obtained by nitration of partly polymerized glycerol or of glycerol mixed with other polyhydric alcohols.

Therapeutics. — Nitroglycerin has a sweet burning taste and is somewhat poisonous. Its vapour produces violent headache but most persons become accustomed to nitroglycerin after periods of weeks or months, and the headaches disappear thereafter. Although a nitrate, its pharmacological actions when it is taken internally resemble those of nitrites such as amyl nitrite. The explanation is that, in an alkaline medium at body temperature, nitroglycerin yields a nitrite, probably as a preliminary stage of decomposition. This gradual conversion in the tissues is a valuable property of nitroglycerin, since its effects take longer to disappear than is the case with amyl and other nitrites. Nitroglycerin is administered as a preventive in cases of cardiac pain, such as angina pectoris. *(See* EXPLOSIVES; PROPELLANTS.)

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(G. B. K.)

NITROSOBENZENE, C_6H_5NO, first obtained by the action of nitrosyl bromide or chloride on mercury diphenyl, is prepared by the oxidation of β-phenylhydroxylamine with chromic acid. It results from the oxidation of aniline by monopersulphuric acid (H. Caro). It forms colourless crystals which melt at 68° C. to an emerald-green liquid. It is very volatile, and its vapour and solutions are green. The colour changes which nitrosobenzene exhibits are explained by the fact that in the solid state, in which it is colourless, it exists in the form of dimeric molecules $(C_6H_5NO)_2$; whereas, in the liquid and vapour states, in which it is green, it has the monomeric form C_6H_5NO.

NITTI, FRANCESCO SAVERIO (1868–1953), Italian statesman, was born at Melfi (Potenza). He was already known as a barrister and as professor of financial science at the University of Naples when he entered parliament in 1904. He made his reputation as an authority on economic and financial questions, and was minister of agriculture, industry and trade in the Giolitti cabinet of 1911–14. When the United States entered World War I in 1917, he was entrusted with an economic mission to that country, and certain of his utterances and acts in this connection were severely criticized. He became minister of the treasury in the Orlando cabinet from Oct. 1917 to Jan. 1919. On the fall of the Orlando ministry, which he helped to bring about in June 1919, he succeeded as premier. Nitti's adoption of the system of proportional representation resulted in an important increase in the Socialist and Popolari deputies at the elections of Nov. 1919, but he failed to conciliate either group. An epidemic of strikes and disorders seriously weakened his position, and he felt forced to resign on March 12, 1920. But no other statesman being willing to assume the succession, he reconstructed his cabinet; defeated in the chamber of deputies after the San Remo meeting of the supreme council presided over by him, to prepare the peace with Turkey. he resigned a second time but again reconstructed his cabinet. The arrest ordered by him of the Dalmatians and Fiumani in Rome provoked further irritation. He resigned for the last time on June 9, 1920, leaving the door open for Giovanni Giolitti's return. On retiring from office he returned to journalism. In parliament he opposed Giolitti, splitting the democratic forces, which helped fascism. Nitti was re-elected in 1921, but did not stand in the 1924 elections held under Benito Mussolini's auspices. He lived abroad after the advent of fascism in Italy, returning to Italy after World War II. He was a member of the *assemblea nazionale,* 1946–48, and in 1948 became a member of the Italian senate. He died in Rome on Feb. 20, 1953.

Nitti wrote several books on economic questions, including one entitled *Nord e Sud* (1900), dealing with what he regarded as the unfair treatment of south Italy by the wealthier north, and *L'Italia all' alba del secolo XX.* (1901). His other works include: *L'Europa senza pace* (Eng. trans., 1922); *La Decadenza dell' Europa* (Eng. trans., 1923); *La Tragedia dell' Europa* (Eng. trans., *They Make a Desert,* 1924); *Meditazioni dell' Esilio* (1947); and *Rivelazioni* (1948). In 1925 his son Vincenzo Nitti published a vindication of his father's policy, *L'Opera di Nitti.*

NITZSCH, KARL IMMANUEL (1787–1868), Lutheran divine, was born near Leipzig on Sept. 21, 1787. He studied at Wittenberg, where he began to teach in 1809. From 1820 to 1822 he was superintendent in Kemberg, and in the latter year he was appointed professor of theology at Bonn, where he remained until called to succeed Philip Marheineke at Berlin in 1847. Subsequently he became university preacher, rector of the university, provost of St. Nicolai (in 1854) and member of the supreme council of the church, in which last capacity he was one of the ablest and most active promoters of the Evangelical union, He died on Aug. 21, 1868. He represented the *Vermittelungstheologie* of the school of Friedrich Schleiermacher, holding "that religion is not doctrine but life, direct consciousness, feeling."

His principal works are: *System der christlichen Lehre* (1829; 6th ed., 1851; Eng. trans., 1849), *Praktische Theologie* (1847–60; 2nd ed., 1863–68). *Akademische Vorträge über christliche Glaubenslehre* (1858) and several series of *Predigten.*

NIUÉ (SAVAGE ISLAND): *see* PACIFIC ISLANDS.

NIVELLE, ROBERT GEORGE (1856–1924), French soldier, was born on Oct. 15, 1856, at Tulle, Corrèze. He entered the Polytechnic in 1876, and left two years later to join the artillery. He served in China in 1900, and then for many years in Algeria. When World War I broke out, he was in command of the 5th artillery at Besançon.

Appointed a general of brigade on Oct. 24, 1914, he fought successfully on the Aisne. and in Jan. 1915 took a prominent part in the attack on Quesnevières. On Dec. 23, 1915, he was placed at the head of the 3rd corps, and in March 1916 was sent to Verdun, where after some remarkable fighting he succeeded in checking the crown prince's first attack. On May 2 he succeeded Gen. Henri Pétain in the command of the 2nd army, and definitely held the enemy before that glorious citadel. It was he who, in orders which have become famous, made the unforgettable declaration: "Ils ne passeront pas." On Dec. 12, 1916, he succeeded Gen. Joseph Joffre as commander in chief of the armies of the north and northeast. In conjunction with the British armies he prepared the great offensive of April 16, 1917, between Soissons and Auberive. After this semidefeat he was replaced by General Pétain in the command of the French armies. On May 15, 1917, he was appointed commander of the armies *chargé de mission,* and on Dec. 23, 1917, took over the French troops in North Africa.

On Oct. 14, 1918, General Nivelle was confirmed in his command despite the rules of superannuation, and on Jan. 30, 1920, was nominated a member of the supreme war council. On March 5, 1920, he gave up the command of the 19th corps, and in Nov. 1920 he was ordered to represent France in the United States at the tercentenary of the arrival of the "Mayflower." He was placed on the retired list on Oct. 11, 1921; he died on March 23, 1924. (M. Gu.)

NIVELLES (Flem. *Nyvel*), town, province of Brabant, Belgium, on the Thines 19 mi. S. of Brussels. Pop. (1947) 11,929.

It manufactures parchment, cardboard and paper. The town is supposed to owe its origin to the foundation of a convent by Itta or Iduberge. wife of Pippin of Landen, and it is the cradle of the Carlovingians.

The Ronianesque church of St. Gertrude, named after Itta's daughter; dates from the 11th century. On the top of the tower is the effigy of a man in iron who strikes the hours with a hammer.

Close to Nivelles is Seneffe, where Condé defeated William of Orange in 1674. At Nivelles the French under Marceau defeated the Austrians in 1794.

NIVERNAIS, an old province of France, bounded by Berry. Burgundy, Auxerrois and Gâtinais. Part of the territory of the Aedui before the Roman conquest. Nivernais was, from the end of the Carolingian period, perpetually coveted by the dukes of Burgundy (*sre* NEVERS). The first Valois duke of Burgundy, Philip the Bold, became master of it thanks to an inheritance from his father-in-law, Louis of Mâle. After Charles the Bold's death, it became a province and a duchy of the kingdom of France, included in the jurisdiction of the *parlement* of Paris and was a *gouvernement militaire*. After the French Revolution it was embodied almost entirely in the department of Nièvre.

See A. Massé, *Histoire du Nivernais (1938).* (M. PAC.)

NIXIE (NIXY), a female water sprite. The word is adapted from Ger. *Nixe,* the male water sprite being *Nix.* The general term for both the male and female is nicker, a kelpie.

NIXON, RICHARD MILHOUS (1913–), 36th vice-president of the Cnited States. was born at Yorba Linda, Calif., Jan. 9, 1913, of Quaker parents. He graduated in 1934 from Whittier college, California, where he specialized in constitutional history, and from Duke university law school, Durham. N.C., in 1937. Nixon practised law in Whittier for five years and. after serving as attorney in the office for emergency management in Washington, D.C.. Jan.–Aug. 1942, was commissioned lieutenant, junior grade, in the U.S. navy and left active service in 1946 as lieutenant commander. Nixon was elected a Republican representative of the 12th congressional district of California in Nov. 1946, unseating the veteran Democratic incumbent. H. Jerry Voorhis, after a series of joint platform discussions reminiscent of the Lincoln-Douglas debates. He was returned to congress unopposed in 1948.

In the house of representatives he helped draft the Taft-Hartley Labour Kelations act and played a prominent role in preparing the case against Alger Hiss. a former state department official convicted of perjury in connection with communist espionage. In Nov. 1950 Nixon, in a hard-hitting senatorial contest, defeated Helen Gahagan Douglas and became the junior senator from California.

He was nominated by the Kepublican national convention of 1952 as the vice-presidential running mate of Dwight D. Eisenhower and elected by a decisive margin. The campaign opened with charges that Nixon had illegally benefited from a private fund raised by his supporters. In answer to demands that he withdraw from the race. Nixon made a dramatic and successful defense in a nation-wide television broadcast.

The office of the vice-president during Nixon's tenure regained some of the importance intended by the framers of the constitution. President Eisenhower promoted this development and Nixon because of his ability became a leading spokesman of the administration. Nixon presided over meetings of the cabinet and of the national security council in the president's absence, headed a cabinet committee on price stability for economic growth, and served as mediator in labour-management disputes. He and his wife Patricia also traveled throughout the world as ambassadors of American good will and were generally well received. Because of discontent of certain elements in Latin America with U.S. policies, and to Nixon's reputation as a foe of communism, he was the victim of mob violence and threat of assassination in Caracas, Venez., in May 1958. On the occasion of Nixon's presence at the official opening of the first American exposition in Moscow, in July 1959, he engaged in the celebrated "kitchen debate" with Premier Nikita Khrushchev. Nominated for the presidency at the 1960 Republican convention, Nixon campaigned vigorously, but was defeated in a close race in the November election by his Democratic opponent. Sen. John F. Kennedy of Massachusetts.

BIBLIOGRAPHY.—The standard biography of Nixon is Earl Mazo, *Richard Nixon* (1959). Others are William Costello, The *Facts about Nixon* (1960) and James Keogh, *This* is *Nixon* (1956). (P. S. S.)

NIZA, MARCOS DE (FRAY MARCOS) (*c.* 1495–1558), Italian Franciscan friar who reached the "seven cities" of the Zuñi Indians in western New Mexico in 1539, nas born in Nizza (Nice) about 1495. He went to America in 1531 and served in Peru, Guatemala and Mexico. He was sent to Culiacán (at 24° N. in Rlexico) and there freed Indian slaves from regions to the north. Later he n-as sent on an advance party under the Negro Estrvan to cross the deserts to the stone-built cities of Cibola where Estevan was killed. Marcos claimed to have come within sight of the cities but then returned in haste and fear. From Indian reports made to please him he described large towns with precious stones. gold and silver, but F. V. de Coronado in 1540 found them to be small and poor. Marcos' report led to the great expedition of Coronado in 1540 into the region of the Colorado river. the furthest penetration of the continent ever made by Spain. Marcos was made provincial of his order for Mexico in 1541. He died in Mexico on March 25, 1jj8.

His journey and the killing of Estevan reveal that Spanish slave raids north of Culiacán and the treatment of Indian women by the Spaniards had antagonized lands far to the north of those reached by Spaniards, and were a factor in limiting Spanish settlement to Mexico for a long time.

See Richard Hakluyt, *Divers Voyages,* ed. by J. M. Dent, pp. 136–178 (1928). (A. Ds.)

NIZAMI (JAMALUDDIN or NIZAMUDDIN ABU MOHAMMED ELYAS IBN YUSUF (c. 113j–1203 or perhaps 121j), Persia's leading romantic poet. was born at Ganja (Kirovabad) in the Caucasus. n-here he spent the whole oi his life. Although he enjoyed the patronage of a number of rulers and princes, he was distinguished by reluctance to indulge in extravagant panegyrics. as well as by his simple life and blameless character. Living at a time when Sunni fanaticism was at its height, he was a kindly and tolerant man and his poetry, which is full of reflections on life and people. reveals broad sympathies and deep insight into psychology. His wide learning is shown by his frequent references to historical, literary and scientific topics (he was especially interested in astronomy and music): while his love of nature is seen in his well-observed descriptions and his likable characterizations of animals, particularly in *Leila va Majnun.*

Only a handful of his odes (*qasida*) and lyrics (*ghazal*) have survived, though some authorities claim that he wrote as many as 20.000 couplets; but his reputation rests on his great quintet (*Khamsé*) of *mathnavi* (rhymed couplet) poems, totaling some 30.000 couplets, which were imitated by many later poets. He drew his inspiration from both Firdausi and Sana'i (*qq.v.*) but is recognized in his own right as the first great dramatic poet of Persian literature. His first *mathnavi, Makhzan al-Asrar* (1174–75; English translation by Gholam Hossein Darab, *Tlze Treasury of Mysteries,* 1945) is mystical and philosophical, and may be compared with *Hadiqat al-Haqiqa* by Sana'i. This was followed by three romantic poems—*Khosrau va Shirin* (1180/81), a legend of the love of the Sassanian emperor Khosrau II and his rival Farhad for the Caucasian princess Shirin: *Leila va Majnun* (1188; abbreviated paraphrase by J. Xtkinson. 1836), the popular Bedouin romance that may be described as the "Romeo and Juliet" of eastern folklore; and *Haft Peikav* (1197; English translation by C. E. Wilson, *The Seven Beauties,* 1924), a collection of stories of the Sassanian monarch Bahram Gur, the central episode of which is the relation of tales, somewhat on the lines of the *Thousand* and *One Nights,* by seven princesses, each dwelling in a palace of a different colour. His last work, possibly completed shortly before his death, was the *Eskandarname* (1200; English translation of part i by H. W. Clarke, The *Sikander Nama,* 1881), two full-length poems on the life of Alexander the Great, the first of which treats of his legendary exploits, while the second describes him as a prophet and seer.

Nizami is admired in Persian-speaking lands for his originality and his sweetness and clarity of style, though it must be admitted that his love of language for its own sake and of philosophical and scientific learning sometimes led him into obscurity.

BIBLIOGRAPHY.—Nizami's complete works have been edited by Vahid Dastgerdi, 7 vol., 2nd ed. (1954 *et seq.*). *See* also E. G. Browne, *A Literary History of Persia*, vol. ii (1938); E. Berthels in *Encyclopaedia of Islam*, vol. iii (1936). (L. P. E.-S.)

NIZHEGOROD (now GORKI; the name Nizhegorod is an abbreviation from Nijni-Novgorod), an' *oblast* of the Central region, Russian Soviet Federated Socialist Republic, U.S.S.R., bounded on the east by the Kirov *oblast* and the Marii, Chuvash and Mordovia Autonomous Soviet Socialist Republics, on the south by the Ryazan *oblast,* on the west by the Ivanovo and Yaraslavl *oblasts* and on the north by the Vologda *oblast.* Area 28,263 sq.mi. Pop. (1959) 3,590,000; urban 1,874,000, rural 1,716,000.

The northern portion consists of a pine forest area lying along each side of the Vetluga from the point where it curves sharply to the south, though the lower course of the Vetluga, and its junction with the Volga, lie in the Marii republic.

South of the Volga is a fertile black earth area, between the Oka on the west and the Sura on the east, which flows through the Chuvash republic in the south, but forms the boundary between that republic and the Gorki region in the north of its course. This southern part has little forest and consists of high plains, with river valleys entrenching them, and the valley black earth is the most fertile soil in the entire *oblast.*

The southern part is not favourable to grass and meadow cultivation, so that dairying has not developed. Grain cultivation occupies 85% of the plowed land, the chief crops being rye and oats, with a little wheat. millet and buckwheat. Potatoes, flax and a little hemp are grown. Fruit and vegetables are cultivated along the Oka and Volga. Sheep, cattle, horses, pigs and goats are raised. The region is sparsely peopled, especially in the north. Bog iron ores, sand, salt and phosphorite are found. The region is rich in peat.

NIZHNI TAGIL (NIZHNE-TAGILSK, TAGIL), a city of the Russian S.F.S.R., U.S.S.R., in the Sverdlovsk *oblast,* in 57° 27' N., 59° 54' E. Pop. (1959) 338,000. It lies in a valley on the eastern slope of the Ural mountains, within a few miles of the place where the Tagil escapes to the lowlands. The southern part of this valley is occupied by the upper Tagil, and its northern portion by the upper Tura.

The town was founded in 1725 by the Russian mine-owner Demidov. Nizhni Tagil is a central foundry for iron mines and other works. Gold, platinum and copper are mined at Nizhni Tagil, and there is a brick-making industry.

NIZHNIY NOVGOROD: *see* NIJNI-NOVGOROD.

NKOLE, an East African people, also known as Banyankole, Ankole or Nyankole, of the Interlacustrine Bantu group who occupy the area between Lakes Edward and George and the Tanganyika border in southwestern Uganda.

The present Nkole kingdom, whose population numbers about 500,000, represents the traditional kingdom of that name with the addition of the neighbouring similar kingdoms of Mpororo, Igara, Buhwezu and Busongora. Together these form a modern administrative district with a common local government headed by the traditional ruler, the *mugabe.*

Although they speak a common language, the Nkole are divided into two quite distinct social groups: the pastoral Hima (Bahima), who constitute about 10% of the population, and the agricultural Iru (Bairu), who make up the remainder. These different economic pursuits give Hima and Iru quite different modes of life. The Hima dwelling is the kraal made up of thatched: beehive-shaped huts arranged in a circle with the intervening spaces filled with branches of thornbush to form a cattle pen. When the grazing in a particular area is exhausted. the kraal, which may house from 12 to more than 100 people, is moved to an area of fresh pasture. The Iru, on the other hand, are sedentary hoe-cultivators of millet. plantains and sweet potatoes who live dispersed in single, though often polygynous, family homesteads surrounded by their gardens and granaries. Both Hima and Iru are divided into patrilineal clans and lineages, though exogamy extends only to children of the same grandparents. Both groups marry with the payment of bridewealth, goats being the medium among the Iru and cattle among the Hima.

Hima and Iru are commonly rather different physically—Hima being generally taller, more slender and lighter in colour—and much Nkole traditional history is concerned with explaining how the two groups came to form a single society. Originally, it is said, they lived separately, exchanging their economic products. Then there appeared a wonderful people, the *bacwezi,* who, like the Hima, were tall, light-skinned pastoralists and who conquered the Nkole and their neighbours, establishing a dynasty of kings.

At length the people began to disobey the *bacwezi* and the latter fled the country; however, one, Ruhinda, was persuaded by an Iru headman to remain. Ruhinda thus became the founder of the present dynasty. This legend provided an ideological foundation for the traditional composite society, in which Iru lived in a politically subordinate but economically symbiotic relationship with Hima. The relationship was further supported by a religious system in which the spirits of the departed *bacwezi* were communicated with by mediums. Marriage between Hima and Iru was prohibited, but Hima sometimes took Iru women as concubines.

Hima were bound to the *mugabe* by clientship—a bond formed by the client's swearing fealty to the *mugabe* and making periodic gifts of cattle to him. From among his clients the *mugabe* chose district chiefs, military captains and the prime minister, the *nganzi.* Often these officials rose in the ruler's service from the band of pages formed by boys sent by Hima families to the royal kraal. Iru headmen were appointed over communities of their fellows and through them Hima chiefs collected tribute in agricultural and craft products. *See* also UGANDA.

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NOAH (in the Douai version of the Bible, NOE), appears in Genesis v, 29 as son of Lamech and tenth in descent from Adam. He is the hero of the story of the Deluge (Gen. vi–viii), being represented as the patriarch who, because of his blameless piety, was chosen by God to perpetuate the human race after his wicked contemporaries had perished in the flood. He receives a divine warning of the impending disaster, and is instructed to build an ark, in which he and his family are preserved alive. In accordance with God's instructions Noah took into the ark specimens of all animals, from which the stocks might be replenished. The story has close affinities with Babylonian traditions, in which Utnapishtim plays the part corresponding to that of Noah.

The narrative of Gen. ix, 18–27 belongs to a different cycle, which seems to know nothing of the flood story. In the latter Noah's sons are married, and their wives accompany them in the ark; but in this narrative they would seem to be unmarried, living in the tent with their father; nor does the shameless drunkenness of Noah accord well with the character of the pious hero of the flood story. Three different motives may be traced in Gen. ix, 18–27: first, the passage explains to whom agriculture, and in particular the culture of the vine, was due; second, it attempts to provide in the persons of Noah's three sons Shem, Ham and Japheth, ancestors for three of the races of mankind, and to account in some degree for their historic relations; third: by its censure of Ham (for whom it is almost certain that Canaan stood in the original text) it reprobates the licentious Canaanite civilization. *See* also GENESIS. (W. L. W.)

NOAILLES, the name of a great French family, derived from the castle of Noailles in the territory of Ayen, between Brive and Turenne in the Limousin, and claiming to date back to the 11th century. In the 16th century, its head ANTOINE de Noailles (1504–1562) became admiral of France, and was ambassador in England during three important years, 1553–1556, maintaining a gallant but unsuccessful rivalry with the Spanish ambassador Simon Renard. HENRI (1554–1623), son of Antoine, was a commander in the religious wars, and mas made comte d'Ayen by Henry IV in 1593. ANNE (d. 1678), the grandson of the first count, played an important part in the Fronde and the early years of the reign of Louis XIV, became captain general of the newly won province of Roussillon, and in 1663 was made duc d'Ayen, and peer of France.

ADRIEN MAURICE (1678–1766), the third duke, served in the wars of Louis XV in Italy and Germany, and became a marshal in 1734. In the war of the Austrian succession he was beaten by the English at the battle of Dettingen in 1743. He married Françoise d'Aubigné, a niece of Madame de Maintenon, and two of his sons became marshals of France. The elder, LOUIS (1713–1793), who bore the title of duc d'Aven until his father's death in 1766, when he became duc de Noailles, served in most of the wars of the 18th century, and was made a marshal in 1773 He refused to emigrate during the Revolution and died in Aug. 1793, beiore the Terror reached its height. On the 4th Thermidor (July 22) the aged duchesse de Noailles was executed nith her daughter-in-law, the duchesse d'Ayen, and her granddaughter, the vicomtesse de Noailles. JEAN PAUL FRANÇOIS (1739–1824), the fifth duke, was in the army, but his tastes were scientific, and for his eminence as a chemist he was elected a member of the Academy of Sciences in 1777. He became duc d'Ayen in 1766 on his grandfather's death, and duc de Noailles on his father's in 1793. He lived in Switzerland from 1792 until the Restoration in 1814, when he took his seat as a peer of France.

One other branch of the family deserves notice. PHILIPPE (1715–1794), comte de Noailles, afterward duc de Mouchy, a younger brother of the iourth duke, served at Minden and in other campaigns, and was made a marshal on the same day as his brother. He was long in great favour at court, and his wife was first lady of honour to Marie Antoinette, and was nicknamed by her Madame Étiquette. This court favour brought down punishment in the days of the Revolution, and the old marshal and his wife were guillotined on June 27, 1794

PHILIPPE LOUIS MARC ANTOINE, duke of Noailles and prince of Poix (1752–1819), was born on Nov. 21, 1752. In 1789 he was elected deputy of the states-general by the nobility of the *bailliages* of Amiens and Ham, but was compelled to resign in consequence of a duel aith the commander of the Garde Nationale at Versailles. He left the country but returned and took part in the revolution of Aug. 10, 1792, after which he again escaped until 1800 At the Restoration he mas brought again into favour and became a peer of France. He died at Paris on Feb. 17, 1819.

LOURS MARIE (1756–1804), vicomte de Noailles, was the second son of the marshal. He served brilliantly under La Fayette in America, and concluded the capitulation of Yorktown. He was elected to the states-general in 1789. He began the famous "orgie," as Mirabeau called it, on Xug. 4, when all privileges were abolished, and with d'Aiguillon proposed the abolition of titles and liveries in June 1790. When the Revolution became more pronounced he emigrated to America. He accepted a command against the English in San Domingo, under Rochambeau. He made a brilliant deiense of the mole St Nicholas, and escaped with the garrison to Cuba; but in making for Havana his ship was attacked by an English frigate, and aiter a long engagement he was severely wounded, and died on Jan. 9, 1804.

NOBEL, ALFRED BERNHARD (1833–1896), Swedish chemist and engineer, who is noted as the founder of the Nobel prizes, was born at Stockholm on Oct. 21, 1833. He spent only two terms in school and thereafter was taught by tutors. About 1850 he was sent on travels to complete his education as an engineer and spent about a year in the United States. He was in ill-health all his life. On his return to Sweden after a stay in St. Petersburg, he studied explosives. especially nitroglycerin. He found that when nitroglycerin was incorporated with an absorbent, inert substance like kieselguhr it could be safely used. In 1867 he was granted a British patent for dynamite and in 1868 a U.S. patent. Nobel next combined nitroglycerin with another high explosive, guncotton, and obtained a transparent. jellylike substance which was a still more powerful explosive than dynamite. Blasting gelatin, as it was called, was patented in 1876. It combined the high power of nitroglycerin with the comparative safety in handling of dynamite. About 13 years later Nobel produced ballistite, one of the earliest of the nitroglycerin smokeless ponders and a precursor of cordite. Nobel's claim that his patent covered the latter was the occasion of vigorously contested lawsuits between him and the British government in 1894 and 1895; eventually the courts decided against Nobel. An accomplishment of importance equal to that of his explosives was his construction and perfection of detonators for such explosives as could not be made to explode by simple firing. His detonators contained fulminate of mercury. These detonators made it possible to set off the explosive energy of nitroglycerin, guncotton, etc., at will; without detonators such explosives could not be used at all. From the manufacture of dynamite and other explosives, and from the exploitation of the Baku oil fields, he amassed an immense fortune. He never married. He was lonely and this together with his ill-health imbued him with pessimism and a satirical view of mankind which was nevertheless combined with benevolence and belief in the future of humanity. At his death on Dec. 10, 1896, at San Remo, Italy, he left the bulk of his fortune in trust to establish five prizes in peace, physics, chemistry, physiology or medicine, and literature. See NOBEL PRIZES.

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NOBEL PRIZES. These prizes, five in number, are awarded annually from the Nobel foundation, a fund established under the will of Alfred Bernhard Nobel (*q.v.*). Distribution was begun on Dec. 10, 1901, the fifth anniversary of the founder's death. The awards are in the fields of physics, chemistry, physiology or medicine, literature and peace. Each consists of a gold medal, a diploma bearing a citation, and a sum of money; the amount is dependent upon the income of the foundation and has ranged from about $30,000 to over $40,000. The prize may be divided among two or three recipients. Any prize may be withheld for one year or longer and when not distributed its amount reverts to the main fund, or to special reserves for each section. The peace prize has been reserved most frequently and special Nobel institutes have been created with the surplus funds. The Nobel prizes are open to all nationalities and are not competitive.

Candidates are nominated by the following agencies: physics and chemistry by the Royal Academy of Sciences in Stockholm, Swed.; physiology or medicine by the Caroline Medical institute in Stockholm; literature by the Swedish Academy of Literature in Stockholm and the academies of France and of Spain; peace by a committee of five elected by the Norwegian *storting* (parliament).

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WINNERS OF NOBEL PRIZES

(Asterisks denote contributors to *Encyclopædia Britannica)*

Physics

1901	Wilhelm Konrad Rontgen	1845–1923	(German)	Discovery of X-rays
1902	Hendrik Antoon Lorentz	1853–1928	(Dutch)	Influence of magnetism on the phenomena of radiation
	Pieter Zeeman	1865–1943	(Dutch)	
1903	Henri Becquerel	1852–1908	(French)	Discovery of the radioactive elements of radium and polonium
	Pierre Curie	1859–1906	(French)	
	Marie Curie	1867–1934	(French) (born Poland)	
1904	Baron Rayleigh*	1842–1919	(English)	Discovery of argon
1905	Philipp Lenard	1862–1947	(German)	Research on cathode rays
1906	Sir Joseph John Thomson	1856–1940	(English)	Conduction of electricity through gases
1907	Albert A. Michelson	1852–1931	(U.S.)	Spectroscopic and metrologic investigations
1908	Gabriel Lippmann	1845–1921	(French)	Photographic reproduction of colours
1909	Guglielmo Marconi	1874–1937	(Italian)	Development of wireless telegraphy
	Karl Ferdinand Braun	1850–1918	(German)	
1910	Johannes Diderik van der Waals	1837–1923	(Dutch)	Equations of conditions of gases and fluids
1911	Wilhelm Wien	1864–1928	(German)	Laws of heat radiation
1912	Nils Gustaf Dalén	1869–1937	(Swedish)	Coast lighting
1913	Heike Kamerlingh-Onnes	1853–1926	(Dutch)	Properties of matter at low temperatures; production of liquid helium
1914	Max von Laue	1879–1960	(German)	Diffraction of X-rays in crystals
1915	Sir William Henry Bragg	1862–1942	(English)	Study of crystal structure by means of X-rays
	William Lawrence Bragg	1890–	(English—his son)	
1916	(No award)			
1917	Charles Glover Barkla	1877–1944	(English)	Discovery of the characteristic Röntgen radiation of the elements
1918	Max Planck	1858–1947	(German)	Discovery of the elemental quantum
1919	Johannes Stark	1874–1957	(German)	Discovery of the Doppler effect in canal rays and the division of spectral lines in the electric field
1920	Charles Edouard Guillaume	1861–1938	(Swiss)	Discovery of the anomalies of nickel-steel alloys
1921	Albert Einstein*	1879–1955	(German)	Founder of theory of relativity and discoverer of law of photoelectric effect

Physics—Continued

1922	Niels Bohr	1885–	(Danish)	Study of structure and radiations of atoms
1923	Robert Andrews Millikan	1868–1953	(U.S.)	Work on elementarv electric charge and the photoelectric effect
1924	Karl Nanne Siegbahn*	1886–	(Swedish)	Discoveries in the area of X-ray spectra
1925	James Franck*	1882–	(German)	Laws governing collision between electron and atom
	Gustav Hertz	1887–	(German)	
1926	Jean Perrin	1870–1942	(French)	Discovery of the equilibrium of sedimentation
1927	Arthur H. Compton	1892–1962	(U.S.)	Discovery of the dispersion of X-rays
	Charles T. R. Wilson	1869–1959	(English)	Method of rendering discernible the courses of electrically charged particles by water condensation
1928	Sir Owen Willans Richardson	1879–1959	(English)	Discovery of the law known by his name (the dependenrv of the emission of electrons on temperature)
1929	Louis-Victor de Broglie	1892–	(French)	Wave nature of electrons
1930	Sir Chandrasekhara Raman*	1888–	(Indian)	Works on the diffusion of light and discovery of the effect known by his name
1931	(No award)			
1932	Werner Heisenberg	1901–	(German)	Creation of auantum mechanics
1933	Paul Adrien Maurice Dirac	1902–	(English)	Discovery of new fertile forms of the atomic theory
	Erwin Schrödinger	1887–	(Austrian)	
1934	(No award)			
1935	James Chadwick*	1891–	(English)	Discovery of the neutron
1936	Victor Hess	1883–	(Austrian)	Discovery of cosmic radiation
	Carl David Anderson	1905–	(U.S.)	Discovery of the positron
1937	Clinton Joseph Davisson	1881–1958	(U.S.)	Discovery of diffraction of electrons by crystals
	George P. Thomson	1892–	(English)	
1938	Enrico Fermi	1901–1954	(Italian)	Artificial radioactive substances
1939	E. O. Lawrence	1901–1958	(U.S.)	Invention of cyclotron
1940–42	(No award)			
1943	Otto Stern	1888–	(U.S.)	Detection of maenetic movements of protons
1944	Isidor Isaac Rabi	1898–	(U.S.)	Studies of atom's nucleus
1945	Wolfgang Pauli	1900–1958	(Austrian)	Discovery of exclusion principle
1946	Percy Williams Bridgman*	1882–1961	(U.S.)	High-pressure physics
1947	Sir Edward Appleton*	1892–	(English)	Discovery of Appleton layer
1948	Patrick Maynard Stuart Blackett	1897–	(English)	Discoveries in cosmic radiation
1949	Hideki Yukawa	1907–	(Japanese)	Theoretical work on meson
1950	Cecil Frank Powell	1903–	(English)	Photographic method of studying atomic nuclei; discoveries about mesons
1951	Sir John Douglas Cockcroft	1897–	(English)	Transmutation of atomic nuclei by artificially accelerated atomic particles
	Ernest Thomas Sinton Walton	1903–	(Irish)	
1952	Felix Bloch	1905–	(U.S.)	Measure of magnetic fields in atomic nuclei
	Edward Mills Purcell	1912–	(U.S.)	
1953	Frits Zernike	1888–	(Dutch)	Introduction of phase contrast microscopy
1954	Max Born	1882–	(English)[1]	Work in mathematics that enabled physicists to understand atom behaviour
	Walther Bothe	1891–1957	(German)	Analysis of cosmic radiation: "the coincidence method"
1955	Willis E. Lamb, Jr.	1913–	(U.S.)	Work with atomic measurements
	Polykarp Kusch*	1911–	(U.S.)	
1956	William B. Shockley	1910–	(U.S.)	Development of the transistoi
	John Bardeen	1908–	(U.S.)	
	Walter H. Brattain	1902–	(U.S.)	
1957	Tsung Dao Lee	1926–	(Chinese)[2]	Investigation of the principle of the conservation of parity
	Chen Ning Yang	1922–	(Chinese)[2]	
1958	Pavel A Cerenkov	1904–	(Russian)	Atomic-particle and cosmic-radiation research
	Ilya M. Frank	1908–	(Russian)	
	Igor Evgenyevich Tamm	1895–	(Russian)	
1959	Emilio Gino Segrè*	1905–	(U.S.)	Discovery of the antiproton
	Owen Chamberlain	1920–	(U.S.)	
1960	Donald Glaser*	1926–	(U.S.)	Development of the bubble chamber

Chemistry

rgor	Jacobus Henricus van't Hoff	1852–1911	(Dutch)	Laws of chemical dynamics and osmotic pressure
1902	Emil Fischer	1852–1919	(German	Synthetic work with the sugar and purine groups
1903	Svante Arrhenius	1859–1927	(Swedish)	Theory of electrolytic dissociation
1904	Sir William Ramsay	1852–1916	(English)	Discovery of different gaseous basic materials in the atmosphere and their places in periodic system
1905	Adolf von Baeyer	1835–1917	(German)	Organic dyes and aromatic hydrocarbon compounds
1906	Henri Moissan	1852–1907	(French)	Isolation of the element fluorine and introduction of Moissan furnace
1907	Eduard Buchner	1860–1917	(German)	Discovery of noncellular fermentation
1908	Sir Ernest Rutherford*	1871–1937	(English)	Decay of elements and chemist of radioactive substances
1909	Wilhelm Ostwald	1853–1932	(German)	Work on catalysis chemical equilibrium and reaction velocities
1910	Otto Wallach	1847–1931	(German)	Pioneer work in alicyclic combinations
1911	Marie Curie	1867–1934	(French)	Discovery of basic materials of radium and polonium; isolation of radium in metallic condition

[1]Born in Germany, naturalized British citizen 1939.

[2]U.S. resident.

Chemisfry—Continued

1912	Victor Grignard	1871–1935	(French)	Discovery of the so-called Grignard reaction
	Paul Sabatier	1854–1941	(French)	Method of hydrogenating organic compounds in presence of finely divided metals
1913	Alfred Werner	1866–1919	(Swiss)	Combined conditions of atoms in molecule; research in inoreanic chemistry
1914	Theodore William Richards	1868–1928	(U.S.)	Exact determination of the atomic weights of numerous chemical substances
1915	Richard Willstätter	1872–1942	(German)	Investigation of dyestuffs in the vegetable kingdom, especially of chlorophyll
1916–17	(No award)			
1918	Fritz Haber	1868–1934	(German)	Invention of a process of procuring ammonia synthetically from its elements
1919	(No award)			
1920	Walter Nernst	1864–1941	(German)	Thermochemical work
1921	Frederick Soddy	1877–1956	(English)	Chemistry of radioactive substances: occurrenceand nature of isotopes
1922	Francis William Aston	1877–1945	(English)	Discovery of the conduct of isotope mixtures and the law of complete numbers
1923	Fritz Pregl	1869–1930	(Austrian)	Microanalysis of organic substances
1924	(No award)			
1925	Richard Zsigmondy	1865–1929	(German)	Heterogeneous nature of colloidal solutions
1926	Theodor Svedberg	1884–	(Swedish)	Work on disperse systems
1927	Heinrich Wieland	1877–1957	(German)	For researches on bile acids
1928	Adolf Windaus	1876–1959	(German)	Constitution of sterins and their connection with the vitamin group
1929	Sir Arthur Harden	1865–1940	(English)	Fermentation of sugars and the enzymes acting in this connection
	Hans von Euler-Chelpin	1873–	(Swedish)	
1930	Hans Fischer	1881–1945	(German)	The chemistry of pyrrole and the synthesis of haemin
1931	Karl Bosch	1874–1940	(German)	Invention and development of chemical high-pressure methods
	Friedrich Bergius	1884–1949	(German)	
1932	Irving Langmuir	1881–1957	(U.S.)	Discoveries in surface chemistry
1933	(No award)			
1934	Harold Clayton Urey*	1893–	(U.S.)	Discovery of heavy hydrogen
1935	Frédéric Joliot	1900–1958	(French)	For artificially producing radioactive elements
	Irène Joliot-Curie*	1897–1956	(French)	
1936	Peter Debye	1884–	(Dutch)	Theoretic and experimental physics
1937	Walter Norman Haworth	1883–1950	(English)	Research on carbohydrates and vitamin C
	Paul Karrer	1889–	(Swiss)	Vitamin researches; vegetable dyestuff3
1938	Richard Kuhn	1900–	(German)	Carotinoid study and vitamin research (declined the award)[3]
1939	Adolph Butenandt	1903–	(German)	Work on sexual hormones (declined the award)[3]
	Leopold Ruzicka	1887–	(Swiss)	Polymethylenes and the higher terpen compounds
1940–42	(No award)			
1943	Georg von Hevesy	1885–	(Hungarian)	Discoverer of hafnium
rg44	Otto Hahn	1879–	(German)	Atomic fission
1945	Artturi Virtanen	1895–	(Finnish)	Conservation of fodder
1946	James B. Sumner	1887–1955	(U.S.)	Crystallizing of enzymes
	John H. Northrop	1891–	(U.S.)	Purified production of enzymes and virus products
	Wendell M. Stanley	1904–	(U.S.)	
1947	Sir Robert Robinson*	1886–	(English)	Alkaloids and other plant products
1948	Arne Tiselius	1902–	(Swedish)	Colloid analysis
1949	William Francis Giauque	1895–	(U.S.)	Properties of matter under conditions approaching absolute zero
1950	Otto Diels	1876–1954	(German)	Development of dien-synthesis
	Kurt Alder	1902–1958	(German)	
1951	Edwin M. McMillan*	1907–	(U.S.)	Discoveries of transuranium elements
	Glenn T. Seaborg*	1912–	(U.S.)	
1952	Archer J. P. Martin	1910–	(English)	Separation of chemical compounds
	Richard L. M. Synge	1914–	(English)	
1953	Hermann Staudinger	1881–	(German)	Study of macromolecule
1954	Linus C. Pauling*	1901–	(U.S.)	Study of atomic structure of molecules of proteins
1955	Vincent du Vigneaud	1901–	(U.S.)	Work on hormones
1956	Nikolai N Semenov	1896–	(Russian)	Studies on molecular reaction
	Sir Cyril Hinshelwood	1897–	(English)	
1957	Sir Alexander Todd	1907–	(English)	Work on nucleotides and nucleotide coenzymes
1958	Frederick Sanger	1918–	(English)	Study of insulin structure
1959	Jaroslav Heyrovsky	1890–	(Czech.)	Origination of polarography
1960	Willard Libb *	1908–	(U.S.)	Development of technique of radiocarbon dating

Physiology or Medicine

1901	Emil von Behring	1854–1917	(German)	Serum therapeutics
1902	Sir Ronald Ross	1857–1932	(English)	Malaria from mosquito to human
1903	Niels Ryberg Finsen	1860–1904	(Danish)	Light treatment in disease, especially skin diseases
1904	Ivan Petrovich Pavlov	1849–1936	(Russian)	Physiology of digestion
1905	Robert Koch	1843–1910	(German)	Founded scientific bacteriology and bacterial cultures
1906	Camillo Golgi	1843–1926	(Italian)	Structure of nervous system
	Santiago Ramón y Cajal	1852–1934	(Spanish)	
1907	Charles Louis Alphonse Laveran	1845–1922	(French)	Protozoans as irritants of disease (trypanosomes, etc.)
1908	Paul Ehrlich	1854–1915	(German)	Immunity
	Elie Metchnikoff	1845–1916	(Russian)	

[3]By Hitler's decree Jan. 31, 1937, all Germans were forbidden to accept Nobel prizes.

Physiology or Medicine—Continued

1909	Emil Theodor Kocher	1841–1917	(Swiss)	Physiology, pathology and surgery of thyroid gland
1910	Albrecht Kossel	1853–1927	(German)	Cellular chemistry, especially albumin and nuclein substances
1911	Allvar Gullstrand	1862–1930	(Swedish)	Dioptrics of the eye
1912	Alexis Carrel	1873–1944	(French)	Vascular seams and organ and blood vessel transplantation
1913	Charles Richet	1850–1935	(French)	Anaphylactic test
1914	Robert Bárány	1876–1936	(Austrian)	Physiology and pathology of human vestibular apparatus
1915–16	(No award)			
1917–18	(No award)			
1919	Jules Bordet	1870–1961	(Belgian)	Discoveries in the realm of immunity
1920	August Krogh	1874–1949	(Danish)	Capillary-motoric mechanism of regulation
1921	(No award)			
1922	Archibald Vivian Hill	1886–	(English)	Discovery relating to the heat production of muscles
	Otto Meyerhof	1884–1951	(German)	Discovery of correlation between consumption of oxygen and production of lactic acid in muscles
1923	Sir Frederick Grant Banting	1891–1941	(Canadian)	Insulin
	J. J. R. Macleod*	1876–1935	(Scotch)	
1924	Willem Einthoven	1860–1927	(Dutch)	Mechanism of the electrocardiograph
1925	(No award)			
1926	Johannes Andreas Grib Fibiger	1867–1928	(Danish)	Discovery of Spiroptera carcinoma
1927	Julius Wagner-Jauregg	1857–1940	(Austrian)	Therapeutic importance of malaria vaccination in dementia paralytica
1928	Charles Nicolle	1866–1936	(French)	Typhus exanthematicus
1929	Christiaan Eijkman	1858–1930	(Dutch)	Antineuritic vitamins
	Sir Frederick Hopkins	1861–1947	(English)	Growth-promoting vitamins
1930	Karl Landsteiner	1868–1943	(U.S.)	Human blood groups
1931	Otto Heinrich Warburg	1883–	(German)	Respiratory ferment
1932	Edgar Douglas Adrian*	1889–	(English)	Function of the neurone
	Sir-Charles-Scott Sherrington*	1857–1952	(English)	
1933	Thomas Hunt Morgan*	1866–1945	(U.S.)	Hereditary functionsof chromosomes
1934	George Richards Minot	1885–1950	(U.S.)	Liver therapy of anaemia
	William Parry Murphy	1892–	(U.S.)	
	George Hoyt Whipple	1878–	(U.S.)	
1935	Hans Spemann	1869–1941	(German)	Embryonic development
1936	Sir Henry Hallett Dale	1875–	(English)	Chemical transmission of nerve impulses
	Otto Loewi	1873–1961	(German)	
1937	Albert von Szent-Györgyi von Nagyrapolt	1893–	(Hungarian)	Biological combustion, especially vitamin C and catalysis of fumaric acid
1938	Corneille Heymans	1892–	(Belgian)	Regulation of respiration
1939	Gerhard Domagk	1895–	(German)	Antibacterial effect of prontosil (declined award)[3]
1940–42	(No award)			
1943	Edward Adelbert Doisy	1893–	(U.S.)	Research into and discovery of vitamin K
	Henrik Dam	1895–	(Danish)	
1944	Joseph Erlanger	1874–	(U.S.)	Differentiation of nerves
	Herbert Spencer Gasser*	1888–	(U.S.)	
1945	Sir Alexander Fleming*	1881–1955	(English)	Discovery of penicillin
	Ernst Boris Chain	1906–	(British cit.)	Development of penicillin
	Sir Howard Florey*	1898–	(English)	
1946	Hermann J. Muller*	1890–	(U.S.)	Heredity effects of X-rays
1947	Carl F. Cori	1896–	(U.S.)[4]	Isolation of enzyme initiating conversion of animal starch into sugar
	Gerty T. Cori	1896–1957	(U.S.)[4]	
	Bernardo A. Houssay*	1887–	(Argentine)	Pituitary hormone function
1948	Paul Mueller	1899–	(Swiss)	Properties of DDT
1949	Walter Rudolf Hess	1881–	(Swiss)	Functions of middle brain
	Antonio Egas Moniz	1874–1955	(Portuguese)	Prefrontal leucotomy
1950	Philip S Hench*	1896–	(U.S.)	Work with cortisone and other adrenal hormones
	Edward C. Kendall*	1886–	(U.S.)	
	Tadeusz Reichstein	1897–	(Swiss)	
1951	Max Theiler	1899–	(South African)	Discoveries concerning yellow fever
1952	Selman A. Waksman	1888–	(U.S.)	Codiscovery of strentomycin
1953	Fritz Albert Lipmann	1899–	(German-U.S.)	Discovery of co-enzyme A
	Hans Adolph Krebs*	1900–	(German-English)	Development of so called Krebs or citric acid cycle
1954	John F. Enders	1897–	(U.S.)	Discovery that poliomyelitis viruses multiply in human tissue
	Thomas H Weller	1915–	(U.S.)	
	Frederick C. Robbins	1916–	(U.S.)	
1955	Axel Hugo Theorell	1903–	(Swedish)	Discoveriesrelating to nature and action of oxidation enzymes
1956	Werner Forssmann	1904?–	(German)	Techniques in heart diagnosis and treatment
	Dickinson W. Richards*	1895–	(U.S.)	
	Andre F. Cournand	1895–	(U.S.)	
1957	Daniel Bovet	1907–	(Italian)[5]	Development of refined synthetic curare and of antihistamines
1958	George Wells Beadle*	1903–	(U.S.)	Work in genetics and heredity
	Joshua Lederberg	1925–	(U.S.)	
	Edward Lawrie Tatum	1909–	(U.S.)	
1959	Severo Ochoa	1905–	(U.S.)	Discovery of enzymesfor producing nucleic acids artificially
	Arthur Kornherg	1918–	(U.S.)	
1960	Sir Macfarlane Burnet*	1899–	(Australian)	Discovery of acquired immunity tolerance to tissue transplants
	Peter B. Medawar	1915–	(English)	

Literature

1901	René Sully-Prudhomme	1839–1907	(French)	Poet
1902	Theodor Mommsen	1817–1903	(German)	Historian
1903	Björnstjerne Bjornson	1832–1910	(Norwegian)	Dramatist, poet, novelist
1904	Frédéric Mistral	1830–1914	(French)	Poet
	José Echegaray	1832–1916	(Spanish)	Dramatist
1905	Henryk Sienkiewicz	1846–1916	(Polish)	Novelist
1906	Giosuè Carducci	1835–1907	(Italian)	Poet

[4]Born in Prague, U.S resident from 1922; U.S. citizen.
[5]Born in Switzerland; Italian citizen from 1947.

Literature—Continued

1907	Rudyard Kipling	1865–1936	(English)	Novelist and poet
1908	Rudolf Eucken	1846–1926	(German)	Philosopher
1909	Selma Lagerlöf	1858–1940	(Swedish)	Xovelist
1910	Paul von Heyse	1830–1914	(German)	Novelist, dramatist, poet
1911	Maurice Maeterlinck	1862–1949	(Belgian)	Dramatist
1912	Gerhart Hauptmann	1862–1946	(German)	Dramatist
1913	Sir Rabindranath Tagore	1861–1941	(Indian)	Poet
1914	(No award)			
1915	Romain Rolland	1866–1944	(French)	Novelist
1916	Verner von Heidenstam	1859–1940	(Swedish)	Poet
1917	Karl Gjellerup	1857–1919	(Danish)	Xovelist
	Henrik Pontoppidan	1857–1943	(Danish)	Novelist
1918	(No award)			
1919	Carl Spitteler	1845–1924	(Swiss)	Poet and novelist
1920	Knut Hamsun	1859–1952	(Norwegian)	Novelist
1921	Anatole France	1844–1924	(French)	Novelist
1922	J. Benavente y Martínez	1866–1954	(Spanish)	Dramatist
1923	William Butler Yeats	1865–1939	(Irish)	Poet
1924	Wladyslaw S. Reymont	1868–1925	(Polish)	Novelist
1925	George Bernard Shaw*	1856–1950	(Irish)	Dramatist
1926	Grazia Deledda	1875–1936	(Italian)	Novelist
1927	Henri Bergson	1859–1941	(French)	Philosopher
1928	Sigrid Undset	1882–1949	(Norwegian)	Novelist
1929	Thomas Mann	1875–1955	(German)	Novelist
1930	Sinclair Lewis	1885–1951	(U.S.)	Novelist
1931	Erik Axel Karlfeldt	1864–1931	(Swedish)	Poet
1932	John Galsworthy	1867–1933	(English)	Novelist
1933	Ivan Bunin	1870–1953	(Russian)	Novelist
1934	Luigi Pirandello	1867–1936	(Italian)	Dramatist
1935	(No award)			
1936	Eugene O'Neill	1888–1953	(U.S.)	Dramatist
1937	Roger Martin du Gard	1881–1958	(French)	Novelist
1938	Pearl Buck	1892–	(U S .	Novelist
1939	Frans Emil Sillanpää	1888–	(Finnish)	Novelist
1940–1943	(No award)			
1944	Johannes V. Jensen	1873–1950	(Danish)	Novelist
1945	Gabriela Mistral	1889–1957	(Chilean)	Poet
1946	Hermann Hesse	1877–1962	(Swiss)	Novelist
1947	André Gide	1869–1951	(French)	Novelist and essayist
1948	Thomas Stearns Eliot	1888–	(English)	Poet and critic
1949	William Faulkner	1897–1962	(U.S.)	Novelist
1950	Bertrand Russell	1872–	(English)	Philosopber, mathematician
1951	Par Fabian Lagerkvist	1891–	(Swedish)	Novelist and poet
1952	François Mauriac	1885–	(French)	Poet, novelist, dramatist
1953	Sir Winston Churchill	1874–	(English)	Historian and orator
1954	Ernest Hemingway	1899–1961	(U.S.)	Novelist
1955	Halldór K Laxness	1902–	(Icelandic)	Novelist
1956	Juan Ramón Jiménez	1881–1958	(Spanish)	Poet
1957	Albert Camus	1913–1960	(French)	Novelist and dramatist
1958	Boris Leonidovich Pasternak[6]	1890–1960	(Russian)	Poet and novelist
1959	Salvatore Quasimodo	1901–	(Italian)	Poet
1960	Saint-John Perse	1887–	(French)	Poet

Peace

1901	Jean Henri Dunant	1828–1910	(Swiss)
	Frédéric Passy	1822–1912	(French)
1902	Élie Ducommun	1833–1906	(Swiss)
	Charles Albert Gobat	1843–1914	(Swiss)
1903	Sir William R Cremer	1838–1908	(English)
1904	Institute of International Law	Founded 1873	
1905	Baroness Bertha von Suttner	1843–1914	(Austrian)
1906	Theodore Roosevelt	1858–1919	(U.S.)
1907	Ernesto Teodoro Moneta	1833–1918	(Italian)
	Louis Renault	1843–1918	(French)
1908	Klas Pontus Arnoldson	1844–1916	(Swedish)
	Fredrik Bajer	1837–1922	(Danish)
1909	Auguste Beernaert	1829–1912	(Belgian)
	Baron d'Estournelles de Constant	1852–1924	(French)
1910	International Peace Bureau	Founded 1891	
1911	Tobias Asser	1838–1913	(Dutch)
	Alfred Fried	1864–1921	(Austrian)
1912	Elihu Root	1845–1937	(U.S.)
1913	Henri la Fontaine	1854–1943	(Belgian)
1914	(No award)		
1915	(No award)		
1916	(S o amard)		
1917	International Red Cross Committee	Founded 1863	
1918	(No award)		
1919	Woodrow Wilson	1856–1924	(U S)
1920	Léon Bourgeois	1851–1925	(French)
1921	Karl Hjalmar Branting	1860–1925	(Swedish)
	Christian Lous Lange	1869–1938	(Norwegian)
1922	Fridtjof Nansen*	1861–1930	(Norwegian)
1923–1924	(No award)		
1925	Sir Joseph Austen Chamberlain	1863–1937	(English)
	Charles Gates Dawes	1865–1951	(U.S.)
1926	Aristide Briand	1862–1932	(French)
	Gustav Stresemann	1878–1929	(German)
1927	Ferdinand Buisson	1841–1932	(French)
	Ludwig Quidde	1858–1941	(German)
1928	(No award)		
1929	Frank B. Kellogg	1856–1937	(U.S.)
1930	Nathan Söderblom	1866–1931	(Swedish)
1931	Jane Addams	1860–1935	(U.S.)
	Nicholas Murray Butler	1862–1947	(U.S.)
1932	(No award)		
1933	Sir Norman Angell*	1874–	(English)
1934	Arthur Henderson	1863–1935	(English)
1935	Carl von Ossietzky	1889–1938	(German)
1936	Carlos Saavedra Lamas	1878–1959	(Argentine)
1937	Viscount Cecilof Chelwood	1864–1958	(English)
1938	Nansen International Office for Refugees	Founded 1921	
1939–1943	(No award)		
1944	International Red Cross Committee	Founded 1863	
1945	Cordell Hull	1871–1955	(U.S.)
1946	Emily Greene Balch	1867–	(U.S.)
	John R. Mott	1865–1955	(U.S.)
1947	American Friends Service Committee (U.S.); Friends Service Council (London)		
1948	(No award)		

[6]Declined award.

Peace—Continued

1949	Lord Boyd-Orr	1880–	(English)
1950	Ralph Bunche	1904–	(U.S.)
1951	Léon Jouhaux	1879–1954	(French)
1952	Albert Schweitzer	18;5–	(Alsatian)
1953	George Catlett Marshall*	1880–1959	(U.S.)
1954	Office of thr United Nations High Commissioner for Refugees	Founded 1951	
1955–1956	(No award)		
1957	Lester B. Pearson	1897-	(Canadian)
1958	Dominique Georges Pire, O r.	1910–	(Belgian)
1959	Philip J. Noel-Baker*	1889–	(English)
1960	(So award)		

NOBILE, UMBERTO (1885–   ), Italian aeronautical engineer and explorer, a pioneer of arctic aviation, was born at Lauro, Avellino, on Jan. 24, 1885. Trained as an engineer in Naples, he did much pioneer work for Italy during and after World War I in the field of aircraft construction. In 1926, together with Roald Amundsen and Lincoln Ellsworth, he flew in his semirigid airship the "Norge" over the north pole from Spitsbergen to Alaska. Nobile was promoted to general in the Italian air force and appointed professor of aeronautical engineering at the University of Naples. Although the type was criticized as being too small and delicate for use in the polar regions, it was with an almost identical airship, the "Italia," that Kobile undertook in 1928 a new series of flights over unexplored areas of the arctic. On the third flight the airship crashed on the ice north-northeast of Spitsbergen. A vast international rescue operation was launched; Kobile and seven of his companions were eventually rescued, but the catastrophe cost, directly or indirectly, 17 lives. Nobile's conduct was the subject of fierce controversy and an Italian commission of inquiry, in all probability partial, found him responsible for the disaster, whereupon he resigned his rank. In 1931 he took part in the arctic voyage of the Soviet vessel "Malygin," and from 1932 to 1936 he was concerned with the construction of dirigibles in the Soviet Union. He was reinstated in 1945 and resumed his teaching post at Naples. In 1936 he was a Communist deputy in the Italian constituent assembly.

Nobile published numerous works, both on aeronautics and his polar experiences, including *Posso dire la verità* (1945), a final statement of his view of the "Italia" tragedy. (P. A. B. G.)

NOBLE, SIR ANDREW, 1ST BART. (1831–1915), British physicist and artillerist whose classical researches with Sir Frederick Abel on fired gunpowder contributed greatly to the progress of gunnery, was born at Greenock. Renfrewshire, Scot.. Sept. 13. 1831 Educated at Edinburgh academy and the Royal Military academy, Woolwich, London, he entered the royal artillery in 1847 and, as secretary of the select committee on smoothbore and rifled cannon, he devised an ingenious method of comparing the accuracy of fire of each type of gun. He became assistant inspector of artillery (1859), then served on the ordnance select committee and the explosives committee, but left the service to join the firm of Sir William (later Lord) Armstrong (*q.v.*) of which he became chairman in 1900. About 1862 he applied his chronoscope, a device for measuring very small time intervals, to determine the velocity of shot in gun barrels with different powders and charges. He was an advocate of nitro (smokeless) powders. Noble was elected a fellow of the Royal society (1870), awarded a royal medal of the society (1880) and created a baronet (1902). He died In Argyllshire, Scot.. on Oct. 22. 1915.

His papers were collected as *Artillery and Explosives* (1906). (*D.* McK.)

NÓBREGA, MANUEL DA (1517–1570), was the Portuguese founder of the Jesuit mission of Brazil. In Bahia. where he arrived from Lisbon in 1549, he founded the first Jesuit college in the new world. He was the first provincial of the Brazilian province of the Society of Jesus (1553–59). He was again named provincial in 1570 but died in Rio de Janeiro before the news of the appointment reached him. Nobrega was instrumental in establishing the Jesuit college around which São Paulo grew (1 j54) and is therefore known as the founder of Brazil's largest city. When the French under Nicolas de Villegagnon, including many Huguenots, settled in Rio (1555), Nóbrega moved heaven and earth against them. They were expelled in part because he won over to the Portuguese side the Tamóio Indians (1563).

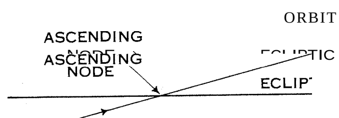
"There is no individual," Robert Southey wrote, "to whose talents Brazil is so greatly and permanently indebted. . . ." In many ways because of Nóbrega, southern Brazil was destined to remain Catholic and Portuguese. *See* also BRAZIL: *History.* (M. CA.)

NOCERA INFERIORE, formerly NOCERA DEI PAGANI (anc. city *Nuceria Alfaterna*), town and episcopal see, Campania, Italy, province of Salerno, at the foot of Monte Albino, 23 mi. E.S.E. of Naples by rail, 135 ft. above sea level. Pop. (1957 est.) 40.-288 (commune). The city early became an episcopal see. and in the 12th century it sided with Innocent II against Roger of Sicily. suffering severely for its choice. A colony of Saracens introduced by Frederick II probably gave rise to the epithet ("of the pagans"), as well as to the town of Pagani, about 1 mi. west.

NOCTURNE or NOCTURN, in music a term meaning night piece, a composition, usually for the pianoforte, of a dreamy, tender, romantic and predominantly sad or wistful character. The name is now inseparably connected with Frederic Chopin's incomparable compositions so described, though it was actually first employed by the Irish composer and pianist John Field for some charming pieces of his own in precisely the same style.

NODDY, the name applied to a sea bird, *Anorrs stolidus*, one of the terns (*q.v.*), showing so little fear of man as to be judged stupid. It is heavier in flight than most terns, with shorter wings and less forked tail. The plumage is of a uniform sooty hue. except the light gray crown of the head. The noddy is generally distributed throughout tropical and subtropical oceans. It breeds in astounding numbers, on low cays and coral islets. making a nest composed of seaweed or small twigs. Other birds of the same genus are the darker Pacific noddy (*A. s. sidgwayi*), the still darker Galapagos noddy (*A. s. galapagoensis*) and the white-headed noddy (*A. leucocapillus*).

NODE (from the Lat. *nodus*, "loop"), in astronomy, the intersection of the ecliptic (the apparent path of the sun among the stars) with the path of the moon or of a planet projected on the celestial sphere. The ascending node is the one where the body crosses from the south to the north side of the ecliptic. the opposite one being the descending node. An eclipse or transit of a planet has to occur when the moon or planet is at or near a node, for that is the only time that the sun, moon or planet and earth can be lined up suitably.



ASCENDING NODE

In the geometry of curves, a node is the name given to the loop formed by a continuous curve crossing itself. The point of crossing is termed a "double point." and at it there are two non-coincident tangents to the curve; the remaining species of double points—termed acnode, spinode or cusp—admits of two coincident tangents. *See* also CURVES. (*H.* M. Lo.)

NODIER, CHARLES (1780–1844). French author. was born at Besançon. His father, on the outbreak of the French Revolution. was appointed mayor of Besançon and Charles is said to have been a member of the Jacobin club when he could not have been more than 12 years old. He was sent to Strasbourg. where he lived in the house of Eulogius Schneider. the notorious Jacobin governor of Alsace, but a good Greek scholar. He became librarian in his native town, but his exertions in the cause of suspected persons brought him under suspicion. For a skit on Napoleon, in 1803. he was imprisoned for several months. He then lived a very unsettled life at Besançon, Dôle (where he married) and in other places in the Jura. During these wanderings he wrote Le *Peintre de Salzbourg, journal des émotions d'un coeur souffrant, suivi des Méditations du cloître* (1803). He continued to lead an unsettled life until in 1824 he was appointed to the librarianship of the Bibliothèque de l'Arsenal. He was elected a member of the academy in 1833. and died on Jan. 27, 1844.

During his 20 years at the arsenal Nodier was able to supply a centre and rallying place to a knot of young literary men of greater individual talent than himself—the so-called Romanticists of 1830—and to colour their tastes and work very decidedly with his own predilections. Victor Hugo, Alfred de Musset and Charles Augustin Sainte-Beuve all acknowledged their obligations to him.

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NŌ DRAMA. Toward the end of the 14th century a father and son, Kan-ami and Zeami (see Zeami Motokiyo), by making innovations and refinements in *sarugaku-nō*—an entertainment derived from ancient native and foreign sources—created the nō theatre of Japan, which survives in modern times in much the same form as that in which it was conceived. Kan-ami's troupe, previously associated with a Shintij shrine, was taken under the patronage of the temporal ruler, the shogun Yoshimitsu. Thereafter and well into the 19th century the nō was a fashionable amusement of the aristocracy and the warrior class but certain performances, called subscription nō, were open to and popular with commoners. The nō thus greatly influenced the subsequent dramatic expression of the commoners, the puppet theatre and the kabuki, which appeared at the end of the 16th century.

The nō is nonrealistic. The actors, all male, are singers and dancers. They wear theatrical versions of 14th-century costumes and in some roles are masked. The rhythmical basis of the performance is provided by two or three drummers and a flutist. A chorus of six or more men chants the narrative parts of the play and sometimes the words of the characters.

Classification of **Nō** Plays.—Out of more than 2,000 plays, about 240—the majority of which were written during the 15th century—constitute the modern repertoire. These are divided into five principal groups: (1) congratulatory pieces praising the prosperity of the country; (2) plays about warriors, as men and as ghosts; (3) those which usually have an elegant, beautiful woman as leading character; (4) plays (the largest group, containing various types) dealing with insanity, obsession and historical characters; (5) pieces concerning demons and gods. The traditional, daylong performance consisted of a play from each of the groups, in the above order, with comic interludes in colloquial language (*kyōgen*) played between them; after 1945 the usual program consisted of two or three plays with comic interludes.

Construction of **Nō Plays.**—Nō plays are written in poetic form, using a variety of complex. untranslatable literary devices. Usually there are only two important roles: the shite or principal character and the *waki* or secondary one. Considered apart from the Japanese classification, the plays are of two types: those set entirely in the "real" world, and those in which an apparition or supernatural being appears. The majority of the plays and those most frequently performed belong to the latter group. These vary in detail but the general form is this: The *waki,* often a priest or monk, enters first; he is joined by the shite at a place of historical or religious significance. The shite, though appearing to be an ordinary person, reveals unusual knowledge of the spot. The *shite* then exits. During a short interlude he changes costume and mask and reappears for the second part in his true form. He is described in his first appearance as the "before"-shite, in his second as the "after"-*shite;* there is often a complete contrast between the two, so that they are entirely different roles. The *shite* may first be a beautiful girl, then a serpent; an old village woman, then a demon; a boy, then the spirit of a warrior. On his second appearance the shite, with the help of the chorus, gives an account of his essential being, climaxed by his principal dance. A hunter dances his killing of birds in life and the punishment he later suffers in hell for this sin. The woman who in life had an illicit passion for a priest reveals her true nature by wearing the mask of a demon and a costume of stylized pattern suggesting the scales of a snake. The great warrior relives his last battle. All such characters are chained to their earthly passions, which bind them to the world of actuality and prevent their attainment of nirvana. They appeal to the priest or monk to pray for the repose of their spirits. Because the priest possesses knowledge of the likeness of all living things he receives requests for deliverance and enlightenment not only from the spirits of human beings, but also from the snow, a butterfly or the wisteria.

Staging.—The stage has two principal areas: the stage proper, about 18 ft. square; and the bridge (hashigakari). about 6 ft. wide and between 33 and 52 ft. long, which connects the dressing room with the stage proper and is used for entrances and exits by the principal characters. Lesser characters and musicians use a low door in the upstage corner of the stage. The chorus occupies an area to the left of the actors; the instrumentalists sit at the rear of the stage. Both playing areas are roofed, as they were in the earliest outdoor theatres, although most *nō* stages are now constructed within a building. The out-of-doors is also recalled in the stylized pine tree painted on the rear wall of the stage, the painted bamboo design on the narrow wall to the side of it, the strip of white pebbles between the playing areas and the auditorium and the three small pine trees in front of the bridge. The pillars supporting the roof have conventional spatial values and determine the pattern of the actor's movement. Scenic objects, rarely used, do not often resemble literal objects, but merely suggest them. Many properties are similarly sketchlike; the most frequently used is the folding fan, which—closed, partially closed or open—conveys any meaning suggested by its form or manipulation.

See also Kabuki Theatre; Mask.

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NOEL-BAKER, PHILIP JOHN (1889–), British statesman and internationalist who advocated international disarmament in the cause of world peace and who was awarded the Nobel peace prize in 1959. Born in London. Nov. 1, 1889, of a Quaker family, he was educated at Bootham school, York; Haverford college, Pennsylvania, and at King's college, Cambridge. President of the Cambridge Union society in 1912, he also captained the 1924 British Olympic Games team. During World War I he served with the Friends' and other ambulance units in France, Belgium and Italy, being decorated for distinguished conduct. After working at the peace conference in 1919 as a member of the British delegation, he joined the secretariat of the League of Nations. He assisted Fridjof Nansen in his work for refugees, Lord Robert Cecil at sessions of the assembly and Arthur Henderson, the president, at the world disarmament conference at Geneva, 1932–33.

In the house of commons Noel-Baker represented Coventry (1929–31), Derby (1936–50) and South Derby after Feb. 1950, as a Labour member. Between 1945 and 1951 he was successively minister of state, secretary of state for air, secretary of state for Commonwealth relations and minister of fuel and power. Aided by a fluent command of seven languages, he campaigned for 40 years for peace through international disarmament. The Arms Race: a *Programme* for *World Disarmament* (1958) was acclaimed as a monumental survey of the whole disarmament problem. (L. R. A.)

NOETHER, (AMALIE) EMMY (1882–1935), German mathematician who specialized in higher algebra, was born at Erlangen on March 23, 1882. Her father Max Noether (1844–1921) was a distinguished mathematician; a brother, Fritz Noether (1884–). was professor of applied mathematics. She studied in Erlangen, later in Gottingen, where she passed her habilitation examination in 1919, after earlier objections from some members of the faculty opposed to women lecturers.

In 1922 she became extraordinary professor in Gottingen, a position she held until 1933, when she left Germany to accept a professorship at Bryn Mawr college, Pennsylvania. She died on April 14, 193j.

Emmy Noether's studies on abstract rings and ideal theory have been of importance for the development of modern algebra; she also exerted great scientific influence through her many able pupils. (O. Oe.)

NOGALES, a desert town in the Mexican state of Sonora, contiguous with and across the border from Nogales, Ariz., U.S., and port of entry into Mexico. Pop. (1950) 24,480. The Pacific highway leading to Mexico City (1,500 mi.) via Hermosillo, Guaymas, Mazatlán and Guadalajara, begins at this point. A rail line follows the same route. Nogales is noted for its cavern restaurant. a cafe in a cave which was once used as a jail under Chureas hill. Nogales is a U.S.-Mexican trading centre in cattle and minerals. Irrigation of large areas of the state in the 1950s brought increased wealth to Nogales, but the main farm areas are to the south. (J. A. Cw.)

NOGARET, GUILLAUME DE (d. 1313), councilor and keeper of the seal to Philip IV of France, was born between 1260 and 1270, the son of a citizen of Toulouse. His family, which took its name from a small property near Saint-Felix de Caramon, was later said by Nogaret's enemies to have adhered to the Albigensian heresy.

Nogaret became professor of jurisprudence at the University of Montpellier (1291); entered the king's service as *juge-mage* in the *sénéchaussée* of Beaucaire (*c.* 1294); was made a member of the *curia regis* in Paris (1296) and, as king's commissary. was entrusted with missions to Normandy, Bigorre and Champagne; and went to Rome with an embassy (1300). In 1299 he took the title of knight. He is the best known of the *légistes* and a good representative of those faithful and even fanatical servants of the royal power, but his influence on Philip IV's policy has been greatly exaggerated. His name is mainly connected with Philip's clash with Boniface VIII (*q.v.*). On March 12. 1303, after the publication of the bull *Unam sanctam* Nogaret addressed an assembly in Paris, denouncing the pope as illegitimate and heretical and demanding a general council to try him. He had already (March 7) been commissioned by the king to go to Italy to notify Boniface of the summons and to take him into custody.

From the castle of Staggia, between Florence and Sienna, Nogaret prepared the arrest of the pope, who had refused the notification and was preparing the bull *Super Petri solio*, which excommunicated the king. He got in touch with some of Boniface's enemies. several cardinals and the population of Anagni. At dawn on Sept. 7, 1303, he entered Anagni, with a small force under Rinaldo de Supino. captain of Ferentino, the gates having been left open by his supporters. But the Colonnas, under Sciarra Colonna, had been informed of this move and entered the town at the same time in pursuance of their vendetta against Boniface. Nogaret's carefully prepared legal apparatus was broken down by their looting and violence, which brought on the rising of the townsmen on Sept. 9. Nogaret, who had in fact saved Boniface's life. was wounded and had to flee to Ferentino. He returned to France early in 1304 and was rewarded by the king with a pension of joo *livres*.

Nogaret's part in this affair must be understood as the action of an almost fanatical Christian ready to sacrifice anything to free the church from a pope whom he thought unworthy. However, much of the odium of the outrage fell upon him; and on June 7, 1304, the new pope Benedict XI issued a bull *Flagitiosum scelus* against Nogaret and 1j others, though he had already cleared Philip of any responsibility. Nogaret, much embittered, devoted himself to getting his innocence recognized. Eventually the French pope Clement V, whose election he had promoted and whom he threatened with proceedings against the memory of Boniface, absolved him on April 27, 1311. Meanwhile, he had kept Philip's favour: as the keeper of the seal (Sept. 22, 1307, to his death. April 1313), he reorganized the chancellor's office; and in 1305 he was put in charge of the inquiry on the denunciations of the Templars by Esquieu de Floyran. On Oct. 13, 1307, he organized the general arrest of the Templars and directed the seizure of the Paris temple; and he played a large part in the subsequent proceedings, especially those against the high dignitaries of the order. There is, however, no reason to see Nogaret's hand in all state trials of his time.

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NOGENT-SUR-MARNE, a suburb 6.7 mi. E. of Notre Dame de Paris. in the *département* of Seine, on a hill on the right bank of the blarne. Pop. (1954) 23,056. Nogent has a Gothic church with a Romanesque tower—in front is a monument to Antoine Watteau. who died there in 1721. Chemical products are manufactured. The fine situation of the town gained it the name of Beauté, and Charles V built a chbteau there which was presented by Charles VII to Agnes Sorel with the title of Dame de Beauté.

NOGUCHI, HIDEYO (1876–1928), Japanese bacteriologist, was born in Inawashiro, Fukushima, Japan, Nov. 24, 1876. He graduated from Tokyo Medical college in 1897 and two years later emigrated to Philadelphia. At the University of Pennsylvania he assisted Weir Mitchell in his studies on snake venoms. In 1904 Xoguchi went to the Rockefeller Institute for Medical Research in New Pork city, where he worked the rest of his life. He was the first to demonstrate spirochetes of syphilis in the central nervous system of patients dying of paresis and tabes dorsalis, thereby proving the syphilitic origin of those diseases. He improved the technique and theory of the Wassermann reaction.

Adapting a method first employed by Theobold Smith, Noguchi devised ingenious means of cultivating microorganisms that had never before been grown in the test tube. He discovered a number of new microorganisms which he erroneously described as causes of infectious diseases now known to be caused by viruses; *e.g.*, poliomyelitis, trachoma and yellow fever. He succeeded in growing spirochetes which he believed to be those that cause syphilis.

During his lifetime: Noguchi was regarded as one of the world's greatest bacteriologists, but of his later "discoveries" only a few —*e.g.*, the cultivation of the parasite of Oroya fever (Carrion's disease, and verruga peruana, which he showed to be different manifestations of the same infection—have stood the test of time. He was a dedicated and indefatigable scientist, and no one who knew him could doubt the sincerity of his own belief in the validity of his claims. When he learned that other bacteriologists had announced that yellow fever was caused by a virus. Noguchi went to British West Africa to join them! in order to resume his study of that disease. While doing so, he contracted yellow fever and died in Accra on May 21, 1928. (C. P. M.)

NOGUCHI, ISAMU (1904–), U.S. sculptor of Japanese descent, one of the strongest advocates of the expressive power of abstract shapes, was born at Los Angeles. Calif., on Nov. 7, 1904. To his terra-cotta and stone sculptures Noguchi brought some of the spirit and mystery of early art, principally Japanese earthenware, studied during residences in Japan. Trained as a premedical student at Columbia university, Noguchi sensed the interrelatedness of bone and rock forms, the comparative anatomy of existence. as seen in his "Kuros" (1945). Recognizing the appropriateness of sculptural shapes for architecture, he made many important contributions toward the aesthetic reshaping of physical environment. His garden for UNESCO in Paris (1958), his playground. lamp, chair and table designs have won international praise. He also designed a monument to the dead and a bridge for Hiroshima, but only the latter was actually built.

See C. Giedion-Welcker, *Contemporary Sculpture* (1955). (A. E. EL.)

NOISE AND ITS CONTROL. In acoustics noise is defined as "any undesired sound." In radio and electronics it is any unaanted disturbance in a device. According to this definition, the sound of church bells may be music to some and noise to others. Usually, noise is a mixture of many tones combined in a nonmusical manner.

Measurement and Specification.—The measurement of sounds (nhether or not adjudged noise) is commonly made with a sound level meter and a frequency analyzer. The sound level meter comprises a microphone and associated electronic equipment. The analyzer is an electronic device for separating the noise into its tonal components. or into groups of tonal components. The results of a measurement are given in decibels (db.), which is called the sound pressure level and is equal to 20 times the logarithm of the ratio of the sound pressure in the air to a reference sound pressure (usually 0.0002 dyne per square centimetre). For example, a sound pressure of one dyne per square centimetre has a sound pressure level of 74 db. The decibel is to sound what the degree is to temperature. It indicates the magnitude of the sound, but not the reaction of human beings to it. Typical sound levels in decibels, considering all audible tonal components contained in the sound, are shown in Table I. Outdoors, the sound levels decrease six decibels each time the distance between the source and the microphone is doubled. Conversely, the sound increases six decibels each time the distance is halved. Indoors, the acoustics of the room greatly modify this rule.

The "strength" of a sound source is indicated by the total power in watts that it produces in the air around it. Acoustic powers of common sound sources are shown in Table II. The total range is nearly 100,000,000,000,000 times.

TABLE *I.—Typical Over-all Sound Levels*

(As measured on an American standard sound level meter)

At a given distance from noise source	Decibels* re 0.0002 microbar	Environmental
	140 dbc.	
50-h.p. Victory siren (100 ft.)		
F-84 at take-off (80 ft. from tail)		
Hydraulic press (3 ft.)	130 dbc.	
Large pneumatic riveter (4 ft.)		Boiler shop (maximum level)
Pneumatic chipper (5 ft.)		
	120 dbc.	
Multiple sand blast unit (4 ft.)		Engine room of submarine (full speed)
Trumpet auto horn (3 ft.)		
Automatic punch press (3 ft.)		Jet engine test room
	110 dbc.	
Chipping hammer (3 ft.)		Woodworking shop
Cut-off saw (2 ft.)		Inside DC-6 airliner
Annealing furnace (4 ft.)		Weaving room
	100 dbc.	
Automatic lathe (3 ft.)		Can manufacturing plant
Subway train (20 ft.)		Inside Chicago subway car
Heavy truck (20 ft.)		
Train whistle (500 ft.)		Inside motorbus
	90 dbc.	
Small truck accelerating (30 ft.)		Inside sedan in city traffic
	80 dbb.	
Light truck in city (20 ft.)		Office with tabulating machines
Auto (20 ft.)		Heavy traffic (25 to 50 ft.)
	70 dbb.	
		Average traffic (100 ft.)
		Accounting office
Conversational speech (3 ft.)		Chicago industrial areas
	60 dbb.	
Transformer (200 ft.) (15,000 kva., 115 kv.)		
	50 dba.	Private business office (noisy)
		Light traffic (100 ft.)
		Average residence
	40 dba.	
		Private business office (quiet)
		Minimum levels for residential areas in Chicago at night
	30 dba.	Broadcasting studio (speech)
		Broadcasting studio (music)
	20 dba.	Studio for sound pictures
	10 dba.	
Threshold of hearing—young men	0 dba.	

*The suffixes attached to db, (dba, dbb and dbc) indicate the manner in which the sound level meter was operated, *e.g.*, when the scale of the meter is set to "c", the meter reads the sound pressure level as defined in the text. When set to "a" or "b" the meter takes into account, partially, the manner in which a human listener judges the loudness of the weaker sounds.

Source: ***Handbook of Noise Measurement,*** General Radio Co., Cambridge, Mass.

TABLE 11.—Acoustic Power for Various Acoustic Sources

Power (watts)	Source
100,000	
	Ramjet
	Turbojet engine with afterburner
10,000	Turbojet engine, 7,000-lb. thrust
1,000	
	4-propeller airliner
100	
	7.1-piece orchestral } peak r.m.s. levels in 1/8-sec. intervals
10	Pipe organ
	Small aircraft engine
1	
	Large chipping hammer
	Piano } peak r.m.s. levels in 1/8-sec. intervals
	BB♭ tuba
0.1	Blaring radio
	Centrifugal ventilating fan (13,000 c.f.m.)
0.01	4-ft. loom
	Auto on highway
0.001	Vaneaxial ventilating fan (1,500 c.f.m.)
	Voice—shouting (average long-time r.m.s.)
0.0001	
0.00001	Voice—conversational level (average long-time r.m.s.)
0.000001	
0.0000001	
0.000,000,01	
0.000,000,001	Voice—very soft whisper

Source: ***Handbook of Noise Measurement,*** General Radio Co., Cambridge, Mass.

Sounds may be divided into three classes: (1) those that are composed of one or more pure tones, such as a note from the piccolo; (2) those that contain a great many very closely spaced tones, such as the noise of a waterfall or of a jet aircraft engine; and (3) combinations of the first two, such as a whistle in a busy factory.

Effects on Man.—Noise may have any one or all of four effects on man. It may (1) annoy him or (2) disturb his sleep; (3) interfere with his ability to converse with someone else; (4) damage his hearing. There is no way to judge the annoyance of a sound because annoyance is related to the mental attitude of a person, to his physical type and to his previous experience. The operators of airports near large cities have learned from experience the relation between the noise produced by aircraft and the number of complaints received from residents. The complaints are related to the power and type of aircraft, the distance from the airport to the residents and the frequency of passage of the aircraft. Similar experiences for other types of noise are becoming available from factory owners and city planners.

Those tonal components of a noise that lie between 300 and 5,000 cycles per second interfere most with conversation.

Damage to hearing may be of one or two types. Sudden damage may result from the noise of a blast or an explosion. Gradual damage may result from continued exposure to noise over a period of years. For a given total power of a sound, one that is steady (such as that of a textile mill) will be less likely to damage hearing than one that is impulsive (as that of a pneumatic hammer or a drop forge). There is great variability among people in their susceptibility to damage to hearing. Many companies periodically test the hearing of workers in noisy areas and transfer those who shows signs of deafness to quieter regions. Those who work around jet aircraft. in boiler shops, in drop forge shops or those who use metal cutting, chipping and shaping tools are most likely to suffer gradual loss of hearing.

Solution of the Noise Problem.—The approach to solving a noise problem can be summed up as follows. First, consider the source. Can a quieter machine or operation be substituted? Can the noise power be reduced? Can a useful change be made in the direction in which the noise is radiated? Are resilient pads beneath the noisy device of any use? Can a muffler be used? Second, consider the path from the source to the listener. Can the source or the listener readily be moved, so that the two are farther apart, to reduce the sound level? Should a barrier be erected between the source and the listener? Is a total enclosure for the source required? Will the addition of an absorbing acoustical material result in significant noise reduction? Third, consider the listener. Can he be induced to wear ear plugs or noise-reducing cushions or helmets? Can he be enclosed in a booth or other quiet space?

Ready-built mufflers are available for engines and air ventilating systems. Many types of sound-absorbing materials are available. Walls between rooms should be as heavy as possible and should be made of two isolated leaves with an intervening air space for maximum sound reduction between rooms. Sound-absorbing materials should be used on the ceiling or walls of a room to prevent the reinforcement of the noise due to room resonances. Rubber-in-shear, cork or felt pads are available for mounting machines to prevent inducing vibrations in the floor or structure.

Barriers such as walls or pens between a sound source and a listener are effective only if they are high enough and if they are either very near to the source or very near to the listener. When a source or a listener is fully enclosed. careful attention must be taken to gasket all cracks around doors and to seal all joints.

Law.—In law, noise may be defined as an excessive, offensive. persistent or startling sound. By the common law of England freedom from noise is essential to the full enjoyment of a dwelling house and noises that affect that enjoyment may be actionable as nuisances. But it has been laid down that a nuisance by noise, supposing malice to be out of the question. is emphatically a question of degree (Gaunt v. Finney, 1872, 8 Ch. Ap. 8). The noise must be exceptional and unreasonable. Ringing of bells, building operations, vibration of machinery. fireworks, bands, a circus, merry-go-rounds, disorderly crowds, dancing, singing, etc.. have been held under certain circumstances to constitute nuisances so as to interfere nith quiet and comfort and have been restrained by injunction. The concept of "legalized nuisance," such as the nuisance arising from noise produced by public transportation, has found some favour in U.S. courts.

In the United States, many cities have passed ordinances containing noise provisions. conformity with which can be determined by readings from a sound level meter and a frequency analyzer with frequency bands approximately one octave in width (the eight frequency bands commonly used are 20–75, 75–150, 150–300, 300–600, 600–1,200, 1,200–2,400, 2,400–4,800 and 4,800–10,000 cycles per second). Individual states have passed laws establishing means for measuring damage to hearing and schedules of compensation that are related to the percentage of hearing damage.

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NOLA, an ancient city and see of Campania, It., province of Naples, pleasantly situated in the plain between Mt. Vesuvius and Apennines, 16¾ mi. E.N.E. of Naples by rail, 121 ft. above sea level. Pop. (1951) 15,842. There is an ancient Gothic cathedral with a lofty tower. July 26 is devoted to the great festival of St. Paulinus (*q.v.*). The church erected by him in honour of St. Felix in the 4th century is extant in part. Giordano Bruno (*q.v.*) was born at Nola in 1548. The Etruscans were in Nola about 500 B.C. They helped Neapolis against the Roman invasion (328 B.C.). The Romans made themselves masters of it in 313 B C. In the Social War it was betrayed into the hands of the Samnites. Sulla in 80 B.C. subjected it with the rest of Samnium; seven years later it was stormed by Spartacus. Nola became a Roman colony under Augustus, who died there. It mas sacked by Genseric in 4jj; by the Saracens in 806 and 904; captured by Manfred in the 13th century; and damaged by earthquakes in the 1jth and 16th.

Nola lay on the Via Popillia from Capua to Nuceria and the south; a branch road ran from it to Abella and Xbellinum. While independent it issued an important series of coins. and in luxury vied with Capua. Its territory was very fertile. A large number of vases of Greek style were manufactured there of pale yellow clay with shining black glaze, decorated with skilfully drawn red figures. Of the ancient city, numerous ruins, an amphitheatre. still recognizable in modern times, a theatre, a temple of Augustus, etc., existed in the 16th century. The neighbourhood was divided into pagi or villages. the names of some of which are preserved (Pagus Agrifanus, Capriculanus, Lanitanus). (T A.)

NÖLDEKE, THEODOR (1836–1930), German philologist whose work dealt with Semitic languages and the history of Islam, was born at Harburg, March 2, 1836, and studied at Goettingen, Vienna, Leyden and Berlin. In 1859 his history of the Koran won the prize of the French Académie des inscriptions; he rewrote it in German with additions (*Geschichte* des Korans, 1860). He taught at Goettingen (1861), Kiel (1868) and Strassburg (1872). Noldeke died Dec. 25, 1930, at Karlsruhe.

NOLLEKENS, JOSEPH (1737–1823), British sculptor, was born on Aug. 11, 1737, in Soho, London, where his father, a native of Antwerp (the "Old Nollekens" of Horace Walpole), was a painter of some repute. At the age of 13 Joseph entered the studio of the sculptor, Peter Scheemakers. In 1760 he went to Rome and his marble bas-relief. "Timoclea before Alexander," brought him a prize of 50 guineas from the Society of Arts in 1762. David Garrick and Laurence Sterne were among the first English visitors who sat for busts. On his return to England he became an associate of the Royal Academy (1771) and in 1772 a full member. By that time he had become knonn to George III, whose bust he executed and. until about 1816, he was the most fashionable portrait sculptor of his day. Other portraits were those of William Pitt. Charles Fox, the prince of Wales (afterward George IV), George Canning, Spencer Perceval, Benjamin West and Lords Castlereagh, Aberdeen. Erskine, Egremont and Liverpool. He himself preferred his imitations of the work of the ancients. such as the "Venus Anointing Herself." His work is remarkable for delicacy, but deficient in vigour and originality. Nollekens died in London on April 23, 1823.

See J T Smith, *Nollekens and His Times* (1949). (A. K. McC.)

NOLLE PROSEQUI, in Anglo-American law, the termination, at the prosecutor's instance, of proceedings against a person accused of crime by indictment or information where it appears that the interests of justice do not require him to be brought to trial. In English law, the power to enter a nolle prosequi is vested in the attorney general and is rarely used. In the United States the power is generally exercised by the prosecuting officer, typically the district attorney. and is an important adjunct to the administration of criminal justice. Particularly in large cities, many more criminal prosecutions are initiated than it is feasible to try. The nolle *prosequi* serves as a screening device by which the district attorney is enabled to exercise a measure of control over the criminal docket. It is also used to effect an informal settlement, as where a thief agrees to make restitution to his victim. In some states, the common-law rule that the entry of a nolle prosequi is within the sole discretion of the district attorney still obtains; in others, his discretion is subject to leave of court.

When entered before trial, the *nolle* prosequi does not bar a subsequent prosecution on the basis of a new indictment or information. (H. L. Pr.)

NOMADS (Gr. *nomas, -ados,* "roaming about for pasture"), peoples who lead a migratory life, having no fixed abode. Although the Greek *nomas* referred to pastoral nomads, the modern term nomad is applied to all wandering peoples, of which there are three main types: primitive nomads, pastoral nomads and tinker or trader nomads.

Primitive Nomads.—The most primitive peoples known today are nomadic, as were Stone Age people all over the world. A people which does not produce food, but only collects that which nature provides, cannot usually stay in one place for very long. After a day or two or a few weeks, depending on the natural resources, the game within walking distance of a camp is killed or frightened away, and the tubers, seeds, fruits and other vegetable food aithin the same radius will also be exhausted. When food becomes scarce, the primitive band must move to another camp site. It is often assumed that nomads wander aimlessly. without a fixed territory. Actually the primitive nomad who depends for survival on what he can find to eat must know the territory in which he roams—location of materholes, where certain plants grow and the habits of the game. Thus each nomadic band, of perhaps from 20 to 50 persons, establishes rights over the territory within which it migrates, although its members may visit bands in other territories.

Pastoral Nomads.—Pastoralists in central Asia and the middle east who depend on domesticated livestock for a livelihood also migrate in order to find pasturage for their animals, and like primitive nomads they have an established territory. Pastoral nomads may be classified according to their economy and by their pattern of migration.

Economy.—The reindeer breeders of Siberia. such as the Urianghai of the Altai mountains, depended on hunting as well as reindeer breeding for subsistence, and the 12th-century Mongols also obtained their meat by hunting. In central Asia generally pastoralists could, and often did, subsist entirely on animal products, although they welcomed trade goods when these were available. On the fringes of the grasslands families which had lost their animals engaged in agriculture. but only grudgingly. Stockbreeding mas the basis of the pastoral economy and nomadism the preferred way of life. In southwest Asia and north and east Africa (also in Tibet which, although geographically a part of central Asia has a nomadic pattern more like that of southwest Asia). pastoral nomadism and settled agriculture have always been interdependent. The camel-breeding Rwala Bedouin of Arabia practiced no agriculture, but they were dependent on grain and other products obtained from their settled neighbours in exchange for camels. The proud Masai of east Africa, who would not condescend to till the soil, obtain grain and other goods from subordinate tribes. A majority of the nomadic tribes in southwest Asia and north Africa practice some cultivation, planting crops and harvesting them between seasonal migrations. These peoples may be described as seminomadic or even semisedentary, for many have fixed abodes where they dmell for a part of each year.

Patterns of Migration.—The migration pattern of pastoral nomads depends to a considerable extent on topography and climate. Some Kazak groups, for example, made migrations of many hundreds of miles between winter quarters in the south and summer pasturage in the north. Other Kazak groups moved only a few miles between winter quarters at the foot of the mountains and high summer pastures. In the Altai region, where the pastures were rich, units followed the same route year after year. In the southern Urals, where pastures were more uncertain. a scout was sent ahead and the first to arrive at a suitable site established rights on the campsite for his group.

In Arabia the Bedouins camped during the hot summer months near a town or oasis, then moved out onto the desert after the rains. In arid Arabia there could be no fixed itinerary such as that of the Altaian Kazaks, but each group had its established territory, and beyond that smaller groups owned certain wells. Seminomads have permanent dwellings where they plant crops before moving out with their livestock in search of grazing. In western Syria and parts of north Africa winter villages are at the foot of the mountains and the animals are taken into the uplands during the summer. In southern Somaliland the people dwell in fixed villages, but send their animals out with the men twice a year—to plateau grasslands in the rainy season and to the river banks at the height of the dry season.

Tinker and Trader Nomads.—In parts of Asia primitive nomads were caught up into a larger society in such a way that they remained nomadic but became dependent on other groups. In Arabia the Sulubba or Slebs are such a people. In addition to hunting, the Slebs breed white asses; the women are prostitutes, while the men do tinkering for the Bedouins and guide them into desert recesses unfamiliar to the camel breeders. In India and West Pakistan there are nomadic peoples who make and sell baskets and other simple products or hire out as labourers on construction jobs. The best-known tinker and trader nomads are the gypsies. Believed to have originated in India, gypsy bands migrated in various parts of Europe and the United States, tinkering, horse trading and telling fortunes.

Nomadism in the 20th Century.—Nomadism has been a way of life for many people, but it is on the wane. Few primitive nomads survived in mid-20th century, although a number were described during the preceding century. Pastoral nomads have been settling down through the centuries. Many groups have made a gradual transition from full nomadism to seminomadism to sedentary life, and whole peoples, under economic or political pressure, have taken up agriculture or, as in the Soviet Union, have become settled stockbreeders. By the 1950s most of the pastoral nomads in the Soviet Union had been settled, and in Iran the nomadic population had dropped from one-third to one-fifth in the first half of the 20th century.

The nomadic way of life dies slowly, however. In the 1950s pastoral nomads were numerous enough in Chinese central Asia (Sinkiang) to be a political force. Gypsies still migrated in the United States. although traveling in Cadillacs instead of carts. A few primitive Bushmen roamed the Kalahari desert of South Africa in search of game and plant food, and Australian aborigines went "walkabout" when they felt the strictures of sedentary life unendurable.

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NOME, a town of Alaska, U.S., on the south Seward peninsula shore of the Bering sea, 525 mi. W. of Fairbanks; at one time (1900) the largest settlement in the territory. Gulch gold was found near the site of Nome on Anvil creek in Sept. 1898; the town was established the following year and diggings on the ocean beach were first worked in July 1899. The rush to Nome in 1900 was one of the most remarkable stampedes in U.S. mining history; the town soon had hotels, banks, stores, several newspapers and weekly mails from the United States; for part of the year there were. it was estimated, 20,000 inhabitants. By 1903 the population had greatly decreased; in 1920 it was 852 by the federal census, growing to 2,316 residents in 1960 (principally Eskimos). In 1905 the gold output of the Nome region amounted to about $2,500,000, nearly all from placers. Into the second half of the 20th century gold was still the principal industry, although the annual production had fallen in value to about $1,500,000. Transportation. tourism. government construction and Eskimo fur and ivory production accounted for most of the town's employment. The town is served by several airlines and roads radiate into the tundra. A few miles of narrow-gauge railway are preserved as a tourist attraction.

Nome mas first called Anvil City; the name Nome is derived from Cape Nome. first so called on a chart dated 1849, and said to have been a draftsman's mistake for the query "?Name" on the original chart. (J. E. Cl.)

NOMENOË or NOMINOE (d. 851), duke of Brittany. To pacify Brittany, Louis the Debonair named him count of Vannes in 819 and governor or duke of Brittany in 826. Throughout the reign of Louis. Nomenoe maintained peace in Brittany. But in 841 he resolved to make himself independent of Charles the Bald. In 843 Charles made a vain attempt to subdue Brittany. In 844 Nomenoë invaded Maine, and in 845 the emperor was completely defeated at Ballon near Bain-de-Bretagne. In 846 Charles recognized the independence of Brittany. Having resolved to detach the duchy from the ecclesiastical province of Tours, Nomenoe accused the Frankish bishops of Vannes, Quimper, Dol and Léon of simony at the council of Coetlouh in 848, replaced them by Bretons, and erected Dol into a metropolitan see. In 849 Nomenoe attacked the Frankish county of Anjou. Charles established a garrison at Rennes. Nomenoe seized Rennes. Nantes and Upper Brittany, and ravaged Maine. In 851 he seized Anjou and invaded Beauce. He died suddenly, leaving as his successor his son Erispoe.

NOMINALISM. Nominalists deny that universals (*q.v.*) exist, arguing that the existence of a general word does not imply the existence of a general thing named by it, though indeed there must be some similarity between the particular things to which the general word is applied. Extreme nominalists would withhold this concession (*e.g.*, perhaps Roscellinus withheld it, but we have only his adversaries' word for this). But, unless it is granted, the application of general words to particulars is made to appear entirely arbitrary, which is absurd. Perhaps extreme nominalism, if anyone ever held it, might be explained as an excessive reaction against exaggerated forms of Platonic realism. Such a reaction mas natural in the middle ages when enthusiastic Platonists verbally denied the reality of material objects. Whenever realists go too far in their depreciation of material objects an alliance between empiricism and nominalism is to be expected: the most notable medieval example of a synthesis of this kind was the work of William Ockham (but he can also be regarded as a conceptualist; *see* below).

In the middle ages, when Platonic and Aristotelian realist doctrines were associated with orthodox religious belief. nominalism could be made to seem heretical. But if nominalism is considered simply as a logical doctrine, stripped of these associations. it is more interesting for what it asserts than for what it denies. It denies that Platonic realism is needed in order to explain our ability to think and speak in general terms. It also seems to deny that Aristotelian realism is needed for this purpose; but this denial is not so unequivocal, since a moderate nominalist (*e.g.*, Hobbes, even though some of his dicta suggest extreme nominalism) would say that there must be some similarity between the particulars to which a given general word is applied, and this is very like saying that a universal must be present in them. What it asserts is, in Hobbes's words, that *ratio est ovatio,* that thought is essentially the same kind of thing as speech. Now thought and speech would be impossible if the world did not contain series of similar things. But, given this condition, it is a further question how exactly thought and speech operate; and the nominalist's answer to this is that they both operate by using symbols, either linguistic symbols, or nonlinguistic symbols like mental images. This immediately brings him into conflict with some forms of conceptualism (*q.v.*), in which it is maintained that the ability to think correctly involves something more than the ability to use sets of symbols correctly; *i.e.,* that it involves the possession of concepts. Also, it is not clear in exactly ivhat sense all thinking can be said to be the using of symbols. On the other hand; it is hard to see what the conceptualist adds to the nominalist's theory when he says that thinking depends on the possession of concepts. Perhaps he is drawing attention to such things as flashes of understanding. It might be possible to reconcile nominalism and conceptualism if the nominalist's analogy between thinking and using something were not pushed too far. *See* also Index references under "Nominalism" in vol. 24. (D. F. P.)

NOMOGRAPHY, the science of calculating charts. Its object is the general study of the representation. by means of diagrams called nomograms, of mathematical laws (Gr. *nomos,* "a law") which are expressed analytically by means of equations. Such graphical devices. once carefully dramn, yield the solutions of complicated problems with speed and with slight labour. They are especially helpful when many numerical problems of a similar sort are to be solved and when high accuracy is not required. They can be used by a person without special knowledge or experience and without the mastery of a difficult technique. Nomograms have been widely used in engineering, in industry and in the physical and natural sciences. Equations in many variables are handled by using a sequence of scale alignments or by employing networks of scales, and a great diversity of problems can be solved.

The use of graphic schemes for computation goes back to antiquity. The graphic solution of spherical triangles was in vogue in the time of Hipparchus. 150 B.C., and simple charts mere designed by the mathematicians of the middle ages. The publication of René Descartes's *Discours de la méthode* (1637), which introduced analytic geometry to the world, gave a powerful impetus to graphical methods and provided their analytical background. The theory of nomograms rests largely on analytic geometry.

Co-ordinate Papers. — The use of squared paper for the representation of relations between two quantities is familiar in many fields. A point on the paper is located by giving its distance X to the right of a vertical axis and its distance Y above a horizontal axis (distances to the left and downward being reckoned negative). X and Y are called co-ordinates. An equation $f(X, Y) = 0$ is pictured by plotting the points whose co-ordinates satisfy the equation. The resulting graph is a line or curve from which corresponding values of X and Y may be determined visually. The eye is guided by the vertical rulings along which X is constant and the horizontal rulings along which Y is constant. The values of X and Y are commonly written along the axes.

It is clear that nothing is essentially changed if the values which are marked on the axes are not proportional to the distances from the origin but more or less arbitrary scales are used. Points whose co-ordinates satisfy a given equation can be plotted as before and a curve be dramn from which corresponding values can be read. The form of the curve can be altered and in some cases simplified. These notions were developed by Léon Lalanne in his *Anamorphose logarithmique* in 1842 and further advances were made by J. Massau and Charles Lallemand in the 1880s. A basic idea is to use such scales that the graphs of the equations under consideration become straight lines, which are easy to draw. The equation $af(x) + bg(y) + c = 0$, where a, b, c are constants. becomes the straight line $aX + bY + c = 0$ if the distances X and Y along the axes to the marks x and y are determined by the functions in the equation; namely. $X = f(x)$, $Y = g(y)$.

Well-known examples based on this principle are the commercial logarithmic and semilogarithmic papers. The former papers use the scales $X = \log x$, $Y = \log y$ and are convenient for plotting the graphs of relations of the form $y^m = ax^n$. Since this may be written $m \log y = n \log x + \log a$, the graph on this paper is the straight line $mY = nX + \log a$. The semilogarithmic papers have the scales $X = x$, $Y = \log y$.

Fig. 1 shows a paper made with the scales $X = x^2$, $Y = y^2$. Thus, the points marked 1, 2, 3, . . . on the axes are at distances 1, 4, 9, . . . from the origin. The graph of the ellipse

$$\frac{x^2}{64} + \frac{y^2}{36} = 1$$

is the broken line of the figure. The hyperbola

$$\frac{x^2}{16} - \frac{y^2}{9} = 1$$

and its asymptotes

$$\frac{x^2}{16} - \frac{y^2}{9} = 0$$

are the parallel lines made of short dashes. These simple graphs can be used for the usual purposes; *e.g.,* we read from the figure that the ellipse and hyperbola intersect at (6.3, 3.6).

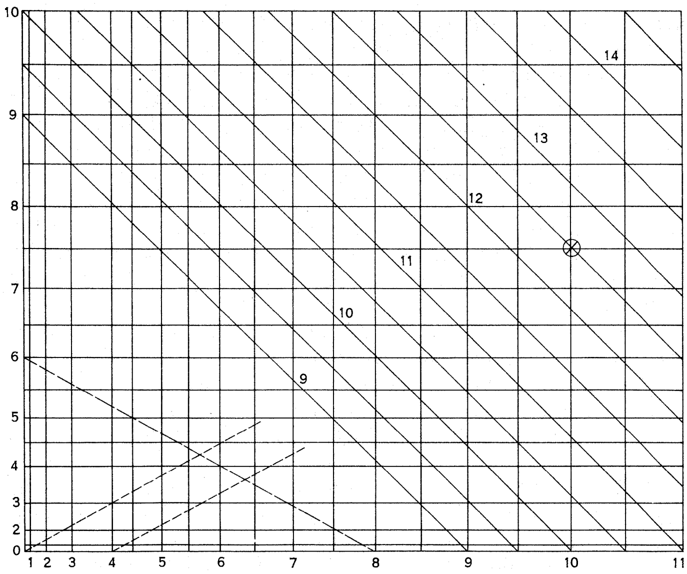

FIG. 1.—CO-ORDINATE PAPER WITH NONUNIFORM SCALES $X = x^2$, $Y = y^2$

An equation in three variables $F(X, Y, Z) = 0$ is represented in the cartesian system by a surface in three-dimensional space. To reduce the representation to a two-dimensional picture the use of contours is resorted to. Holding Z fixed, there is an equation in X and Y, whose graph is drawn. This is done for various values of Z and the values are written beside the curves. Other values of Z can be estimated visually. The resulting figure resembles a geographic map with contour lines upon it or a weather map showing isothermal lines or isobars.

Sometimes the contours can be reduced to straight lines by a happy choice of scales on the axes. An equation of the form $p(z)f(x) + q(z)g(y) + r(z) = 0$ yields a straight line for each fixed z, say z_0, using the scales $X = f(x)$, $Y = g(y)$, since the equation now is linear in the variables: $p(z_0)X + q(z_0)Y + r(z_0) = 0$. For example, a chart for solving right triangles can be made from the equation $x^2 + y^2 = z^2$ by drawing contours across fig. 1. Giving z the values 9, 9.5, 10, etc., we get the heavy slanting lines of the figure. To find the hypotenuse of a right triangle whose sides are 10 and 7.5 we are led to the point marked in the figure: from which $z = 12.5$.

Alignment Charts.—The word nomogram is sometimes restricted to a special type of chart which is used by bringing the points of three scales into alignment. In fig. 2 is shown an

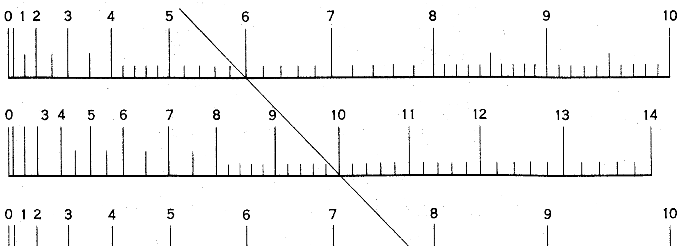

FIG. 2.— ALIGNMENT CHART FOR SOLVING $X^2 + Y^2 = Z^2$. FOR $X = 6$, $Y = 8$ THE LINE DRAWN SHOWS THAT $Z = 10$

alignment chart for the solution of $x^2 + y^2 = z^2$. On the upper and lower horizontal lines are laid off from a vertical axis the scales $X_1 = x^2$, $X_2 = y^2$ identical with those on the axes in fig. 1. Midway between is a line with a scale half as large, $X_3 = \frac{1}{2}z^2$. Now let a straight line be drawn across the figure cutting the scales at points marked x, y and z. It is seen from elementary geometry that $X_3 = \frac{1}{2}(X_1 + X_2)$, whence the equation $x^2 + y^2 = z^2$ is satisfied. The equation is solved for one of the variables by joining given values of the other two variables on the scales by a straight line and reading the solution where this line cuts the third scale.

A chart for solving any equation containing three variables can be made in a similar manner provided the variables can be segregated into three separate terms, $h(z) = f(x) + g(y)$. We have merely to plot the scales $X_1 = f(x)$, $X_2 = g(y)$ on the outside lines and $X_3 = \frac{1}{2}h(z)$ on the middle line. Thus, a scale for multiplication, $z = xy$, could be made after first writing the equation in the form $\log z = \log x + \log y$, the three plotted scales then being logarithmic.

This type of chart has certain obvious advantages. Only three scales need be drawn, and they are more easily used than a complicated diagram. Interpolation can be accurately done since the line cuts cleanly across the scale. As a practical matter the line across the chart should not be actually drawn since a few lines in pencil would mar the chart. A fine thread may be stretched across the chart. An excellent line may be made on a transparent ruler with the point of a knife, a little graphite being worked in to give it visibility, and this can be laid across the chart.

The principle of the alignment chart was first described in *1884* by Maurice d'Ocagne (1862–1938) of the École Polytechnique in Paris. He developed the subject in many papers and books and particularly in his treatise of *1899*. *Traité de nomographie,* in which were brought together both the general theories and a multitude of practical applications. D'Ocagne may properly be called the creator of nomography.

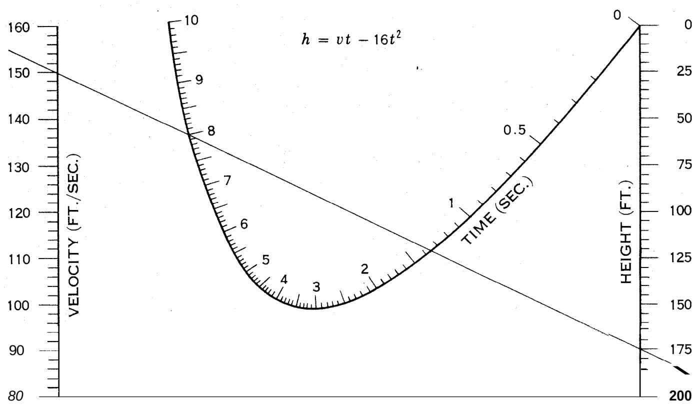

FIG. 3.— ALIGNMENT CHART FOR FINDING THE TIME AT WHICH A BODY THROWN UPWARD WITH A GIVEN VELOCITY ATTAINS A GIVEN HEIGHT (NEGLECTING FRICTION)

The line drawn shows that for an initial velocity of 150 ft. per second the body will be 175 ft. high in 1.36 sec. and again (on the way down) in 8 sec.

In its more general forms the alignment chart for the solution of an equation in three variables may employ straight scales arranged in various ways, or one or more of the scales may be curved as in fig. 3. A curved scale may be constructed from parametric equations $X = f(t)$, $Y = g(t)$. A value of t gives a point (X, Y) on the curve. Points for suitably spaced values of t are marked and the value of t is attached. Thus, $X = \cos t$, $Y = \sin t$ gives a circular scale, since $X^2 + Y^2 = 1$. Whether the resulting scale is curved or straight depends upon the parametric equations.

Take two functions of a variable x, two functions of y and two functions of z. Let these form three scales: an x scale $X_1 = F(x)$, $Y_1 = f(x)$; a y scale $X_2 = G(y)$, $Y_2 = g(y)$; and a z scale $X_3 = H(z)$, $Y_3 = h(z)$. Three points (X_1, Y_1), (X_2, Y_2) and (X_3, Y_3), corresponding to readings x, y and z, respectively, on the three scales lie on a line if the slope of the line joining the first two points is equal to the slope of the line joining the last two points; that is,

$$\frac{Y_2 - Y_1}{X_2 - X_1} = \frac{Y_3 - Y_2}{X_3 - X_2}$$

This condition may be put in the form

$$F(x)\,[g(y) - h(z)] + G(y)\,[h(z) - f(x)] + H(z)\,[f(x) - g(y)] = 0$$

or as a determinant

$$\begin{vmatrix} F(x) & f(x) & 1 \\ H(z) & h(z) & 1 \\ G(y) & g(y) & 1 \end{vmatrix} = 0$$

The chart will solve this equation for one of the variables when the other two are knonn. Conversely. an alignment chart can be made for any equation which can be written in this form.

If an equation can be solved by an alignment chart it can be solved by an infinitude of alignment charts. By applying a projective transformation

$$X' = \frac{a_1X + b_1Y + c_1}{a_3X + b_3Y + c_3} \qquad Y' = \frac{a_2X + b_2Y + c_2}{a_3X + b_3Y + c_3}$$

where the as, *b*s. *c*s are constants! to the plane of the chart we get another chart. The degree of a curve remains invariant. whence collinear points remain collinear and we still have an alignment chart for the equation. Because of the large number of constants at our disposal the chart can be thrown into a multitude of forms. Projective transformations are used to bring distant portions of a chart back on the page, to change the positions of scales so as to make the best use of the space on the page and to get convenient arrangements generally. The scales of fig. 3 consist of two parallel lines and a hyperbola. We could, for example, carry the linear scales into intersecting lines, or make the curved scale parabolic or circular, or greatly magnify some portion which we wish particularly to use. A useful result is that a convex quadrilateral covering any part of a chart can be carried into a rectangle of desired dimensions so that it fits on the page. *See* GRAPHIC METHODS IN MATHEMATICS. For applications to marine navigation, *see* CHART.

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NONCONFORMITY, LAW RELATING TO. (*See* BAPTISTS: CONGREGATIONALISM; ENGLISH HISTORY: FRIENDS, SOCIETY OF: METHODISM; etc.; also OATH AND AFFIDAVIT.) It is proposed here to note the matters in which the lam as to nonconformists still differs from that applicable to members of the Church of England.

Judicial Notice.—Where the tenets and authorities of a nonconformist body come in question they must be proved by evidence. By Lord Lyndhurst's act. the Nonconformist Chapels act, 1844, where no particular religious doctrine or mode of worship has been prescribed by the deed or instrument of trust the usage of the congregation for 25 years is to be taken as conclusive evidence of the doctrine and worship which may be properly observed in such meetinghouses.

Tribunal.—Matters arising in nonconformist bodies can be tried only by the ordinary secular courts and generally depend upon the question whether a minister has done any act which is not in accordance with the rules governing the particular body of which he is a minister. A nonconformist body is in law nothing more than a voluntary association whose members may enforce discipline by any tribunal assented to by them but must be subject in the last degree to the courts of the realm.

Status of Ministers.—A nonconformist minister is not in holy orders. and his chapel is not a consecrated building. His status is. however. recognized to a limited extent. By the Toleration act (1 Will. and Mar., c. 18), a minister. preacher or teacher of a nonconformist congregation is exempt from certain parochial offices. as that of churchwarden. He is also exempt from serving in the reserve forces or on a jury. These privileges attach only where the place of worship of which he is a minister has been duly registered (Places of Worship Registration act. 1855), unless in the case of bodies subject to special legislation as Quakers. By the Municipal Corporations act, 1882.s. 12, a nonconformist minister (as is a clerk in holy orders) is disqualified from being elected an alderman or councilor of a town council, but under the Local Government act. 1888, a clerk in holy orders. or other minister of religion, may be a councilor or alderman of a county council and, under the London Government act, 1899, of a metropolitan borough.

Marriage.—The first act of parliament relieving dissenters (other than Jews and Quakers) from restrictions was the Marriage act of 1836. By that act the ceremony of marriage might be performed in a nonconformist place of worship, but it must be after due notice to the superintendent registrar and in his presence or in that of a registrar, and the building must be one that is duly certified for marriages. The Marriage act, 1898, dispensed with the necessity of the attendance of a registrar at marrisges celebrated at a nonconformist place of worship, substituting in place thereof a person duly authorized by the trustees of the place of worship, if the persons intending to be married so desire: but the parties may. if they wish, still require the presence of the registrar. Marriage by banns, licence or special licence cannot take place except in a church. *See* MARRIAGE.

Burial.—By the Burial Laws Amendment act. 1880, burial may take place in a churchyard n·ithout the rites of the Church of England. But in such a case notice must be given in a specified form, which is unnecessary if the burial service is conducted by a clergyman of the Church of England. *See* FUNERARY RITES AND CUSTOMS.

Parish Offices.—By 1 Will. and Mar., c. 18, s. 5, a dissenter chosen churchwarden and scrupling to take the oaths may execute his office by deputy. His acceptance of office is made optional by the act: there is nothing to prevent his diccharging it if he see fit to do so. This seems to he still the law. although a declaration was substituted for the oath by the Statutory Declarations act. 1835, s. 9. *See* JEWS; ROMAN CATHOLIC CHURCH.

NONFEASANCE, MISFEASANCE. MALFEASANCE. The expressions nonfeasance and misfeasance and occasionally malfeasance are used in English law with reference to the discharge of public obligations existing by common law, custom or statute. The rule of law laid down is that no action lies for nonfeasance. *i.e.*, for failure or refusal to perform such obligation, but that an action does lie for damage resulting from misfeasance or malfeasance. *i.e.*, for negligently and improperly performing the obligation. (*See* NEGLIGENCE.) At present the terms misfeasance and nonfeasance are most often used with reference to the conduct of municipal authorities with reference to the discharge of their statutory obligations. In the case of nonfeasance there is a remedy by indictment or mandamus or by the particular procedure prescribed by the statutes. This rule is fully established in the case of failure to repair public highways; but in other cases the courts are astute to find evidence of carelessness in the discharge of public duties. and on that basis to award damages to individuals who have suffered thereby. Misfeasance is also a term used with reference to the conduct of directors and officers of joint-stock companies.

NONGKHAI, a province (*changhwat*) in the northeast corner of 'I'hailand adjacent to the hfekong river. Area 2,789 sq.mi.; pop. (1960) 256.530. Cultivated land is concentrated in the valleys of the Mekong and its tributaries. where there is water for supplementary irrigation. and alluvial soils. Along the Mekong are hoth natural and artificial terraces with loam soils. Nongkhai. the capital. pop. 11960) 21.121, is 298 mi. by rail from Bangkok. Goods destined for Laos are unloaded in Nongkhai, ferried across the river and taken by highway 16 mi. to Vientiane. capital of Laos. (T. F. B.)

NONIUS MARCELLUS (date unknown), African Latin grammarian and lexicographer. author of the *De compendiosa doctrina* (a sort of lexicon. in which are preserved extracts from the works of many earlier writers), was born at Thubursicum Numidarum (in Algeria) between the end of the 2nd and the jth century A.D. The *De compendiosa doctrina* consists of 20 chapters—the 16th is lost. The first 12 deal with language and grammar and in the brief remaining chapters words are grouped according to the nature of what they refer to. Except in the last chapter examples are given from ancient authors. There are editions by L. Mueller (1888) and W. M. Lindsay (1903). Nonius was a man of little understanding or accuracy but posterity is indebted to him for preserving fragments of Latin tragedies and the satires of Lucilius and Varro.

See Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft,* xvii (1936); W. M. Lindsay, *Nonius Marcellus' Dictionary of Republican Latin* (1901). (G. B. A. F.)

NONJURORS, the name given to those beneficed clergy of the Church of England who refused to take the oaths of allegiance to William and Mary in 1689. They were about 400 in number, and included William Sancroft, archbishop of Canterbury, and four others of the "seven bishops" — Thomas Ken of Bath and Wells, John Lake of Chichester, Thomas White of Peterborough and Francis Turner of Ely, together with the bishops of Gloucester, Worcester and Norwich. Other distinguished nonjurors were: William Sherlock, master of the Temple, Jeremy Collier, the ecclesiastical historian, George Hickes, dean of Worcester, Nathanael Spinckes, John Fitzwilliam, canon of Windsor, Henry Dodwell, Camden professor of history at Oxford, Henry Hyde, second earl of Clarendon, and Roger North, the lawyer. Afterward their number was augmented by refusals to swear the oaths of allegiance to George I. Ken, the most eminent of the nonjurors. disapproved of their subsequent proceedings, and Sherlock and Dodwell afterward took the required oaths, the former becoming dean of St. Paul's.

Believing in the doctrine of nonresistance to established authority, the nonjurors argued that James II was still the rightful king. and likened the position of William to that of Cromwell. With the approval of William III, Gilbert Burnet. bishop of Salisbury, attempted to reconcile them to the new order. It was only when the generous terms offered by Burnet had been refused, that, in Feb. 1690, they were deprived of their sees and other benefices. Although they had only a small following among the mass of the people, who were not required to take the oaths of allegiance. Sancroft and his colleagues claimed to represent the true Church of England, and requested James II in his exile to nominate two new bishops to carry on the episcopal succession. James chose Hickes and Thomas Wagstaffe (1645–1712), who were consecrated in 1694 as bishops of Thetford and Ipswich respectively. A further consecration took place in 1713 when Collier, Spinckes and Samuel Hawes (d. 1722), were consecrated bishops-at-large. In 1718 the introduction of a new communion office with some "usages" taken partly from primitive liturgies and partly from the first prayer book of Edward VI caused a schism among the nonjurors, dividing them into "usagers" and "nonusagers." The four usages were: (1) the mixed chalice, (2) prayers for the faithful departed. (3) prayer for the descent of the Holy Ghost on the consecrated elements and (4) the Oblatory Prayer, offering the elements to the Father as symbols of His Son's Body and Blood Accepting the usages the two bodies united in 1731, but other dissensions followed, although the episcopal succession was maintained until the death of a bishop named Charles Booth in 1805. The last nonjuror was probably James Yeowell, who died in 1875. Public worship was conducted in chapels or oratories and in private houses.

In Scotland the nonjurors included the greater part of the clergy of the Episcopal Church, which ceased to be the state church in 1689. The Scottish clergy maintained their opposition to the government until the death of Prince Charles Edward Stuart in 1788, when the bishops met at Aberdeen and unanimously agreed to submit to the government of King George III. A large number of the Presbyterians in Scotland, principally found among the Cameronians, also refused to take the oaths of allegiance to William and Mary; but as their reasons for this refusal were quite different from those of the episcopalian nonjurors, they are not usually referred to by this name (see CAMERONIANS).

NONNUS (Egyptian for "saint"), Greek epic poet, a native of Panopolis (Akhmim) in the Egyptian Thebaid, probably lived at the end of the 4th or beginning of the 5th century A.D. His principal work is the *Dionysiaca,* an epic in 48 books, the main subject of which is the expedition of Dionysus to India and his return. In its luxuriance and preoccupation with action, it resembles the Indian epics. His chief merit consists in the systematic perfection to which he brought the Homeric hexameter, but this very quality tends to monotony. His influence on later poetic vocabulary was considerable.

There is also under his name a paraphrase of the Gospel of St. John, which is chiefly interesting as apparently indicating that Nonnus in his later years was a convert to Christianity. His style, in this content, produces an impression of extreme bombast and want of tsste. According to an epigram in the Palatine anthology (ix 198), Nonnus was also the author of a Battle of the Giants, and four lines of the Bassarica (also on Dionysus) have been preserved in Stephanus of Byzantium.

Editio princeps (1569); H Kbchly ("Teubner" series, critical introduction and full index of names, 1858); a most useful edition is that by the comte de Marcellus (1856), with notes and prolegomena and a French prose translation. On the metre, see J G. Hermann, Orphica, p. 690 (1805); A Ludwich, *Beiträge zur* Kritik des *Nonnus* (1873), critical, grammatical and metrical; C. Lehrs, Quaestiones epicae, pp. 255–302 (1837), on metrical questions; on the sources, R. Kohler, *Über* die Dionysiaka des Nonnus (1853), short connected analysis of the poem, with comparison of earlier and later myths; see also I Negrisoli, *Studio* critico . . . *Nonnus* Panopolita, with short bibliography (1903). Paraphrase on St John (editio princeps, c. 1505) is edited by F. Passow (1834) and A. Scheindler (1881).

NONPAREIL or PAINTED BUNTING, a small, brilliantly coloured finch (Passerina *ciris*) with blue head, green-yellow back, scarlet body and black wings and tail. After wintering in Central America, the painted bunting arrives in the southern states of the U.S. in April, and breeds north to Virginia. Ohio and Kansas. The pin-tailed nonpareil of Africa (Erythrura *prasina*) is blue in colour; the male has a long tail. It belongs to the Ploceidae. See WEAVERBIRD.

NONPARTISAN LEAGUE, a U.S. political and economic organization of farmers founded by Arthur C. Townley at Bismarck, N.D.. in Feb. 1915. For years the farmers of the state had complained of exploitation by grain speculators, bankers and politicians. The 1915 session of the legislature, at which members of the Equity society — a farm organization — received scant attention, fanned agrarian discontent into immediate flame. The Nonpartisan league, applying modern sales methods. rapidly organized the farmers into a cohesive political body. which captured control of the state Republican party and elected its candidates for state offices and congress. In 1916 the league began work outside North Dakota, and eventually established active organizations in 12 other western and middle western states, where influence was exerted in behalf of sympathetic candidates with varying degrees of success. Though confining its own membership to farmers. the league regularly co-operated with urban labour in political action. During World War I the league was bitterly attacked on the ground of the socialist connection of some of its leaders and its advocacy of conscription of wealth to pay for the hostilities. In 1919 the league put its economic program into effect in North Dakota. A state-owned bank, mill and terminal elevator, home-building association, and hail, fire and tornado insurance constituted the principal enterprises. The league, as such, gradually disintegrated, though not before it had given birth to the Farmer-Labor party in Minnesota and had stimulated many farmers to "nonpartisan" voting.

BIBLIOGRAPHY. — Because of the bitter controversy over the league, little unbiased discussion exists. See H. E. Gaston, *The* Nonpartisan League (1920) and C. E. Russell, Story of the *Nonpartisan* League (1920) both sympathetic; whiie A. A. Bruce, The *Nonpartisan* League (1921) is hostile. See also files of the *Nonpartisan* Leader (later the National Leader), published to July 1923. (N. A. C.)

NONTHABURI, a small province (*changwat*) of Thailand, north of and adjacent to Phra-Nakhon and Thonburi *changwats* which comprise the Bangkok metropolitan area. Area 240 sq.mi., pop. (1956 est.) 170,660. Its population density is more than 710 per square mile. one of the heaviest rural population densities in Thailand. Little waste land, irrigated alluvial soil, nearness to the Bangkok market, excellent transportation facilities and an industrious people all contribute to make this an area of intensive cultivation and high productivity. Rice, fruit and vegetables are raised. The capital, Nonthaburi. makes pottery and bricks which are shipped 1; mi. by boat to Bangkok. (T. F. B.)

NOON, midday. 12 o'clock. The O.E. ndn, Nor. non, Dutch *noen,* are all from Lat. *nona* sc. hora, the ninth hour; *i.e.,* according to the Roman system, three o'clock P.M. The early uses of noon until the 13th and 14th centuries are either as translating the Latin, especially with reference to the Crucifixion, or as equivalent to the canonical hour of "Nones."

The ordinary word for 12 o'clock was *middaeg,* ("midday"), also the equivalent of the canonical hour "Sext." Both the office and the meal taken about that time were shifted to an earlier hour, and by the 14th century the use of "noon" is that current today

NOOTKA (AHT), an Indian linguistic group of the southwest coast of Vancouver Island, B.C , whose territory extended from Cape Cook to San Simon point (near Victoria) and inland to the watershed. The Nootka. together with the Makah of northwesternmost Washington, constituted one of the two main divisions of the Wakashan linguistic stock. The second was the highly divergent Kwakiutl of northern Vancouver Island and the adjacent mainland. Salishan nas spoken by all other natives of the island. The Nootka mere located near the middle of the Northwest Coast culture area and their ways of life perhaps represent best the older and more basic aspects of that culture. Nootkans were oriented to the sea and their villages were located on bays or inlets. They made a specialized type of cedar dugout canoe a remarkably seaworthy craft. These canoes and an intimate knowledge of coastal waters enabled the Nootka and Makah to travel considerable distances for sea-mammal hunting. visiting and trading. Both hunted the whale. a dangerous economic activity in which only two other coastal tribes engaged. Both also exploited the dense forests at their backs for game roots and berries Art was highly developed in the Northnest Coast manner. Totem poles and other elaborate stylized carvings were characteristic Ceremonial feasts and property exchanges, called potlatches, were frequent. Northern Nootkan groups formed a social and political confederacy but the southern groups retained local autonomy Numerous group names ended in *-aht (e g ,* Nitinat. Clayoquot, Kyuquot. Mooachaht); hence some early writers used Xht as a collective designation. Capt. James Cook entered Nootka sound in 1778, at nhich time the population of the Nootka was perhaps 6 ooo, the Makah 1.500 Henceforth the fur trade flourished and the Indians rapidly acquired iron tools and many other appurtenances of western culture.

See Philip Drucker, *Indians of the Northwest Coast* (1955); James G. Swan, "Indians of Cape Flattery," *Smithsonian Contributions to Knowledge,* vol. 16, (1870). (V. F. R.)

NORA, an ancient site about 22 mi. S.W. of Cagliari (Carales) on the southern coast of Sardinia. Although according to tradition it was founded by Iberians from Tartessus, it occupies a characteristically Phoenician site, a triangular promontory ending in a steep cliff (Capo di Pula). The name Nora is related to the proto-Sard *norake* (tower, castle). Remains of a Sardinian *nuraghe* or towerlike monument were found nearby, and blocks from another were incorporated in a building identified as the Punic temple of Tanit. Apart from these. the earliest antiquities discovered at Nora are Phoenician, dating from the 7th century B.C.

In the Republican period, after the Roman annexation of Sardinia, Nora was its capital; under the Empire, it became a *municipium.* The latest Roman inscription records repairs of its aqueduct by Theodosius II and Valentinian III. A.D. 425–450; the last ancient writer to mention Nora, the *Anonimo Ravennate* (c. A.D. 700), describes it as a *præsidium* (fortified outpost).

Excavations in 1952–54 brought to light a wealthy imperial city overlying a typical Punic port. The Punic town, unfortified except for a watchtower at the tip of the promontory. had narrow irregular streets and buildings of characteristic Carthaginian construction. A *tophet,* where the bodies of cremated children were buried in great jars under steles carved with a temple façade and an image of the goddess Tanit, whose identity is confirmed by a *graffito* on a vase of the 3rd century B.C., is evidence for the violence of the period of the first Punic war. The imperial city dates from the Flavian period; a fine theatre, an aqueduct, a temple of Juno (probably the Carthaginian Tanit in Roman form). a handsome nympheum. baths and private villas were uncovered. The ruins of a paleo-Christian church. dedicated to the local saint, Efisio, and rebuilt in 1089, stand nearby.

See G. Pesce, *Nora, Guida agli Scavi* (1957). (E. H. RI.)

NORADRENALINE (NOREPINEPHRINE), one of the hormones produced by the medulla of the adrenal gland. It has an effect on the body similar to that of stimulation of the sympathetic nervous system, producing rise in blood pressure, increase in concentration of blood sugar, etc. *See* ADRENALINE AND NORADRENALINE; ADRENAL GLANDS; HORMONES.

NORBANUS, GAIUS, surnamed BULBUS or BALBUS, Roman politician. was a seditious and turbulent democrat. In 103 B.C., when tribune of the people, he accused Q. Servilius Caepio of having brought about the defeat of his army by the Cimbri through rashness and also of having plundered the temple of Tolosa. Caepio was condemned and went into exile. About ten years later Norbanus himself was accused of treason because of the disturbances that had taken place at the trial of Caepio, but the eloquence of M Antonius, grandfather of the triumvir, procured his acquittal. In 89 Norbanus as praetor successfully defended Sicily against the Italian socii. During the civil war betaeen Marius and Sulla he sided with the former, but was defeated by Sulla at Mt. Tifata near Capua and again by Metellus at Faventia in cisalpine Gaul (82). He fled to Rhodes, where he committed suicide.

NORBERT, SAINT (*c.* 1080–1134), archbishop of Magdeburg, reformer and founder of the canons regular of Prémontré (variously known as Premonstratensians [*q.v.*], Norbertines, White canons). Born between 1080 and 1085 in Xanten, Ger., Norbert became a canon of the collegiate church of Xanten, but he lived a worldly life at the court of the emperor Henry V. He was converted during a thunderstorm in 1115 and ordained a priest in the same year. Failing to reform his fellow canons at Xanten, he became an itinerant preacher who urged reform of morals for clergy and laymen alike. Unsuccessful in an attempt to reform the chapter of St. Martin at Laon, France, he was prevailed upon to found a religious institute at Prémontré near Laon (1121), of which the characteristic feature was the combination of an extensive. priestly apostolate with monastic discipline. St. Augustine's rule was adopted and the constitutions were modeled on those of the Cistercians. At Antwerp in 1124 Norbert preached successfully against the heresy of Tanchelin or Tanchelm. He was chosen archbishop of Magdeburg in 1126. Like his friend St. Bernard of Clairvaux he supported Innocent II against the antipope and won over the emperor Lothair II. He died on June 6, 1134, and was canonized in 1582. His feast day is June 6 (but July 11 in the order).

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NORD, the most northern *dkpartement* of France. Area 2.229 sq.mi. Pop. (1954) 2,098,545. Bounded for 21 mi. by the North sea, it has Belgian territory on the northeast and east. It lies below and parallel to the chalk scarp of Artois, famous for its defense in World War I. The coast is formed largely of sand dunes drained by canals. The *dkpartement* is crossed by the Scheldt (Escaut) with its tributaries and by the Sambre, the chief tributary of the Meuse. The climate of Nord is colder than that of France in general, the mean temperature being 49° or 50° F. Average annual rainfall is about 28 in.

In agricultural and industrial importance Nord is the first of French *départements.* In the southeast stock raising flourishes; in the central zone beetroot is characteristic, while mixed farming prevails in the northwest. Cereals (especially wheat and oats) and potatoes are grown in abundance, while flax, tobacco, chicory, colza and hops are minor crops. Market gardening and horticulture are practised in some localities. There are mineral springs, notably at St. Amand, where the mud baths are used in the treatment of rheumatism. The mineral wealth lies chiefly in coal mines forming part of the Valenciennes basin, the most important in France, which extends into Belgium and Pas-de-Calais. The textile industry centres in Lille, Roubaix and Tourcoing, which spin and weave cotton, linen and wool, as also around Fourmies. Other centres are Armentières (cloth weaving), Dunkirk (flax. jute and hemp spinning), Cambrai (batiste and other delicate fabrics; also chicory), Douai, Avesnes, le Cateau and Caudry. Other great industries are glass, brick, pottery and sugar manufacture, alcohol distilling, dyeing, iron founding and steel production. Branches of the metallurgical industry are at Denain, Hautmont, Maubeuge, Valenciennes, Douai, Raismes, etc. Dunkirk and Gravelines equip fleets for the cod and herring fisheries. Dunkirk is the chief port. Its system of inland navigation is highly developed, comprising a line of waterways from the Scheldt to the North sea at Dunkirk, with which the coal basin of Valenciennes is linked by the canalized Scheldt and the textile region of Lille by means of the Deûle canal and the canalized Lys.

The *département* is divided into six *arrondissements* (Avesnes, Cambrai, Douai, Dunkirk, Lille, Valenciennes) with 68 cantons and 665 communes. It forms the archiepiscopal diocese of Cambrai and part of the region of the 1st army corps (headquarters at Lille) and of the educational division of Lille. Its court of appeal is at Douai

NORDAU (originally SÜDFELD), **MAX SIMON** (1848–1923), Jewish Hungarian author, was born at Budapest on July 29, 1849, and practised medicine in his native town. He made his name by his pseudo-philosophical *Entartung* (Eng. trans., *Degeneration*, 1895), which was translated into many languages. and had a great vogue. Other norks mere *The Conventional Lies of Society* (Eng. version, 1895) and *Biologie der Ethik* (1921). Nordau was an ardent Zionist, and took Theodor Herzl's side in wishing to accept the British government's offer of land for a Jewish settlement in east Africa. In 1903 an attempt was made on his life by a Jew opposed to the scheme. He died on Jan. 22, 1923.

His works include novels and stories: *Gefühlskomödie* (1892), *Die Drohnenschlacht* (1897), *Morganatisch* (1904), etc.; dramas: *Das Recht zu lieben* (2nd ed., 1894), *Doktor Kohn* (1898) and others, some books of travel; and the critical works *Zeitgenössische Franzosen* (1901) and *Von Kunst und Kunstlern* (1905).

NORDENFLYCHT, HEDVIG CHARLOTTA (1718–1763), Swedish poet, remembered for her sensitive love poems, was born, Nov. 28. 1718, at Stockholm. She fought all her life to keep her faith although disturbed by the ideas of the Enlightenment, and this conflict is expressed in her reflective poetry. The deaths of her fiancé in 1737 and of her husband soon after their marriage in 1741 inspired her finest poems. some of them published in *Densorgande Turtur-Dufwan* (1743). During the 1750s she enjoyed a literary collaboration with Gustav Philip Creutz (*q.v.*) and Gustav Fredrik Gyllenborg. In 1761 she fell tragically in love with a man much younger than herself, and her poems about him mark the height of her achievement. She died at her home near Stockholm, June 29, 1763 Her *Samlade skrifter* were edited by H. Borelius and T. Hjelmqvist. 4 vol. (1924–38).

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NORDENSKIÖLD, (MILS) ADOLF ERIK, BARON (1832–1901), Finnish-Swedish scientist and arctic explorer. was born in Helsinki on Nov 18. 1832. During his studies at Helsinki university he incurred the displeasure of the authorities for his Swedish and western sympathies, and in 1858 he settled in Stockholm. During this year he made his first arctic expedition, to Spitsbergen under Otto Torell, and was appointed professor and curator of the mineralogical department of the Swedish State museum. He now undertook a series of further expeditions to Spitsbergen—in 1861 with Torell again, and in 1864, 1868 and 1872–73 as leader—and made fundamental contributions to the knowledge of the geology of the area, while in 1870 he led an expedition to west Greenland to study the inland ice. During the 1868 expedition, partly financed by the Goteborg businessman Oscar Dickson. the patron who was to provide such decisive support for all his subsequent expeditions, Nordenskiöld reached 81° 42′ N. in the mail boat "Sofia." In 1873, after a winter had been spent in difficult conditions in north Spitsbergen, he crossed the ice sheet of North East Land. Nordenskiöld's thoughts now turned to what was to be his greatest achievement—the accomplishment of the northeast passage In two preliminary voyages in 187j and 1876 he penetrated the Kara sea to the mouth of the Yenisei. On July 21, 1878, Nordenskiöld sailed from Tromso on board the steam vessel "Vega"; he reached Cape Chelyuskin on Aug. 19. and after being frozen in at the end of September near Bering strait, completed the voyage successfully in the following summer.

The "Vega" made a triumphal voyage home via the Mediterranean and when Xordenskiold re-entered Stockholm on April 24, 1880, he was made a baron by King Oscar. In 1883. on his return from west Greenland. where he penetrated far onto the inland ice. he became the first to break through the southeast coast's great sea ice barrier. In 1893 he was elected to the Swedish Academy. He died at Dalbyo on Aug. 12. 1901.

Nordenskiold's bibliography lists 178 works. Geologist, mineralogist and geographer, he also broke new ground in his contributions to the early history of cartography. His two great works in this field are *Facszmite-atlas* (1889), and the indispensable collection of hand-drawn maps and charts entitled *Periplus* (Eng, trans by F A. Bather. 1897) (P A B G.)

NORDENSKJÖLD, OTTO (1869–1928), Swedish explorer, was born in 1869; his father was a brother of Baron A. E. Nordenskiöld (*q.v.*). He specialized in geology in the University of Uppsala and after travels in Tierra del Fuego and Alaska. he led an expedition (Oct. 1901) to the south polar regions. He landed at Snow Hill Island, off the east coast of Graham Land. Weather conditions made it impossible for the "Antarctic," which had continued her course to Tierra del Fuego, to relieve them in 1902–03, and she sank in the attempt. After several attempts at rescue had been made, they were eventually brought back by a vessel sent by the Argentine government in Nov. 1903. (*"Antarctic" Två år bland sydpolens isar*, 2 vol.. 1904; Eng. trans., *Antarctica*, 1905). In 1920–21 Nordenskjöld explored the Peruvian and Chilean Andes. He died on June 3, 1928.

NORDERNEY (*i.e.*, "northern island"), the largest of the East Frisian group, Germany. Area 10 sq.mi. Pop. (1950) 7,519. It is 8 mi. long and about 1½ mi. broad and is reached by steamer from Norddeich, Bremerhaven or Hamburg, and at low tide by road. The village is a popular resort. Norderney is associated with Heinrich Heine's *Nordseebilder*.

NORDHAUSEN, a town in the district of Erfurt, Ger. It is situated on the Zorge to the south of the Harz mountains, at the west end of the Goldene Aue (Golden Plain), a fruitful valley watered by the Helme. Pop. (1950) 39,452. Nordhausen possessed a royal palace in 874 and a convent was founded there in 962. It was destroyed by Henry the Lion in 1180, but was soon rebuilt and was made a free imperial town in 1253. In this and the following century several diets and other assemblies were held there. The protector *(Vogt)* of the town was the elector of Saxony and from 1702 to 1715 the elector of Brandenburg. Nordhausen accepted the reformed doctrines in 1522. It was annexed by Prussia in 1803 and again in 1815, having in the meantime belonged to the kingdom of Westphalia. The upper and lower parts of the town are connected by flights of steps. Among its churches the most notemorthy are the Roman Catholic cathedral, late Gothic with a Romanesque crypt, and the Protestant church of St. Blasius. Near the medieval town hall stands a Roland's column, the ancient symbol of free commercial intercourse and civic liberty. The chief importance of the place arises from its distilling of "Korn Schnapps." a spirit somewhat akin to whisky.

NÖRDLINGEN, German town in the *Land* of Bavaria, on the Eger. Pop. (1950) 13,425. From 898, when first mentioned, to 1215 Nordlingen was subject to the bishops of Regensburg, but about 1215 it became a free city of the Empire. It was annexed to Bavaria in 1803. It is still surrounded with walls and towers. The church of St. George is a Gothic structure erected in the 15th century and restored in 1880. The Late Gothic town hall has a collection of pictures and antiquities.

Military **Operations.**—Nördlingen was the scene of two great battles in the Thirty Years' War (*q.v.*). In the first, which was fought on Sept. j and 6, 1634, the hitherto invincible Swedish army, commanded by Duke Bernhard of Saxe Weimar and Marshal Horn. was defeated with great loss by a somewhat superior army of Imperialists and Spaniards under Gen. Gallas, Horn being taken prisoner.

In the second battle, fought 11 years later (Aug. 3, 1645), Condé (then duke of Enghien) and Turenne were the leaders on the one side, and Mercy and Johann von Weert, the dashing cavalry commander whose onset had decided the battle of 1634, on the other. The Germans mere posted about j mi. to the east of Nördlingen, about Allerheim. In rear of the village the plain was occupied by Mercy's army in the customary two lines, foot in the centre, horse in the wings. The French army, similarly arrayed, was more heterogeneous than the German. After a cannonade in which it suffered more severely than its entrenched enemy, the French centre furiously attacked the village of Allerheim; the fighting there was very heavy, and on the whole in favour of the Germans, although Mercy was killed. The right wing of the French cavalry was swept off the field by Johann von Weert's charge, but the German troopers. intoxicated with success, dispersed to plunder. On the French left, meanwhile, Turenne saved the day. Fighting cautiously at first with his leading line to gain time for his second to come up, he then charged and broke up the hostile' right wing of cavalry, uhile some battalions of infantry scaled the hill and captured the Bavarian guns. Unlike Weert the marshal kept his troops in hand, and swung around upon the Bavarian infantry behind Allerheim, who were at the same time cannonaded by their lost guns. A prolonged fight then ensued, in which the Bavarians had the worst of it, and Weert, returning at last to the field, dared not attempt to engage afresh. The armies faced one another all night with their sentries 50 paces apart, but in the morning the Bavarians were found to have retreated. Nothing was gained by the victors but the trophies and the field of battle, and the losses of both sides had been enormous. Nordlingen, therefore, is a classical instance of the unprofitable and costly *bataille rangée* of the 17th century.

See Beyschlag, *Geschichte der Stadt Nordlingen* (Nordlingen, 1851), and Mayer, *Dze Stadt Nördlingen, ihr Leben und zhre Kunst im Lichte der Vorzeit* (Nordlingen, 1856)

NORDSTRÖM, LUDVIG ANSELM (1882–1942), Swedish writer whose best work describes life in his native province, was born at Harnosand (the "dbacka" of his novels), Norrland, on Feb. 2j. 1882. He studied at Uppsala and became a journalist, traveling widely at home and abroad. A follower of Strindberg, in his early works (the collections of short stories *Fiskare,* 1907; *Borgare,* 1909; and *Herrar,* 1910; and the novel *De tolv sondagarna,* 1910), he treated themes from his birthplace with imaginative power, ironic realism and humour. Keenly interested in economics and industrialism, and influenced by Herbert Spencer, Émile Durkheim and H. G. Wells, he developed a highly individual view of society, and in his numerous later writings—theoretical treatises, travel books and journalistic works, short stories and novels—preached a utopian world society based on a universal economic solidarity which he called "totalism." He died at Stockholm, April 1j, 1942. Selections from his diary were published in *Ur Ludvig Nordstroms dagbocker* (1955).

See M. Stiernstedt, *Kring ett bktenskap* (1953); *G*. Qvarnstrom, *Från Öbacka till Urbs* (1954). (H. En.)

NORE, THE, a sandbank in the Thames estuary marked by a lightship, the first to be established in English waters (1732). The name is used also of the area of the estuary roughly coinciding with the naval port of Sheerness. The Nore anchorage was much used by the fleet in the wars of the 17th and 18th centuries. In 1797 sailors at the Nore mutinied against conditions, and their leader, Richard Parker. was hanged from the yardarm of his ship. The commander in chief, the Nore, is the naval commander of the eastern area of England.

See G E Manwaring and B Dobrée, *The Floating Republic* (London, 1935)

NOREPINEPHRINE (Noradrenaline), one of the hormones produced by the medulla of the adrenal gland. It has an effect on the body similar to that of stimulation of the sympathetic nervous system, producing rise in blood pressure, increase in concentration of blood sugar, etc. See Adrenaline and Noradrenaline; Adrenal Glands; Hormones.

NORFOLK, EARLS AND DUKES OF. The 1st earl of Norfolk was Ralph de Guader, a follower of William the Conqueror, who forfeited the earldom when he revolted against William in 1075; the 2nd was Hugh Bigod (d. 1177), one of Stephen's supporters, to whom the earldom was granted by this king before 1141. Hugh's grandson, Hugh (d. 1225), the 3rd earl of this line, married Matilda, daughter of William Marshal, earl of Pembroke, and from the Marshals their son Roger (d. 1270), the 4th earl, inherited the office of marshal of England. This powerful family of Bigod retained the earldom until Roger, the 5th earl. died childless in Dec. 1306.

The next earl of Norfolk was Thomas of Brotherton (1300–1338), a younger son of Edward I, to whom the earldom was granted in 1312 by his half-brother, Edward II. In addition to the estates which had formerly belonged to the Bigods Thomas received the office of marshal. He joined Queen Isabella when she landed in England in 1326, and was one of the group of nobles who brought about the deposition of Edward II. He died in August 1338, leaving no son. The survivor of his two daughters, Margaret (c. 1320–1400), who was countess of Norfolk in her own right, married John de Segrave, 3rd Lord Segrave (d. 1353), and their only child Elizabeth (d. c. 137j) became the wife of John de Mowbray, 4th Lord Mowbray (d. 1368), and the mother of two sons John and Thomas. In 1397 the countess Margaret was created duchess of Norfolk, and at the same time her grandson Thomas Mowbray was made duke of Norfolk.

On the death of John Mowbray, 4th duke of this creation, in 1476 the dukedom became extinct, but the earldom passed to his daughter Anne, wife of the young Richard, duke of York, who was murdered in the Tower. With her the earldom became extinct.

The dukedom was given in 1483 to John Howard whose mother, Margaret Mowbray, was a daughter of Thomas Mowbray the 1st duke. The dukedom has remained in the Howard line until the present day. (*See* Howard.)

NORFOLK, JOHN HOWARD, 1st Duke of (of the Howard line) (c. 1430–1485), was the son of Sir Robert Howard by his wife Margaret, daughter of Thomas Mowbray (*q.v.*), the first duke of that family. From her he was coheir (1481) of the Mowbray estates. In 1455 John Howard was sent to parliament as member for Norfolk, although he "hadde no lyvelode in the shire"; in 1461 he was knighted and served Edward IV assiduously. Though created baron in 1470 by Henry VI. he next year mustered support for Edward IV. He remained treasurer of the royal household from 1467 to 1474, and went to France with Ednard IV in 1475. After Edward's death, however, he supported Richard III, who created him duke of Norfolk and made him earl marshal of England in June 1483. He was killed at Bosworth while fighting for this king on Aug. 22, 1485, and the title thus suffered attainder.

NORFOLK, THOMAS HOWARD, 2nd Duke of (1443–1524), son of the 1st duke, John Howard, whose fortunes he shared. He fought at Barnet for Ednard IV, and was made steward of the royal household and created earl of Surrey in 1483 when his father nas made duke of Norfolk. Taken prisoner at Bosworth he was attainted and remained in captivity until Jan. 1489. when he mas released and restored to his earldom but not to the dukedom of Norfolk. He was then entrusted with the maintenance of order in Torkshire and with the defense of the Scottish borders; he was made lord treasurer in 1501, and helped to arrange the marriage between Margaret, the daughter of Henry VII, and James IV of Scotland. Henry VIII, too, employed him on public business, but he grew jealous of Thomas Wolsey, and for a short time absented himself from court.

He commanded the army which defeated the Scots at Flodden in Sept. 1513, and was created duke of Norfolk in Feb. 1514, with precedency as of the creation of 1397. Later Norfolk worked more harmoniously with Wolsey. He was guardian of England during Henry's absence in France in 1520, and acted as lord high steward at the trial of his friend Edward Stafford, duke of Buckingham, in 1521. Norfolk died on May 21, 1524. Among his sons were William, 1st Lord Howard of Effingham (1510?–1573), and Sir Edward Howard (c. 1477–1513), lord high admiral, who defeated the French fleet off Brest in Aug 1512, and died in April 1513.

NORFOLK, THOMAS HOWARD? 3rd Duke of (1473–1554), eldest son of the 2nd duke, married in 1495 Anne, daughter of Edward IV, thus becoming a brother-in-law of Henry VII, who had married Anne's sister Elizabeth. He became lord high admiral in 1513, and led the van of the English army at Flodden in September, being created earl of Surrey in Feb. 1514. In 1513 he married Elizabeth (d. 1558), daughter of Edward Stafford, duke of Buckingham. In 1520 Surrey went to Ireland as lord deputy, but soon vacated this post to command the fleet which sacked Morlaix and ravaged the neighbourhood of Boulogne in 1522; in 1523 he raided and devastated the south of Scotland. He succeeded his father as lord treasurer in 1522 and as duke of Norfolk in May 1524, and as the most powerful nobleman in England he headed the party hostile to Cardinal Wolsey. He favoured the divorce of Henry VIII from Catherine of Aragon, and the king's marriage with his niece Anne Boleyn.

In 1529 Norfolk became president of the council, but in 1536 his position was shaken by the fate of Anne Boleyn, at whose trial and execution he presided as lord high steward. But his military abilities rendered him almost indispensable to the king, and in 1536, just after the rising known as the Pilgrimage of Grace had broken out, he was dispatched into the north of England; he temporized with the rebels until the danger was past, and then, as president of the council of the north, punished them with great severity. Sharing in the general hatred against Thomas Cromwell, Norfolk arrested the minister in June 1540. He led the English army into Scotland in 1542 and into France in 1544; but the execution of Catherine Howard, another of his nieces who had become the wife of the king, had weakened his position.

In Dec. 1546 his son Henry Howard, earl of Surrey (*q.v.*), was arrested on a charge of treason; Norfolk himself suffered the same fate as accessory to the crime. In Jan. 1547 Surrey was executed; his father was condemned to death by a bill of attainder, but the king died and the sentence was not carried out. Norfolk remained in prison during Edward VI's reign but in Xug. 1553 he was released and restored to his dukedom and later in the month he acted as lord high steward at the trial of John Dudley, duke of Northumberland. In Jan. 1554 he was sent to suppress the rebellion which had broken out under Sir Thomas Wyat, but his men fled before the enemy. He died on Aug. 2j. 1j54.

Norfolk was a brutal and self-seeking man, a conservative in religion and, as he himself admits, "quick against the sacramentaries."

(R. B. Wm.; X.)

NORFOLK, THOMAS HOWARD, 4TH DUKE OF (1536–1572), son of Henry Howard, earl of Surrey (*q.v.*), was born on March 10, 1538. After his father's execution, the council removed him from his mother's charge and he was given as tutor John Foxe, the Protestant martyrologist. Restored to his father's title on Mary's accession; he succeeded his grandfather as duke of Norfolk in Aug. 15j4. Although too young to take much part in affairs in Mary's reign, he was in favour both with her and with Elizabeth I. After some hesitation he took command of the English forces in the north during the intervention in Scotland in 1559–60. In 1j68 he presided over the commission to enquire into the quarrel between the Scots and their queen Mary Stuart, who had just fled to England. Jealous of Leicester's favour and William Cecil's influence with Elizabeth, and having recently lost his third wife, he listened readily to suggestions from Maitland of Lethington and others that he should marry Mary. He was not, however, bold enough to ask Elizabeth's consent or disloyal enough to agree to a rising against her; and while he hesitated, Elizabeth in Oct. 1569 had him arrested. He was released in Aug. 1570, after the suppression of the rising of the northern earls, but soon allowed himself to be drawn into Roberto di Ridolfi's plot for a Spanish invasion to put Nary on the English throne. The discovery of the plot brought him to the scaffold (June 2, 1572), despite Elizabeth's reluctance to order his execution. He died protesting his innocence and that "he was never a papist."

By his first marriage to Mary, daughter of the earl of Arundel, the duke of Norfolk left a son, Philip, who became earl of Arundel (1580) in right of his mother; by his second marriage he left two sons, Thomas Howard, first earl of Suffolk (1603), and Lord William Howard.

(R. B. Wm.)

NORFOLK, THOMAS MOWBRAY, 1ST DUKE OF (c. 1366–1399), son of John, 4th Lord Mowbray (d. 1368), mas, as a youth, a familiar companion of Richard II; he was created earl of Nottingham in 1383, and made marshal of England for life in 1385. Jealousy of the king's favourite, Robert de Vere, earl of Oxford, probably caused Nottingham, in 1387, to join a group of nobles led by Thomas, duke of Gloucester, and his own father-in-law, Richard, earl of Arundel, who sought to deprive the king of his power. They routed de Vere, at Radcot Bridge, and Richard was at their mercy. Partly because of Nottingham's moderate counsels the suggestion to depose him was not carried out; but in the "merciless parliament" of 1388 his favourites were "appealed" of treason and were sentenced to death. For nearly two years the chief power was in the hands of the lords appellant, as Nottingham and his friends were therefore called.

As soon as the king regained his authority, in 1389, he showed Nottingham marked favour and detached him from his former colleagues. Later he became captain of Calais and the royal lieutenant in the northeast of France. Richard took him to Ireland in 1394 and soon afterward sent him to arrange a peace with France and his marriage with Isabella, daughter of Charles VI. But the earl's supreme service to the king was in 1397 when Richard took a tardy but severe vengeance upon three of the appellants. In their turn these lords were appealed of treason before the parliament, and as on the former occasion Nottingham was one of the accusers. Gloucester was entrusted to his keeping at Calais, and in Sept. 1397 he reported that his prisoner was dead. The duke had been murdered, and Nottingham was perhaps responsible, although the evidence against him is not conclusive.

Norfolk received most of Xrundel's lands in Surrey and Sussex, and was created duke of Norfolk. He then began to fear for his own safety, and took the duke of Hereford (afterward Henry IT'), into his confidence. Hereford carried his words to the king, who summoned him to his presence, and at Oswestry Norfolk accused Hereford of speaking falsely. A court of chivalry decided that the dispute should be referred to the arbitrament of single combat at Coventry; but when everything was ready (Sept. 16, 1398) for the fight Richard interposed and ordered both combatants into banishment. Norfolk was exiled for life and deprived of his offices, although not of his titles. He died at Venice! It., on Sept. 22, 1399. Norfolk's quarrel with Hereford forms act I of Shakespeare's *Richard II*.

See M. V. Clarke, *Fourteenth Century Studies* (London, 1937); A. B. Steel, *Richard II* (London, 1941, New York, 1942); T. F. Tout, *Chapters in Mediaeval Administrative History*, vol. iii–iv (London, 1928).

(T. B. P.; X.)

NORFOLK, an eastern county of England: bounded north and east by the North sea, northwest by the Wash, south by Suffolk and west by Cambridgeshire and Lincolnshire. The area, excluding tidal water, is 2,053.6 sq.mi., the county being the fourth in size in England; the total population in 1951 was 548,062.

Physical **Features.**—Norfolk is low-lying, the highest areas are a little more than 300 ft. above sea level, while in parts of the Fenland the surface is below ordnance datum. The solid geology of the area is relatively simple: the superficial geology complex, giving rise to well-defined natural subregions. The commonest rock of the county is the Chalk outcropping in west Norfolk as a long broad ridge mostly more than 200 ft. above ordnance datum and dipping sharply eastward until at Great Yarmouth its surface is 450 ft. below ordnance datum. Beneath the Chalk on its western edge lie the older beds of Kimeridge Clay, Lower Greensand and Gault and from the Norwich area to the coast the Chalk is chiefly overlain by the marine Crag deposits. Successive glacial advances have moulded the surface topography by the deposition of large areas of boulder clays, sands and gravels which have later been eroded. Postglacial changes of land and sea level have led to the formation of peats and clays in low-lying regions.

Parts of the go-mi. long coastline are diversified by dunes of blown sand, and spits and islands of shingle and sand. Generally the west and northwest coasts are subject to accretion but from Sheringham southeast to Caister-on-Sea there has been marked erosion.

Nine subregions characterized by distinctive combinations of soil, vegetation and land utilization may be recognized in Norfolk: (1) About one-eighth of the English Fenland lies within Norfolk. In the north silt predominates. in the south peat. Its intensive cultivation is only possible through the maintenance of an elaborate system of drainage. (2) The North Alluvial plain extends along the north coast from Hunstanton to Cley and consists entirely of marshland. much of it salt marsh. (3) The Greensand belt zone runs southward for about 2j mi. from near Hunstanton and is characterized by undulating heathland and magnificent woodland and by the use of carstone as a building material. (4) Breckland in southwest Norfolk is a thinly populated area with an unusually sandy soil. Agriculturally the area is marginal and its former extensive heaths have been largely replaced by modern coniferous forests. (5) The "Good Sands" region comprises the upland area of northwest Norfolk and was formerly desolate heathland but was transformed by pioneering agriculture into great productivity. (6) High Norfolk occupies the centre of the county almost from the north coast to the southern boundary with Suffolk and is characterized by its heavy loam soils and is still well wooded. (7) The Cromer-Holt ridge consists of coarse gravels with the thinnest of soils, ending seaward in lofty cliffs where landslides are common. (8) The Loam region area of northeast Norfolk possesses good soils, largely arable. is well wooded and thickly populated. (9) The Broadland (see below) consists of marshland, often below high-tide level. in the lower courses of the Bure, Yare and Waveney rivers and their tributaries.

Archaeology and History.——Norfolk is rich in archaeological evidence of past human cultures though many prehistoric structures have largely been destroyed by the extensive arable farming of recent centuries. Palaeolithic flint implements mainly of the Acheulean-Clactonian cultures occur commonly in the gravel beds and clays formed by succeeding glaciations. Flint tools left by Mesolithic hunters are found on the lighter soils. Kelling is the best-known site. In all subsequent periods. as well as in the Roman and early Anglo-Saxon periods. population was mainly concentrated on the relatively easily worked soils of Breckland, the Greensand belt and the West Norfolk ridge. The Cromer-Holt ridge and the Norwich area also attracted settlers. The heavier afforested soils of High Norfolk and the Loam region were neglected until late Saxon times. Sea-borne invaders chiefly entered the area by the rivers draining into the Wash or along those which outflow at Yarmouth. By land. the Chalk ridge linked west Norfolk with southern England and was traversed by the important Icknield way.

The chief monuments of the Neolithic Age in Norfolk are the extensive group of flint mines (Grimes Graves) in Breckland and elsewhere in the Chalk area, in addition to two long barrows and the henge monument at Arminghall. There are extensive traces of the Beaker invaders from the Rhineland and to them and their Middle Bronze Age successors may be attributed most of the numerous round barrows. It was only in the Late Bronze Age that this metal was freely available in Norfolk and many metalsmiths' hoards attest this. The beginning of the Iron Age (about 450 B.C.) saw the arrival of fresh invaders from the continent. well represented by a farmstead excavated at West Harling. In the 3rd century B.C. a new ruling class came from the Seine-Marne area of France and provided the dynasty which ruled those living in Xorfolk and northwest Suffolk known later as the Iceni. To the last phase of the Iron Age belong a group of remarkable hoards of gold and bronze ornaments and gold, silver and tin coins. The remains of the Roman era in Norfolk are neither numerous nor impressive and suggest a scanty and poor population (though larger than in prehistoric times) probably because of the severe repression which followed the revolt of Queen Boadicea (Boudicca) in A.D. 61. The administrative centre was the walled town at Caistor-by-Norwich and there was a fortified port at Caister-by-Barmouth.

Villa estates were most common in west Norfolk and the Fenland was thickly settled by peasant cultivators. In the 3rd and 4th centuries there was a coastal fort at Brancaster to repel Saxon pirates. The road system is still imperfectly known.

From about A.D. 450 Norfolk received fresh invaders—Angles, Frisians and Saxons—from northwest Germany and the Low Countries but the detailed geography and chronology of these intrusive groups are uncertain. By about 575 the smaller units had been brought under the control of an East Anglian monarchy which for a brief period; under Redwald in the early 7th century achieved a temporary dominance but later fell under the sway of its neighbours. Norfolk became officially Christian in 631 and formed part of the diocese of East Anglia until this was divided in 673 and the bishop's see for Norfolk established at North Elmham, where substantial remains of the 10th-century cathedral may be seen. To the 8th century belongs the revival of town life as witnessed by excavations at Thetford and at Norwich where a mint was in operation by 930. From mid-9th century Norfolk was subject to Danish invasion. In 869 the Danes wintered at Thetford and King Edmund was killed. East Anglia becoming part of the Danelagh and receiving large numbers of Danish settlers. especially in Flegg north of Yarmouth. In the renewed Danish invasions of the early 11th century both Norwich and Thetford were burned. Despite these setbacks, late Saxon times in Xorfolk saw a great growth of population and a corresponding expansion of cultivated land through the deforestation of much of central Norfolk. By the time of the Dornesday survey of 1086 Norfolk was one of the most thickly populated and wealthiest regions of England and remained so throughout the mediaeval period. The opening up of central Korfolk led to the development of Norwich while Thetford remained static. the bishop's see being transferred from there to Norwich in 1094. Yarmouth and Lynn were also important towns as early as the Norman conquest. The mediaeval prosperity of Norfolk rested on its successful agriculture and on its woollen production. This mediaeval wealth is reflected in its magnificent buildings both secular and ecclesiastical. Surviving castles include such imposing structures as Norwich, Castle Rising, Caister, Baconsthorpe and Oxborough ranging from the 12th to the 15th centuries.

The numerous monasteries suffered severely at the Reformation but Norwich cathedral survives from a rich Benedictine monastery and there are substantial traces of other religious houses such as the Blackfriars at Norwich, and monasteries at Castle Acre, Binham, Thetford and Wymondham. Little remains of the Augustinian house at Little Walsinpham, one of the most famous shrines of the middle ages. Many parish churches were rebuilt in the 14th or 1jth centuries and are conspicuous for their size and rich embellishments.

The peace of mediaeval Norfolk was ruffled from time to time by baronial warfare, the rising of 1381, the private strife of the 15th century revealed vividly in the Paston letters (*q.v.*), and the formidable rebellion of Robert Ket (Kett) in 1549. During the Civil Wars Norfolk was largely on the parliamentary side but some magnates supported the king and Lynn was held on his behalf.

Many great country houses from the 16th century onward survive to attest the wealth of the county based on successful sheep farming and other agricultural developments. Outstanding among these great buildings are East Barsham manor house (early 16th century), Blickling and Raynham halls (early 17th century). Holkham and Houghton halls and Wolterton park (18th century) and many 19th-century mansions, among which Sandringham has special interest as the Norfolk home of the royal family.

Broadland.— The broads (lakes) are situated in close relationship to the three confluent rivers of east Norfolk—the Waveney, Yare and Bure with its tributaries, the Ant and the Thurne. A few broads lie just over the border in Suffolk but belong to the same system. Physically the broads are of two types—side-vailey, such as South Walsham and the Ormesby-Rollesby-Filby series, and bypassed, such as those at Wroxham and Hoveton where they are separated from the river channel which passes close to them. Investigations mainly based on thousands of borings in and around them showed conclusively that the broads originated as peat cuttings made probably in late Saxon and early mediaeval times when the water table was lower, and have silted up since their abandonment.

During the 19th century many were steadily reduced in size by the encroachment of vegetation on former open water, and some have disappeared completely.

The Norfolk broads, and the river system which links them, form an important holiday area, with pleasure boats, both sail and power propelled, centred chiefly on Wroxham. Potter Heigham, Stalham and Yarmouth. There are more than 150 mi. of navigable waterway. Only the Yare is used by sea-going trading vessels, bringing mainly coal and timber to Norwich. The unique physical and vegetational characteristics of the region are reflected in its rich and varied natural history. Many rare birds. insects and plants in this area are likely to survive if physical conditions remain constant as a result of the establishment of nature reserves at such places as the following broads—Alderfen, Barton, Hickling, Ranworth. Cockshoot and Surlingham (all under the care of the Norfolk Naturalists' trust); Horsey mere (National Trust, 1948) and Calthorpe broad and Martham broad with Winterton dunes (Nature conservancy). In 1954 a nature reserve was declared on Scolt Head Island; it was extended in 1955 to include the whole island. It is used for the study of coastal erosion and of the formation of sand and shingle banks and salt marshes. A colony of sandwich terns breeds on the island.

Agriculture, Industries, Communications and **Administration.**—The county is largely agricultural, nearly 1,000,000 ac. being under crops and grass in the latter 1950s, of which 132.673 ac. were under wheat, 238.960 ac. under barley and 99,706 ac. under sugar beet—the highest figures in England for the two last named crops. Large areas were devoted to peas for canning or freezing. Most kinds of livestock and turkeys are raised: the county was second to Hampshire in the number of turkeys. Catering for visitors and holidaymakers, especially to the Broads area and the coastal towns of Sheringham, Cromer. and Great Yarmouth, is a big summer industry. Norwich (*q.v.*), the county town, is the main industrial and marketing centre. Agricultural machinery is made in many towns and the old silk industry survives in Norwich.

There is a lack of harbours along the dangerous coast; in 1953, for example, serious floods did much damage. Sea walls were rebuilt after the floods and stronger defenses put up against the sea's encroachment. Fishing is carried on from Great Yarmouth. The other principal port is King's Lynn (Lynn) and there is a small trade at Wells.

The railways of the Eastern region of British railways serve the principal towns. The eastern rivers afford water communication with Great Yarmouth, while the Great and Little Ouse and some of the drainage cuts communicate with Lynn.

The area of the administrative county is 2,035.2 sq.mi. with a population in 1951 of 375,721. The municipal boroughs are King's Lynn (pop., 1951, 26,176); Norwich, a city and county borough, a cathedral town and the county town (121,236); Thetford (4,447) and Yarmouth, properly Great Yarmouth (51,105), a county borough. The county is in the southeastern circuit, and assizes are held at Norwich. The county quarter sessions meet at Norwich and King's Lynn. Norwich. Yarmouth and King's Lynn have separate courts of quarter sessions. Norfolk is in the diocese of Norwich except for three rural deaneries in west Norfolk, which are in that of Ely. There are six county parliamentary divisions—South-West, North, Central and South Norfolk: King's Lynn, and Yarmouth (which includes the county borough of Yarmouth)—as well as the parliamentary borough of Norwich which returns two members.

Of three large, well-known boys' schools in the county, two are in Norwich, namely, King Edward VI's school and the City of Norwich school. The third. Gresham's school, was founded at Holt, near Sheringham, in 1555, by Sir Thomas Gresham (*q.v.*).

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NORFOLK,

a city and seaport in the tidewater region of eastern Virginia, U.S.. in, but independent of. Korfolk county, is located about 18 mi. W. of the Atlantic ocean near the mouth of Chesapeake bay. Its harbour of Hampton Roads (*q.v.*), formed by the junction of the James river and two tidal estuaries known as the Nansemond and Elizabeth rivers, is one of the world's most magnificent harbours, free o f ice the year around. About it are located the port cities of Norfolk. Portsmouth (*q.v.*), South Norfolk. Hampton and Newport News (*q.v.*). In 1960 Norfolk. the largest city in Virginia, had a population of 305.872. The Norfolk-Portsmouth standard metropolitan statistical area, consisting of the cities of Norfolk. Portsmouth, South Norfolk. Virginia Beach and the counties of Norfolk and Princess Anne, had a population of 578,507.

History.—The history of Norfolk began with an act of the Virginia general assembly of June 1680, on instructions from the King, which required each county to purchase 50 ac. and lay out a town and warehouses in order to encourage "trade and manufacture." Land for the town in lower Xorfolk county was to be located "on the Easterne Branch on Elizabeth river at the entrance of the branch." The required land was purchased from Nicholas Wise, a carpenter, for 10,000 lb. of tobacco, and the town was laid out in 1682. In 1705 the house of burgesses made it a port of entry and landing, retaining the name Norfolk, and it was incorporated as a borough in 1736 with Samuel Boush as mayor and Sir John Randolph as recorder.

The commerce of Norfolk for many years depended chiefly on trade with the people of eastern North Carolina, who brought such raw materials as tar, pitch, juniper shingles, plank, hides and tobacco over treacherous waterways or crude roads. As business increased, artisans set up their crafts and shipbuilding and ship repairing became important industries.

Later a brisk trade developed with Barbadoes and the West Indies; and, as merchant ships became too large to load and unload conveniently at the quays along the rivers and bays. Norfolk became a busy warehouse centre. In recognition of its importance and the loyalty of its citizens. Gov. Robert Dinmiddie in 1753 presented Norfolk with a silver mace still cherished by the city.

The American Revolution brought complete destruction to Norfolk. At first the Norfolk citizens were outspoken against the Stamp act and Great Britain's "most tyrannick exercise of unlawful power." as one of their protests stated it. But when the royal governor, Lord Dunmore. started open warfare against Virginia and protests ended in bloodshed. much of the population, especially the Scottish merchants, who had close ties with their mother country, made the town a rallying point for Tories.

In Dec. 1775 Governor Dunmore took over Norfolk as his headquarters, declared martial law and defeated a group of Virginia militiamen at Kempsville. southeast of the city. Later in the month Col. William Woodford and his Virginia, riflemen completely routed the British at Great Bridge and occupied Norfolk.

On New Year's day of 1776 Dunmore's fleet anchored in the Elizabeth river. shelled the town and set fire to some of the warehouses. The British burned 19 houses in all. The Virginians under Woodford burned more of the town after the bombardment, and the following month the rest of the town, except for St. Paul's church (which still has one of Lord Dunmore's cannon balls imbedded in its walls), was destroyed to prevent its use by the British.

Although the restoration of Norfolk was surprisingly rapid, the stifling of the West India trade by Great Britain, restrictions on trade and privateering by the French. British and Spanish during the Napoleonic Wars. a disastrous fire in 1799, rivalry of the fall-line cities such as Richmond and lack of an adequate commercial program by the state prevented even more substantial progress.

During the War of 1812 Norfolk was twice saved from invasion by the British. The first time, local militia. reinforced by U.S.

marines, beat off a land attack on Portsmouth. An able defense of Craney Island (near the mouth of the Elizabeth) by Gen. Robert B. Taylor prevented the second invasion by barge.

After that war canals and railroads brought improved communications and increased trade with North Carolina and the whole Roanoke river valley. Norfolk continued to grow and in 1845 was incorporated as a city, but yellow fever struck in 1855. killing about 10% of the population, and in 1861 came the Civil War. Shortly after the outbreak of hostilities the navy yard at Portsmouth was burned and the port abandoned by Federal forces. During the next year the Confederates repaired and made good use of the shipyard facilities in the area, among other things, building the "Virginia," first ironclad warship to be tested in battle, from the remains of the Union ship "Merrimack" (see "MONITOR" AND "MERRIMACK," BATTLE OF). In May 1862, however, Norfolk fell to Union forces under Gen. John E. Wool and remained an occupied city, part of the time under Gen. Benjamin Franklin Butler (*q.v.*), throughout the remainder of the war.

The progress of Norfolk was accelerated after 1870 because of the completion of railroads converging on the port with its superior facilities. The extension of the Norfolk and Western railroad to the coal fields of Virginia and West Virginia in 1883 started a trade which made Hampton Roads one of the world's greatest coal exporting ports.

During World Wars I and II Norfolk experienced accelerated prosperity, at first caused by heavy shipments to the Allies, and in the later phases of both wars by the activities at the military posts in the area. Correspondingly severe was the postwar deflation following World War I when many of these posts were closed or reduced to skeleton installations. After World War II Norfolk experienced a building boom during which many of the outlying sections of the city were transformed from woods, fields and swamps into urban communities.

Government. — The city of Norfolk, which in 1906 annexed the town of Berkley on the south side of the Elizabeth river, adopted a council-manager form of government in 1918 which controls the city's municipal affairs. The port of Hampton Roads is under the jurisdiction of a state port authority created in 1926. Holdings of the federal government are also extensive in and around Norfolk. The more than 20 major military installations and commands include the naval operating base (Sewell Point), the naval air station (Breezy Point) and the amphibious training base (Little Creek) on the northern edge of the city; the Norfolk naval shipyard and the naval hospital in Portsmouth; and the headquarters of the U.S. Atlantic fleet and the supreme allied command, Atlantic (SACLANT) of the North Atlantic Treaty organization (NATO).

In 1957 Norfolk adopted an elaborate downtown master plan of redevelopment.

Commerce, Industry and Transportation. — Trade in Norfolk consists mostly of exporting bulk cargoes such as coal, tobacco, cotton, timber, truck crops and grain. Although it is the Atlantic coast leader in export tonnage and stands high in the value of exports import tonnage is relatively low. This was initially because of the mountains that stand between Norfolk and the major consumer markets of the eastern and midwestern U.S., thus making inland transportation of goods expensive and causing Norfolk to lose this import trade to ports such as New York and Baltimore, and later to the lack of a thickly settled manufacturing hinterland.

Shipbuilding is perhaps the most important of Norfolk's industries, but the city also produces chemicals, fertilizers, insecticides, peanut and cottonseed oil, sea foods, textiles, automobiles, agricultural machinery and electric motors.

Norfolk is connected to every port city in Hampton Roads by bridge, tunnel, ferry or, in the case of Hampton, by a combination bridge-tunnel completed in 1957. In the 1960s work was begun on another bridge-tunnel across the entrance of Chesapeake bay to Cape Charles, connected to Norfolk by ferry. The Dismal Swamp canal (1828) and the Albemarle and Chesapeake canal (1860), both parts of the Atlantic Intracoastal waterway (*q.v.*), connect Norfolk with Currituck and Albemarle sounds in North Carolina.

Education and Culture. — In addition to excellent public- and parochial-school systems, Norfolk contains Norfolk college of the College of William and Mary (1930) and a division of Virginia State college (1935). Also important in the cultural life of the city are the Norfolk Symphony orchestra and the Norfolk Museum of Arts and Sciences. Places of historical interest include the Myers house (1791), St. Paul's church (1739), the Adam Thoroughgood house (*c.* 1636–40), the city hall (1850) and Ft. Norfolk (1794).

Parks and Recreation. — Besides being a busy commercial and industrial city, Norfolk also offers much in the way of recreation. Ocean View, a beach resort area on Chesapeake bay, lies within the city limits and Virginia Beach is only about 18 mi. E. on the Atlantic. The Norfolk Municipal gardens in the northeastern section of the city contain beautiful displays of azaleas and camellias. h'ear the city are also fishing grounds and additional bathing beaches. (R. L. Mo.)

NORICUM, a district south of the Danube, corresponding to part of Styria and Carinthia, Austria, Bavaria and Salzburg. The population was Illyrian afterward subordinate to various Celtic tribes. The country is mountainous and the soil poor, but it was rich in iron, and the famous Noric steel was used for Roman weapons. The inhabitants were warlike and paid more attention to cattle breeding than to agriculture. Gold and salt were found in considerable quantities; the wild nard grew in abundance, and was used as a perfume. Noricum was the southern outpost of the Celtic peoples and the starting point of their attacks upon Italy. The cemeteries of Hallstatt (*q.v.*), less than 40 mi. from Noreia, contained weapons and ornaments from the Bronze Age up to the fully developed Iron Age. Prof. Ridgeway (Early Age of Greece, i. ch. v.), holds that here was the cradle of the Homeric Achaeans. For a long time the h'oricans enjoyed independence under princes of their own, and carried on commerce with the Romans. In 16, having joined with the Pannonians in invading Histria, they were defeated by Publius Silius, proconsul of Illyricum. From this time Noricum was called a province, although not organized as such, but remaining a kingdom with the title regnum Noricum, under the control of an imperial procurator. In the reign of Marcus Antoninus the Legio II. Pia was stationed at Noricum, and the commander of the legion became governor.

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NORMAL SCHOOLS: see TEACHERS, TRAINING OF.

NORMAN, MONTAGU COLLET (1871–1950), British financier, was educated at Eton and King's college, Cambridge, and served in the South African War, 1900–01. He afterward became connected with finance and his active association with the Bank of England began during World War I. In 1918 he was appointed deputy governor and in 1920 governor of the Bank of England. By 1926, when he was re-elected for the seventh time, he had held the post longer than any previous governor. He finally retired in April 1944 because of failing health and was succeeded as governor by Lord Catto. During his governorship the gold standard was restored (1925) and again abandoned (1931). In 1923 he was made a privy councilor and in 1933 he married Priscilla Worsthorae, granddaughter of the 7th Earl of Abingdon. He was created a baron in July 1944 and took the title Baron Norman St. Clere in the county of Kent. He died Feb. 4, 1950.

NORMAN, a city in central Oklahoma, U.S., 18 mi. S. of Oklahoma City, is located on a plateau overlooking the valley of the South Canadian river; the seat of Cleveland county. Norman is the marketing and distribution centre of an extensive agricultural area nhich produces livestock and dairy products. There are also oil wells in the vicinity and some light industry.

Beginning as a tent city in April 1889, when Oklahoma was opened to white settlement, Norman was named in honour of an engineer who, in the 1870s, had aided in constructing the Santa Fe railroad through the territory. Before the settlement the railroad called the site Norman Switch. Incorporated in 1902, Norman adopted a commission-manager form of government in 1919.

The University of Oklahoma (see OKLAHOMA: *Education*), with 12 schools and colleges, was established there in 1892 on land donated by the people of Norman. The city is also the site of a state mental hospital and a cerebral palsy institute. For comparative population figures see table in OKLAHOMA: Population.

(GE. H. S.)

NORMANDY, an ancient province of France, bounded on the northeast by the river Bresle. which falls into the English channel at Le Tréport and separates Normandy from Picardy, and then roughly by the Epte, which divides the Vexin into two parts. In 1791 the old duchy was divided approximately among the modern *départements* of Seine-Maritime, Eure, Orne, Calvados and Manche. Geographically, Normandy is characterized by its bordering on the sea, which encourages maritime life and explains the dampness of the climate; by the predominance of agriculture and stock raising; and, finally, by the importance of the Seine valley, which determined the situation of the capital city, Rouen, and attracted industry and trade, taking advantage of the neighbourhood of Paris.

History. — Till the 10th century A.D. Normandy retained certain Gallo-Roman features. The Germanic invasions and the conquest by Clovis before 506 little modified the features of the part of the old province of Lugdunensis Secunda, henceforth named Neustria; civitas and *pagi* subsisted. Christianity, introduced in the 4th century by St. Mello and St. Victricius, was extended under the protection of the Merovingians, benefactors of the abbeys of Fontenelle (modern Saint-Wandrille), Jumièges and Mont-Saint-Michel. The Norman settlement was established by the treaty of Saint-Clair-sur-Epte, concluded in 911 between King Charles the Simple of France and Rollo, chief of the Normans. The latter received territory comprising the town of Rouen and a few *pagi* situated on the coast; but afterward Rollo also received Bessin and Maine. This settlement put an end to plundering by the Normans, who, moreover? seem to have left intact much that they found. Rollo had been baptized; he and his successors maintained the great abbeys and kept the domanial system of farming almost unchanged. But since even today many proper names and place names of Scandinavian origin are found there, the newcomers must have been fairly numerous. Without losing the spirit of adventure which carried them in the 11th century to the conquest of England and southern Italy (on the pilgrims' road to Jerusalem). the Normans soon acquired the standards of the older population of France. They played their part in the troubles of the last Carolingian reigns and the feudal conflicts. Contact, if not rivalry, developed between the Norman duchy and the neighbouring county of Flanders, the counties of Maine and Anjou, the duchy of Brittany, the Capetian duchy (soon afterward kingdom) of France and, 'finally, England.

The first two dukes of Normandy, Rollo and his son William I "Longsword," displayed a certain fidelity to the Carolingian dynasty, and in 936 William did homage to Louis IV d'Outremer of France. However, during the minority of William's successor, Richard I, Louis IV attempted to reconquer Normandy; but Richard was helped by King Harold of Denmark, and Louis was captured by the inhabitants of Rouen and handed over to Hugh the Great. William Longsword had been assassinated in 942 by Arnulf (Arnoul), count of Flanders, who was an ally of Louis IV; and Normans, Flemings and Robertian Frenchmen were rivals for the possession of Ponthieu.

The need for defense against common enemies brought together the Norman dukes and the Robertians and their heirs. In 958 Duke Richard I married Hugh the Great's daughter; and Richard's help facilitated the accession of his brother-in-law Hugh Capet to the French throne. Richard II (996–1026) had no need of external assistance to crush the peasant insurrection, of which William of Jumièges has given so horrifying an account; but his son Robert the Devil (1027–35), was clever enough to support Henry I of France against his brother Robert, who was laying claim to the throne; and in return for this service he received the Vexin-Français (1131). In turn, Henry I supported the young duke Williani II the Bastard (later William I the Conqueror of England), son of Robert the Devil and Arlette (daughter of a tanner of Falaise), and helped him defeat the rebellious Norman nobles at Val-aux-Dunes (1047). William in his turn supported the king against Geoffrey Martel, count of Anjou. There the exchange of good offices stopped.

A second phase of Norman history began with William's successes abroad. Normandy appeared as a dangerous rival of the Capetian monarchy. Henry I reconquered the Vexin-Français, supported Geoffrey Martel against William and encouraged the count of Eu and Montreuil in his claims to the duchy, but almost to no purpose. William conquered Maine, attacked Brittany and married Matilda, daughter of Baldwin V, count of Flanders; and the conquest of England doubled his power (1066). Normandy, however, was first administered by Matilda and then devolved not to William Rufus but to the Conqueror's eldest son, Robert Curthose, from whom his brother Henry Beauclerk (Henry I of England) finally wrested it, annexing it to England only in 1106.

Yet the duchy remained the geographic centre of the Anglo-Norman state, and its prospects were intimately linked with the feudal complications of the continent. Protected by the king of France, the son of Robert Curthose, William Clito, laid claim to Normandy, but defeat at Brémule (1119) destroyed his hopes. After the death of Henry I (1135) Normandy was once more disputed by his single heir Matilda (widow of the emperor Henry V and wife, by her second marriage, of Geoffrey Plantagenet, eldest son of Fulk V, count of Anjou); by Theobald II, count of Champagne, grandson of William the Conqueror, candidate of the Normans of Normandy; and on the other side by Stephen, count of Blois and Theobald's brother, whom the Normans of England supported. Geoffrey, with French and Flemish help, gradually subdued Normandy. In 1144 Theobald, whose position had been much weakened by loss of the castle of Rouen, gave up his rights to Henry Plantagenet, son and successor of Geoffrey. Bounded to Maine and Anjou, Normandy mas, more than England and Aquitaine (brought in dowry), the main piece of the Angevin empire Its wealth and the perfection of its administration by viscounts and then by *baillis* brought the prince both money and soldiers. The French kings, now fully conscious of the Angevin menace, struggled against it. The reign of Louis VII was occupied by the struggle against Henry II; and Philip Augustus pursued the same policy with tenacity and at last with success. Richard Coeur-dc-Lion, however, was victorious at Fréteval and at Courcelles near Gisors and built Château-Gaillard to bar access into Normandy. On Richard's death at Châlus in 1199, Philip mas in a position and was lucky enough to make peace by the treaty of Goulet (1200). But when the feudal condemnation of John Lackland. Richard's brother and successor, allowed Philip to confiscate his vassal's property, he invaded Normandy in June 1202 and besieged the castle of Arques, near Dieppe. Château-Gaillard was occupied after eight months' siege (Sept. 1203–April 1204), and the rest of Normandy was taken in the following months, Rouen surrendering in 1204 but obtaining a guarantee of the privileges alloued by Henry II (*Établissements* de Rouen). The French conquest of Normandy was not, houever, recognized officially by the kings of England till the treaty of Paris (1259). The Capetians even modelled the institutions of their other estates after those of Normandy, which became prosperous. In 1329 the duchy was revived in favour of John, son and future successor of Philip VI. In his turn, John the Good gave Normandy as an appanage to the dauphin Charles (1350).

The Hundred Years' War opened a tragic and decisive period for Normandy. Its geographical position made the province a field of battle; the claims of the English kings to the French crown gave them a pretext for uniting the duchy with England. In 1346 Edward III invaded Normandy. Landing at Saint-Vaast-la-Hougue (Juiy 12) and arriving at Caen on July 25, he laid waste to the country as far as Poissy. The treaty of London (1359) stipulated the cession of Normandy to England, but its provisions were modified by that of Brétigny (1360), and Normandy remained in the poisession of France.

The most striking event of the war in Normandy during the reign of Charles V (1364–80) was the siege of Saint-Sauveur-le-

Vicomte, which was occupied by the English and surrendered only after a siege of several years. At the death of Charles V, the English possessed only Cherbourg, which they evacuated in the last years of the 14th century. Still the war and taxes *(aides)* had so much overburdened the country that a revolt, the "Harelle," broke out in 1381 at Rouen, in punishment for which the town lost its privileges.

In 1415 the war with England was resumed. An English army of 60,000 men landed on Aug. 14 at the mouth of the Seine, took Harfleur on Sept. 16 and finally defeated the French king's army at Agincourt. During the following years the whole of Normandy was occupied, though Rouen held out for nearly six months (July 29, 1418–Jan. 13, 1419). Henry V of England entrusted the administration of Normandy to a special council. Under the government of the duke of Bedford, brother of Henry V and regent for the young Henry VI, Normandy profited from a policy of relative conciliation. But after the campaigns of Joan of Arc and her death at Rouen (May 30, 1431) there was an outbreak of patriotic feeling, which had been smouldering chiefly in the country districts. After the death of Bedford and the treaty of Arras, which deprived England of the Burgundian alliance, the position of the English in Normandy became insecure. The whole district of Caux revolted at the end of 1435, as did that of the Val-de-Vire in 1436. Mont-Saint-Michel had never been taken by the English, who built Granville to control it. But Normandy was not recovered by the French till after the sack of Fougères (1449). Cotentin was reconquered by the earl of Richmond, Arthur III (*q.v.*) of Brittany. Rouen surrendered on Oct. 29, 1449. An English army under Thomas Kyriel landed at Cherbourg and marched across Cotentin to Bayeux, but was met at Formigny (April 15, 1450) by the count of Clermont and routed. Caen and finally Cherbourg capitulated.

After the reconquest by the king of France, the history of Normandy is less eventful, but the province contributed its peculiar share to the life of France. Charles VII respected the local institutions — the provincial estates; the exchequer, which he transformed into a permanent court of justice (the *parlement* of Rouen); and the University of Caen (founded by the kings of England). The restored peace was to be troubled only in the 16th century during the wars of religion. The Reformation had most effect at the University of Caen, at Alençon and in the Pays-de-Caux. The Huguenots were helped by Queen Elizabeth, but the Catholic league established itself in Normandy, and Henry IV had to conquer it by force of arms, winning the victories of Arques and Ivry (though Rouen, defended by Alexander Farnese, duke of Parma, was surrendered only after Henry had abjured the Reformed religion). The weight of taxation gave rise in 1639 to the peasant insurrection of the *Va-nu-pieds,* but the Normans took little share in the Fronde, being temperamentally inclined to moderate courses.

The Normans combine the spirit of enterprise with prudence. From the early 16th century their voyages to Newfoundland, Brazil and the Indies, on the initiative of Jean Ango of Dieppe and of the Florentine explorers Giovanni and Girolamo Verrazano, in the service of Francis I, enriched Rouen and the new port of Le Havre, founded in 1517. Jean Colbert recruited many Norman settlers for New France; and it was an inhabitant of Rouen, René Robert Cavelier, sieur de la Salle, who explored the valley of the Mississippi and founded Louisiana. In the 18th century Rouen inaugurated, with John Holker, the cotton manufactures which in the 19th century were to supersede the woollen. But the basic wealth of the province remains in agriculture and stock raising.

The architecture of Normandy is magnificent. Examples are the churches of flamboyant style, castles and also the urban residences of the merchants. Pierre Corneille may be regarded as typifying the balanced mind of the Normans; the economist Pierre le Pesant, sieur de Boisguilbert, their practical common sense.

Hostile to the dictatorship of men or parties, the Normans were for federalism against the Montagnards in 1793; Charlotte Corday, who killed Marat, was a native of Caen. Among the Norman middle class Louis-Philippe found his most faithful supporters and protectionism its most resolute partisans. In the politics of the third republic the bulk of the Norman population inclined to the moderate parties of the centre.

Spared in World War I, when it sheltered the exiled Belgian government, Normandy was devastated during World War II in June 1940 and more disastrously from June to August 1944, after the Allied landing (June 6) on the beaches of Calvados. Reconstruction began with the cessation of the fighting.

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(Mi. M.)

NORMANS, the softened form of the word "Northman," applied first to the people of Scandinavia in general, and afterward specially to the people of Norway. In the form of "Nor-[illegible] it [illegible] the name of those colonists from Scandinavia who settled in Gaul, founded Normandy, adopted the French tongue and French manners, and from their new home set forth on new errands of conquest, chiefly in the British islands and in southern Italy and Sicily. Normans and Northmen must be carefully distinguished. For these Normans began to adopt a new religion, a new language, a new system of law and society, new thoughts and feelings on all matters. To all outward appearance the Norman conquest of England was an event of an altogether different character from the Danish conquest. The one was a conquest by a people whose tongue and institutions were still palpably akin to those of the English. The other was a conquest by a people whose tongue and institutions were palpably different from those of the English. The Norman settlers in England felt no community with the earlier Danish settlers in England. In fact the Normans met with the steadiest resistance in a part of England which was largely Danish. But the effect of real, though unacknowledged, kindred had none the less an important practical effect. There can be no doubt that this hidden working of kindred between conquerors and conquered in England, as compared with the utter lack of all fellowship between conquerors and conquered in Sicily, was one cause which made so wide a difference between the Norman conquests of England and of Sicily.

Character of the Normans. — The English and the Sicilian settlements form the main Norman history of the 11th century. The new creed, the new speech, the new social system, had taken such deep root that the descendants of the Scandinavian settlers were better fitted to be the armed missionaries of all these things than the neighbours from whom they had borrowed their new possessions. With the zeal of new converts they set forth very much in the spirit of their heathen forefathers. The same spirit of enterprise which brought the Northmen into Gaul seems to carry the Normans out of Gaul into every corner of the world. Their character is well painted by a contemporary historian of their exploits, Geoffrey Malaterra. He sets the Normans before us as a race specially marked by cunning, despising their own inheritance in the hope of winning a greater, eager after both gain and dominion, given to imitation of all kinds, holding a certain mean between lavishness and greediness—*i.e.*, perhaps uniting, as they certainly did, these two seemingly opposite qualities. Their chief men. he adds, were specially lavish through their desire of good report. They were, moreover: a race skilful in flattery, given to the study of eloquence, so that the very boys were orators, a race altogether unbridled unless held firmly down by the yoke of justice. They were enduring of toil. hunger. and cold whenever fortune laid it on them, given to hunting and hawking, delighting in the pleasure of horses, and of all the weapons and garb of war. Love of imitation is marked. Little of original invention can be traced to any strictly Norman source; but no people were ever more eager to adopt from other nations, to take into their service and friendship from any quarter men of learning and skill and eminence of every kind. To this admirable quality is perhaps to be attributed the fact that a people who accomplished so much, who settled and conquered in so large a part of Europe, has practically vanished from the face of the earth.

Their Faculty of Adaptation. — But Geoffrey hardly did justice to the Normans if he meant to imply that they were simple imitators of others. Their position was very like that of the Saracens. In no department of science or art did any Saracen, strictly speaking, invent anything; but they learned much both from Constantinople and from Persia, and what they learned they largely developed and improved. The Normans did just the same. They adopted the French tongue, and were presently among the first to practise and spread abroad its literature. They adopted the growing feudal doctrines of France, and worked them, both in Normandy and in England, into a harmonious system. From northern Italy, as it would seem, they adopted a style of architecture which grew in their hands, both in Normandy and in England, into a marked and living form of art. Settled in Gaul, the Scandinavian from a seafaring man became a landsman. Even in land-warfare he cast aside the weapons of his forefathers; but he soon learned to handle the weapons of his new land with greater prowess than they had ever been handled before. He welcomed the lore of every stranger. Lanfranc brought law and discipline; Anselm brought theology and philosophy. The gifts of each were adopted and bore fruit on both sides of the Channel. And no people ever better knew how to be all things to all men. The Norman power in England was founded on full and speedy union with the one nation among whom they found themselves. The Norman power in Sicily was founded on a strong distinction between the ruling people and the many nations which they kept in peace and prosperity by not throwing in their lot with any one among them.

The quality which Geoffrey Malaterra expresses by the word "effrenatissima" is also clearly marked in Norman history. It is, in fact, the groundwork of the historic Norman character. It takes in one case the form of ceaseless enterprise, in another the form of that lawlessness which ever broke out, both in Normandy and in every other country settled by Normans. when the hand of a strong ruler was wanting. But it was balanced by another quality ahich Geoffrey does not speak of, one which is not really inconsistent with the other, one which is very prominent in the Norman character, and which is, no less than the other, a direct heritage from their Scandinavian forefathers. This is the excessive litigiousness, the fondness for law, legal forms, legal processes, which has ever been characteristic of the people. If the Norman was a born soldier, he was also a born lawyer. But nothing so well illustrates this formal side of the Norman character as the whole position of William the Conqueror himself. His claim to the crown of England is something without earlier precedent, something as far as possible removed from the open violence of aggressors who have no pretexts with which to disguise their aggression. It rested on a mass of legal assumptions and subtleties, fallacious indeed, but ingenious, and, as the result proved, effective. His whole system of government, his confiscations, his grants, all that he did, was a logical deduction from one or two legal principles, arbitrary certainly in their conception, but strictly carried out to their results. Even Norman lawlessness in some sort took a legal shape. In the worst days of anarchy, in the minority of William or under the no-reign of Robert, the robber-baron could commonly give elaborate reasons for every act of wrong that he did.

The Normans were, therefore, crusaders before crusades were preached. Norman warriors had long before helped the Christians of Spain in their warfare with the Saracens of the Peninsula, and in Sicily it was from, the same enemy that they won the great Mediterranean island. Others had done a kindred work in a more distant field as helpers of the Eastern emperors against the Turks of Asia. All these might pass for religious wars, and they might really be so; it needed greater ingenuity to set forth the invasion of England as a missionary enterprise designed for the spiritual good of the benighted islanders The Norman, a strict observer of forms in all matters. attended to the forms of religion with special care. No people were more bountiful to ecclesiasticdl bodies on both sides of the Channel; the foundation of a Benedictine monastery in the 11th century, of a Cistercian monastery in the 12th seemed almost a matter of course on the part of a Norman baron. On the other hand, none were less inclined to submit to encroachments on the part of the ecclesiastical power, the Conquerer himself least of all.

Neither England nor Sicily has become a Norman land, and the tongue which the Norman brought with him into both has not for ages been spoken in either Norman influence has been far stronger in England than in Sicily, and signs of Norman presence are far more easily recognized. But the Norman, as a distinct people, is as little to be seen in the one island as in the other, a result due to different and almost opposite causes. The whole circumstances of the conquest of England constrained the conquerors to become Englishmen in order to establish themselves in the conquered land. In William's theory, the forcible conquest of England by strangers was an untoward accident. The lawful heir of the English crown was driven against his will to win his rights by force from outside. But he none the less held his crown as an English king succeeding according to English law. Moreover, every Norman to whom he granted lands and offices held them by English law in a much truer sense than the king held his; he was deemed to step into the exact position of his English predecessor, whatever that might be. This legal theory worked together with other causes to wipe out all practical distinction between the conquerors and the conquered in a wonderfully short time. By the end of the 12th century the Normans in England might fairly pass as Englishmen, and they had largely adopted the use of the English language. The fashionable use of French for nearly two centuries longer was far more a French fashion than a Norman tradition. When the tradition of speaking French had all but died out, the practice was revived by fashion. Still the tradition had its effect. The fashion could hardly have taken root except in a land where the tradition had gone before it.

The Normans in Engiand therefore became Englishmen, because there was an English nation into which they could be absorbed. The Normans in Sicily could hardly be said to become Sicilians. for there assuredly was no Sicilian nation for them to be absorbed into. While the Normans in England were lost among the people of the land, the Normans in Sicily were lost among their fellow-settlers in the land The Normans who came into Sicily must have been much less purely Norman than the Normans who came into England Indeed, we may doubt whether the Norman invaders of Sicily were Norman in much more than being commanded by Norman leaders They were almost as little entitled to be called pure Scandinavians as the Saracens whom they found in the island were entitled to be called pure Arabs. The conquest of England was made directly from Normandy, by the reigning duke, in a comparatively short time, while the conquest of Sicily grew out of the earlier and far more gradual conquest of Apulia and Calabria by private men. The Norman settlements at Aversa and Capua were the work of adventurers, making their own fortunes and gathering round them followers from all quarters. They fought simply for their own lands, and took what they could by the right of the stronger. They started with no such claim as Duke William put forth to justify his invasion of England; their only show of legal right was the papal grant of conquests that were already made. The conquest of Apulia, won bit by bit in many years of what we can only call freebooting, was not a national Norman enterprise like the conquest of England, and the settlement to which it led could not be a national Norman settlement in the same sense. The Sicilian enterprise had in some respects another character. By the time it began the freebooters had grown into princes. Still there was a wide difference between the duke of the Normans and the duke of Apulia, between an hereditary prince of 150 years' standing and an adventurer who had carved out his duchy for himself.

The characteristic point of Norman rule in Sicily is that it is the rule of princes who were foreign to all the inhabitants of the island, but who were not more foreign to the inhabitants of the island than different classes of them were to one another. The Norman conqueror found in Sicily a Christian and Greek-speaking people and a Muslim and Arabic-speaking people. The relations between the two differed widely in different parts of the island, according to the way in which the Saracens had become possessed of different towns and districts. In one place the Christians were in utter bondage, in another they were simply tributary; still, everywhere the Muslim Saracen formed the ruling class, the Christian Greek formed the subject class. We speak of the Saracen very much as we speak of the Norman; for of the Muslim masters of Sicily very many must have been only artificial Arabs, Africans who had adopted the creed, language and manners of Arabia. In each case the Arab or the Norman was the kernel, the centre round which all other elements gathered and which gave its character to the whole. Besides these two main races, Greek and Saracen, others came in through the Norman invasion itself. There were the conquerors themselves; there were the Italians, in Sicily known as Lombards, who followed in their wake; there were also the Jews, whom they may have found in the island, or who may have followed the Norman into Sicily, as they certainly followed him into England. The special character of Norman rule in Sicily was that all these various races flourished, each in its own fashion, each keeping its own creed, tongue and manners, under the protection of a common sovereign, who belonged to none of them, but who did impartial justice to all. Such a state of things might seem degradation to the Muslim, but it was deliverance to the native Christian, while to settlers of every kind from outside it was an opening such as they could hardly find elsewhere. But the growth of a united Sicilian nation was impossible; the usual style to express the inhabitants of the island is "omnes" or "universi Siciliae populi." In the end something like a Sicilian nation did arise; but it arose rather by the dying out of several of the elements in the country, the Norman element among them, than by any such fusion as took place in England.

Normans in Scotland, Wales and Ireland.—From England, the Norman spread into Scotland, Wales and Ireland. In Scotland he was not a conqueror, but a mere visitor, and oddly enough he came as a visitor along with those whom he had himself overcome in England. Both Normans and English came to Scotland in crowds in the days of Margaret, Edgar and David, and Scottish national feeling sometimes rose up against them. In Scotland again the Norman settlers were lost in the mixed nationality of the country, but not till they had modified many things in the same way in which they modified things in England. They gave Scotland nobles and even kings; Bruce and Balliol were both of the truest Norman descent; the true Norman descent of Comyn might be doubted, but he was of the stock of the Francigenae of the Conquest. In Wales the Norman came as a conqueror, more strictly a conqueror than in England; he could not claim Welsh crowns or Welsh estates under any fiction of Welsh law. The Norman settler in Wales, therefore, did not to any perceptible extent become a Welshman. In Ireland the Norman was more purely a conqueror than anywhere else; but in Ireland his power of adaptation caused him to sink in a way in which he sank nowhere else. While some of the Norman settlers in Ireland went to swell the mass of the English of the Pale, others threw in their lot with the native Irish, and became, in the well-known saying, *Hibernis ipsis Hiberniores* (see BOROUGH).

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(E. A. F.; F. M. S.)

NORMAN STYLE, in architecture, the Romanesque style developed in Normandy and England during the 11th and 12th centuries, up to the time of the general adoption of Gothic architecture in both countries. Since it was only shortly before the Norman conquest of England that Normandy became settled and civilized enough to produce an architecture, the origin in both countries is the same, and early types are extremely similar. This common early Norman differed from Romanesque in its love of geometric ornament such as zigzags, general crudeness in the scant figure and leaf carving, and a daring originality in construction ideas, possibly owing much to the fact that Lanfranc of Pavia (d. 1089) had introduced Lombard ideas into many Norman abbeys.

Although the English and French phases of the style were thus identical at the start, they soon became different. The French was characterized by careful structural articulation (Abbaye-aux-Dames and Abbaye-aux-Hommes, Caen, both founded in 1062 but altered later) and elaboration of tower and spire (St. Michel de Vaucelles, Caen, 12th century).

In England the chief characteristics are enormous length of church plan, the frequent use of great round columns for the nave arcade (Gloucester cathedral, 1089–1100; Tewkesbury abbey, 1123; and Durham cathedral, alternate piers, 1099–1128) and great decorative richness (Prior's door, Ely cathedral, late 12th century; St. Mary's chapel, Glastonbury abbey, 1186; the front of Iffley church, 12th century; and the Galilee porch at Durham, *c.* 1175). The general Norman structural genius is most markedly shown in the buttressing system and in the ribbed vault of Durham cathedral, whose date is much debated, being placed as early as 1133 and as late as the 13th century. *See* ROMANESQUE ARCHITECTURE; GOTHIC ARCHITECTURE.

NORNS, in northern mythology, the female divinities of fate, like the Greek *Moirai* generally represented as three in number, and said to spin, or weave, the destiny of men. They dwell beside the "spring of fate," beneath the "world tree," Yggdrasil's ash, which they water from the spring. Sometimes the Norns are indistinguishable from the Valkyries (*q.v.*). They appear as prophetesses (*völur*) at the birth of children. The most famous story is in the *Tháttr af Nornagesti. See* TEUTONIC PEOPLES.

NORRIS, FRANK (BENJAMIN FRANKLIN NORRIS) (1870–1902), U.S. novelist of the naturalistic school, was born in Chicago, Ill., March 5, 1870. He studied art in Paris and attended the University of California, Berkeley, and Harvard. He was news correspondent in south Africa, 1895; editorial assistant on the *San Francisco Wave,* 1896–97; and war correspondent in Cuba for *McClure's Magazine,* 1898.

Norris' *McTeague* (1899) is a tragedy of mean streets in San Francisco. *The Octopus* (1901), first of a projected trilogy, *The Epic of the Wheat,* pictures with bold symbolism the growth of the wheat in California and the struggle of the ranchers with the railway corporation. *The Pit* (1903) deals with wheat speculation on the Chicago board of trade, and *The Wolf,* unwritten at his death, would have shown the wheat relieving an old-world famine. *Vandover and the Brute* (1914) is a memorable study of degeneration.

After the example of Zola and the naturalists, Norris emphasized the determinism of heredity and environment in human life. Early influenced by Kipling and by popular notions of evolution, he exalted primitivism, but he finally adopted a more humanitarian ideal and began to view the novel as a proper agent for social betterment. He thus gave an impulse to the "muckraking" movement which followed, though he disavowed overt propaganda in the novel (*see* MUCKRAKERS). He strove to return American fiction, then dominated by historical romance, to more serious themes. Despite philosophic inconsistencies and romantic intrusions in his work, Norris was a writer of great original force. He died in San Francisco, Oct. 25, 1902.

Among his other works are: *Moran of the Lady Letty* (1898), *Blix* (1899), *A Man's Woman* (1900) and *The Responsibilities of the Novelist* (1903). His writings were collected (10 vol.) in 1928, and *The Letters of Frank Norris* edited by F. Walker in 1956.

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NORRIS, GEORGE WILLIAM (1861–1944), U.S. legislator, was born on a farm in Sandusky county, O., on July 11, 1861. The death of his father and only brother while he was very young left the family in straitened circumstances, and Norris was required to work out among the farmers in the summer and attend school only in the winter. He afterward taught school and studied law, and earned enough to finish his law course at Valparaiso (Ind.) university. He was admitted to the bar in 1883. In 1885 he moved to McCook, Keb.. and began to practise. He was later elected prosecuting attorney of Furnas county, and in 1895 district judge of the 14th judicial district; re-elected in 1899, he was serving in this position when in 1902 he became a U.S. representative. Hc was re-elected for five successive terms and in 1910 was the leader of the insurgent group which successfully held out for a reform of house rules, putting an end to the autocratic ccntrol of the speaker. He also led the fight against secret committee meetings. Norris was elected to the senate in 1912 and served nith that body until 1942, thus finishing 40 years in congress. He voted against the entrance of the U.S. into World War I. and denounced the Versailles treaty. He fought for the direct election of senators and for presidential primaries, and was the author of the 20th amendment, abolishing "lame-duck" congresses. Norris favoured strict restrictions on private power interests; the Norris bill for the retention by the government of the Muscle shoals power development, the Tennessee Valley authority which he fathered and fought through congress and the Norris dam are the result of his efforts to provide publicly produced electric power. He was a leader in the demand for farm relief legislation, and the leader of the independent group in congress. Though noininally a Republican, party ties rested lightly upon him, his dictum being that the people "ought to be independent of all parties." He backed the Roosevelt New Deal administration wholeheartedly because he believed it would carry out his own aims for governmental reiorm. His last fight was an unsuccessful attempt to pass antipoll-tax legislation. Senator Norris died Sept. 3, 1944, in McCook. Neb.

NORRIS, JOHN (1657–1711), English philosopher and divine. notable both as a continuator of Cambridge Platonism and as an exponent of the theories of Nicolas Malebranche, was born at Collingbourne-Kingston in Wiltshire. Educated at Winchester and at Exeter college, Oxford, he became a fellow of All Soul's college in 1680. In 1689 he was appointed to the living of Newton St. Loe in Somerset. Thence in 1691 he was transferred to the rectory of Bemerton in Wiltshire, where he spent the remainder of his life. His numerous publications include (1) poems and translations; (2) moral and mystical writings; and (3) theological and philosophical works, as well as a political tract, A *Murnival of Knaves, or Whiggism Planely Displayed and Laughed out of Countenance* (1683).

1. The poems (chiefly represented in his *Collection of Miscel-Zanies,* 168 j; *cf.* A. B. Grosart (ed.). *The Poems of John Norris,* 1871) and the translations must be ranked as minor works.

2. The mystical and moral writings are those in which Norris shows most clearly the influence of the Cambridge Platonists, in particular that of Henry More and of Ralph Cudworth. In *An Idea of Happiness* (1683), following Plato, he places the soul's highest happiness in the contemplative love of God. *The Theory and Regulation of Love* appeared in 1688, with Norris' correspondence with More as an appendix. Other publications of this group were *Reflections upon the Conduct of Human Life* (1690), in the form of a letter to Lady Masham; *Christian Blessedness, or Discourses upon the Beatitudes* (1690); *Practical Discourses on Several Divine Subjects,* 3 vol. (1691–93); and *Letters Concerning the Love of God* (1695), being his correspondence with Mary Astell.

3. Norris' first considerable philosophical work was *Reflections upon a Late Essay Concerning the Human Gnderstanding,* appended to the first edition of *Christian Blessedness;* in this he anticipated many later criticisms of Locke's theory, though he agreed with Locke in dismissing the doctrine of innate ideas. His adoption of blalebranche's theory of divine illumination involved him in controversy with the Quakers, against whose notion of "the Light within" he published *Two Treatises Concerning the Divine Light* (1692). His *Account of Reason and Faith* (1697) is one of the best of the many answers to John Toland's *Christianity Not Mysterious:* reason, according to Norris, is nothing but the exact measure of truth. that is to say. divine reason. which differs from human reason only in degree, not in nature. His most important work. *An Essay Towards the Theory of the Ideal or Intelligible World,* appeared in two parts (1701–04): the first treats the intelligible world absolutely; the second considers it in relation to human understanding. This work is a complete exposition of the system of Malebranche. in which Norris refutes the assertions of Locke and the sensualists. In A *Philosophical Discourse Concerning the Natural Immortality of the Soul* (1708) Norris defends that doctrine against Henry Dodwell.

See F. J. Pomicke, *A Dissertation on John Norris (1894)*; F. I. Mackinnon, *The Philosophy of John Norris of Bemerton (1910)*; also J. H. Muirhead, *The Platonic Tradition in Anglo-Saxon Philosophy (1931).*

NORRISTOWN, a borough of southeastern Pennsylvania, U.S., is located on the north bank of the Schuylkill river, about 18 mi. N.W. of Philadelphia, the seat of Montgomery county. The present site was purchased by Isaac Norris and William Trent from William Penn, Jr., in 1704, and was originally known as Norriton plantation. When Montgomery county was created in 1784 the Pennsylvania legislature instructed that its courthouse be erected in Norriton township along the Schuylkill, and the community which grew around the courthouse was named Norristown and incorporated in 1812. The river and then a canal encouraged its growth, and in 1834 it obtained a railroad connection with Philadelphia. The city rises on gradual slopes northward from the river, with factories on the river shore giving way to increasingly better residential districts as the ground rises. Manufactures include metal and fibre products, machinery, drugs and tires. For comparative population figures *see* table in PENNSYLVANIA: *Population.* (R. F. WE.)

NORRKOPING, a port town of Sweden. in the district (*län*) of Östergötland, 113 mi. S.W. of Stockholm. Pop. (1950) 54,647. A bull of Pope Lucius III shows that Korrkoping existed in 1185. In the 17th century. Duke John of Östergötland introduced German craftsmen into Norrköping. Under Charles XII the town suffered from war and pestilence. After the Russian invasion of 1719 the population was only 2.600.

Norrköping occupies both banks of the Motala, the wide and rapid emissary of Lake Vetter. Fires in 1719, 1812, 1822 and 1826 have caused rebuilding on modern lines. The falls in the river afford motive power to the cloth and cotton mills and to factories for sugar, paper, lithography, tobacco and carpets, joinery works and breweries. There are also shipbuilding yards and docks. Fine granite is quarried at Grafversfors, 7½ mi. N.

NORSE LANGUAGE: *see* NORWEGIAN LANGUAGE and SCANDINAVIAN LANGUAGES.

NORTE DE SANTANDER, a department of the republic of Colombia, located in the eastern Cordillera adjacent to Venezuela. It was created in 1910 from the provinces of Cucuta, Ocafia and Pamplona, which formed the northern part of the department of Santander. Area 7,797 sq.mi.; pop. (1951) 387,450. The eastern Cordillera bifurcates in Norte de Santander, one arm continuing northward as the Sierra de Ocaña and Sierra de Motilones while the other bends eastward to form the Venezuelan Andes. The largest rivers in the department drain into Lake Maracaibo. The Catatumbo region, near the Venezuela border, is an important oil-producing area. Agricultural products are grown largely for local use. In the cooler uplands wheat, potatoes, barley, maize and horse beans are the principal crops. Coffee and sugar cane are grown on the middle slopes and lower valleys, as in the vicinity of the capital city of Cucuta, pop. (1951) 70,375. (Js. J. P.)

NORTH, BARONS. The English title of Lord North of Kirtling was created for Edward North (*c.* 1496–1564), son of Roger North, a London citizen, in 1554; he was a successful lawyer, clerk of the parliament (1531) and chancellor of the court of augmentations (1j45). His second son was Sir Thomas North (*q.v.*), and he was succeeded as 2nd baron by his son Roger, a courtier and soldier of Queen Elizabeth's day, who married the daughter of Lord Chancellor Rich.

DUDLEY NORTH, 3rd Baron North (1581–1666), son of Sir

John North and of Dorothy, daughter and heiress of Sir Valentine Dale, was born in 1581 and succeeded his grandfather, the 2nd Baron North, at the age of 19. He was educated at Cambridge, and married in 1599 Frances, daughter of Sir John Brockett of Brockett Hall, Hertfordshire. He traveled in Italy, took part in the campaign of 1602 in the Netherlands, and on his return became a conspicuous figure at court, excelling in athletic exercises as well as in poetry and music, and gaining the friendship of Prince Henry. In 1606, while returning from Eridge to London, he discovered the springs of Tunbridge Wells, which cured North himself of a complaint and quickly became famous. He also recommended the Epsom springs to the public. He supported and subscribed to the expedition to Guiana made by his brother Roger North *(c.* 1582–*c.* 1652) in 1619, and when Roger departed without leave Dudley was imprisoned for two days in the Fleet. In 1626 he attached himself to the party of Lord Saye and Sele in the Lords, who were in sympathy with the aims of the Commons; and when the civil war broke out he was on the side of the parliament. In 1641 he was a member of the Lords' committee on religion, and served on the committee to consider Laud's attainder in 1644, finally voting for the ordinance in Jan. 1645. He was placed on the admiralty commission in 1645, and acted as lord lieutenant for Cambridgeshire. He was one of the small group of Lords who continued attendance in the House of Peers, and on Dec. 19, 1648, with three others, visited Fairfax, when they "cast down their honours at his Excellency's feet" and protested their desire not to retain any privileges prejudicial to the public interest. (Gardiner's *Civil War,* iv, 285.) He passed the rest of his life in retirement at Kirtling in Cambridgeshire, with .his family, finding "employment with many airy entertainments as poetry, writing essays, building, making mottoes and inscriptions as well as in music." He wrote A *Forest of Varieties* (1645), a miscellany of essays and poems, another edition of which was published in 1659 under the title of A *Forest promiscuous of various Seasons' Productions.* He died on Jan. 16, 1666. North is described as "full of spirit and flame," of imperious temper but of well-balanced judgment, Lord Holland declaring that "he knew no man less swayed with passion and sooner carried with reason and justice." He left, besides one daughter, two sons, the elder of whom, Sir Dudley, succeeded him as 4th Baron North.

DUDLEY NORTH, 4th Baron North (1602–77), increased the family fortune by marrying the daughter of Sir Charles Montagu, brother of the 1st earl of Manchester. He was an accomplished man of studious bent and had 14 children, of whom the third son, Francis, became lord chancellor as Lord Guilford; the fourth was Sir Dudley North *(q.v.),* the economist; the fifth, John (1645–83), master of Trinity, Cambridge, and professor of Greek in the university; and the sixth, Roger *(q.v.),* the lawyer and historian.

The eldest son, Charles (d. 1691), was created Lord Grey of Rolleston during his father's life, and succeeded his father as 5th Baron North; and on the death of his son, William, 6th Lord North, without issue, in 1734, the barony of North went to a cousin, Francis North, 3rd baron, afterwards 1st earl of Guilford. The title of Lord North is that by which the and earl of Guilford, prime minister from 1770–82, is best known in history. *(See* GUILFORD, BARONS AND EARLS OF.)

George Augustus, 3rd earl of Guilford (d. 1802), left three daughters, and the barony of North fell into abeyance till 1841 when it vested in Susan, Baroness North (1797–1884), wife of John Sidney Doyle, who took the name of North; at her death her son William Henry John North (b. 1836) succeeded as 11th baron, the title now being separate from that of Guilford.

NORTH, SIR DUDLEY (1641–1691), English economist, was 4th son of Dudley, 4th Lord North. who published *Passages relating to the Long Parliament,* of which he had himself been a member. He was born on May 16, 1641, and in his youth was carried off by gypsies and recovered with some difficulty by his iamily. He engaged in foreign trade, especially with Turkey, and spent many years at Constantinople and Smyrna. During the Tory reaction under Charles II he was one of the sheriffs forced on the city of London with an express view to securing verdicts for the crown in state trials. He was knighted, and was appointed a commissioner of customs, afterwards of the treasury, and again of the customs. Under James II, "he took," says Roger North, "the place of manager for the croun in all matters of revenue" After the revolution he was called to account for alleged unconstitutional proceedings in his office of sheriff. He died on Dec. 31. 1691.

His tract entitled *Discourses upon Trade, principally directed to the cases of the interest, coinage, clipping and increarr of money,* was published anonymously in 1691. and was edited in 1856 by J R M'Culloch in the *Select Collection of Early English Tracts on Commerce* printed by the Political Economy club of London. In this emphatic assertion of the free-trade doctrine against the prevailing system of prohibitions, North shows that wealth may exist independently of gold or silver. its source being human industry, applied either to the cultivation of the soil or to manufactures The export of money in the course of traffic, instead of diminishing. increases the national wealth, trade being only an exchange of superfluities Nations are related to the world just in the same way as cities to the state or as families to the city.

North emphasizes more than his predecessors the value of the home trade With respect to the interest of capital, he maintains that it depends, like the price of any commodity, on the proportion of demand and supply, and that a low rate is a result of the relative increase of capital, and cannot be brought about by arbitrary regulations. In arguing the question of free trade. he urges that every advantage given to one interest over another is injurious to the public and that no trade is unprofitable to the public.

North, Locke and Petty are named by Wilhelm Roscher as the "great triumvirate" of English economists of the period.

NORTH, ROGER (1653–1734), English lawyer and biographer. was the sixth son of the 4th Baron North. He acquired a good practice at the bar, being helped by his elder brother Francis. who became lord chancellor and was created Baron Guilford *(q.v.),* and in 1684 he became solicitor-general. But the Revolution stopped his advancement, and he retired to his estate of Rougham in Norfolk, and increased his fortune by marrying the daughter of Sir Robert Gayer. He collected books, and was constantly occupied in writing. He is best known for his *Lives* of *the Norths,* published after his death, together with his own autobiography *(see* the edition in Bohn's *Standard Library,* 1890, by Jessopp), a classic authority for the period. He died at Rougham on March 1, 1734.

He is to be distinguished from Roger North (1585–1652), brother of the 3rd baron, one of the captains who sailed with Sir Walter Raleigh in 1617, and who projected the plantation of Guiana.

NORTH, SIR THOMAS (1535–1603?), English translator whose version of Plutarch's *Lives* was the source for many of Shakespeare's plays. was born in London on May 28, 1535. Possibly a student at Peterhouse, Cambridge, he was entered at Lincoln's Inn, London, in 1557, where he joined a group of young lawyers interested in translating. In 1574 North accompanied his brother Roger. 2nd Baron North. on an embassage to France. Thomas North had an extensive military career: he fought twice in Ireland as captain (1582 and 1596–97), served in the Low Countries (1585–87?) and trained militia against the threatened invasion of England in 1588. He was knighted about 1596–97. He was justice of the peace for Cambridge in 1592 and 1597, and was pensioned by the queen in 1601. He died in 1603 or shortly afterward.

In 1557 North translated (from the French) Antonio de Guevara's *Libro del emperador Marco Aurelio con reloj de principes* under the title *Diall of Princes (K. N.* Colvile. ed., 1919). Guevara's elaborate prose influenced many early English translators, but North did not originate the mannered style which culminated in Lyly's *Euphues.* His translation (from the Italian) of oriental beast fables, *The Moral Philosophie of Doni* (1570; J. Jacobs. ed., 1888). was rapid and colloquial narrative. Plutarch's

Lives of Noble Grecians and Romans, translated in 1579 from the French of Jacques Amyot, has been described as "after Malory's *Morte D'Arthur* and the *Book of Common Prayer* the earliest great masterpiece of English prose" (F. O. Matthiessen, *Translatzon: an Elizabethan Art*, Harvard University Press, Cambridge, 1931). There is an edition by C. F. T. Brooke, 5 vol. (1929–30). Shakespeare actually paid North the compliment of putting his prose directly into blank verse. (H. H. Ds.)

NORTH, THE, originally those of the English Colonies in America north of the Mason and Dixon line (*q.v.*), as distinguished from those south. They were New Hampshire, Massachusetts. Rhode Island, Connecticut, New York. New Jersey and Pennsylvania.

With the extension of settlements across the Alleghenies, the Ohio river was considered as a continuation of the Mason and Dixon line to the Mississippi river. Missouri, west of the Mississippi, was before the Civil War, considered part of the South because it was a slave-holding State, but after the Civil War it became a part of the North in its political and economic life. West of Missouri the boundary between the two sections followed the southern boundary of Kansas (37° N. lat.) to the Great Plains. Beyond were the Western States which. because they supported the North, nere usually considered part of it during the great struggle over slavery. The characteristic Northern life and settlement was broken, however. by the Great Plains which may, therefore, be considered to form the western boundary of the section.

The division between the North and the South was in no slight degree a natural one. In the North land and climate made small farms with diversified crops the only profitable type of agriculture. In the older sections the limited supply of farm land and the abundant amount of water-power stimulated manufacturing and the growth of town life. In the South, large plantations growing only cotton, or only tobacco, and dependent upon slave labour came into existence. As these economic systems with their attendant social differences grew in power and clashed in conflict over the virgin lands of the West, an intense struggle developed for supremacy, a struggle fought first, but vainly, in the halls of congress, and later on the battlefields of the Civil War. The north through its victory gained undisputed political, economic and cultural supremacy. During the latter half of the 19th century and the early years of the 20th century, the north was the stronghold of the Republican party. which fostered its industrial interests. During the great depression of the early 1930s the north's allegiance to the Republican party weakened as the Democrats made a strong appeal to workers and minority groups in northern cities.

NORTH ADAMS, a city of Berkshire county in northwestern Massachusetts, U.S., on the Hoosic river, is located in the northern Berkshires, 4 mi. S. of the Vermont border and 19 mi. K.E. of Pittsfield.

Within the city limits is a natural bridge 50 to 60 ft. high across Hudson brook. Among the city's educational facilities is North Adams State Teachers college (1897). Manufactures include boots and shoes, machinery, electronic components, wire. paper, textiles and chemicals. Limestone is also quarried in the vicinity. In the western part of the city are the ruins of Ft. Massachusetts, built in 1745 by the Massachusetts Bay colony as a frontier defense and burned in 1746 by the French and Indians. Initially settled about 1737, Korth Adams had several false starts before being permanently settled in the 1770s by Quakers from Rhode Island. Incorporated as Adams in 1778, North Adams was set off and incorporated as a separate town in 1878; it was chartered as a city in 1895. For comparative population figures *see* table in MASSACHUSETTS. *Population.* (R C. L. S.)

NORTHALLERTON, an urban district, market town and the administrative capital of the North Riding of Yorkshire. Eng., in the Richmond parliamentary division, 32 mi. N.W. of York by road. Pop. (1951) 6.087. Area, 5.7 sq.mi. It is on a slight eminence at the foot of the Cleveland and Hambleton hills. 3 mi. from the bank of the Snale, where the western scarp of the Wolds causes the Vale of York to narrow to a width of 10 mi, forming the Northallerton Gate. Thus situated, midway between the coast and the manufacturing areas in the nest of the county, it forms the gateway to the dales. The Romans are thought to have had a signal station there, on the terraced mounds of Castle hills, and the Conqueror chose it as a camping place for his army in 1068. According to the Domesday survey the Normans ravaged the area to such an extent that it was still waste in 1086. Northallerton suffered much from warfare with the Scots. In 1138 they were terribly defeated by the English in the battle of the Standard, and their bodies were thrown into pits at a site still known as Scots Pits lane. In 1174 the castle was destroyed and in 1317 the town was burned by the Scots under Robert Bruce. Northallerton had been given by William Rufus to the bishop of Durham. nhose successors continued to hold it until it was taken over by the ecclesiastical commissioners in 186j. According to an inquisition taken in 1333, the town, markets and fairs were held by the burgesses governed by tno reeves and the bishop's bailiff This form of government continued until 1851, nhen a local board uas formed, and this was superseded by an urban district council in 1894 As a borough by prescription. Northallerton returned two members to the parliament of 1298, but was not represented again until 1640 when its earlier privileges were restored. From 1832 to 188j it returned one member.

The church of All Saints, a cruciform building dating from 1120, is mainly Early English nith a Perpendicular tower. Near it is the ancient Porch house, where Charles I was imprisoned. and the site of the Carmelite friary founded in 1356 by Edward III. Mount Grace priory. founded in 1397, was destroyed at the dissolution of the monasteries. Its ruins $5\frac{1}{2}$ mi. N.E of the tonn, display the most complete ground plan in England of a pre-Reformation Carthusian monastery. The North Riding county library building was opened in 1938 in Northallerton. The library had 490 branches by 1943 The town hall, on the site of the shambles, was built in 1874 with a market hall on the ground floor. The county hall was opened in 1906 and the county courthouse in 1936. The town has a considerable trade in dairy farming and has held a weekly fair since 120j. There are flour mills. metalnorks, tanning and leather finishing spring manufacturing. agricultural engineering, dried milk making, timberyards and laundering.

NORTH AMERICA, the northern part of the land mass comprising the Americas of the western hemisphere which includes continental United States and Canada (sometimes referred to as Anglo-America) and the countries and islands of the Caribbean area (generally called Middle America). As thus defined, it is the third largest continent, occupying more than 9,000,000 sq mi, slightly above 16% of the earth's land area, with a population of about 247,000.000.

North America is bounded on the north by the Arctic ocean, on the west by the north Pacific and the Bering sea. on the east by the north Atlantic, with the Gulf of Mexico and the Caribbean sea to the southeast. It is separated in the northeast from Greenland, which is situated on the North American continental shelf and is sometimes considered part of North America. by Baffin bay. To the south, it is connected with South America by the Isthmus of Panama at lat. 7°–9° N., and extends for more than 5,000 mi. to 83° 7 N. on the north coast of Ellesmere Island. Its greatest width is about 4,000 mi., roughly bisected by the meridian of 100° W.

Tremendous cultural differences exist between the two major components of the continent. Canada and the United States have both experienced the colonizing effects of Great Britain. and many evidences of their common British heritage are evident, including a common language, common political and legal institutions, and many everyday customs. Middle America, on the other hand, received its cultural imprint more from Spain and Portugal, and like the countries of South America is primarily Latin in its culture.

Economic differences are as marked as their social and political contrasts. Canada and the United States are outstandingly rich in natural resources and possess highly industrialized economies. In Middle America, farming, often at a subsistence level, is still the dominant activity; industrial production is very small uhen compared with that of the two large nations to the north, and the level of prosperity is decidedly lower.

This article is divided into the following sections and sub-sections:

It is not intended to present here the story of nations or of tribal peoples. but to summarize the continent's main natural, economic, anthropologic, historic and demographic aspects. These features receive further treatment in separate articles on the individual countries and regions, the major natural features, tribes and other specific subjects discussed. (C. F. Ko.)

I. PHYSICAL GEOGRAPHY

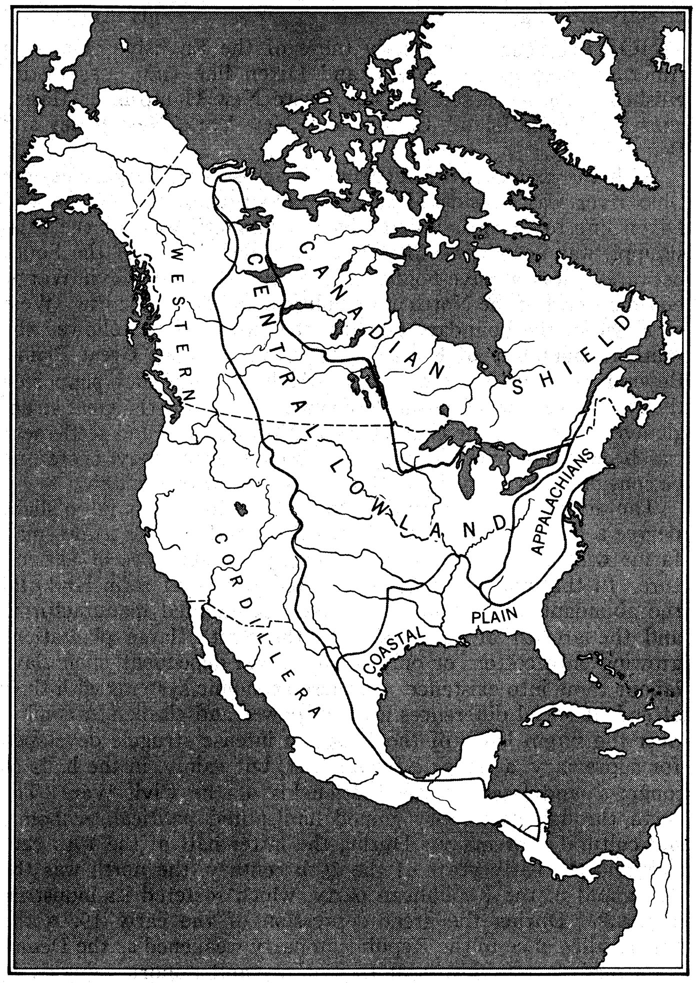
1. Geological History and Physiography.—North America may be divided into five areas which are roughly homogeneous with respect to the types of rock present and their structural relationships, the geologic history of the region and its present appearance.

Canadian Shield.—The Canadian shield includes some of the oldest rocks on the face of the earth. The region. as a whole, is composed of ancient crystalline rocks whose complex structure attests to a long history of uplift and depression, mountain building and erosion. Some of the ancient mountain ranges may still be recognized as a ridge or belt of hills. but the present appearance of the physical landscape of the Canadian shield is not so much a result of the folding and faulting and compression of the rocks millions of years ago as it is the work of ice in relatively recent geologic time. During the Pleistocene, the vast continental glaciers which covered northern North America had this region as a centre. The ice. in moving to the south, scraped the land bare of its overlying mantle of weathered rock. Some of this material was deposited on the shield when the ice melted, but the bulk of it was carried south to be deposited in the Central louland

The resulting surface consists of rocky, ice-smoothed hills with an average relief of 100 ft., and irregular basins, which are mostly filled by lakes or swamps. In places. the old mountain ranges may be recognized by hills several hundreds of feet in height.

Central Lowland.—South and west of the Canadian shield the ancient basement of crystalline rocks was covered by sediments derived from mountains to the nest and east, and from the shield itself. This broad region nas little affected by the forces that warped the earth's crust. Domes and arches, basins and troughs can be detected in the structure of the old Paleozoic sediments of the central lowland, but within any local scene the rocks appear to be almost flat lying. The western portion of the lonland nas veneered by more recent Mesozoic and Tertiary sediments derived from the Rocky mountains. These were eroded by the relatively few streams of the dry Great Plains into steep-sided river valleys and canyons separated by broad fat uplands.

The debris carried by the glaciers of the Pleistocene was dumped east of the Missouri river and north of the Ohio river. The tongue-like glacial lobes formed ridges and rows of hills 100 to 200 ft. high about their margins (end moraines) although most of the



FIE. I.— PHYSIOGRAPHICREGIONS OF NORTH AMERICA

area within the lobes has a more even surface nith hills ranging from 20 to 100 ft. in height. The disorder with which the drift was deposited resulted in many undrained pockets or depressions which filled with water to form lakes or swamps. South of the glacial border the old sediments form a hilly transition to the Appalachian highlands and their western extension—the Ozark-Ouachita upland. In this zone. the relief ranges up to several hundred feet, and is usually roughest along the many stream valleys nhich drain the area.

Appalachian Highlands.—Paleozoic sediments deposited at roughly the same geologic time as those of the central lowland were subjected to considerably greater uplift and folding and faulting in the area to the east. The area of most intensive mountain building is represented by the crystallized sediments of the Piedmont and the Blue Ridge mountains in the southern portion of the highlands and by the mountains of New England and eastern Canada to the north.

Directly to the west of the crystallized zone are ridges and valleys, their northeast-southnest lineament attesting to the compression from the east. Successive periods of uplift and erosion, accompanied by folding and faulting, created the complex structures that permitted the present topography to develop on the alternating hard and soft rocks of the area. The compressional forces died out to the west and the land, although uplifted further and hence with greater relief. has much the same structural characteristics of the eastern portion of the central lowland. Through-

NORTH AMERICA

PHOTOGRAPHS, (TOP) NICHOLAS MORENT FROM FPG, (CENTRE LEFT) FPG, (OTHERS) EDWIN VAN BAERLE,

LARGE MAMMALS OF NORTH AMERICA

Top: Moose (*Alces alces*) feeding in a shallow stream in Canada. They are found in Canada, Alaska and other parts of the extreme north of the U.S. in North America; they are also distributed in parts of northern Europe and Asia. Height, from the ground to the highest point of the shoulder, 6 ft.

Centre left: Mountain sheep or bighorn (*Ovis canadensis*). Found in mountains and rough terrain of southwestern Canada, western U.S. and northern Mexico. Height (ram) : 3½ ft.

Centre right: Black bear (*Ursus americanus*). Found in forested parts of Canada, U.S., including Alaska, and northern Mexico. Length, about 5½ ft.

Bottom left: Bison or American buffalo (*Bison bison*), once the great herd animal of America with a population in the tens of millions, it is now reduced to about 25,000, ail in zoos or protected areas. Height, 5¾ ft.

Bottom right: Polar bears (*Thalarctos maritimus*). Found in the arctic regions of North America and also Eurasia. Length, 7 ft.

NORTH AMERICA

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE LEFT) CY LA TOUR; (CENTRE RIGHT) FPG, (BOTTOM LEFT) D. EDWARDS FROM FPG, (BOTTOM RIGHT) WILLIS PETERSON

LARGE MAMMALS OF NORTH AMERICA

Top left: Mountain lion (***Felis concolor***), also called **cougar** or puma. Length, 4½ ft., exclusive of tail. Found chiefly in the Rocky mountains in North America, but its range also extends to South America

Top right: Northern **sea-lion** (***Eumetopias jubata***). Length, 10½ ft. Found in coastal waters from southern California to the Bering Sea

Centre left: **Virginia**, or white-tailed, deer (***Odocoileus virginianus***). Height, 3¼ ft. at the shoulder. Found in mixed woodlands and forest edges in southern Canada, throughout the U.S. and south to the northern part of **South America**

Centre right: Timber or gray, wolf (***Canis lupus***). About the size of a large shepherd dog. Found chiefly in Canada. The timber wolf is also distributed in parts of Europe and Asia

Bottom left: **Wapiti** or elk (***Cervus canadensis***). Shoulder height about 5 ft. Found in central Canada and western U.S.

Bottom right: Pronghorn or American **antelope** (***Antilocapra americana***). Mature specimens are about 3 ft. high. Found in southern Canada, western U.S. and northern Mexico

PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) CY LA TOUR, (TOP RIGHT) LANKS FROM FPG, (CENTRE LEFT, CENTRE RIGHT) FPG, (CENTRE) WILLIS PETERSON, (BOTTOM LEFT) THREE LIONS

SMALLER NORTH AMERICAN MAMMALS

Top left: Red fox *(Vulpes fulva)*. Found throughout most of the U.S. and Canada. About the size of a small collie.

Top right: Raccoon *(Procyon lotor)*. Found in forested parts of North America from southern Canada to Panama. Length: 2 ft.

Centre left: Opossum *(Didelphis marsupialis)*. Found in wooded parts of both North and South America from wuthern Canada to Brazil. It is about 1½ ft. long, with a tail of about 1 ft.

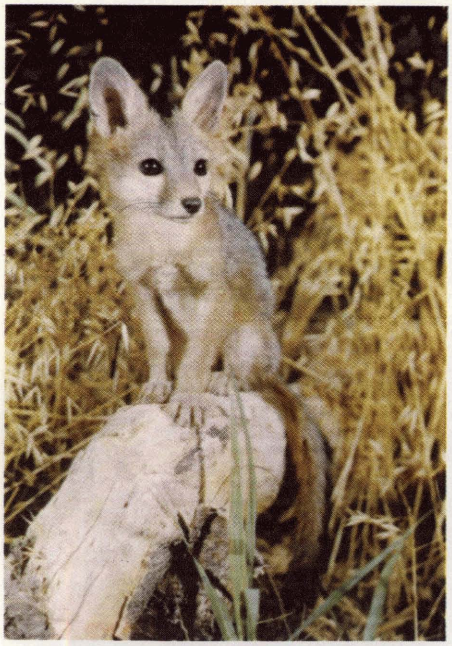
Centre: Badger *(Taxidea taxus)*. Found in dry, open country of western and north central U.S. and southwestern Canada. Length: 20 in.

Centre right: Ermine or short-tailed weasel *(Mustela erminea)*. Found from northern U.S. to the arctic. Also distributed in Europe, northern Asia and Algeria. About the size of a chipmunk.

Bottom left: Beaver *(Castor canadensis)*. Found in wooded parts of Canada, U.S., including Alaska, and the Mexican border region. Length: 28 in.

Bottom right: Wolverine *(Gulo luscus)*. Found in northern U.S., including Alaska, and Canada. Length: 31 in.

NORTH AMERICA









PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, BOTTOM LEFT) WILLIS PETERSON, (TOP CENTRE, UPPER) THREE LIONS, (TOP CENTRE, LOWER; BOTTOM CENTRE) EDWIN VAN BAERLE © ENCYCLOPÆDIA BRITANNICA, (CENTRE LEFT) CY LA TOUR, (CENTRE RIGHT) FPG, (BOTTOM RIGHT) H. LANKS FROM FPG

SMALLER MAMMAL8 OF NORTH AMERICA

Top left: Bray fox ***(Urocyon cinereoargenteus)***. **Widely distributed in** the **U.S.** and southward to northwestern South America. **Length: 27** in.
Tog centre, upper: Eastern mole ***(Scalopus aquaticus)***. Found **in eastern** and **central** U.S. Length: **5½ in.**
Top centre, lower: Kangaroo rat ***(Dipodomys)***. Found In the **drier parts** of **western** U.S., **southwestern** Canada and northern Mexico. **Length:** 8 in., with a **tail** as long as the body
Top right: **Ringtail** cat ***(Bassariscus astutus)***. Found **in southwestern U.S. and northern Mexico.** Length: 15 in., with a tall of equal **length**
Centre left: Striped skunk *(Mephitis mephitis)*. **Found** in almost all parts of Canada, **U.S.** ahd northern Mexico. Length: 16 in.
Centre right: **Snowshoe** hare *(Lepus **americanus**)* **It**, winter **pelage.** Found in **forests and** swamps of northern **U.S., including Alaska,** and Canada. **Length:** 16 in.
Bottom left: Porcupine ***(Erethizon dorsatum)***. **Found in** woodlands of northern and **western U.S.** and most of **Canada. Length: 20 in.**
Bottom centre: **Woodchuck** or ground-hog ***(Marmota monax)***. Found **in** woodlands of **eastern** Alaska and the eastern **states and Canada.** Length: **18** in.
Bottom right: **Western Gray squirrel *(Sciurus)*. Found** in western US. and **parts of Mexico.** Length: 10 **in.**

out this hill region and the ridge and valley area the relief ranges from 300 to 1,500 ft., with the steepest slopes and highest hills to be found along the valleys of the many streams which carve the area. (See APPALACHIAN MOUNTAINS.)

Coastal Plain.—The simplest structure of North America is to be found in the coastal plain. This is an area of relatively soft, young (Mesozoic and Tertiary) sediments overlapping the crystalline rock of the Piedmont in the east, the central lowland in the west, and extending as far south as the Yucatan peninsula. The rocks dip uniformly toward the sea and the margin of the plain gives evidence of its youth in its extensive marshes and swamps, any of which could be converted to ocean floor by a rise in sea level of only a dozen feet.

The dip of the plain toward the sea has exposed successive bands of rock of varying resistance to erosion, creating belts of hills 100 to 200 ft. high alternating with flattish vales of very low relief.

Western Cordillera.—Somewhat younger than the ancient mountains of the Canadian shield and those of the Appalachian area, the high rugged mountains of the western Cordillera exhibit the greatest relief of the continent. The structural picture is so diverse as to include almost every conceivable type. The general north-south lineament of the ridges of varying rock type defines also the direction of the valleys and structural depressions which are filled with debris eroded from the mountain slopes. In the north and on the highest peaks in the south, glaciation has sharpened the ridge crests and provided still more debris with which to choke the valleys. Volcanoes, both active and dead, form some of the highest peaks and are often even the more impressive because of their relative isolation from other high mountains. Extensive outpourings of lava and the exclusion of some areas from intensive folding and faulting while they were being uplifted thousands of feet produced vast tablelands and plateaus. The rocks in this region range from the youngest sediments to the oldest crystalline~depending on the geologic history of the particular local unit.

Drainage.—The successive crustal movements by which North America was developed have determined the growth of several great river systems. The broad upheavals which developed the medial plains had the effect of engrafting many rivers from the eastern and western highlands upon trunks of unusual dimensions. Thus the Mississippi system, some of whose eastern tributaries probably date from early Mesozoic times, received great reinforcement by the addition of many long western branches in late Tertiary time, roughly contemporaneous with the uplift of the southern coastal plain, by which the lower trunk of the river was extended from its mid-length into the gulf. The present headwaters of that river trunk to which the name Mississippi has been rather arbitrarily applied are of very modern date, as they are consequent upon the abundant glacial deposits of northern Minnesota; and relatively modern courses appear to have been taken by the earlier-born Ohio and Missouri rivers around the margin of invading Canadian ice sheets, which displaced them from earlier courses.

The evolution of the Mackenzie resembles that of the Mississippi in a general way, but it presumably was much affected by glacial erosion and deposition, in consequence of which it, like the St. Lawrence, has many large lakes in its course (see GREAT LAKES, THE). The regime of this great north-flowing river is strikingly unlike that of its south-flowing analogue on account of its course being from a warmer to a colder climate; hence while Mississippi floods have a free southward discharge, the floods of the Mackenzie have an obstructed northward discharge due to ice dams. Indeed, but for the complications that appear to be related to the outspread of Laurentian ice sheets, the areas drained by the Nelson and the St. Lawrence, now flowing to Hudson bay and St. Lawrence gulf, would be discharged by the Mackenzie and Mississippi. For a time, during the presence of the ice sheets, that simpler system was realized for the Mississippi, when it carried to the Gulf of Mexico much drainage now received by the St. Laurence and Nelson; the flood plain of its lower trunk was probably given its wide breadth at that time.

Lake Superior is peculiar in apparently attributing its great depth to a somewhat pronounced displacement of its basin floor, in addition to whatever deepening it gained by glacial erosion.

The chief rivers that discharge to the Pacific rank below those that discharge to the Atlantic; but the Yukon, flowing from farther Canada and inner Alaska, is one of the great rivers of the world. The Columbia, of hardly inferior rank, drains a large area of the Cordilleran system in Canada and the United States; it is peculiar in having one of its head branches rise at the eastern base of the Rocky mountains in Montana, so that its waters flow westward through all the Cordilleran ranges of its latitude. The Colorado discharges a muddy current into the Gulf of California. (See also separate articles on the rivers.)

2. Climate.—The climatic character of an area derives from the operation of weather mechanisms over a long period of time. The weather of North America is of two main types: mid-latitude, the result of conflict between polar and tropical air; and tropical, in which cold polar air plays no part, and hence, in which frost is uncommon or nonexistent.

Mid-latitude Weather and *Climate*.—The vagaries of the weather of most of the United States and Canada are because of the location of the North American land mass in a zone of interaction between polar and tropical air masses. Air generally assumes the character of the surface over which it lies for periods of several days or weeks. As a result of the general circulation of the atmosphere, air masses from such unlike source areas as the tropical north Atlantic ocean and the Canadian arctic are drawn together over North America. The differences in the heat and moisture characteristics of these air masses result in the development of storms, known as cyclones. The zones of conflict between unlike air masses are known as storm tracks, the cyclones moving generally from west to east. As the northern hemisphere warms with the increasingly vertical attitude of the sun's rays in summer, the storm tracks shift northward. These shifts in the position of the storm tracks largely determine the nature of the climate of various portions of North America.

The Canadian arctic lies generally to the north of these storms, and is characterized by cold winters and cool summers with little precipitation.

Winter is the time of greatest storminess. Many cyclones enter the continent from the north Pacific ocean, having originated over eastern Asia or the waters immediately off the Asiatic coast. These cyclones deliver little moisture in the lowlands, but the mountains of the western Cordillera cause lifting and chilling of the air, thus ensuring heavy rain and snowfall on the western slopes. Most of the storms enter the continent north of San Francisco bay, but an occasional storm delivers heavy rain to southern California.

As the cyclones from the north Pacific move over the western Cordillera, they lose most of their moisture. Often these cyclones are rejuvenated as they descend the leeward slopes of the mountains into the central lowland. The more northerly of these are centred on the Alberta storm track, delivering small quantities of snow, but with a high frequency of occurrence, to the northern central lowland and Canadian shield, especially in the vicinity of the Great Lakes and the St. Lawrence valley. The more southerly storm tracks, called the Colorado and Texas cyclones, are able to draw in air from the Gulf of Mexico. This warm, moist tropical air enables much heavier snowfall to be delivered to the central lowland and the St. Lawrence valley, but with less frequency than is the case with the Alberta-type storm. This air in crossing the southeastern United States usually delivers heavy rain showers as well, so much so that some portions of the lower Mississippi valley actually receive more moisture under these conditions than in the summer season.

During the summer half year, the cyclone belts shift northward. The northwest Pacific coast receives storms from the Asiatic source area, but they are somewhat less frequent during this season and result in less rainfall than in uinter. The shift of the storm tracks away from the southwestern United States creates desert conditions in the lowlands. The highlands receive thunderstorm rainfall from an occasional errant air mass of Atlantic ocean origin.

East of the Rockies a somewhat different picture prevails. The northward shift of the cyclone belts results in a lowered frequency of rainfall in much of the area. but this is more than offset by the torrential nature of the rainstorms that do occur. This is due to the tropical characteristics of the air which is drawn into the North American land mass from the Gulf of Mexico and the tropical north Atlantic ocean. Most of the eastern United States and Canada receive the bulk of their moisture from summer thunderstorms and the cyclones which draw the tropical air northward.

Tropical *Weather and Climate.*—Tropical North America (Central Xmerica and the islands of the Caribbean and the Gulf of Mexico) is little affected by the mid-latitude cyclones. Instead. the weather and hence the climate of these areas is characterized by relatively inonotonous heat. unaffected by frost except in the high mountains. The seasons are recognized by their wetness or dryness. rather than by cold or warmth.

Just. as the bulk of mid-latitude North America receives most of its moisture during the northern hemisphere summer. so does this tropical regime. The mechanisms causing moisture to fall are more complex in the tropics. but seem also to be associated with the vertical attitude of the sun's rays. The same air that delivers inoisture to the eastern United States and Canada in the summer drops rain from thunderstorms as it surges through this area. Hurricanes are common in late summer, and are also responsible for heavy precipitation.

The northern hemisphere winter is characterized by less frequent rain showers in this area. and by a predominance of clear. sunny skies.

3. Vegetation and Animal Life. — Patterns of vegetation and animal life generally conform to the broad controls of climate. On

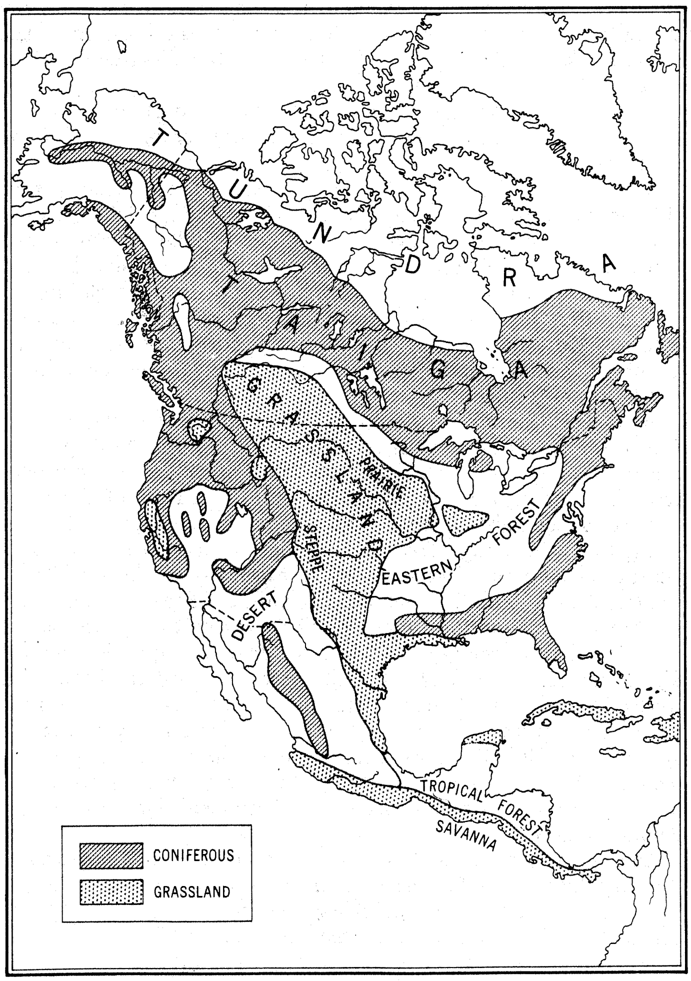


FIG. 2.— VEGETATION SOURCES OF NORTH AMERICA

a more local scale. topography and soils have altered and modified these broad zones. Man has also made his impress, changing the pattern and character of the flora and fauna with the use of fire. the clearing of forests. plowing of grasslands. and grazing of domesticated animals. Thus the Sorth American landscape of the 20th century shows the influence of all these factors. Temperature and moisture availability differences set the stage for consideration of the major variations in distribution.

Arctic. — The long cold winters and short cool summers of the far north create an environment that is too harsh for tree growth. Mosses in the extensive bogs. and lichens and short herbaceous plants on the better-drained uplands comprise the bulk of the tundra vegetation. Relatively few animal species can exist there. Caribou. musk ox. polar bear and arctic fox are the larger varieties. Lemmings and the arctic hare are characteristic. Hordes of mosquitoes plague summer visitors. Few birds stay the winter, although many species migrate to nest there in the summer.

Subarctic.—Longer and milder summers to the south enable the forest to appear in the form of dwarf birches, willows, alders and spruce. As temperatures become less severe. the taiga or northern coniferous forest covers the landscape. Relatively pure stands of spruce. fir and several species of pine are intermingled with birch. willow. larch and poplar. There is little undergrowth except near streams. Carnivores. such as the black bear. lynx. fox and wolves are present. as are deer. moose. elk and caribou. Rodents abound. among them squirrels. porcupines, rabbits and beavers. Woodpeckers and jays are common birds. Both arctic and subarctic life forms trend far equatorward along the east and west coastal areas 7%-herehigh elevations ameliorate the warmer conditions of the lower latitudes. The western Cordillera blocks moisture-bearing winds and creates rain shadows that set lower timber-line limits based on aridity. There the conifers give way to desert and grassland forms.

The windward slopes of the mountains receive heavy precipitation. and near the Pacific ocean dense growth results. as well as giant forest trees 200 ft. or more in height. Cold temperatures at high elevations result in an upper timber line. Tundralike vegetation is found above this level. which gradually descends as one proceeds north until. in central Alaska, trees are found only in the valleys.

Eastern *Forest* and *Coastal Plain.*—In the central lowland. cyclones bring warm tropical air as far north as the Great Lakes. Deciduous tree forms assume dominance in the landscape under natural conditions, and the conifers die out. Birch. beech. maple and oak are predominant in the north. and walnut, oak. hickory and the tulip tree in the south. Much of the forest has been cut by man, especially on the flatter uplands and in fertile soil areas. The stream valleys remain wooded and provide shelter for the smaller mammals and birds that have withstood the pressures of civilization. Deer and fox may be found where there is sufficient cover. and skunks. raccoons and muskrats join the squirrels and rabbits as significant forms. Hawks and thrushes are important birds. Numerous varieties of insects are present. as are many reptiles.

The sandy belts of the coastal plain are generally covered by open longleaf pine forests which may he relicts from glacial periods. The stream valleys of the coastal plain are likely to be very poorly drained, with swamp trees such as cypress and gum as dominant forms. The outermost margins of the coastal plain are occupied by marshes in which the characteristic vegetation consists of grass forms.

Grasslands.—Moisture variability from year to year and fire probably combined to slow the extension of forest vegetation into the dry west. aiter a climatic change had produced desert conditions in the heart of the interior. As a result. the first explorers found a broad belt of grassland between the forested humid east and the deserts of the west. The eastern portion has long been cultivated, but on the drier, western grasses. grazing is still the most significant land use and some semblance of the natural cover remains. The grasslands of the east consist of dense growth of tall varieties. often six feet or more in height. Glades occur in the forests often on droughty limestone or sand plains.

Farther west, in the prairie triangle of Illinois and Iowa, or on the margins of the Great Plains in Oklahoma and Texas, the grasses become dominant on the uplands. Only the stream valleys remain in forest or woods, for the break in topography of the belts of bluffs and the dampness of the bottom lands protect the trees from prairie fires and from drought.

The grasses and herbaceous vegetation of the prairies become less dense, and less tall bunch grass forms in the western steppe lands. These in turn form the transition to desert vegetation types in the driest parts of the west. Only along the moist valleys of perennial streams are cottonwoods and other deciduous trees to be found. Shrub forms, such as mesquite, are present in the warmer margins where high evaporation increases dryness, but they did not become dominant until man controlled fire.

Although lack of moisture in summer, and occasional blizzards in winter constitute formidable hazards, large numbers of animals are found in the grasslands. Noteworthy were the tremendous herds of bison, which have been practically exterminated. Antelope, coyote, jack rabbits, prairie dogs and ground squirrels are common forms that remain in great numbers. Insects such as grasshoppers and locusts and ants are characteristic. Turtles, lizards and various snakes (some of them poisonous) have adapted to the environment.

Deserts.—In the desert even less moisture is available for plant growth than in the grasslands. The only perennial streams are those which flow from exotic, humid sources. Plants and animals have had to adjust to long periods with little or no moisture. Shrub forms become dominant over grasses; these include sagebrush, greasewood and creosote bush. High evaporation rates and closed topographic depressions combine to produce high saline concentrations in many of the soils. Thus, salt tolerance is another attribute necessary for plant growth. Around depressions or stream valleys there is often a zonation of plants, with the most salt tolerant found nearest the centres, and the least on the better-drained uplands. In the driest places numerous forms of cacti abound. Some of these may attain heights of 20 to 30 ft. Much of this landscape is not suited to intensive grazing, and so only in the irrigated valleys was the natural vegetation materially disturbed.

The larger animals have difficulties surviving where water is so scarce. Fox are present and feed on rabbits. Owls, lizards and snakes may be found. But the total numbers and the varieties of animal life are less than in more well-watered areas.

Tropical Forests.—The dry deserts and grasslands extend well equatorward into Central America. The better-watered portions of the tropics are covered by a dense growth of broadleaf evergreen trees. Several "stories" of tree and shrub growth are likely, with vines and lianas common. Seasonally well-watered areas are characterized by savanna, a tall grass landscape with scattered trees which are particularly dense near the mater courses. Monkeys and squirrels, ants and termites, snakes and a wide variety of colourful birds constitute the animal life. In both vegetation or animal life, the number of species and the density of individuals increases in these frost-free, well-watered climates. See also the Physical Geography sections of UNITED STATES (OF AMERICA), CANADA, MEXICO, WEST INDIES, CENTRAL AMERICA; and ARCTIC, THE. (N. E. S.)

II. NATURAL RESOURCES

When Anglo-American pioneers took possession of the land there was a superabundance of natural resources. Subsequently wasteful exploitation was not only condoned but frequently encouraged. Vast tracts of virgin timber were destroyed, mild game killed and soils became eroded. This situation was further aggravated by the severe droughts of the 1930s and the consequent wind erosion in the dust bowl of the high plains. By mid-20th century, the U.S. and Canadian governments, alarmed at the wasteful practices and ignorance, undertook conservation measures and established agencies to study the problem. Genuine attempts are being made to gear the economic system to nature. (See WILDLIFE PRESERVATION, NATIONAL PARKS AND NATURE RESERVES; SOIL EROSION AND CONSERVATION; NATURAL RESOURCES.)

1. Water Resources.—In North America, as in other parts of the world, water has six major uses: domestic, irrigation, industry, transportation, power and waste disposal. Nearly all of these uses have expanded rapidly, partly because of expanding populations and industries, but also because per capita needs have been increasing rapidly. As a consequence, actual or impending shortages of water have occurred in many parts of the continent, not only in areas of small precipitation. but also in many of the more densely populated portions of the humid sections. The availability of water has thus become a major concern for the people of North America.

Man has come to identify three principal sources of water: (1) precipitation, usually as rain or snow; (2) surface supplies. in the rivers, lakes and oceans; and (3) subsurface sources, usually brought to the surface by wells or springs. In North America, few attempts have been made to control precipitation, or to use that source of water directly, but there have been tremendous efforts to conserve waters by constructing reservoirs and other storage facilities in order to provide larger supplies at places not adequately served by lakes, rivers and other natural reservoirs. These reservoirs, both natural and artificial, have become the major source of water for the North American people. Underground supplies, including well water and spring water, were proved adequate only in a few areas with particularly favourable climate and geological conditions.

Water resources must always be viewed in the light of both quantity and quality. In populous industrial areas such as the northeast United States, southeast Canada and the central plateau of Mexico, so much water is utilized for sewage and industrial wastes that adequate domestic supplies are frequently difficult to obtain. in spite of the relatively heavy rainfall and large surface storage facilities of those areas. The natural mineral content of underground waters also varies a great deal, being very high in most areas underlain by limestone rocks and low in areas having acid rocks. In North America nearly all of the plains and plateau areas have limestone rocks and are consequently supplied with hard (mineralized) water from underground sources.

In the arid sections of northern Mexico, the western United States and portions of western Canada, water for irrigation is of prime importance. Giant storage reservoirs are used to hold winter precipitation until the water is needed for summer crops. Many streams in these areas have their sources in high mountains and, since many of the reservoirs are located at relatively high elevations, water power is cheaply and abundantly produced.

The most serious deficiencies of uater appear in dry areas that have experienced marked urban development, notably in the Los Angeles (*q.v.*) metropolitan area of southern California where the new demands of a rapidly expanding population have been added to those of irrigation agriculture. An extensive system of aqueducts now brings water to the area from the Colorado river; and a program of securing additional supplies by purification of sea water was projected. Long-distance transportation of water is not confined to low-rainfall areas, however, since extensive supply systems were constructed to bring water to New York and other urban-industrial centres, usually from highland areas that lie considerable distances inland. In this manner, surpluses of water in many of the less populous areas nere created to satisfy needs in metropolitan centres, where local supplies were inadequate.

Water for supplemental irrigation is being used increasingly by farmers in the upper Mississippi valley, where, in summer, short periods of drought may occur. Supplies usually are obtained either from wells or streams, and the severe competition for nater prompted several states in that area to enact irrigation laws. Problems of water scarcity have appeared in all parts of the continent where there are considerable numbers of people.

Power, recreation and navigation uses of nater differ from the others as they do not materially affect either the quantity or quality of available supplies. Hydroelectric poner is most cheaply generated where there is heavy precipitation on high land. The best resources are therefore in the states and provinces that border the north Pacific coast of the United States and Canada, although eastern areas, which have splendid natural storage facilities in the Great Lakes and the lakes of the Canadian shield, also possess important power resources. Water for recreation is available in all sections of the continent, either in natural lakes and streams, or in man-made reservoirs and canals. Water transportation generally demands a relatively smooth terrain and a productive tributary area. In North America. the major navigation resources lie in the Great Lakes-St. Lawrence system, the Mississippi river and its branches, and the river systems of northwest Canada.

2. Soils.—Soils are classified in many ways, according to their colour, texture, trafficability, origin, but most significantly, according to the uses that can be made of them in agricultural production. A soil is valuable to man only in the light of its usefulness in producing a valuable commodity. This kind of perspective is necessary if we are to understand why, in North America, the best soils are those that can be made to successfully produce specific annual crops, especially the grain crops and cotton, which are of great importance in man's existence. Soils that produce only trees, grass or weeds, on the other hand, are usually considered less desirable, regardless of the lushness and vigour of their vegetation. Therefore, the quality of a soil is judged by its food-producing capacity, and if, in the course of human progress, this need changed, so would soil evaluations.

The geography of North American soils is most easily approached through the location of native vegetation. the dominant feature of which is a large, centrally located grassland region that is roughly triangular in shape, mith apexes lying near the cities of Chicago on the east, San Antonio (Texas) on the south, and Edmonton (Alberta) on the north, and which has the richest soils of the continent. To the west and southwest lie the less fertile dry-land soils of the western United States and northern Mexico. which were formed under a vegetation cover of shrubs and related plants. To the north, northwest and east lie the less-productive soils of the areas that were originally in forest; and beyond them in the north are the generally infertile soils of the tundra. Only in the great central grassland did nature provide the physical environment necessary to form soils best suited for modern crop production.

The relative infertility of soils in both the dry regions and the humid forested regions is attributed to both climatic conditions and the characteristics of the parent material (rock) from which soils are formed. Limestone and its associated sedimentary rocks generally provide soils with minerals needed by grains and other annual crops. Soil-building materials in the central grassland region of North America generally contain those minerals. which were brought to the area mainly by (1) continental glaciers, in the area generally north of the Missouri and Ohio rivers; (2) streams of running water, in a broad belt lying immediately east of the Rocky mountains; or (3) wind, in scattered areas generally near the southern margins of the glacial deposits. In the southern portions of the central grassland area, much of the native surface rock has a high calcium content and is disintegrated into soils having these same general characteristics.

Outside the grassland region, where climates are either colder, drier or more humid, poorer soils usually occur. In the humid areas, deterioration is attributed to the removal of soluble minerals (especially nitrates, potash and phosphate) by heavy rainfall and the percolation effect of ground water, so that those minerals are available only to deep-rooted plants such as trees and vines. In the cold and dry regions poor fertility is due to lack of humus, the sparseness of the vegetation and consequent lack of annual contribution of vegetable matter such as roots, leaves and branches to the soil. Soils deficient in humus generally are unable to store moisture near the surface and thus cannot support shallow-rooted vegetation such as the grain crops and cotton. Mineral deficiencies of humid-climate soils may be offset considerably by the application of fertilizers; and water deficiencies in dry soils may be overcome by irrigation. Both these procedures provide good examples of the ways in which man can adapt his natural environment to his better advantage.

The foregoing describes only the very general features of soils geography in North America. Locally, there are many small areas where a combination of good parent materials and a favourable climate have produced soils of marked fertility. In the humid areas of the southeastern United States, as nell as in Mexico and Central America. favourable materials often appear in the alluvial flood plains of major streams, the deposits of basaltic lava from nearby volcanoes and other fissures. and local occurrences of limestone. Soils derived from lava occupy many of the most fertile valleys of southern Mexico. and limestone soils are prominent in Cuba.

In the humid tropics, river valleys, deltas and basins that can accumulate new (and unleached) minerals brought as alluvium from lime-rich upstream sources, nearly always have the richest soils.

In dry areas, the best soils usually occur in catch basins where water storage is sufficient to support considerable amounts of humus-giving vegetation.

3. Minerals.—Most of the world's mineral wealth is taken from rocks that appear at or near the earth's surface. A few are derived from the waters of the sea, or from the atmosphere, but their quantities and economic importance are small. Among the great families of rocks, sedimentary types are the main sources for the production of the mineral fuels (coal, petroleum and natural gas), as well as most of the building stone, many kinds of rare earths, and a fen of the metals. It is from the other great families, the igneous and metamorphic types. however, that most of the ores. the metal-bearing rocks of modern industrial civilization, are taken. The general distribution of these two kinds of rocks may therefore be used to identify areas in which these three great classes of minerals. the fuels, the metals and the other nonmetallic types, may be found.

Large areas of North America were occupied by ancient seas during geological periods when the mineral fuels were being formed with sedimentary rocks. The sedimentary regions include nearly all of conterminous United States, except for relatively small sections adjacent to the Atlantic and Pacific coasts, as nell as most of western Canada. Alaska and northern Mexico, and large areas in the West Indies and beneath the Gulf of Mexico and Caribbean sea. Changes in the earth's crust, associated particularly nith the appearance of the Rocky mountain system in the western portions of the continent, caused much of the sedimentary surface to be folded, broken, uplifted and in large part removed by erosion in areas affected by that major geological disturbance. Volcanic fires probably destroyed large amounts of fuels that were contained in sedimentary rocks. but at the same time, aided by the tremendous pressures present in the disturbance, seem to have created favourable conditions for the concentration of metallic minerals into beds. veins and other deposits to form rich mineral-bearing rock This process mas frequently aided by the percolation of water through newly exposed rocks. These are believed to be the general circumstances under mhich the mountainous sections of western North America became the continent's leading source of ores, with the notable exception of iron.

Iron is mostly obtained from rocks that lie in the Canadian shield region near the margin of a much older mountain mass, whose interior rocks were long since exposed when the surface was removed by continental glaciation. These igneous and metamorphic rocks, which occupy most of eastern Canada and portions of the adjacent United States, are also important sources of nonferrous ores. Mines in the area of the Canadian shield, together with those in the Canadian Rocky mountains, provide a major element in the Canadian national economy. In Mexico the most important nonferrous metal is silver and in the western United States it is copper. Large reserves of iron ore occur in both areas, and there are many lesser metals, such as gold. silver, lead and zinc, much of which occurs in complex ores which yield several nonferrous metals. Metamorphosed and folded rocks in northern Arkansas yield bauxite for aluminum, and similar formations in Alabama yield iron ore for the Birmingham steel industry. Southeast Cuba also produces iron ore.

Outside the ore-producing areas lie the great sedimentary basins that extend from the Arctic ocean, on the north. southward through the middle of the continent. to the highlands of northern South America. There are produced most of North America's mineral fuels. It is of considerahle significance that most of the continent's coal. and a very considerable fraction of its petroleum and natural gas are produced near the margins of these sedimentary basins. where much folding and faulting was experienced in the formation of mountains. These crustal changes often had the effect of compressing coals into harder and more valuable fuels, and forming "traps" for the underground accumulation of petroleum and natural gas. Drilling of wells to great depths has shown that these crustal deformations often occur at considerable distances from present or former mountains but the tendency for coal. petroleum and natural gas production to transpire most prominently near the margins of the sedimentary basins is nevertheless a readily observed geographic fact.

Other minerals occur in almost endless variety. Some, such as sand, gravel and the stone that is crushed for use in concrete work. are found almost everynhere. but are of limited value. expensive to ship, and are mined only if a market exists. Others. such as gold and uranium, are extremely rare, and so valuable that they are likely to be mined wherever they are found. Thus, many communities in North America are connected with some sort of mining or related activity, but centres, where mining is the dominant element in the local economy, occur only where favourable conditions of geological occurrence and location in relation to markets are present.

4. Land Use.—Economic development of North America has been held within relatively narrow geographic limits by the character and spstial distribution of the resources described above. All such developments must be considered, however. not only in the light of available resources, but also as a consequence of the aspiraticns and productive capacities of the people who inhabit the continent.

The broad facts of land utilization include agriculture, manufacturing and trade. but the simple facts of economic development in North America indicate that less than one-fifth of the productive activity is concerned directly with the resources of nature and the raw materials that are extracted from the land—crops. minerals. fisheries, timber and other associated features. The remaining four-fifths of the productive effort is devoted either to further refinement of natural materials that have already been transformed into manufactured goods. or to the rendering of services that satisfy human wants directly. In North America. the latter type of production is generally more important than the former, which is concerned with goods.

An understanding of the relative importance of the two kinds of production is vital to an understanding of patterns of land utilization in North America. In general. these considerations seem to indicate that conditions surrounding resource utilization and the production of raw materials may be expected to account for the location of only a minor fraction of the total productive activity and that the location of the remainder must be accounted for in some other way. In other words, there is no reason to expect the spatial distribution of production to bear any specific resemblance to the distribution of that continent's resources.

Nearly one-half of all the goods and services are produced in a relatively small area that lies generally south of a line drawn westward from Quebec in Canada, to Minneapolis in Minnesota, and thence south to St. Louis, Mo., and eastward to Baltimore, Md. Other areas of major importance appear in southern California and in the southern portions of the central plateau of Mexico. These regions. which together comprise less than one-tenth of the land area of the continent, but which account for more than one-half its total production of goods and services, do not appear prominently on any map of raw-materials production. Their resources apparently are not ordinarily considered in surveys of the type undertaken here.

The most basic preliminary observation may well be that most of the working hours of the people of North America are spent in rendering services rather than in changing the form of goods. Fundamentally nearly all services must be rendered while in close proximity to the customer. as in the case of barbers, physicians, teachers, salesmen and many others. Thus it appears that the most important factor in the location of services is the presence of considerable numbers of people who have an appropriate volume of money and a desire for those services. But what brings these people to an area? The problem is further complicated as frequent research shows that many types of manufacturing are attracted by potential customers; this provides a basis for understanding why the location of only a minor fraction of these productive activities can be accounted for in terms of the location of natural resources. What apparently happens is that in the early stages of production. the location of activity is rather closely adjusted to the existence of local resources. Raw materials leaving the farms, forests and mines. whose locations are adjusted to the presence of those resources, may be subjected locally to a small amount of elemental processing, such as canning. sawing or milling; but most of the work of increasing their usefulness is likely to be carried on in some distant location nearer markets for the finished products. These manufacturers. together with others in the region, attract additional service employees, and the ultimate outcome of this concentration appears in the great industrial cities and metropolitan regions.

The locations of markets for the continent's products must be considered in any explanation of the distribution of land uses. Historically, the greatest concentrations of population and productive activities first appeared at the western termini of the North Atlantic trade route to Europe, over which exports from Canada and the United States reached their most important world markets. Seaport cities with good harbours grew and prospered as this export trade expanded, and, in the process, developed large import, financial, industrial and other related economic interests. With the westward movement of population and production, these same types of activities were attracted to cities nearer those markets. and they sought sites mainly along major transportation routes, notably the Great Lakes-St. Lawrence waterway and the major trunk-line railroads. Climate and raw materials were also important in the rise of other metropolitan centres such as Los Angeles and Mexico, D.F. Many analysts believe that. in the long-run future, favourable concentrations of resources will come to outweigh historical factors in determining the location of economic activities.

By mid-20th century, regional planning (*q.v.*) in North America demonstrated by the TVA, for large areas of like characteristics, grew out of a series of initiatives. Politically directed, it is based mainly upon the social and natural resource structure, and economically seeks the fullest development of local resources and skills. Natural resources are also discussed in The Economy sections of articles on the various countries. (H. H. McC.)

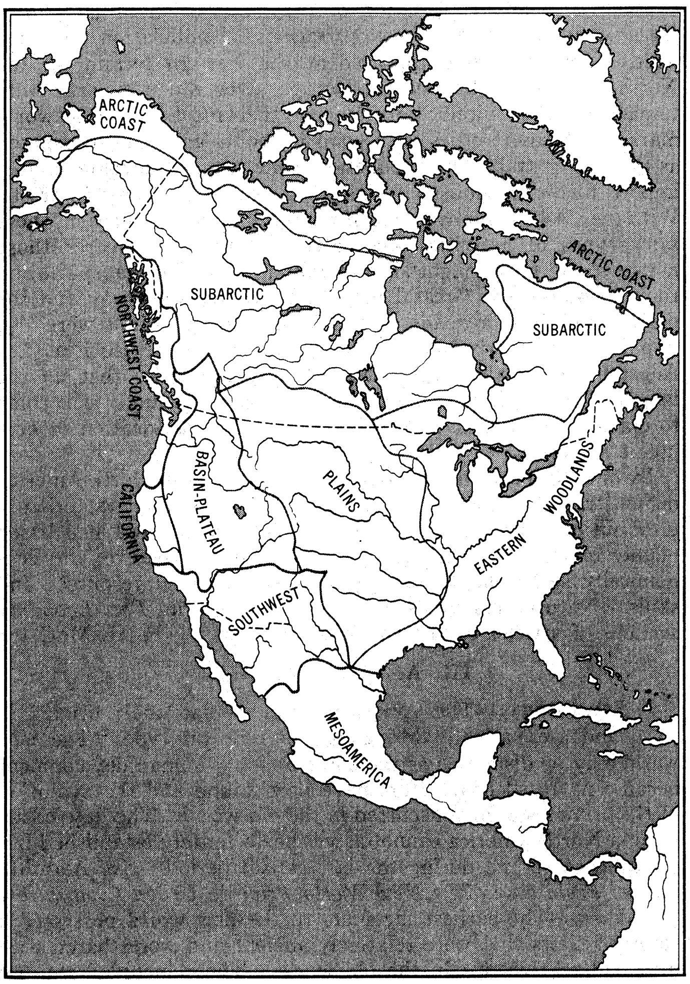
III. ANTHROPOLOGY

1. Ethnology.— The American Indians had their origins in Asia, and are basically Mongoloid in physical type. The new world may be dismissed as the home of fossil human development because no fossil progenitors have been found and the evolution of the primates clearly occurred in the old world. The date of arrival in North America cannot as yet be accurately established but occurred sometime during the last glacial period See ARCHAEOLOGY: *Prehistory:* The New World Prior to Urban Civilization.

Culture.— The earliest incomers to the new world possessed a series of traits that were relatively ancient and were shared with most cultural groups in the old world. These included the use of fire and the fire drill; the domesticated dog; stone implements of many kinds; the spear thrower. harpoon and simple bow; cordage, netting and basketry; crisis rites and shamanistic beliefs and practices. Important traits lacking in the new world but known in the old world included all the significant domesticated animals, plants and artifacts of the latter, cattle, sheep. the goat. pig, horse, camel and reindeer: wheat. barley and rice: the wheel and the plon; iron; and stringed instruments. The higher cultures of the new world, all possessing enough advanced traits to warrant calling them civilizations, were spread from the valley of Mexico south to Peru. The economic base of the American high cultures was horticulture with maize, beans and squash the staple crops. These crops mere cultivated from the St. Lawrence river in the north to the La Plata river in South America The plants mere tended by hand, using only the simple digging stick, or a hoe.

Middle America was a region of tonns therefore of higher political organization, and in Mexico and Peru of considerable empires. The intellectual achievements. dependent upon the existence of a priesthood, culminated in the mathematical and calendrical systems and in an incipient system of writing employed by the Maya and Aztec. (See ARCHAEOLOGY: *Mesoamerica;* AZTEC; MIDDLE AMERICA.)

The question of whether or not the advanced techniques used by the higher cultures of America were independent inventions or the result of contact and borrowing from the old world is still debated. No evidence is presently available to document the possibility of old world contact, and until such evidence is forthcoming the only possible conclusion is that of independent invention. Analysis of the known intellectual achievements shows them to be unique. The Maya devised position numerals and a sign for zero, but their system of numeration was vigesimal and they were using the system several hundred years before the sign for zero was invented in the old world.



FROM A. L. KROEBER IN "AMERICAN ARCHAEOLOGY AND ETHNOLOGY"

FIG. 3.— CULTUREAREAS OF ABORIGINAL NORTH AMERICA

Culture Areas.—According to Harold E. Driver and William C. Massey there were about 240 different tribal entities in North America at the time of European contact who were divided into a number of groups or culture areas. (See fig. 3.)

Classification of groups of tribes into culture areas is an attempt by anthropologists to reduce the complexity of cultural types into fewer meaningful units. Ideally, a culture area is a geographic region inhabited by tribes who resemble each other in the totality of culture traits more than they resemble other tribes. Because of the variable diffusion of traits, however. there is often considerable difference between tribes within a culture area. In the Plains culture area of *c.* A.D. 1800 there were fully nomadic bison hunters, semisedentary hunters who possessed some agriculture and sedentary village farmers. The following classification is somewhat arbitrary but necessarily so in a brief summary. Nine culture areas are listed and indicated in fig. 3. The more important or better known areas are described in separate articles and in Prehistory and Archaeology below. The main areas are: (1) arctic coast (see ESKIMO); (2) subarctic, which includes both Athapaskan and Algonkian forest hunters (see CANADA: *Native* Peoples; ATHAPASKAN; ALGONKIAN TRIBES); (3) northwest coast; (4) basin-plateau. the area of somewhat marginal cultures in the intermontane west; (5) California; (6) southwest, including northern Mexico (see PUEBLO); (7) plains (see PLAINS INDIANS; SIOUAN INDIANS); (8) eastern woodlands (see MUSKOGIAN INDIANS; IROQUOIS); (9) Mesoamerica (see AZTEC; TOLTEC; CENTRAL AMERICA: Anthropology; ARCHAEOLOGY: *Mesoamerica*).

Indian Population.—The number of Indians in North America at the time of Columbus was estimated by A. L. Kroeber at about 1,000,000 north of Mexico and about 3,000.000 in Mexico and Central America. They declined significantly after contact with the Europeans, mainly because of increased warfare and introduced diseases such as measles and smallpox which were fatal to many. Some tribes became extinct, others merged and lost their identity. Since about 1910 the Indian population has steadily increased. and some, like the Navaho (*q.v.*), are more numerous than in aboriginal times.

2. Languages.—The outstanding characteristic of American Indian languages is their diversity. There are more than 60 language families in North America comprising over 500 languages, but these have been reduced to a smaller number of superstocks by Edward Sapir and others. No genetic relationship to any language group in the old world has been fully demonstrated as yet. One may conclude from this, that the ancestors of the Indians left the old world so long ago that any relationship was lost through linguistic change. The most widespread linguistic families are shown in fig. 4. (See AMERICAN ABORIGINAL LANGUAGES; CENTRAL AND NORTH AMERICAN LANGUAGES.)

3. Physical Anthropology.—American Indians are not uniform in physical type but are basically Mongoloid. They possess a number of distinctive traits: Reddish-tan skin colour, pronounced cheekbones, prominent noses, thin lips, well-developed chins and heavy faces. Hair and eye colour is uniformly dark except in cases where admixture with Europeans has occurred. Some of the classic Asiatic Mongoloid physical traits such as epicanthic eye fold and fatty cheeks, are generally absent in the new world populations, excepting for the Eskimo.

The popular stereotype of the Indian as a taciturn, sullen and humourless individual is incorrect. Emotional control is considered a virtue in most groups, and in comparison to the European the Indian is more stoical! but he possesses a well developed sense of humour and within his own group is jovial and friendly. Much of what the average white American thinks he knows about Indian personality is misconception based on behaviour at a time when most American Indians were fighting desperately to retain their land and culture. Actually there are wide differences in temperament and character among the various American Indian groups. See also. INDIAN, NORTH AMERICAN; INDIAN, LATIN-AMERICAN; FOLKLORE (AMERICAN INDIAN); and The People sections of articles on the various countries. (R. J. R.)

IV. PREHISTORY AND ARCHAEOLOGY

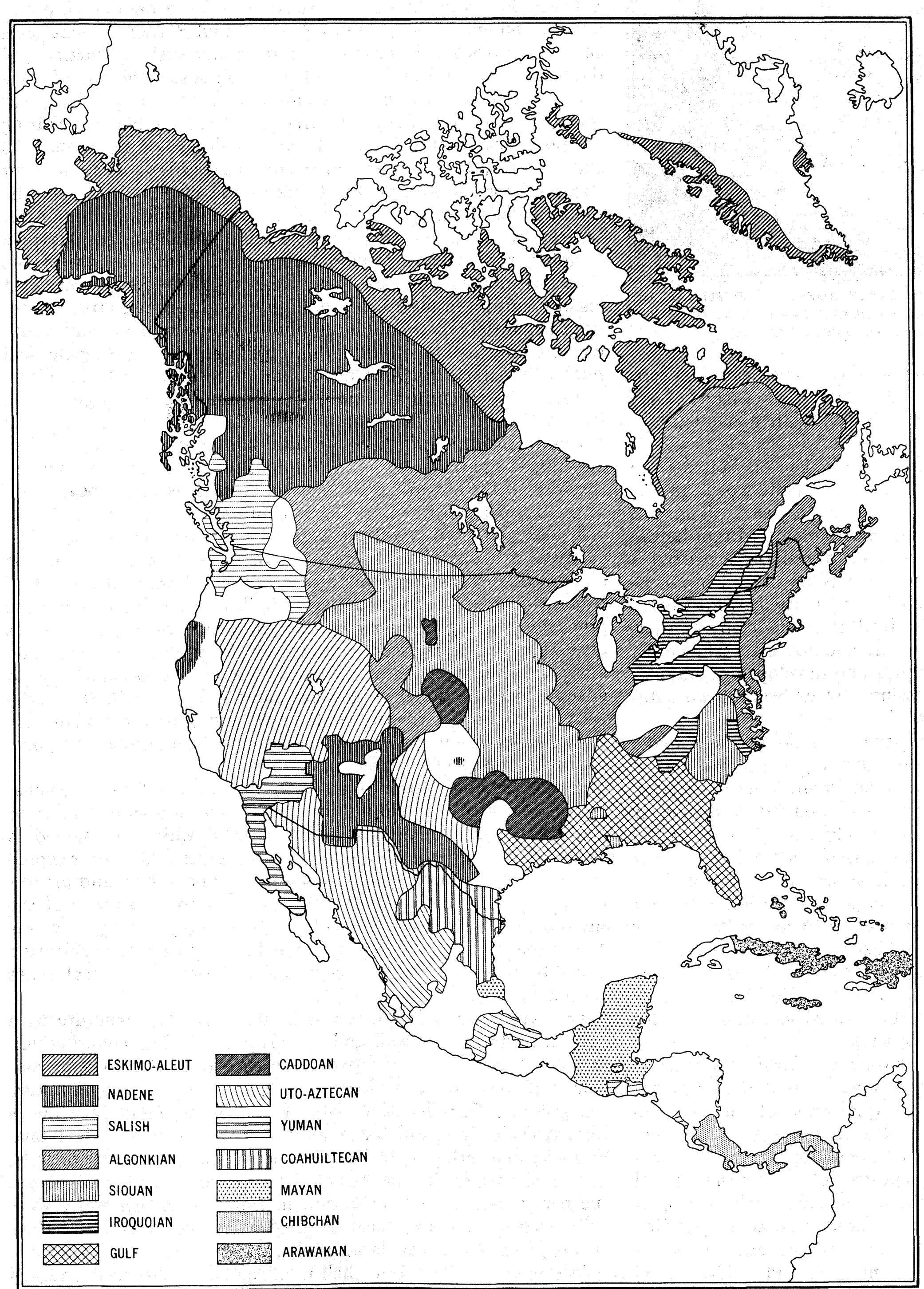
Korth American prehistory is a complex and changing record of man's adaptation to the various continental environments and his developing culture over more than 25.000 years. The earliest records of the peopling of North America are scanty and it is difficult to characterize their culture except in terms of a hunting and gathering economy with simple stone and bone tools. The earliest remains were found in the western United States, Mexico and South America. America's first settlers came across the Bering straits region from Asia during the expansion of the last major Pleistocene ice sheets. As the great ice sheets developed and expanded they not only covered major land areas in the northern hemisphere, but they also brought above sea level considerable areas of the continental shelves. In the arctic this provided a tundra coastal plain across which man could move from Asia to North America. The amount of the earth's moisture incorporated into the glacial sheets lowered sea level some 350 to 450 ft. Asia and America were thus not separated by the gradual rise of the sea until about 9,000 years ago and many sites of the earliest migrants are now below sea level.

Some authorities believe that the culture of the earliest inhabitants is represented by crude percussion shaped scrapers, choppers, knives and a few bone perforators. Such tools are equated with an eastern Asiatic mid-Pleistocene complex which lasted well up into the Late Paleolithic when more advanced and varied industries were developed in western Asia and Europe and spread east and northeast.

The Americas were the last major land mass, with the possible exception of Australia, to be occupied by prehistoric man, who first had to develop the cultural equipment to exist in the arctic area. Once this adjustment was made, during the Würm-Wisconsin glaciation he was able to move, by way of the nonglaciated areas, into the Mackenzie basin and into continental United States. The time of the initial dispersal into North America is estimated to be between 20,000 to 30,000 years ago. Some period of time should be allowed for the gradual spread of the first Americans throughout the varied environments during the retreating phase of the Wisconsin ice. There were significant displacements of vegetational and climatic zones to the south during this period.

1. Early American Hunters.—In contrast to the sparse knowledge of the period from 25,000 to 10,000 years B.C. is the considerable body of data on the cultural pattern of primarily hunting people whose remains were found from the Pacific to the Atlantic and from the Gulf of Mexico to the borders of the last major stand of the Pleistocene ice sheets in the north central United States between 10,000 and 8,000 years B.C. (See fig. 5.) In spite of regional differences in detail there was a remarkable similarity in the industrial complex of these people. They lived in a variety of environments, from mountain passes and valleys in the west to the then better watered grasslands of the plains, and the varied forest and park-land environment of the eastern woodlands. Their projectile points (a variety of fluted forms), scrapers, perforators, knives and a variety of bone tools indicated that one of their major food supplies came from animals, whose hides provided clothing. In the western plains and the southwest they hunted such extinct North American animals as the camel. ground sloth, tapir. mammoth and horse.

In the Great Lakes area of the eastern uoodlands they may have hunted mastodon but other commoner animals such as the elk and deer presumably formed the bulk of their meat diet Some of their bone and wooden tools were probably used for working and ornamentation. These early hunteis had temporary shelters and moved about as small bands in search of game. Their presence was known primarily from "kill" sites and a few areas indicated



FROM H. E. DRIVER AND W. C. MASSEY IN "TRANSACTIONS OF AMERICAN PHILOSOPHICAL SOCIETY" (1957)

FIG. 4.—LINGUISTIC FAMILIES OF NORTH AMERICA

FIG. 5.— APPROXIMATE BOUNDARIES OF EARLY AMERICAN FLUTED BLADE HUNTERS AND AREA OF DESERT CULTURE IN NORTH AMERICA AT 8000 B.C. (IMPORTANT SITES AND CULTURE GROUPS OF PERIOD SHOWN)

temporary occupation along streams or lakes. Their physical type is not clearly known but it was related to that of the eastern Asian Late Paleolithic population and is less Mongoloid than many groups of American Indians of the historic period.

2. The Desert Culture.— In the western United States from Oregon to northern Mexico and from the Pacific coast to the eastern foothills of the Rocky mountains there was a distinctive cultural adaptation to this dry, upland environment. From before 8000 B.C., to the historic period in some areas, there existed a desert culture type (see figs. 5–7) which may be viewed in a general way as an equivalent to the Archaic level in the eastern United States. The Desert culture people lived as small bands of wandering seasonal food gatherers, collectors and hunters. They ate a wide variety of animal and plant foods and developed techniques for small seed harvesting and processing. Their best known habitations were caves and rock shelters.

Because of their dry environment, twined basketry, nets; mats, cordage, fur cloaks,, sandals, wooden clubs, digging sticks and in some instances even their desiccated bodies, were found preserved. They had the spear thrower, with darts of pointed hardwood or with points of flint and later of obsidian. Their rough stone implements were shaped by percussion and consequently many of their choppers and scrapers had a Paleolithic appearance. When these were discovered on open sites where organic materials were not preserved they give a false impression of great antiquity. Their projectile points however showed excellent craftmanship and followed continent-wide styles. Milling stones and handstones were a prominent feature of Desert culture sites. The dog, another migrant from Asia, was known by about 4000 B.C. and was also found at this time in eastern Archaic sites.

3. California.— On the far west coast in California, the marked variety of geographical situations developed a number of regional complexes dependent upon intensive exploitation of the local resources. None of these were agricultural, although population density in some of the more favoured areas appears to have approached that of the early farming cultures of the southwest and east. In the southern desert area the people subsisted upon plant seeds and small game with utilization of crude flint tools, grinding stones and later arrowheads as the main implement forms recovered. In the mountainous area of the state and in the central better watered areas, larger game animals such as the elk and deer, supplemented by acorns, fish and birds were the major food supply. By at least 2000 B.C., in this central area, the utilization of the local resources plus cultural intrusions from the north, resulted in the adaptation which only changed in minor details up to the historic period. The coastal groups from north to south depended upon the sea for their food supply, some subsisting mainly on shell fish, some on sea mammals, others on fish and still others a mixture of all three. All of these may be said to be on an Archaic level of development, hut they are probably better viewed as developed regional variants of the Desert culture. The intensive regional adaptations probably account for the linguistic variability and many small tribal groups found in California at the historic period.

4. Northwest Coast.— In the north Pacific part of the United States and in western British Columbia, some of the early sites of the hunters had fluted blades, crude choppers and cutting tools. Between 9000 and 7000 B.C. there were varied economic activities but with an emphasis on hunting. By about 8000 B.C. some sites showed a strong orientation toward salmon fishing particularly during the salmon runs and tended to emphasize the use of bone and antler tools. The burin, a chisellike bone working tool, was found in these levels along with prepared cores and blades. During the postglacial warming period which culminated between 3000 and 2000 B.C., the inhabitants of the dryer areas, without permanent streams, took on more of the traits of the Desert culture to the south, while others turned toward riverine fishing and marsh resources. or to sea food. In the first millennium B.C., the Marpole complex, a distinctive ground slate complex was known in the Frazer river area with basic resemblances to the northwest coast historic culture in maritime emphasis, woodworking, large houses and substantial villages. The emphasis on ground slate and woodworking tools is like that in the eastern boreal forest Archaic, and recalls similar emphasis in northwestern Siberian early Neolithic cultures. Another culture trait of ultimate Siberian origin to the British Columbia area which came in shortly after A.D. 1, was a second introduction of the polyhedral core and blade, regarded as a distinctive part of the Arctic Small Tool tradition. In most of the areas of the northwest coast clear indications of the beginnings of the historic cultures were not known until about A.D. 1300.

5. The Eastern Archaic.— In the eastern woodland area, partly as a result of the variety of forest environments, climatic differences and physiographic features, there developed a series of regional adaptations to local food supplies. The change from the primarily hunting economy of the early American hunters was gradual and is clearly seen in slowly evolving projectile point and other implement changes. The pattern of life became one of mixed hunting and collecting, with some groups by 6000 B.C. developing a taste for riverine and coastal living with abundant fish and mollusk resources to supplement the vegetational products such as acorns, seeds. berries and tubers.

During the long eastern Archaic from 8000 to 1500 B.C. regional diversification was developed and strong continuities or traditions may have been seen in local areas some of which are named in fig. 6. These reflected both the greater exploitation of regional environments through generations of experimentation and greater familiarity with the resources, and the resultant resistance of the environmentally conditioned culture to group mobility. It was during the Archaic that significant early linguistic diversification probably occurred, and during which varieties of physical types developed.

The typical Archaic house was a small circular structure with wooden posts for the wall and roof supports. The covering was probably hark. Cooking was done in the open by boiling in containers of wood, bark or hides or by baking in pits or by roasting and grilling. Identification lists of animal, fish and bird bones from Archaic sites read like a listing of the early historic fauna. Various game gathering techniques such as nets, traps and pitfalls, were used besides the spear and dart thrower. Fishhooks, gorges and net sinkers mere known, and in some areas fish weirs were built. River, lake and ocean mollusks were consumed and their discarded shells formed large shell middens near the, favourable collecting areas. The deep shell middens have preserved a record of stylistic change and the introduction of new industries to the Archaic economy. While relatively little of the vegetal foods were preserved, nut hulls are known and the grinding and pounding stones attest to this type of food supply. Probably a great many native roots, berries, fruits and tubers known as food in the early historic period were incorporated into the diet during the Archaic. Also the extensive list of plant medicines recorded by the early colonists were probably a part of the primitive Archaic pharmacopeia.

The large variety of chipped flint projectiles, knives, scrapers, perforators, drills and adzes reflect regional styles and changes during the long Archaic period. The Late Archaic was distinguished by the gradual development of ground and polished grooved stone axes, celts, pestles, gouges, adzes. plummets and forms attached to the spear thrower. This was a reflection of a growing versatility in their technology and economy. Trade and exchange are also known from the distribution of native copper implements from the Michigan-Wisconsin area to as far south as Louisiana and Florida, and the finds of southeastern marine shells as far north as the upper Mississippi-Great Lakes area. An extensive system of trails and water routes was probably in existence during the Late Archaic.

The great boreal forest zone of spruce, fir and pine which now runs from New England and the maritime provinces of Canada westward to the Canadian plains and the Mackenzie valley gradually acquired its present distribution following the retreat and melting of the Canadian ice cap. Its present distribution was reached by about 2500 B.C. This forest zone is not well known archaeologically because of its inaccessibility and the absence of modern settlements. The forest cover and the climate had a limiting effect on the cultural development and the general pattern of hunting and fishing supplemented by some use of plant material. The early historic Algonkian tribes of the area from the Kaskapi on the east to the various Cree (*q.v.*) and Ojibwa (*q.v.*) bands to the south and southwest of Hudson bay were the cultural descendants of the cultural adaptation which took place in this forest zone.

In the upper Great Lakes area the Old Copper culture has a special interest because copper implements and weapons were made from the native copper of the Lake Superior basin. This culture appeared about 3000 B.C. and lasted about 2,000 years. It was a northern expression of the Late Archaic. Its tools and weapons, particularly in the adzes, gouges and axes, clearly indicate an adaptation to the forest environment. In the area south of James bay to the upper St. Lawrence about 2000 B.C., there was a regional variant called the Laurentian Boreal Archaic and in the extreme east the Maritime Boreal Archaic. In this eastern area, slate was shaped into points and knives of similar form to the copper implements to the west. Trade between the eastern and western areas could be recognized and this evidence along with general similarities of the culture suggest that water transportation by canoe was known at this time.

Along the southern border of the central and eastern boreal forest zone between 1500 and 500 B.C. there developed a distinctive burial complex, reflecting an increased attention to burial ceremonialism. These burials, many including cremations, were often accompanied by red ochre, caches of triangular blanks, fire-making kits of iron pyrites and flint strikers, copper needles and awls, and polished stone forms. The triangular points of this complex may have represented the introduction of the bow and arrow from the pre-Dorset and Dorset cultures east of Hudson bay. The earliest Woodland pottery appeared in the Great Lakes area about 1000 B.C. It is another of the culture traits derived from northeastern Asia and across northern Alaska to northwestern Canada. The route by nhich it reached the Great Lakes is not known.

6. The **Plains** Archaic. — In the western plains from about 8000 to 3000 B C. the fluted blade points mere no longer made, and many styles or types were produced which were identified by such local names as Plainview, Angostura, Milnesand, Agate Basin, Scottsbluff and others. These minor varieties of dart and spear point and their primarily hunting culture may be included in the term Plano. The Plano complex or culture type was a direct descendant from the fluted blade early American hunters. Their primary game animal was the bison, for the larger animals of the preceding period had died out or were exterminated.

The stone complex associated with the Plano hunters was markedly similar from site to site over a considerable period of time during which the climate became increasingly warmer and until the major warm period was reached about 3000 to 2000 B C. As the climate moderated, peoples of the Late Plano complex moved north into Saskatchewan and Alberta (see fig. 6) with the grazing game animals, and by 3000 B.C. had reached the arctic tundra zone in the Northwest Territories of Canada at Grant and Dismal lakes and Great Bear river. Important elements of this culture also moved east in the Mississippi valley and western Great Lakes area.

FIG. 6.— HUNTING AND GATHERING CULTURES IN NORTH AMERICA, ABOUT 3000 B.C.

Many of the sites of this culture type were kill sites with abundant bison bones which accounted for the number of implements and tools associated with hunting and leather working. In the tundra zone the major game animal was the caribou. However, some choppers, pounders and milling stones were known and living sites indicate that the Plano economy was not as limited as it now seems.

7. The American Arctic. — There is little evidence of man in the American arctic in the period between 25,000 and 10,000 years ago, but only scattered finds and no excavated sites of culture which could have occupied the period between 8000 and 5000 B.C. There were some finds of fluted blades and of Plano forms which probably reached Alaska via the McKenzie corridor, and also knives and graving tools of immediate Siberian origin which may have been of this same antiquity. In the Seward peninsula and in the Brooks range there were indications of a land hunting and to some degree sea-mammal hunting group which may have been related to some of the boreal forest cultures to the south. Their estimated time period would be from 5000 to 3000 B C. Interior Alaska and western Canada are not well known archaeologically.

Between 3000 and 2000 B C. the Arctic Small Tool tradition developed in northuestern Alaska. It was based on the hunting of caribou and other tundra animals along with some dependence on sea mammals. This culture included some elements from the northern spread of the Plano hunters to northwestern Canada but was primarily derived from northeastern Asia. It gradually spread eastward in the Canadian tundra to the northwest and northeast side of Hudson bay, into extreme northeastern Canada, and to western and northern Greenland. This eastern spread was accomplished by 1000 B.C.

In the dominant culture centre of the arctic, the Bering sea area, there developed from 500 B C. to A.D. 500 a number of cultures identified as Paleo-Eskimo whose primary adaptation was that of sea-mammal hunting. These cultures blended elements of the earlier Arctic Small Tool tradition with pottery and other traits from the Lena valley, and with elements from cultures which developed along the northeastern Siberian coast. The sea-mammal hunting economy gradually moved eastward as the Thule culture and became the economic base for most of the Eskimo groups in the central and eastern coastal arctic by the time of European expansion into the area. Another branch of the sea hunting culture was found in southeastern Alaska where it came into the historic period with the Aleut and western Eskimo.

8. Early American Planters. — Primitive agricultural practices began in Mexico by 6000 to 4000 B.C., and by approximately 2000 B.C. were known on the northern fringe of the Mesoamerican culture area. Maize was not the only crop plant, for gourds, squash. peppers, cotton and varieties of beans were also domesticated. Maize was grown in the southwestern United States by 2000 to 1000 B.C. but most of the other domesticates did not arrive until just before and after A D. 1. The early introduction of maize in the southwest had no marked effect on cultural development, and the existence of pottery, storage pits, domestic houses with semisubterranean floors and lateral entryways were not known until about A.D. 1. These houses had wood uprights for walls, central roof supports, radiating beams and wattle and daub plastered walls. Ceremonial houses were much larger than the domestic ones and evidence of everyday occupational debris is not found. Two important cultural traditions, Hohokam and Mogollon (*qq.v.*), developed in southern New Mexico and Arizona (*see* fig. 7). These two traditions, developed from similar late preceramic phases of the Desert culture, were influenced by similar traits from northwestern Mexico but evolved into different complexes as the result of differing environmental conditions and subsequent cultural accretions from Mexico (see *Southwestern Village Farmers* below). The early Anasazi (*q.v.*) culture expressions called Basket Maker of the Four Corners area (namely northwestern New Mexico, southwestern Colorado, southeastern Utah and northeastern Arizona) were primarily stimulated through contact with Mogollon populations to the south. These early small settlements were the first village agriculturalists in the southwest.

On about the same time level were the first village cultures of the east which, however, developed an elaborate burial ceremonialism. The cultural expressions of the east known as Early Woodland were in some part a development from Late Archaic complexes and in part stimulated by new techniques and concepts which came into the area from a number of directions. Woodland pottery was introduced from northeastern Asia about 1500 B.C. and burial mounds make their first appearance slightly later (*see* MOUND BUILDERS). It is believed early agricultural activities began about 1000 to 500 B.C. although clear evidence for this in the humid east is not yet available. It is not certain whether

FIG. 7.— DISTRIBUTION OF EARLY AMERICAN FARMERS AND CONTEMPORANEOUS GROUPS IN NORTH AMERICA, ABOUT A.D. 1

agriculture was introduced directly from northeastern Mexico or by nay of the southwest The best-known culture types were Adena nhich began in Early Woodland in the Ohio valley, and Hopewell (*q* v.) uhich maiked the beginning of Middle Woodland in the northern Mississippi and Ohio valley. Both these cultures were stimulated by the arrival of concepts and practices from Mexico which were recognized by the production of figurines, ear spools and certain ceramic innovations such as the negative painted pottery. Late Adena and Hopewell reached their peak of development and expansion during a relatively warm minor climatic phase between 200 B.C. and A.D. 200, which allowed a northern spread of this early agricultural economy into Wisconsin and the southern half of Michigan.

The village areas of Adena and Hopewell varied in size from ½ ac. to about 5 ac. Circular and oval houses for single family occupancy were built of wood and bark, and storage and refuse pits were excavated in the village area. The villages were usually located in major stream valleys adjacent to, or on, easily tilled alluvial flood plains. The earthwork patterns of Ohio valley Adena and Hopewell were placed in or near the village and are ceremonial expressions not clearly understood by archaeologists. The size and complexity of these geometric earthworks and the accompanying burial mounds compare favourably with those of northwestern Europe during the Bronze and Early Iron ages. Extensive trade and travel by these people was proved by raw materials brought into the Ohio-Illinois areas from the Rocky mountains, North Dakota. Lake Superior, the southern Appalachians and the Gulf and South Atlantic sea coasts. Ohio, particularly, served as a distributing centre for ceremonial goods and special products over a wide area in the eastern Cnited States. These cultures were the first indications of craft specialization and of social stratification.

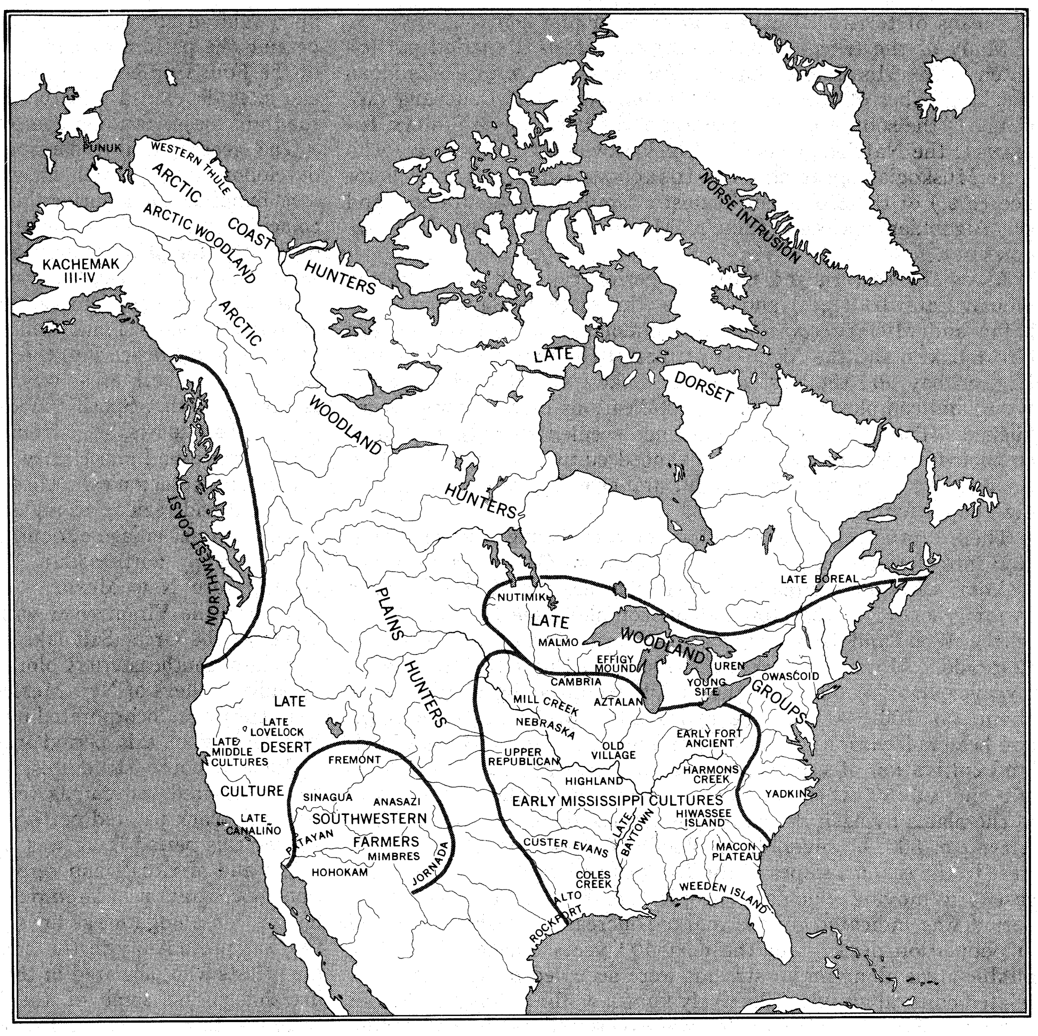


FIG. 8.— EXPANSION OF FARMING VILLAGES AND CONTEMPORANEOUS WESTERN AND NORTHERN HUNTING-GATHERING CULTURES IN NORTH AMERICA. ABOUT A.D. 1000

There is a clear evidence of cultural regression between A.D. 200 and 700 in the north-central United States following the Hopewell expansion and florescence. This is attributed to a minor cold phase which did not allow a continuation of agriculture in this area under the then current techniques. While there was concurrent change in the south, this did not take the form of a lowering of the cultural level.

9. Eastern Village Farmers.— The last major cultural development in the eastern United States is called Mississippian because its primary centre was in the valley of the Mississippi river, and along its major tributaries, and in the southeast This predominantly agricultural complex was a marked cultural advance over earlier stages in the east. Its initial growth and expansion was at approximately the same period (A.D. 700–1200) as that of the southwestern Anasazi complex. (*See* fig. 8.) The initial growth took place along the Mississippi between St. Louis and Vicksburg. It was stimulated by the introduction of concepts religious practices and improved agricultural procedures from northern Mexico which resulted in a sedentary societal organization. By A.D. 1000 large villages were in existence with subsidiary villages and farming communities nearby. Regional specialized production in pottery, projectile points. house types and other utilitarian products reflected the tribal groupings of the period. An outstanding feature of this culture type was the earthen temple mound, which served as a raised platform on which the major community buildings were placed. These council houses and "temples" served as the political and ceremonial centres. The platform mounds were placed on the sides of a central plaza which served as a ceremonial centre for the tribal community during important recurrent functions or during times of crisis. The more permanent buildings, both family or community, were wattle and daub construction, usually rectangular in floor plan. In some areas large, circular charnel houses received the remains of the dead. but burial was normally made in large cemeteries, or in the floor of the dwelling. The size of the ceremonial tribal centres varied from 10 ac. to 100 ac. Important household industries included the production of mats, baskets, clothing and a variety of vessel forms for specialized uses. Food surplus was kept in ground storage pits and in storage cribs above the ground.

One of the more striking developments was the production of ceremonial costumes and ornaments, for use in the religious ceremonies which were carried by an organized priesthood with a well established ritual. The religious symbolism spread throughout the Mississippian complex and a number of centres of production of specialized ceremonial items are known. Other innovations were walled fortifications with timber palisades and bastions surrounding the village, which reflected an increase in intergroup aggression and a tendency continuing into the historic period toward the development of confederacies. The intergroup conflicts apparently were ,primarily quests for prestige and revenge instead of means of territorial expansion or economic control.

Many of the tribal groups of the early historic period participated in the blississippi culture. Among these were the Caddoan speaking tribes of Arkansas, Oklahoma, Texas and Louisiana (see CADDO); the southern Siouan Osage and Quapaw (see SIOUAN INDIANS); the Natchez, Choctaw, Chickasaw and Creek (*qq.v.*) who were Muskogian speaking (see MUSKOGIAN INDIANS); the Cherokee (*q.v.*) of the Iroquoian linguistic family (see IROQUOIS); and the Algonkian speaking Illinois, Miami and Shawnee (see ALGONKIN).

Along the eastern and northern periphery, such tribes as the Siouan Catawba (*q.v.*) and Tutelo, the eastern Algonkian Powhatan and Micmac (*qq.v.*); the Iroquoian tribes of the eastern Great Lakes, and the Algonkian tribes of the forest zone south of Hudson bay and the western Great Lakes, all retained the older Woodland complex but with some indications of Mississippian influence. The extent of this influence seemed to have depended on their nearness to the more advanced cultural complex, and on their ability to maintain an agricultural economy along with hunting and gathering.

There was a spread of Woodland culture during Middle Woodland into the eastern part of the plains from Oklahoma to North Dakota, with some sites, particularly in eastern Kansas, clearly forming a part of the Hopewellian complex (see fig. 7). Some of the Woodland traits went as far west as the high plains in Colorado. Most of the Woodland sites in this latter area were, however, Late Woodland in their relationships and probably began about A.D. 700–800. In the plains there was evidence of corn and bean cultivation during Middle Woodland, and in Late Woodland cultivation of gourds and squash. Between about AD. 300–400 and A.D. 800 there was little occupation of the western part of the plains by agricultural people because of the relative aridity. After A.D. 800, however, Late Woodland populations had spread west to the eastern slopes of the Rockies and were in contact with eastward moving Puebloan people. A favourable agricultural period was indicated by the marked increase in village size and in population density for the next 400 years during which hospitable areas along major streams were occupied by various interrelated cultural groups collectively known as the plains Mississippi cultures. Part of this complex was connected to the developing Mississippi complexes to the east by diffusion, and to some degree by a migration of such groups as the Omaha (*q.v.*) and Ponca from the St. Louis area by about A.D. 1000. Some cultural characteristics such as the earth lodges with entranceways had connections into the southwest, but the major orientation was toward the Mississippi valley. Together with a northward expansion of agricultural people along the Missouri into North and South Dakota before A.D. 1200, segments of the Upper Republican adaptation were developing along stream and creek valleys west into the high plains (see fig. 8) but because of increasing aridity in the western area they subsequently withdrew to the east. Between A.D. 1500–1700 the high plains from New Mexico to Wyoming and in eastern Oklahoma, Kansas and Nebraska was pre-empted by horse-using, part agriculture and plains Apache and Comanche (*qq.v.*). Prehistoric village agriculturalists of a plains Mississippi tradition came into the historic period as the Pawnee, Arikara, Mandan, Hidatsa, Crow (*qq.v.*) and Wichita.

10. **Southwestern Village** Farmers. — The southwestern village farmers were distributed from eastern Utah, and southern Colorado through most of New Mexico and Arizona. The effective agricultural area varied with fluctuations in climate, which profoundly affected the ability of the Indians to occupy marginal regions. While corn and some other agricultural plants were introduced from Mexico between 2000 B.C. and A.D. 1, the first village dwellers mith 5 to 15 pit or surface houses, ceremonial buildings, refuse pits and pottery were not known until shortly before A.D. 1, in southern Arizona and New Mexico. Two of the major farming complexes began at this time: Mogollon mas located in the mountainous belt of west central New Mexico and east central Arizona, while Hohokam was located in the desert area of the Gila basin of southern Arizona. The latter group depended upon irrigation for their crops while Mogollon depended upon rainfall and stream diversion over flood plains. Mogollon became the pattern of agriculture adopted by the Indian groups of the Four Corners area along with other traits from the south, and later developed into the Anasazi (*q.v.*) or Puebloan culture, the third major farming complex of the southwest.

The geographical expansion, population growth and striking development of permanent villages with multiroom and multilevel buildings came during the period from A.D. 700 to 1200, which coincided mith a minor climatic period of favourable distribution of rainfall for plant growth over the entire southwest. For the same climatic reasons, there was an expansion of population and cultural movement from central and western Mexico into northwestern Mexico. Trade and cultural stimuli then moved from northwestern Mexico into the American southwest at a time when the climate in both areas was most favourable for population and cultural growth. Specific trade items such as cast copper bells, parrots, ball courts, shell trumpets, pottery vessel shapes and designs, were found and clearly reflect the transmission of religious beliefs and ceremonies. These southern influences were blended into local and regional complexes.

The Anasazi village agricultural complex had expanded by A.D. 900 to occupy northeastern Arizona, southwestern Colorado and northwestern New Mexico. By A.D. 1100 expansion had taken place into the Virgin river valley of southeastern Nevada, north as far as the Great Salt lake and northwestern Colorado, to the east into southeastern Colorado and to the Pecos and upper Canadian valleys of New Mexico. Some of the important cultural characteristics, incorporated into the architectural plan, that identify Anasazi of this period were stone masonry, multiroom and multistory house structures, oriented kivas (ceremonial chambers), textured and corrugated gray cooking and utilitarian pottery and black painted pottery on a white slip were also evident. During this period there was probably a development of priestly offices and of rituals and ceremonialism. The increasing population concentration in large pueblos was apparently organized into households, along lineage lines. Control of the agricultural activities was presumably in the hands of clan leaders, who were also the priests who officiated in the rain-producing ceremonies. During this period some of the larger village populations ranged from 300 to more than 1,000 people.

Primarily because of increasing aridity there was a marked retraction of Anasazi culture between 1100 and 1300 from its northern, western and eastern limits of expansion. As a result, a concentration of the pueblos took place in northeastern Arizona, and along the Rio Grande and its immediate tributaries, and in the present Zufii area of western New Mexico. In these favourable areas the Anasazi groups were able to maintain their societies by sand-dune and flood-water farming and some canal irrigation. Between 1300 and 1540 the increased importance and elaboration of religious rain-producing ceremonies was deduced from paintings on kiva walls and from a more elaborate symbolism in pottery decoration. Polychrome painted pottery was the dominant decorative technique. At this time the village houses were grouped around one or more plazas, as in the upper Rio Grande and Little Colorado areas.

The early historic and modern Pueblo (*q.v.*) Indians, from the Zuñi and Hopi (*qq.v.*) on the west to the Rio Grande groups on the east, were the direct descendants of the Anasazi populations.

The Mogollon complex in its early phases from 200 B.C. to AD. 700 consisted of relatively small villages of pit houses grouped near a large ceremonial structure. The pit houses had a rounded to quadrangular floor plan with or without long, lateral entries. No organization of the village structures into a pattern is apparent and trash disposal was random. Burials were flexed, and brownish textured, smudged, polished. red filmed and red painted pottery was made. While the initial impetus for sedentary village life appeared early in the Mogollon area there was an apparent period of cultural quiescence about A.D. 400 to 600. With the growth and spread of the Anasazi complex in the post-700 period, the main flow of culture was from that area, and Mogollon villages from A.D. 900 to 1100 nere a blend of local development strongly influenced from Anasazi. During the climatic deterioration after

A.D. 1200 much of the Mogollon territory in southwestern New Mexico was abandoned. The western Puebloan groups of the late prehistoric period also seemed to represent this blend.

The Hohokam culture of southeastern Arizona was primarily limited to main river valleys. Their agriculture was made possible by extensive irrigation canals which required intervillage cooperation. They lived in villages of scattered pit houses made of brush and mud which were dispersed along the streams and canals. Their main settlements and major culture growth took place also during the A.D. 700–1200 period. Following this for 200 years, there was a blend with Anasazi and Mexican elements and a tendency toward the construction of more compact settlements surrounded by compound walls with a few massive multiroom and two story buildings. Some of the other distinct characteristics were etched shell ornaments, paddle and anvil shaping and finishing of pottery, red-on-buff pottery, excellent stone carvings, well-made projectile points and grooved stone axes. hall courts, small kivas, cremated burials, relative absence of indications of trade and influences from northwestern Mexico. Such historic groups as the Pima and Papago (*qq.v.*) are regarded as descended from the Hohokam people.

North American prehistory presents a great variety of cultural adaptations from the early hunting and gathering groups, who initially occupied the U.S. territory and gradually moved into the Canadian area, to the early historic agricultural societies and hunting, fishing peoples. The major climatic and ecological areas strongly influenced the culture types which arose between 10000 and 1000 B.C. Following the introduction of agriculture and associated concepts from the dominant Mesoamerican civilization there developed two important centres of farming societies in the southwest and in the Mississippi valley. Their growth and development was arrested by the intrusion of European explorers and colonists and North America rapidly became a part of western civilization. *See* also ARCHAEOLOGY; INDIAN. NORTH AMERICAN; INDIAN, LATIN AMERICAN; for Prehistory and Archaeology of Middle America see MIDDLE AMERICA. (J. B. GN.)

V. EXPLORATION AND SETTLEMENT

Although Northmen from Scandinavia established colonies on Greenland during the 10th century and evidently reached North America in a series of expeditions about A.D. 1000 their experiences contributed little to the eventual European exploitation of the continent.

Europeans entered an age of geographical discovery during the 15th century, reflecting developments in economic, social and political life under way for some centuries. Merchant groups had developed in western Europe, eager to expand trade and able to finance increasingly ambitious ventures. Most valuable of trade goods were the spices, coming overland from the orient to the eastern end of the Mediterranean. Since Italian merchants controlled the spice trade, merchants to the northnest wished to find new routes to the east.

The intellectuai climate was prepared for an age of discovery by Renaissance scholars who developed an interest in the natural world, reviewed the speculations of the Greeks about the earth, and hazarded their own. At the same time Europeans were advancing in ship construction and improving navigational aids. After the first discoveries the new printing press allowed wide distribution of explorer accounts, encouraging other venturers.

The rise of national states. Portugal, Spain, France, England and the united Netherlands, contributed also to the age of discovery. Monarchs encouraged exploring ventures in hope of increasing trade, and acquiring treasure or territory. In the tradition of militant Christianity, Europeans wished to convert the non-Christians of the world. With the coming of the Reformation in the early 16th century, moreover, religious differences sharpened national rivalries as Protestants sought to outstrip the Roman Catholic Spanish and Portuguese, whose kings had divided the new worlds between themselves with papal approval in the treaty of Tordesillas of 1494.

1. Early Spanish Explorations.—In 1492 Christopher Columbus reached the Bahama Islands with three ships, proceeding then to Cuba and La Espaiiola (Hispaniola). A Genoese adventurer Columbus sailed under a commission from the Spanish crown. Encouraged by tales of lands beyond the Canary Islands and stories of oriental riches, Columbus accepted the theory that the earth was spherical and sought the east by sailing west. He was probably motivated by a sense of Christian mission and a desire to rule new lands as Spanish governor, to win riches and to be knonn as a great geographer. Returning to Spain. Columbus maintained that he had reached the eastern fringe of Asia. Although he traversed much of the Caribbean and traced the mainland coast from Honduras to the Isthmus of Panamá in three subsequent voyages, Columbus found no passage to Cathay, the medieval name for China. As governor of the Indies he also failed, but his discoveries of gold and pearls drew others and the royal fifth of such treasure interested the Spanish rulers. (See COLUMBUS, CHRISTOPHER.)

Based on La Española, Spanish captains probed the Caribbean, the Gulf of Mexico and Central America, hoping to find a western passage, to establish principalities and to exploit local resources. Shortly after 1500. Ferdinand V gave rights of conquest and government on the Mosquito coast and the adjacent South American coast line to two adventurers. From their ventures. initially plagued by disease. dissension and hostile Indians, emerged Vasco Núñez de Balboa who led a force across the isthmus to the Gulf of Panamá in 1513. (See BALBOA, VASCO Núñez DE.) From the isthmus, captains worked north along the Pacific and Caribbean shores.

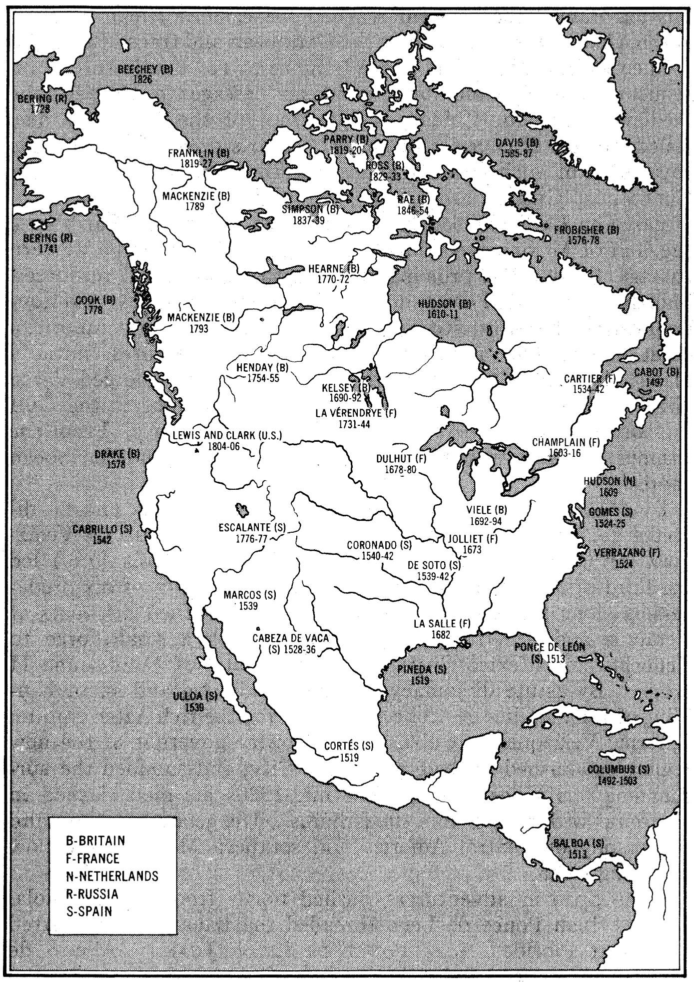
By 1516 Diego de Velázquez had subjugated Cuba and he directed the attention of his lieutenants to the mainland (see Velázquez [DE CUÉLLAR], DIEGO). In 1519 Hernán Cortés (*q.v.*) led the third of such expeditions. Retracing the routes of his predecessors along the Gulf of Campeche, Cortés burned his boats at Veracruz and penetrated the mountains with a small force to Tenochtitlán (Mexico City), the Aztec capital of Montezuma II (*q.v.*). By astute diplomacy, brilliant soldiering and adept handling of Indian allies he broke and plundered the rich Aztec empire. Ignoring Velázquez in Cuba, Cortés became governor of the new region, established himself at Mexico City, and subdued the surrounding territories. During the mid-1520s his men clashed in Honduras with forces from the isthmus. The general outlines and topography of Central America and southern Mexico were now becoming clear.

Some Spanish adventurers pushed north from La Española. In 1513 Juan Ponce de León threaded the Bahamas and skirted peninsular Florida. (See POKCE DE LEÓN, JUAN.) Alonso de Pineda (1519) traced the shore of the Gulf of Mexico from the Florida Keys to the Pánuco river. During 1524–25 the Portuguese Esteban Gomes coasted from the Grand Banks to Florida in Spanish service. Later expeditions probed the continental interior. Pánfilo de Narváez (*q.v.*) landed a large party in Florida in 1528. Eight years later, two survivors, Alvar Núñez Cabeza de Vaca and the slave Estevan, reached the Petatlán river after walking from Galveston bay. De Vaca's tale encouraged minds inflamed by Inca treasure and Indian legends of the seven cities of Cibola.

Expeditions begun by Fernando (Hernando) De Soto and Marcos de Niza (Fray Marcos) in 1539 and by Francisco Vázquez de Coronado in 1540 followed routes which stretched, when combined, from the Grand canyon to the Savannah river, ascended the blississippi valley beyond the Ohio and linked the upper waters of the Brazos to the Kansas river. (See DE SOTO, HERSANDO; NIZA, MARCOS DE; CORONADO. FRANCISCO VÁSQUEZ DE.) Early major Spanish explorations were completed in 1542-43 when Juan Rodrigues Cabrilho and Bartolomé Ferrelo surveyed the Pacific coast from lower California to a point beyond latitude 42° N, although minor figures explored in the eastern Appalachians and the southwest after 1550.

2. French, English and Dutch Explorations Before 1772.—While the Spanish exploited the lower latitudes, other European captains ranged the coasts to the north. Backed by the British cronn and Bristol merchants. the Genoese, John Cabot (*q.v.*), made such a voyage in 1497. Subsequent English, Portuguese and

French expeditions found little of interest until the Frenchman, Jacques Cartier (*q.v.*), ascended the St. Lawrence river in a series of expeditions beginning in 1534. But he found no equivalent to Aztec or Inca treasure and interest in the interior waned. In 1578–79 Sir Francis Drake (*q.v.*) explored the Pacific coast of North America to 48° in an attempt to find a passage to the east. Increasingly, however, Frenchmen and Basques fished the



ADAPTED FROM HAROLD E. DAVIS, "THE AMERICAS IN HISTORY," THE RONALD PRESS COMPANY

FIG. 9.— PRINCIPALEXPLORERS OF NORTH AMERICA: GENERAL LOCATION AND DATES OF THEIR MOST IMPORTANT DISCOVERIES

Gulf of St. Lawrence and incidentally began a trade in furs with the natives. American furs, particularly beaver, were sufficiently popular in Europe by 1600 that the French king tried to nurture the trade by assigning it as a monopoly to favoured merchants.

French fur traders founded Port Royal in 1605 but in 1608 Quebec became the centre of the trade. From there the governor of French Canada, Samuel de Champlain, hoped also to discover a Pacific passage (see CHAMPLAIN, SAMUEL DE). The fur trade also drew the French into the interior since it was always profitable to forestall tribes seeking to act as middlemen. After 1615 the desire of the Récollet (Franciscan), Jesuit and Sulpician religious orders to Christianize the Indians contributed to exploration. But the hostile Five Nations of the Iroquois (*q.v.*), west of the Hudson and below the St. Lawrence and Lake Ontario impeded the French. Allies of the Dutch at Fort Orange, these Iroquoians fought the northern tribes friendly with the French. Because of the Iroquois the French initially avoided the lower lakes and followed the Ottawa into the interior, traversing to Georgian bay. From the explorations of Champlain, of subordinates like Étienne Brulé, and of the missionaries, the French, in 1650, understood the St. Lawrence-Great Lakes system in a general way, although western Lake Superior and southern Lake Michigan were unexplored. They knew also of both the Hudson and Susquehanna river routes to the sea and had heard of a northern sea beyond the Laurentian divide.

During the 1660s, French activities impinged on those of the English. Annoyed by trading restrictions in New France and by the hampering Iroquois, Pierre Esprit, sieur de Radisson. and Medart Chouart, sieur de Groseilliers, sought British backing to establish a northern trade outlet, having perhaps been themselves to James bay. As a result Englishmen organized the Hudson's Bay company (*q.v.*). They were already familiar with the approaches to Hudson's bay and its general character through the efforts of English explorers including Sir Martin Frobisher, John Davis and Henry Hudson (*qq.v.*) who sought a northwest passage around 1600.

The French now attempted to widen their sovereignty in North America. During 1671–72. Paul Denis, sieur de St. Simon, followed the Saguenay and Rupert rivers to James bay. Simon François Daumont, sieur de St. Lusson, proclaimed French rule of interior North America at Sault Ste. Marie in 1671. Daniel Greysolon, sieur Dulhut (Duluth), declared French sovereignty at Lake Mille Lacs and descended the St. Croix and Mississippi rivers to the Wisconsin while rescuing Father Louis Hennepin from the Sioux Indians. The French also tried to push south to Spanish territory in order to confine the British settlements along the Atlantic coast. In 1673 Louis Jolliet and the Jesuit, Jacques Marquette (*qq.v.*), followed the Fox-Wisconsin traverse from Green bay and descended the Mississippi almost to the Arkansas, returning by the Illinois river to Lake Michigan. Nine years later René Robert Cavelier, sieur de La Salle, descended to the mouth of the Mississippi and claimed the whole region, which he named Louisiana, for France. (See LA SALLE, RENÉ ROBERT CAVELIER. SIEUR DE.)

After reaching the lower Mississippi valley, the French sought trade connections with the Spanish settlements. Notable in this effort were the expeditions of Louis Juchereau de Saint Denis from Natchitoches, La., to San Juan Bautista (Villahermosa), Mex., in 1714, of Bénard de la Harpe along the Red, Arkansas and Canadian rivers between 1719 and 1722 and that of Pierre and Paul Mallet. Beginning in the winter of 1738–39 the Mallet brothers followed the Missouri, the Platte and the South Platte into the high plains, angled southwest to Taos and Santa Fe and returned to the Mississippi along the Canadian and Arkansas rivers.

In the northern plains Pierre Gaultier de Varennes, sieur de la Vérendrye, countered British competition by pushing trading posts beyond Lake Superior, baiting his request for a western trading monopoly by promising to seek the Western sea. Between 1731 and 1744, Vérendrye and his sons discovered and described lakes Winnipeg, Winnipegosis and Manitoba and their relation to the major rivers of the region. They reached the Black hills and mapped the upper Missouri but decided that the Saskatchewan river provided the best route to the Pacific.

While the French ranged from James bay to the Gulf of Mexico, the British and Dutch explored below the Great Lakes and east of the Mississippi. Englishmen established Jamestown in 1607 and the Dutch occupied the Hudson valley following its discovery by Henry Hudson in 1609. By 1650 fur traders were searching for passes through the Appalachian barrier. During 1671 Virginians discovered the upper Kanawha. Two years later James Needham reached a Cherokee village on the upper Tennessee river and accompanied braves to the Kanawha and the Ohio rivers and to the junction of the Chattahoochee and the Flint rivers. During 1692–94 Arnout Cornelius Viele from Albany descended the Ohio, pekhaps to the Ihlissississippi. During the late 1690s, Carolinians reached the junction of the Arkansas and Mississippi rivers and followed an expatriate French trader. Jean Couture, down the Tennessee to the Ohio. Carolinian competition with French and Spanish in the Gulf hinterland revealed the topography of this region.

Initially the Hudson's Bay company showed little interest in the interior, allowing superior trade goods to draw the Indians to Hudson Bay. Henry Kelsey's expedition during 1690–92 was an exception to this policy. Kelsey ascended the Hayes river from York factory. crossed the head of Lake Winnipeg and explored beyond Lake Winnipegosis. Kelsey was the first European to see the Canadian plains. Spurred by French activity. the company sent Anthony Henday into the interior in 1754. He pushed beyond longitude 113° W. between the major branches of the Saskatchewan Seeking in 1770–72 to locate the source of copper, brought by Indians to company posts. Samuel Hearne (*q v*) reached the lower Coppermine river, crossing Great Slave lake to strike the Slave river while returning. Hearne's discoveries long discouraged exploration in the barren lands northeast of his route.

3. Pacific Coast, Northwest and Arctic Explorations.—Russian interest in the relation of Asia to North America prompted exploration in the early 18th century. Vitus Jonassen Bering (*q.v*), although his achievement was disparaged, traversed Bering strait in 1728. Both he and Alexei Chirikov reached southern Alaska in 1741 and Russian traders began the China trade in Aleutian sea otter and seal. Russian efforts provoked response from Spain, Great Britain, France and ultimately the United States

By sea, Spanish expeditions of 1774 and 1775 coasted from California to latitude 57° N. Capt. James Cook (q v.), cruised from Oregon to Bering strait in 1778, seeking the terminus of a northnest passage. After his death the expedition reached latitude 70° 44″. Official Russian, Spanish, British and French expeditions and numerous traders probed the northwestern coast after 1785.

On land, the Spanish pushed their settlements to San Francisco bay during the 1760s and 1770s exploring back from the coast in the process and seeking trails to link this frontier to Santa Fe and Taos. During 1776–77 Father Silvestre Vélez de Escalante led a notable expedition from Sante Fe northwest to Utah lake, southwest to Sevier lake and the upper Virgin river, and back to Santa Fe.

On the northern plains, the North-West Fur company of Montreal replaced the French traders after New France passed to Great Britain in 1763 Seeking to forestall the Hudson's Bay company, and to tap the fur fields of the Russians, Sir Alexander Mackenzie (*q.v.*) descended the Mackenzie river from Great Slave lake to the Arctic ocean in 1789 In 1793 he followed the Peace river into the Rockies, traversed to the Fraser and then cut overland to the Pacific to complete the western passage by land.

After the United States purchased Louisiana, the official Lewis and Clark expedition ascended the Missouri, crossed from the Jefferson fork to the Pacific slope and reached the mouth of the Columbia in 1805 (see LEWIS, MERIWETHER; CLARK. WILLIAM). American traders and trappers soon explored the Rockies and Great basin to the south To the north, British fur traders explored the Fraser and upper Columbia and entered the upper Yukon country. Meanwhile servants of the Russian-American company pushed into the interior of Alaska.

Prior to 1818 explorers by sea in the north had stopped short of Point Barrow and on land had reached the arctic coast only at the hfackenzie and the Coppermine rivers. In the next 40 years. the British admiralty, the Hudson's Bay company and private scientific ventures revealed the features of the arctic. The land based expeditions of Sir John Franklin, John Rae (*qq.v.*) and Thomas Simpson explored most of the coast line betneen Point Barrow and the Melville peninsula. On sea, Frederick W. Beechey filled the gap nest of Point Barrow, Lt William (later Sir William) Edward Parry (*q.v.*) sailed from Baffin bay to Melville Island and Sir John Ross (*q.v.*) explored the Boothia peninsula and nith his nephew James (later Sir James) Clark Ross determined the position of the north magnetic pole. When Sir John Franklin sought the northwest passage in 1845. ice trapped his ships south of Prince of Wales Island and the crews perished. During the next decade searching parties ranged the arctic, amassing information about the arctic archipelago. But not until 1903–06 did Roald Amundsen (*q.v.*) sail from the Atlantic to the Pacific north of the continent.

4. European Settlement.—Although Swedish and Dutch traders established colonies on the Delaware and the Hudson during the 17th century and Russian traders were active on the west coast of North America for more than a century, their contributions in settling North America were minor in comparison to those of the Spanish. French and English.

Spanish Settlement.—During the 16th century individuals, willing to organize expeditions and transport colonists, obtained contracts from the Spanish crown, allowing them to exploit regions in North America. Although the contracts conveyed extensive rights of government and economic privileges, the authority of these impresarios was usually soon challenged by royal officials. After 1535 the viceroyalty of New Spain provided the major frame of government for Spanish holdings in the Caribbean and on the mainland, north of the Isthmus of Panamá.

Dissatisfaction with prospects and desire to find adventure and wealth. or to carry Christianity and European culture abroad. impelled Spaniards to seek the new world. Impresarios, and sometimes the crown. encouraged such movement, although only Spanish citizens of undoubted orthodoxy could migrate. By 1570 the white population of New Spain numbered about 54.000, mainly of Andalusian antecedents The possibility of riches, the sophistication of many natives and the climate, encouraged the Spanish to use Indian labour widely. The crown soon forbade Indian slavery but it persisted. and other systems of forced labour also evolved. Spanish arms, European diseases and the new regimen almost extinguished the island natives, whom the Spanish replaced by African slaves. There were more than 93.500 Negroes and mestizos in New Spain by 1570. Although the mainland Indians also decreased in numbers they always dominated the population, numbering about 4,000,000 in 1570. Spanish settlement was characterized by considerable miscegenation.

The success of Cortés caused an exodus from the Caribbean islands. The Greater Antilles developed a prosperous sugar plantation economy, but smaller islands remained unoccupied. After the initial conquests, Spanish settlement on the mainland reflected mining and agricultural opportunities and strategic considerations. The preliminary conquest was complete in Central America by 1600 but portions of the region remained unconquered in 1700. By 1600 Spanish colonization, pushing north from the valley of Mexico. had reached points due west of the mouth of the Rio Grande Although silver and gold mines like those of Zacatecas produced concentrations of population, much grain and livestock was produced in New Spain. Dominican. Franciscan and Jesuit missions helped pacify the Indians in frontier regions. At times, colonies of civilized Indians were moved to the frontier to assist soldier and missionary.

After Huguenot colonization on the Florida coast threatened Spanish shipping in the Bahama channel. the Spanish finally occupied Florida during the 1560s. Missionary efforts in Virginia failed but missions along the Carolina and Georgia coasts survived. At the end of the 16th century Juan de Oñate colonized New Mexico and Santa Fe was established in 1609. During the 18th century the Spanish pushed their Pacific frontier from the Sonora region to San Francisco bay.

Settlement of the British Colonies and *the* United States.—After the Virginia company of London founded Jamestown, the English established numerous colonies along the North American coast line from Maine to Georgia and in the West Indies. Individuals sought patents from the British crown. which conferred upon them territorial and administrative privileges in the new world Economic opportunities attracted most colonial promoters. although experience in Virginia dispelled hope of matching Aztec treasure. But desire to modify Anglican church doctrines, or to alleviate the condition of nonconformists and indigents influenced promoters in a number of colonies. The crown never closed the colonies to religious dissenters. Although companies or proprietors originally controlled the colonies. they were ultimately in most cases brought directly under the crown.

The English colonists engaged in farming, fishing, shipbuilding and trade. with tobacco, rice and indigo important in the southern mainland colonies and sugar plantations characterizing the Indies. Xlthough important, the mainland fur trade nas never dominant. Mortality was high initially in Virginia and Plymouth but emigration attracted Englishmen because of enclosures on estates in Britain, high land prices, dissatisfaction with Stuart political and religious policies and the generous colonial systems of land disposal and government. Many emigrated as indentured servants. During the 1630s a large Puritan migration arrived in Massachusetts, soon itself supplying emigrants for Connecticut, Rhode Island and New Hampshire. A British Quaker migration began to develop Pennsylvania in 1682. Germans and Scotch-Irish came after 1700 to settle mainly in Pennsylvania and the colonies to the south. Scottish, Welsh and Huguenot settlers arrived also. After 1600 many African slaves were brought to the southern colonies. By 1760 the British colonies in North America were supporting about 2,000,000 inhabitants of European and African origin.

Indian relations, land policy, topography, soil fertility and a number of minor factors modified settlement. The agricultural

FROM SANFORD-GORDY, AMERICAN HISTORY SERIES; REPRODUCED BY PERMISSION OF A. J. NYSTROM & CO

FIG. 10.— AREAS CLAIMED BY BRITAIN. FRANCE AND SPAIN IN NORTH AMERICA IN 1750

frontier was in the piedmont region until 1700 and was roughly marked by the Alleghenies until 1800. The Mississippi provided the frontier of the early 19th century in the United States. During the 1840s pioneers established the Oregon, Utah and California settlements. Subsequently miners flocked to the cordilleras as a succession of gold and silver strikes followed the California discoveries of 1848. Between 1860 and 1900 farmers occupied the high plains. Established settlements provided settlers for new lands, the pioneers migrating generally along isothermal lines. Immigration to the United States averaged about 10,000 annually between 1790 and 1830: by the 1850s the average inflow had risen to slightly more than 280.000 people yearly and during the 1890s it was almost 370,000. Many immigrants remained in the older regions, but Germans, Scandinavians and British particularly helped to settle the northern territories and states. The small farms and urban orientation of these regions apparently attracted the foreign born more strongly than did the systems of slavery and plantation agriculture prevalent in the southern section of the United States before the Civil War. (See also AMERICAN FRONTIER, THE.)

Settlement of the French Colonies and Canada.—French settlements developed in New France (Canada) and Acadia on the North American mainland. The fur traders, required to transport colonists under their trading monopolies, performed these obligations unsatisfactorily. There were only 1.800 French on the Bay of Fundy when Acadia passed to England in 1713. Ineffective administration by the merchant company, holding the fur monopoly in New France, led the crown to assume direct control in 1663 when the colony numbered about 2,500. Thereafter settlers were obtained by offering free passage and land on easy terms and by inducing French soldiers to remain in New France. The government inducted girls from France as wives for settlers and seigneurs brought in colonists to work their land grants. For a time during the 18th century, French criminals were transported to the colony. After 1680 the population grew mainly from natural increase. Since royal policy barred dissenters and French agriculture experienced few disruptive changes, little interest in emigration developed in France. Settlement in New France spread out from Quebec, Three Rivers and Montreal along the St. Lawrence, penetrating the back country along the Richelieu but little elsewhere. Although primarily a farming settlement by the 18th century, New France produced little agricultural surplus and the fur trade dominated its commerce.

Established in 1699, Louisiana (*q.v.*) developed under a merchant proprietor and later the Compagnie des Indes Occidentales. In 1731. it became a royal province and was enlarged to include the Illinois country. The fur trade, agriculture and lead mining in Missouri occupied the residents.

By 1760 the French mainland colonies of North America had a European population of about 80,000 while the Indies numbered an additional 45.000 plus about 300,000 slaves. Aside from the French nucleus, Great Britain, then including Ireland, and the American colonies provided most of the settlers for the British provinces which ultimately amalgamated as the dominion of Canada. During the 1760s New Englanders moved to Nova Scotia and merchants from New York and New England established communities in Quebec and Montreal. The American Revolution caused Loyalists to migrate to Upper Canada, Nova Scotia and New Brunswick. Between 1790 and 1815 many settlers from the Cnited States entered Upper and Lower Canada. After 1815 immigration from the British Isles became important. including Irish famine refugees and Scottish crofters. The Fraser river gold rush in 1856 drew a polyglot population to British Columbia but this province developed slowly. Although Lord Selkirk established a colony of Scottish settlers in the Red River valley in 1812 (see RED RIVER SETTLEMENT), and the fur trade left some retired servants and half-breeds. few settlers entered the Canadian prairies before 1890. The government actively promoted the region and by 1930 settlers from the older provinces, from the United States. Great Britain, western and central Europe had occupied most of the arable land.

Major Territorial *Adjustments* in North America.—The European monarchs assumed that their sovereignty followed their nationals in the new world but colonial policies. European wars and American rivalries produced territorial adjustments in North America. When the Spanish focused their attention on the mainland, English, French, Dutch and Danes seized unoccupied Caribbean islands, from the Bahamas to the Windward group during the 17th century. In 1655 the British occupied Spanish-held Jamaica and subsequently gained footholds on the Honduras and Mosquito coasts. The French established themselves on the uninhabited portions of Haiti.

During 1664 England seized New Netherland and in 1713 acquired French claims to Acadia, Newfoundland and Rupert's Land, the region draining into Hudson bay. In 1763 France ceded all mainland territory east of the Mississippi to Great Britain and west of that river to Spain. Concurrently Spain surrendered Florida to the British. Follo ing the American Revolution, the United States in 1783 obtained the territory south of Nova Scotia and the Canadas, and east of the Mississippi, while Spain regained Florida.

Napoleon wrested Louisiana from Spain in 1800 but revolt in Haiti jeopardized French plans in America and paved the way for the independence ultimately of Haiti and the Dominican Republic. The United States purchased Louisiana from France in 1803 (see LOUISIANA PURCHASE). The Spanish transferred Florida to the United States in the Adams-Onís treaty of 1819, the United States accepting here also a western boundary for Louisiana which left Texas in Spanish hands.

Beginning in 1810 revolution shattered the Spanish empire in America. On the mainland Mexico, Guatemala. El Salvador, Honduras, Nicaragua and Costa Rica emerged, although the countries of Central America together formed the Central American federation between 1823 and 1839.

In 1835 settlers from the United States in Texas revolted, proclaiming a republic which gained admission to the United States in 1845. After a short war with the United States, Mexico in 1848 renounced claims to Texas and also ceded New Mexico and upper California. In 1853 the United States acquired the Gadsden purchase lying south of the Gila river (see GADSDEN, JAMES).

The boundary between the United States and the northern British provinces was extended along the forty-ninth parallel beyond Lake of the Woods to the crest of the Rockies in 1818 and to the Pacific in 1846. Russia and Great Britain set the interior boundary of Alaska by treaty in 1825 and Russia sold this region to the United States in 1867.

Important changes in territorial administration occurred in the British provinces after 1860. In 1867 Nova Scotia and New Brunswick joined Canada (modern Ontario and Quebec), in the dominion of Canada. Canada purchased Rupert's Land from the Hudson's Bay company in 1869, British Columbia joined the federation in 1871, Prince Edward Island in 1873 and Newfoundland, including Labrador in 1949.

Following the Spanish-American War in 1898, Cuba gained independence from Spain, and Puerto Rico. Guam and the Philippines were ceded to the United States. Panamá declared its independence from Colombia in 1903 and granted a Canal Zone in perpetuity to the United States. The United States purchased the Virgin Islands from Denmark in 1917, and in 1958 the West Indies federation, comprising a nation within the British Commonwealth, came into existence. See also AMERICA; LATIN AMERICA; CENTRAL AMERICA; and ARCTIC, THE; and the History sections of UNITED STATES (OF AMERICA); CANADA; MEXICO; GREENLAND; WEST INDIES; and of articles on the Central American and Caribbean republics. (A. G. Bo.)

VI. POPULATION

North America, with approximately 9% of the world's population, ranks as the third most populous continent in the world, next to Asia and Europe. Because it occupies about 16% of the world's land area, its population density is below that for the world as a whole.

1. Distribution.—People are quite unevenly distributed within the continent. The southeastern quarter of the United States and Canada contains one of the world's great population concentrations. In this area live more than four-fifths of the U.S. population and nearly two-thirds of Canada's, comprising the densest urban concentrations and many of the largest cities of the two countries.

Within southeastern Anglo-America, the most densely settled area for its size is to be found about the mouth of the Hudson river in what is commonly known as the New York-Northeastern New Jersey standard metropolitan statistical area or Greater New York. From this centre northeastward to Boston and southwestward to Baltimore is the largest aggregation of people on the whole continent.

Some of the islands of the West Indies are also very densely populated. Barbados contains an average of more than 1,200 persons per square mile. Since most of the population of this tiny island of the West Indian federation is rural, its density is comparable to that of some of the more heavily populated rural areas elsewhere in the world. Other Caribbean islands which have high rural densities include: Martinique, Puerto Rico, Jamaica, the

Area and Population of the Countries of North America, 1950–60 and 1880–82, with Density per Square Mile

Area	Population	Date	Area (sq.mi.)	Density per square mile	Population 1880–82
Continental United States	178,690,403	1960 census	3,608,787	49.5	50,189,209
U.S. possessions†					
Panama Canal Zone	41,684	1960 census	553	75.4	...
Puerto Rico	2,353,297	1960 census	3,435	685.1	752,000
Virgin Islands of the U.S.	31,904	1960 census	133	239.9	33,763
Canada	16,080,791	1956 census	3,851,809	4.2	4,504,319
United Kingdom possessions					
Bahama Islands	84,841	1953 census	4,404	19.3	43,521
Bermuda	37,403	1950 census	21	1,781.1	14,888
British Honduras	85,098	1957 estimate	8,866	9.6	27,452
British Virgin Islands	7,760	1957 estimate	59	131.5	...
Cayman Islands	9,046	1957 estimate	100	90.5	4,700
Turks and Caicos Islands	6,500	1957 estimate	169	38.5	4,732
West Indies, The (British West Indies Federation)	3,035,232		7,740	392.1	...
Antigua	54,228	1956 estimate	170	319.0	...
Barbados	229,579	1956 estimate	166	1,383.0	171,860
Dominica	65,890	1957 estimate	305	216.0	...
Grenada	90,852	1957 estimate	133	683.1	42,403
Jamaica	1,610,573	1957 estimate	4,413	365.0	580,804
Montserrat	14,378	1956 estimate	32	449.3	...
Saint Christopher Nevis and Anguilla	57,531	1957 estimate	153	376.0	...
Saint Lucia	91,107	1957 estimate	238	382.8	38,511
Saint Vincent	78,594	1956 estimate	150	524.0	40,548
Trinidad and Tobago	742,500	1956 estimate	1,980	375.0	...
Danish possessions					
Greenland	26,933	1955 census	840,000‡	0.03	10,000
French possessions					
Guadeloupe	229,120	1954 census	687	333.5	200,329
Martinique	239,130	1954 census	431	554.8	167,679
St. Pierre and Miquelon	4,827	1957 census	93	51.9	5,534
Netherlands possessions					
Netherlands Antilles	183,795	1955 estimate	371	495.4	...
Costa Rica	969,640	1955 estimate	19,695	49.2	...
Cuba	5,829,029	1953 census	44,218	131.8	1,521,684
Dominican Republic	2,135,872	1950 census	18,703	114.2	300,000
El Salvador	1,855,917	1950 census	8,260	224.7	613,273
Guatemala	2,790,868	1950 census	42,042	66.4	1,224,606
Haiti	3,097,220	1950 census	10,714	289.1	872,000
Honduras	1,368,605	1950 census	43,277	31.6	350,000
Mexico	34,625,903	1960 census	760,373	45.5	10,447,974
Nicaragua	1,057,023	1950 census	57,143	18.5	275,815
Panama	805,285	1950 census	28,753	28.0	285,000
Total	255,683,126		9,360,836	27.3	...

*Excludes U.S. portion of Great Lakes area, 60,960 sq. mi. †Excludes area and population of Navassa and Swan Islands. ‡Includes 708,069 sq. mi. of ice cap.

Windward Islands, the Leeward. Islands and the republic of Haiti.

The distribution of population within Mexico is representative of many other Middle and South American republics. Almost one-half of Mexico's inhabitants are found in the basins and valleys clustering about the capital city, in a district representing less than one-seventh of the country's entire area.

Two large, sparsely populated areas characterize the continent of North America. One of these is in Canada, which is a relatively unoccupied country except for a rather narrow fringe scarcely more than 100 mi. wide along a part of the northern border of the United States. The second area includes the western half of the United States with the exception of portions of Washington and Oregon west of the Cascade ridge, central and southern California, and the irrigated lands along the major river valleys. Alaska is the United States' largest but least densely populated state.

2. Population Growth.— At mid-20th century most political divisions in North America were experiencing a rapid growth in population, exceeding the average annual rate of 1.6% for the world as a whole. Canada's annual growth was about 2.7%; that of the United States 1.7%. The growth of these two countries is due principally to increases in their birth rates following World War II, their extremely low death rates and to an excess of immigration over emigration.

The islands of the Caribbean and the republics of Middle America are also growing at annual rates far in excess of those of many other parts of the world. Among them are Costa Rica, 3.9%; and the Dominican Republic, El Salvador, Nicaragua and Honduras, all with a percentage growth of about 3.4% annually. The growth throughout Middle America is the result of extremely high birth rates and declining death rates. In the mid-1950s they had an average crude birth rate of about 42 per 1,000 population as compared with a world average of 34. Death rates for the area as a whole averaged 16 per 1,000 population compared with 18 for the world.

North America has been an area of considerable population growth for most of its recorded history. From about 1880 to mid-20th century the population of the continent increased almost threefold. In 1850 the United States had a population of 23,300,000, whereas that of Canada mas 2,400,000. In 1960 the population of these countries had grown to a total of 196,600,000, or a total increment of 665%.

3. Racial Composition.— In Canada, about 50% of the total population are of British stock, 30% are French, and about 10% have been classified as having mostly German, Scandinavian and Ukrainian backgrounds. The native groups comprise Indians and Eskimos, but these make up only slightly more than 1% of the total population.

Of the total U.S. population in 1950 89.5% were white; Negroes constituted 10%; the remaining fraction consisted of Orientals and others.

The population of Middle America is a complex mixture of Indians, descendants of Europeans and Negroes. Indians constitute more than 50% of the population of most of the mainland republics, but great variations exist among the countries of Middle America. Costa Rica, for example, is almost entirely white; Guatemala is predominantly Indian; Mexico classifies about 30% as pure Indian, 15% white and 55% mestizo. The predominant stock of many of the West Indian islands is Negro. Jamaica has a population which is about 76% Negro and 17% mulatto. The population of Haiti is 90% Negro with the remainder being mulatto of French-Negro descent. Only a very small proportion of the population of Middle America can claim pure white descent.

For the continent as a whole, more and more people are moving to urban centres. The 1960 census shows the United States as being 69.9% urban. In 1956 Canada was found to have an urban population of 66.6%.

See Central America: *Population,* the *Population* sections of articles on the various countries and the article Negro, American. Comparative statistics may be found in the annual *Demographic Yearbook* published by the United Nations statistical office. See also Index references under "North America" in the Index volume.

(C. F. Ko.)

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NORTHAMPTON, EARLS AND MARQUESSES OF.

The Northampton title has been held in various English families. Waltheof, son of Siward, earl of Northumberland, became earl of Northampton and Huntingdon in 1065. He was executed in 1076. His eldest daughter, Matilda, married Simon de Senlis or St. Liz, who thus acquired the title, possibly by 1090. On Simon's death, c. 1111, Matilda married David I of Scotland, youngest son of King Malcolm III. David thus became earl of Huntingdon and probably of Northampton also. His stepson, the second Simon de St. Liz, was. however, recognized as earl of Northampton in 1136; and this Simon's son, also called Simon, succeeded to the title in 1153 but died childless in 1184. In 1337 William de Bohun (*c.* 1312–60). youngest son of Humphrey de Bohun, 4th earl of Hereford and 3rd earl of Essex, was created earl of Northampton; and his son Humphrey, who succeeded, fell heir also in 1361 to the earldoms of Hereford and Essex. The titles, however, became extinct at his death in 1373.

In 1547 William Parr (1513–71), son of Sir Thomas Parr and brother of Catherine Parr, queen of Henry VIII, was created marquess of Northampton, and though attainted in 1553 was recreated marquess in 1559. He favoured the claim of Lady Jane Grey to the English throne. Although sentenced to death he mas released from prison at the end of 1553 and pardoned shortly afterward. Northampton died at Warwick on Oct. 28, 1571. He left no children and his marquessate became extinct. In 1604 Henry Howard (see below) was created earl of Northampton, his title dying with him. It next passed into the Compton family, where it remained thereafter. The 1st earl of Northampton in this line, William Compton (d. 1630). who received the title in 1618. was a great-grandson of the Sir William Compton (c. 1482–1528) who was with Henry VIII at the Field of Cloth of Gold, and his son, the 2nd earl, is noticed below. The 9th earl, Charles Compton (1760–1828). was created a marquess in 1812, receiving at the same time the titles of Earl Compton and Baron Wilmington.

HENRY HOWARD, earl of Northampton (1540–1614), was the second son of Henry Howard, earl of Surrey, the poet, and of Lady Frances Vere, daughter of the 15th earl of Oxford. and younger brother of Thomas Howard, 4th duke of Norfolk (*q.v.*). After discovery of his brother's plot to marry Mary, queen of Scots, and of his own correspondence with her. he was arrested more than once on suspicion of harbouring treasonable designs. In 1580 he wrote in favour of Elizabeth I's proposed marriage to Francis, duke of Anjou. In 1583 he published a work entitled A *Defensative* Against the Poyson of Supposed Propheczes, an ostensible attack upon astrology, which, being declared to contain heresies and treason, led to his imprisonment for a short time.

After the accession of James I he received many honours, and became lord privy seal (1608) and a commissioner of the treasury (1612). He was one of the judges at the trials of Sir Walter Raleigh and Lord Cobham in 1603. of Guy Fawkes in 1605 and of H. Garnet in 1606, in each case pressing for a conviction. In 1604 he was one of the commissioners who composed the treaty of peace with Spain. and from that date he received from the Spanish court a pension of £1,000. Iiorthampton died in London on June 16. 1614. His title died with him. He built the house in London later known as Northumberland house; and superintended the construction, for his nephew, the earl of Suffolk, of the fine house of Audley End, Essex. He founded and planned several hospitals. Bacon included three of his sayings in his "Apophthegms" and chose him, as "the learnedest councillor" in the kingdom, to present to the king his Advancement of Learning. Northumberland was the author of a number of philosophical. devotional and political writings. most of which remain in manuscript.

See the very uncritical life in The Works of H H., Earl of Surrey, and of Sir T. Wyatt the Elder, ed by *G.* F. Nott, 2 vol (London, 1815), Sir Sidney Lee's article in the Dictionary of National Biography.

SPENCER COMPTON, 2nd earl of Northampton in the Compton line (1601–43), was the son of William, 1st earl, lord president of the marches. On the outbreak of the Great Rebellion he was entrusted with the execution of the commission of array in Warwickshire. After varying success and failure in the midlands he fought at Edge Hill, and after the king's return to Oxford was given in Nov. 1642, the military supervision of Banbury and the neighbouring country. He was attacked in Banbury by the parliamentary forces on Dec. 22, but relieved by Prince Rupert the next day In March 1643 he marched from Banbury to relieve Lichfield and, having failed there, proceeded to Stafford, which he occupied. Thence on March 19, accompanied by three of his sons, he marched out with his troops and engaged Sir John Gell and Sir William Brereton at Hopton heath. In the moment of victory he was surrounded by the enemy, and, refusing quarter, was slain.

See Sir C. H. Firth's article in the Dictionary of National Biography.

(R B WM)

NORTHAMPTON, a municipal, county and parliamentary borough and the county town of Northamptonshire. Eng., 66 mi. N.W. of London by road. Pop. (1951) 104,432. Area 9.7 sq.mi. The earliest written reference to Northampton (Hamtune) is to A.D. 914. It was occupied by the Danes, who probably fortified it, in the reign of Edward the Elder. Town walls and a castle (east of the present Castle station) were built by Simon de Senlis (St. Liz) c. 1084. It is mentioned as a borough in Domesday Book. Henry II granted it a charter in 1185, superseded by Richard I's in 1189. In 1888 it was made a county borough.

Tanning was an industry in the time of Edward I and in 1675 a law was made forbidding strangers to purchase hides in the town except on fair days. Boots and shoes were made there in the reigns of John, who visited the town 31 times and bought a pair of boots there for 9*d.*, and of Edward I. By the 17th century it was one of the most noted places in England for the manufacture of boots and shoes. Northampton castle was the meeting place of several important councils and parliaments, the most famous council being that of 1164 when Henry II judged Thomas Becket on charges of defiance of royal authority. In the wars between John and his barons the castle withstood a siege by the latter, but in 1264 it was occupied by the barons under the earl of Leicester. In the Wars of the Roses it was the scene of the battle in which Henry VI was defeated and taken prisoner in 1460. During the Civil Wars of the 17th century it was held for parliament by Lord Brooke. Part of the castle was re-erected on a new site when the Castle station was built.

The town stands on the Nene river above which four main roads converge to meet at All Saints' church and the civic centre. Below this is the large market square. Of the old sandstone churches, All Saints', the civic church. was rebuilt after the fire of 1675 when 600 houses were destroyed; St. Giles is a cruciform structure dating from the 12th century; St. Peter's, near the castle. was built about 1160 by Simon de Senlis (restored 1851–52) and has richly carved capitals and a splendid west-end arch; St. Sepulchre's, the Northamptonshire regimental church, is one of the four round churches remaining in England and was built early in the 12th century. In St. Matthew's, a modern church, are Henry Moore's "Madonna and Child" and Graham Sutherland's picture of the Crucifixion. Northampton is the seat of a Roman Catholic bishop, the cathedral (1864) being by the Pugins in early Decorated style. In the 13th century there were Franciscans. Dominicans, Augustinian~Carmelites. Austins and Poor Clares in the borough. but little remains of their monasteries. In Hardingstone, south of the town, is one of the original Eleanor crosses. The town and county school was founded in 1541; there are grammar schools for boys and girls, a technical high school and a college of technology and of art. The town has tuo theatres. Abington is the chief of the parks and the county cricket ground is within the borough. In the Central museum and art gallery is a collection of footwear from the 15th century; the Abington museum (a 16th-century manor house in the park) contains exhibits of ethnography and natural history; the Northamptonshire Regimental museum shows uniforms dating from 1790.

NORTHAMPTON, a city of west central Massachusetts, U.S., on the Connecticut river, is located about 16 mi. N. of Springfield; the seat of Hampshire county.

Since its founding in 1654, chiefly by settlers from Connecticut, Northampton's character has reflected much of the general development of New England. Throughout the 18th century it was a self-sufficient agricultural community; its pastor from 1729 to 1750 was Jonathan Edwards (*q.v.*). After the American Revolution it was the scene of several debtors' demonstrations during Shays's rebellion. (See MASSACHUSETTS: History.)

In the 19th century Northampton became a major stagecoach stop and the northern terminus of a canal from New Haven. Conn., completed in 1834. Railroad connections with the south and east came in 1845. The establishment of a woolen factory in 1809 ushered in a slow transition from agriculture to industry, which boomed after the American Civil War. Manufactures include brushes, cutlery, wire cable, caskets and optical equipment. The silk industry, once the leader, declined in the 1920s.

Smith college was founded under the will of Sophia Smith (1796–1870) of nearby Hatfield to provide young women with a college education equal to the best offered to men. Chartered in 1871 and opened at Northampton in 1875, Smith became the largest independent college for women in the U.S. The Smith college school for social work, which trains social caseworkers and prepares students for the degree of master of social sciences, was founded in 1918. From 1925 the college sent groups of students abroad to study during their junior year.

George Bancroft, the historian, founded his Round Hill school for boys in 1823 on the site occupied after 1867 by the Clarke School for the Deaf. The People's institute, now primarily a community centre, was founded by the novelist George Washington Cable in 1896 for adult education.

Northampton was also the home of Sylvester Graham, the advocate of coarse flour for whom the graham cracker was named. Calvin Coolidge, 30th president of the U.S., who began his law practice in Northampton, died there in 1933.

Incorporated as a town in 1656 and as a city in 1883, Northampton is part of the Springfield-Holyoke standard metropolitan statistical area. For comparative population figures see table in MASSACHUSETTS: Population. (D. H. S.)

NORTHAMPTON, ASSIZE OF, a number of ordinances agreed upon by the king and magnates in council at Northampton in 1176, issued as instructions to six committees of three judges each, who were to visit the six circuits into which England was divided for the purpose. Parts of the assize repeated the substance of some provisions of the Assize of Clarendon (1166), but with several differences. Thus, arson and forgery now appeared among the crimes about which juries of presentment were to inquire, and those who failed at the ordeal were to lose a hand as well as a foot. An important section defined some of the rights of the heir, the lord (or lords) and the widow of a deceased free tenant; its protection of the heir's right to succeed to land established the possessory action of mort d'ancestor. The justices were also ordered to hear pleas of novel disseizin (recent ejectment from a free tenement) arising since May 1175, and to try proprietary actions commenced by the king's writ for the recovery of land held by the service of half a knight's fee or less. In their fiscal capacity they were to inquire into escheats. churches, lands and women in the king's gift. Monies accruing to the king from proceedings before the justices were among the receipts for which royal bailiffs were to account at the exchequer. As a result of the rebellion of 1173–74 it was provided that an oath of fealty should be taken by all, "to wit, barons, knights, freeholders, and even villeins (rustici)." and that anyone who refused should be arrested as the king's enemy; the justices were to see that castles whose demolition had been ordered were razed, to inquire into castle-guard and to prepare a register of fugitives from the realm.

See A. L. Poole, *From Domesday Book to Magna Carta* (Oxford, New York, 1951). The text is printed in W. Stubbs, *Select Charters,* 9th ed. (Oxford, 1913); an English translation in D. C. Douglas and G. W Greenaway (eds.), *English Historical Documents* (London, New York, 1953) (ER S)

NORTHAMPTONSHIRE, an east midland county of England, bounded north by Lincolnshire and Rutland. west by Leicestershire and Warwickshire, south by Oxfordshire and Buckinghamshire and east by Bedfordshire. Huntingdonshire and Cambridgeshire. The area of the county is 914.3 sq.mi. Pop. (1951) 359,690.

Physical Features. — The underlying structure of the county is very simple. It forms part of the Jurassic escarpment, there known as the Northampton uplands. All the rocks are of Jurassic age, the dip being in a general way to the southeast, and the strike from southwest to northeast. The oldest and most westerly belt consists of Lias formations which cover a large surface in the southwest and centre around Banbury, Daventry and Market Harborough, and they are also exposed along the rivers near Towcester, Northampton, Wellingborough and Kettering. The marlstones of the Middle Lias were formerly much used for building material; the Upper Lias is worked for bricks at Raunds. Long Buckby, Wellingborough. Rothersthorpe, Gayton and Stoke Bruern. Through the middle of the county, northeast to Northampton, Rockingham and Peterborough. is an elevated tract of Oolitic rocks, which formerly supplied the building stone for many villages, as well as lime and marl. The New Duston quarries have several varieties of good stone, the district around Northampton a limestone known as Pendle, and Weldon (Lincolnshire Oolite) a noted freestone; Barnack Rag (near Stamford) is no longer worked. The great Oolite Limestone, though unsuitable for building material because of the ease with which it weathers. was largely used in the past, making Culworth, Blisworth and Cosgrove quarries famous. At the base of the Inferior Oolite, Northampton sands yield iron ore and the county contains one of the main ironstone fields in Britain, mainly worked in the triangular area between Rockingham, Oundle and Wellingborough, though there are smaller uorkings in other parts of the county. Certain hard shelly beds in the Oolite rocks have been polished and used as marble.

Along the southeast border of the county, a belt of Oxford Clay occupies the surface, good exposures occurring in the briclrfields about Peterborough. Boulder Clay is widely distributed over the uplands and in the east of the county, and glacial and river gravels are also plentiful.

The southwest portion of the county forms the principal watershed of the midlands; the Cherwell, the Avon, the Leam. the Welland and the Nene have their sources in this region, and all form sections of county boundaries. Because of its central position and elevation Daventry has become a communication and transportation centre. The Nene river flows in a northeasterly direction along the foot of the uplands, draining to the Wash.

History. — In primitive times the waters of the North sea reached almost to the foot of the Northamptonshire uplands. Palaeolithic flint implements and mammalian remains have been found in the gravels of the Nene river. Peterborough is a type site for the pottery of one of the most important secondary Neolithic cultures. Some Beaker and other Bronze Age pottery has been found, chiefly on the uplands. Iron Age A, B and C cultures are represented and a number of hill forts are known (Hunsbury, 1½ mi. S.W. of Northampton, is the most famous). The latter has yielded a bronze decorated sword scabbard which is an important example of pre-Christian Celtic art. Two main Roman roads, now known as Watling and Ermine streets, crossed the west and east of the county respectively. Important Romano-British settlements were situated at Towcester, Whilton, Irchester and Castor. The latter was a main centre of pottery manufacture in the 3rd and 4th centuries. Numerous villas are known in the county. In the 7th century the district suffered simultaneous invasions by West Saxons from the south and Anglian tribes from the north and a mingling of races resulted. West Saxon influence, however, never spread farther north than Daventry and Warwick, and with the extension of the Mercian kingdom under Penda and the conversion of the midland districts, it ceased altogether. The abbey at Medeshamstede (now Peterborough) was begun by Saxulf, a monk, and Penda's son, Peada. in 655. Foundations were also established at Peakirk, Weedon Beck, Castor and Oundle. In 870 the district was overrun by the Danes, and Northampton was one of the five Danish boroughs until it was recovered in 921 by Edward the Elder. who fortified Towcester.

In the 11th century Korthamptonshire was included in Tostig's northern earldom; but in 1065, together with Huntingdonshire, it was detached from Northumbria and bestowed on Waltheof. The monastic foundation of Peterborough survived the Conquest. Norman castles existed at Rockingham, Barnwell, Lilbourne and Northampton. The shire is probably of Danish origin, representing in the 10th century the area which owed allegiance to Northampton as a political and administrative centre. In 921 this area extended to the Welland, and at the time of the Domesday survey the boundaries were approximately those of the present day. Korthamptonshire is first mentioned by name in the *Historia Eliensis,* in connection with events which occurred at the close of the 10th century.

The Geld roll (William I) and Domesday Book (1086) mention 28 hundreds in Northamptonshire, and part of Rutland is assessed under this county. By 1316 the divisions were changed, renamed and reduced to 20, and have remained practically unaltered. The names of the hundreds point to primitive meeting places gradually superseded by villages and towns. The court for Fawsley hundred met under a large beech tree in Fawsley park until the beginning of the 18th century, when it was transferred to Everdon. The shire court met at Northampton.

Northamptonshire was originally included in the diocese of Lincoln. The archdeaconry of Northampton is mentioned in the 12th century, and in 1291 included the deaneries of Peterborough, Northampton. Brackley, Oundle, Higham, Daventry, Preston, Weldon, Rothwell and Haddon. The diocese of Peterborough was created in 1541, and the archdeaconry of Oakham in 187; There are now 21 rural deaneries in Northamptonshire.

At the time of the Domesday survey the chief lay tenant in Northamptonshire was Robert, earl of Mortain, whose fief escheated to the crown in 1106. The estates of William Peverel, founder of the Augustinian abbey of St. James at Northampton, also escheated to the crown in the 12th century. Yardley Hastings was named from the Hastings', formerly earls of Pembroke; Higham Ferrers was the seat of the Ferrers family; Braybrooke castle mas built by Robert de Braybroke. a favourite of King John; and Burghley house gave the title of baron to William Cecil. During the middle ages the Nene was an artery of trade, and many moated homesteads were built on its banks.

Northampton was a favourite meeting place of the councils and parliaments of the Norman and Plantagenet kings. In 1215 John was besieged in its castle by the barons. and in 1264 Henry III captured the castle from the younger Simon de Montfort. During the Wars of the Roses Henry VI was defeated at Northampton in 1460. In the Civil War of the 17th century the county declared almost unanimously for the parliament, though traditionally the Gunpowder plot was hatched at Ashby St. Ledgers, the home of Robert Catesby's mother (the Tudor mansion and the village have been remarkably renovated by Sir E. Lutyens).

In 1547 Brackley and Peterborough each returned two members of parliament, and in 1557 Higham Ferrers returned one member. Under the act of 1832 the county returned four members in two divisions, the boroughs being merged in the county divisions. Under the 1949 act the divisions of the county with the soke of Peterborough were: Kettering, Peterborough, South Northants and Wellingborough. The county borough of Northampton also returned one member.

Architecture. — Of monastic foundations, the abbey church of Peterborough, afterward the cathedral, is the only remaining one of importance. At Geddington, and also at Hardingstone. on the outskirts of Northampton, there are Eleanor crosses, erected by Edward I. The county is famous for its churches with beautiful broached spires. To the Saxon period belong the tower of Earls Barton church, on what is probably the mound of an old English strong house; the tower. etc , at Brigstock; the ground plan, etc., at Wittering; the remarkable tower at Barnack; and Brixworth church, built mainly of Roman bricks.

Of Norman work, excluding Peterborough cathedral, the finest examples are St. Peter's and St. Sepulchre's, Northampton, and the tower of Castor church. St. Mary's in Higham Ferrers, formerly collegiate, Early English and Decorated, is one of the finest churches in the county; those at Irthlingborough and Lowick (with their lantern towers), Warmington (fine Early English work), Rushden, Finedon, Raunds and Fotheringhay should be mentioned.

Rockingham castle is mainly Elizabethan with a Norman gateway and a hall rebuilt by Edward I. Some castellated ruins remain of the castle at Fotheringhay, famous as the scene of the imprisonment, trial and execution of Mary, queen of Scots. Barnwell castle, the Northamptonshire home of the duke of Gloucester, is said to have been built in 1266; it includes four of the round towers and an imposing gateway.

Holdenby manor house, built by Sir Christopher Hatton (1540–91) and later a royal residence, is largely restored. Castle Ashby, Elizabethan with a front by Inigo Jones, is the seat of the Comptons, marquesses of Northampton. Althorp, the seat of the earl of Spencer, dates from the 16th century. Burghley house. Stamford, was founded by Lord Burghley (1553); Kirby hall aas a beautiful Elizabethan building, once the residence of Sir Christopher Hatton and now a ruin taken over by the ministry of works. Sulgrave manor was the home of George Washington's ancestors; Rushton hall was acquired by the county council in 1955.

Agriculture and Industries. — During World War II there began an increase in tillage from 93,000 ac. (1939) to 230,000 ac. (1944) to 292,010 ac. (1955). Cereal crops alone increased from 61,000 ac. (1939) to 144,148 ac. (1955). Concurrently there was a considerable increase in mechanization.

Industries are mainly concentrated in three areas: along the London-Inverness road from Rushden in the southeast to Desborough in the northwest; the steel town of Corby; around the county borough of Northampton. Smaller industrial areas are at Brackley, Thrapston, Daventry (important wireless installations) and Towcester. The main occupations are the manufacture of boots, shoes and allied leather products, clothing, iron and steel; agriculture; engineering; and foodstuffs.

The rapid growth of Corby (pop., 1931, 1,596; 1951, 16,703) gave rise to a New Town corporation making provision for an ultimate population of 40,000. Light industries have been introduced for the employment of women workers.

The selling of fat cattle for Christmas markets formerly set the population free in winter for hunting, giving rise in the 18th century to the making of whips at Daventry, while the long winter evenings encouraged the use of the tobacco pipe, made almost exclusively from Northampton clays. Northampton is still a great hunting county, the Pytchley and the Grafton packs being kennelled there. Easy access to hides and bark for tanning in the forests originated an industry in leather and Northampton became famous for the manufacture of boots and shoes. The difference in bulk between imported rawhides and exported finished boots and shoes creates an economic problem in connection with this trade.

Sheep are kept in large numbers on the rich pastures, improved Leicesters for wool and Southdown for mutton. Wool was important in Norman times; in the 17th century the centre of weaving changed from Northampton to Kettering. Charcoal burning was an early industry in the forests (Rockingham, etc.), mast from the oaks also feeding large numbers of pigs.

Communications. — Lying between London and the industrial north, Northamptonshire is traversed by three main railway routes and there are numerous branch lines.

The Watling street crosses the southwestern part of the county. Silverstone is a popular centre for motor racing.

The former Grand Junction canal (now, with the Grand Union canal, part of British waterways) enters the county at Braunston on the borders of Warwickshire and passes by Daventry and Blisworth into Buckinghamshire, a branch connecting it with Northampton. The former Grand Union canal unites with the Grand Junction near Daventry and runs north until it joins the Leicester canal at Foxton, branches passing to Welford and Market Harborough.

Population and Administration. — The area of the administrative county (which excludes the soke of Peterborough and the county borough of Northampton) is 904 6 sq.mi. and its population in 1951 was 255,258. The soke of Peterborough, itself an administrative county, has an area of 83.5 sq.mi. and pop. (1951) 63,791, while the county borough of Northampton occupies 9.7 sq.mi., pop. (1951), 104,432. There are four municipal boroughs, namely, Brackley (pop., 1951, 2,531), Daventry (4,077), Higham Ferrers (3,681) and Kettering (36,817), in addition to Peterborough and Northampton, and nine urban and eight rural districts.

There are one court of quarter sessions and nine petty sessional divisions. The borough of Northampton and the liberty of the soke of Peterborough have each a separate court of quarter sessions and a separate commission of the peace. The total number of civil parishes in 1955 was 294, of which 25 were in the soke of Peterborough. The geographical county, including the soke of Peterborough, is in the diocese of Peterborough. The National trust owned 31 ac. in Northamptonshire in 1955 and protected 519 ac.

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(P. I. K.; AN. W.)

NORTH ATLANTIC TREATY ORGANIZATION.

On April 4, 1949, in Washington. D.C., representatives of 12 countries signed the North Atlantic treaty. The signatory nations were Belgium, Canada. Denmark, France, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom and the United States. This list was increased to 14 during the Korean war, when on Oct. 22. 1951, in accordance with the provisions of art. 10. Greece and Turkey acceded to the treaty. Three years later, in

Dec. 1954, west Germany entered the alliance coincident with the ratification of the refurbished western European union.

The North Atlantic treaty consisted of 14 articles, the most important of which mere art. 6, defining the area to be covered by the treaty; art. j, the "trigger" clause, setting forth the obligations of the member states if an armed attack should occur within the defined area; and art. 2, providing the basis for political and economic co-operation within the alliance. As modified with the adherence of Greece and Turkey, art. 6 explicitly included "the territory of any of the Parties in Europe or North America, . . . the Algerian departments of France, . . . the territory of Turkey or . . . the islands under the jurisdiction of any of the Parties in the North Atlantic area north of the Tropic of Cancer." Within this vast expanse, far greater of course than the North Atlantic plus western Europe, the parties agreed (under art. j) that "An armed attack against one or more of them . . . shall be considered an attack against them all; and consequently they agree that, if such an armed attack occurs, each of them, in exercise of the right of individual or collective self-defense recognized by Article 51 of the Charter of the United Nations, will assist the Party or Parties so attacked by taking forthwith, individually and in concert with the other Parties, such action as it deems necessary, including the use of armed force, to restore and maintain the security of the North Atlantic area."

The hope of the members that the treaty would transcend the essentially defensive, military features of art. j is expressed in art. 2, by which "The Parties will contribute toward the further development of peaceful and friendly international relations by strengthening their free institutions, by bringing about a better understanding of the principles upon which these institutions are founded. and by promoting conditions of stability and well-being. They will seek to eliminate conflict in their international economic policies and will encourage economic collaboration between any or all of them."

The treaty formally and definitively recognized that a brief chapter of world history had ended. a chapter which had been marked by a European and American coalition with the Soviet Union to defeat the Axis powers in World War II and establish a new international order after that defeat. Soviet action inside the United Nations had forced the west to the conclusion that the international organization could not in and of itself maintain peace and security. The swiftness with which the Soviet Union converted eastern European countries from German satellites into Communist puppets indicated that Russia was bent on external expansion. Above all, the Communist coup *d'état* in Czechoslovakia in 1948 and the breakdown of the four-power control commission in Germany posed for western statesmen a threat to their national security and independence.

Preservation of free institutions required three types of action. First was the elimination of Communists from the ministries of certain European countries and the isolation if not the reduction to impotence of the various national Communist parties, avowedly instruments of Soviet design and tools of Soviet policy. In 1947 this step had been taken in France and Italy, the two countries with the largest Communist parties; in the rest of western Europe by that time Communist organizations could not undertake successful programs of subversion or insurrection. The second requisite was co-operation among European nations, since individually each was patently incapable of defending itself against the Communist colossus. A beginning in this direction was made with the establishment in 1948, as the European co-ordinating agency for the European Recovery program (ERP), of the Organization for European Economic Cooperation (OEEC). More significant as forerunner of the North Atlantic treaty was the Brussels pact (a 50-year mutual defense alliance)! signed in March 1948 by Belgium, the Netherlands and Luxembourg (the so-called Benelux countries), France and the United Kingdom just one month after the Coinmunists seized control of Czechoslovakia.

In the third place, however. western European countries, even united and determined to remain outside the enlarging Soviet orbit, could attain their objective only if North America threw its weight into the balance. Under the Marshall (ERP) plan, the United States in 1948 had undertaken a multibillion-dollar program of economic assistance, but military aid and political commitments were also needed if the Soviet Union was to be convinced of the folly of further European aggrandizement. For Canada as a member of the British Commonwealth such a commitment followed most logically upon the close involvement of the mother country, Great Britain, in continental affairs after World War II. beginning with the Dunkerque treaty with France in 1946. Canada was therefore a leader in arguing for a broadening of the Brussels pact to include North America.

Change in **U.S.** Policy. — United States membership in a military alliance in peacetime represented a sharp break with the nation's former policies of neutrality and isolation. The United States had joined with the other American republics of the western hemisphere in the Inter-American Treaty of Reciprocal Assistance (Rio treaty), which became a prototype of the North Atlantic treaty in its self-defense aspects. Bipartisan leadership proceeded to use the Rio treaty as the precedent for United States membership in "such regional and other collective arrangements as are based on continuous and effective self-help and mutual aid." These words from the Arthur S. Vandenburg resolution adopted by the U S senate in June 1948 clearly indicated the increasingly favourable disposition of the United States toward a North Atlantic treaty soon to be negotiated.

From Pact to Organization. — Some time passed before the North Atlantic treaty became an organization. The transition was accelerated by North Korea's attack on South Korea in June 1950, which was interpreted to mean that international Communism would not shrink from overt military aggression anywhere in the world, including Europe. where weakness and indecision seemed to provide favourable opportunities.

The core of the organization as it evolved between 1949 and 1954 comprised two complexes of committees, one civilian and one military. The directing political body was the North Atlantic council, within which representatives of the various member states sat in continuous session. Especially important in the operation of the council was the secretary-general, a post held first by Lord Ismay of the United Kingdom and then by Paul Henri Spaak of Belgium. Working under the direction of the secretary-general was an international staff secretariat, made up of nationals from the 15 countries acting as international civil servants. The North Atlantic council had several civilian committees. perhaps the most significant of which were those concerned with infrastructure (the network of installations supporting the military capability of the organization) and the annual review committee, whose function it was to survey the military programs of the member governments to determine the adequacy of their contributions to the organization and the forces which they might justly be called upon to maintain at the disposal of the NATO commanders.

Responsible within the organization to the North Atlantic council was the complex of military committees, at the head of which was the military committee itself. A noteworthy subsidiary was the standing group, meeting in Washington and composed of British, French and United States representatives whose task it was to provide advice co-ordinated among the three senior nations of the alliance.

Also beneath the military committee were the various regional commands into which the area covered by the treaty was divided. Of these commands the supreme allied commander in Europe (SACEUR) was so important, by reason of the central continental area for whose defense he was responsible, as to overshadow. at least in the popular view, the other commands, administratively on the same level. SACEUR began to emerge with the appointment late in 1950 of Gen. Dwight D. Eisenhower, of the Gnited States. As in the case of other commands, including most prominently the supreme allied commander Atlantic (SACLANT), with headquarters in Norfolk, Va., SACEUR was in turn divided regionally into subordinate forces for northern, central and southern Europe and for the Mediterranean. On the European continent another division was by the type of forces involved — land, sea and air.

Problems of Co-ordination. — Not without difficulty were arrangements for defense set in place. While recognizing the necessity for co-operation, nations were understandably reluctant to accept subordinate positions in areas which for centuries they had individually fought to defend—often against their contemporary partners. Where overlapping interests threatened to conflict, as in the Mediterranean, organizational arrangements perforce reflected compromises hammered out in lengthy sessions. Furthermore, it was easier to advocate national concentration on particular weapons and particular forces than it was in practice to induce nations to abandon portions of their military establishments. Equality of sacrifice was another principle accepted in theory by all, but practically impossible to write into any acceptable mathematical formula for the sharing of defense costs. That lasting, divisive disputes on questions such as these could be avoided was evidence of the underlying foundation on which NATO was built: the conviction that the Soviet Union posed a military threat to the nations involved which only considerable sacrifice of national independence could frustrate.

Problems of **Implementation.**—Of even greater seriousness were three other interrelated military problems: (1) the number and type of forces which the allies should raise, (2) the contribution which west Germany should make to that total and (3) the degree of involvement of United States forces and weapons in the organization.

1. After the outbreak of the Korean war military estimates placed at about 90 the number of divisions needed in western Europe to deter and defeat Soviet attack. At the same time it was apparent that NATO nations could not and would not come close to this desired level. Reconciliation of the initially large gap between what ought to be done and what would be done was attained, not without uneasiness, by first accepting an increased element of risk contained in force goals only slightly more than half as large as initially established.

After 1954 another step toward closing the gap was taken with the announcement that NATO forces would feel free to use nuclear weapons in case of Soviet attack. It was expected that the possession of these weapons and warning to Russia that they would be used to stop aggression would increase the effectiveness of NATO as a deterrent to attack. Once more a reduction, to about 30, was made in the estimate of the number of divisions "required" both as deterrence and as defense.

2. Into this problem of the number and type of forces needed to defend western Europe the question of west Germany intruded. The logic of defense dictated a "forward strategy" or concentration of forces in west Germany. Economic and political decisions made by western European nations, when measured against the units available to the Soviet Union for any attack, pointed to the desirability if not the necessity of a west German military contribution. However, for some countries, particularly France, which had welcomed west German co-operation in European political and economic institutions, the reconstitution of a German army was difficult to accept. Four years passed after Sept. 1950, when the Gnited States first pressed for a German military contribution, before France, under the arrangement known as western European union, accepted German membership in NATO and the right of Germany to a military establishment. In the interim, French opposition finally destroyed the formula for subordination of German units to a supranational military and political control as embodied in the European Defense and European Political Communities (EDC and EPC) respectively. Restraints on Germany still existed in the agreement within the western European union that Germany should manufacture no nuclear weapons of its own. Against the decision to use such weapons if necessary and the inexorable spread of nuclear technology it was uncertain how long German self-denial could last.

3. The United States mas the key to both of these problems. It obviously was not disposed, even if it were able, to bridge the gap alone between available and needed western forces. Moreover, existing legislation prevented the United States from handing over nuclear weapons or information on their manufacture to its allies. This position, in addition to making a German contribution more urgent. also influenced profoundly the operating principles of NATO. Until countries other than Great Britain and the United States developed atomic armament. these weapons were controlled by the two countries alone and were to be passed to NATO only after a Soviet attack had taken place. Under the circumstances oi their own relative weakness, western European countries accepted the fact that a substantial degree of the deterrent to Soviet attack came from that portion of the U.S. military establishment not under NATO control at all, principally the strategic air command. For their own protection the other NATO members, including Great Britain with its independent bomber command, depended on Russian recognition and acceptance of the thesis that the United States mould throw its full might against a Soviet attack on western Europe and that this power would destroy the Russian military base before Soviet arms had penetrated the continental defense screen set up by NATO.

Significance.—NATO was designed primarily, therefore, as an instrument of military defense in the particular postwar era characterized by a perceived Soviet military threat to western Europe and by a U.S. preponderance of nuclear military power. The existence of other organizations, such as the Coal-Steel Community (E.C.S.C.) and the European Payments union (E.P.U.), and the projection of such other European institutions as the Common Market (European Economic Community) and Euratom (European Atomic Community) made it seem inadvisable to some member nations, notably the United States, for the organization to venture far on its own in the field of economic co-operation. At the same time diversity of interests and power prevented the organization from utilizing such supranational agencies as the supreme commanders, the international secretariat and the annual review as foundations on which to build a united Atlantic community. Nonetheless its viability over the long range seemed to depend on its ability to serve both nonmilitary and non-European ends. Particular stress on political consultation mas laid by the "committee of three"—Halvard M. Lange of Norway, Gaetano Martino of Italy and Lester B. Pearson of Canada—reporting to the council of ministers after the abortive invasion of the Suez area in 1956 by British and French troops. Time was needed to assess the effectiveness of NATO in contributing to the solution of conflicts between NATO countries, such as that represented by the Suez affair or by the Greek-Turkish-British imbroglio over Cyprus. The enduring strength of the organization rested also in large part on the solution to other important problems of NATO countries outside the NATO area, as in the case of France with African territories and perhaps the U.S. with Communist China.

Finally, the security of the allies bound up in NATO could not be restricted to Europe. The loss of freedom to international Communism by nations of Africa and of the near, middle and far east would enable a Soviet Union possessing acknowledged superiority both in manpower and in certain categories of nuclear armament to pose a renewed threat to western Europe and to North America which the 15 members of the Korth Atlantic Treaty organization would find immeasurably more difficult to meet than was the Communist challenge in 1949.

For a discussion of the opposing eastern European Communist military command, *see* WARSAW TREATY ORGANIZATION. *See* also ALLIANCE; PAX-EUROPEAN MOVEMENT. For other regional agreements for mutual defense and consultation, *see* SOUTHEAST ASIA TREATY ORGANIZATION; BAGHDAD PACT.

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(E. S. F.)

NORTH BAY, a lumber, mining and railway city on the northeast shore of Lake Nipissing, northern Ontario, Can., 227 mi. N. of Toronto. on the Canadian Pacific, Canadian National, and Ontario Northland railways and a port of call of the main Trans-Canada Air Lines. North Bay is the base of supply for the mining districts of Cobalt, Gowganda and Porcupine, and is a summer resort. Pop. (1956) 21,020.

NORTH BERWICK, a royal and small burgh of East Lothian. Scot., on the southern shore of the entrance to the Firth of Forth, $23\frac{1}{2}$ mi. E.N.E. of Edinburgh by road. Pop. (1951)

4,001. Created a royal burgh in the 14th century, it was once a port of some importance. It is now a holiday town with a dry climate, sandy beaches, golf courses and a small fishing harbour, close to which are exposed the foundations of the 12th-century parish church of St. Andrew. Korth Berwick Law (613 ft.) rises just south of the town. About 3 mi. E. the ruins of the 14th-century diked Tantallon castle stand magnificently on the cliffs.

NORTHBROOK, THOMAS GEORGE BARING, 1ST EARL OF (1826–1904), English statesman, eldest son of the first baron (long known as Sir Francis Baring; see BARING), was born on Jan. 22, 1826, and educated at Christ Church. Oxford, where he graduated with honours in 1846. He was successively private secretary to Labouchere (Lord Taunton), Sir George Grey and Sir Charles Wood (Viscount Halifax). He was member of parliament for Penryn and Falmouth (1857–66). He was a lord of the admiralty in 1857–58; undersecretary for war, 1861; for India, 1861–64; for the home department, 1864–66; and secretary to the admiralty, 1866. In the Gladstone ministry of 1868 Korthbrook was undersecretary for war (1868–72). He was then governor general of India, but resigned in 1876 because his policy of coming to an arrangement with Shere Ali, which might have prevented the Afghan War, was overruled by the duke of Argyll, then secretary of state. From 1880 to 1885 Northbrook, who had received an earldom, was first lord of the admiralty in Gladstone's second government. In Sept. 1884 Northbrook was sent to Egypt as special commissioner to inquire into its finances. He died on Nov. 15, 1904.

See B. Mallet, *Thomas George, Earl of Northbrook (1908).*

NORTH CAPE (NORDKAPP), a promontory on the island Magerö off the north coast of Norway in 71" 10' 20" N., 25" 45' E., 78 mi. northeast of Hammerfest. Knivskjaerodden, an island a little to the west, is actually a little farther north than the North Cape, and Nordkyn, 45 mi. farther east, is the northern extremity of the mainland (71° 7' N.). The desolate cape, rising abruptly over 1,000 ft. from the sea, is frequently visited during the summer period of the "midnight sun."

NORTH CAROLINA, popularly known as the "Tar Heel state" and the "Old North state," one of the original 13 states, the 12th to ratify the constitution, is located in the southeastern part of the United States. It is bounded on the north by Virginia. on the east and southeast by the Atlantic ocean, on the south by South Carolina and Georgia and on the west and northwest by Tennessee. North Carolina has an extreme length from east to west of 503¼ mi., which is greater than that of any other state east of the Mississippi river. Its total area is 52.712 sq.mi., of ahich 3,645 sq.mi. are water surface; in size it ranks 28th among the states. The name Carolina ("land of Charles") was first used in 1629 in honour of Charles I of England. The capital of the state is Raleigh (*q.v.*), named in honour of Sir Walter Raleigh. The North Carolina state motto is Esse *quam* videri ("To Be Rather Than to Seem"). The flag has a blue union containing a white star and the letters "N" and "C," the star surmounted by a scroll bearing the inscription "May 20th, 1775" (the date of the Mecklenburg declaration of independence), and below the star another scroll inscribed "April 12th. 1776"; the fly consists of two equal bars of red and white. The state bird is the cardinal, the flower the dogwood and the song "The Old North State."

PHYSICAL GEOGRAPHY

Physical Features.—The state (between latitude 33° 52' and 36" 34' N., and between longitude 75° 27' and 84° 20' W.) lies wholly within the three leading topographical regions of the eastern portion of the United States: the Coastal plain, which occupies approximately the eastern half; the Piedmont plateau, which occupies about 20.000 sq.mi. in the middle; and the Appalachian mountain region, which occupies about 6,000 sq.mi. in the west.

Coastal Plain.—At the eastern extremity of the Coastal plain region an outer coast line is formed by a chain of narrow sandy islands, known as the Outer banks, from which project capes Hatteras. Lookout and Fear, whose outlying shoals are known for their difficulty of navigation. Between Hatteras and Lookout is Raleigh bay and between Lookout and Fear is Onslow bay; and between the chain of islands and the deeply indented mainland Currituck, Albemarle (see ALBEMARLE SOUND), Croatan, Pamlico, Core and Bogue sounds form an extensive area, especially to the northward of shallow, brackish and almost tideless water. Projecting into these sounds and between the estuaries of rivers flowing into them are extensive tracts of swampland, the best known of which is the Great Dismal Swamp, which lies mostly in Virginia and is about 37 mi. long and 22 mi. wide (see DISMAL SWAMP). The Coastal plain contains many natural lakes, the largest of which are hfattamuskeet, Waccamaw, Black and Phelps. Through most of the region, which extends inland an average of 150 mi., the country continues very level or only slightly undulating, and rises to the westward at the rate of little more than one foot to the mile. The Fall line, the boundary between the Coastal plain and the Piedmont plateau, has a very irregular course across North Carolina, but lies in a general southwesterly direction from the Falls of the Roanoke between Halifax and Northampton counties to Anson county on the South Carolina border; it marks a rapid increase in elevation of about 200 ft.

Much of the land near the coast is low and swampy, but the western part of the Coastal plain has much fertile soil, chiefly sand silt loams. This is the largest and best farming area in the state, the place where much of the nation's bright-leaf tobacco is grown as well as a great variety of other crops. The Sandhills area in the vicinity of Pinehurst and Southern Pines, at the western edge of the Coastal plain, is famous as a winter resort and as a peach-producing area. The chief rivers in the Coastal plain are the Roanoke, Chowan, Tar-Pamlico, Neuse-Trent and Cape Fear. With the exception of the Cape Fear, which empties directly into the ocean, all of these rivers flow into the sounds, which are shallow and not very good for navigation and trade. Wilmington (*q.v.*), the state's leading deep-water port, is situated on the Cape Fear river.

Piedmont *Plateau.*—North Carolina has the largest Piedmont plateau area of any of the eastern states. This region extends from the Fall line westward to the Blue Ridge escarpment, toward which its mean elevation increases at the rate of about 3½ ft. to the mile. This gently rolling country ranges in elevation from about 400 ft. in the Durham area to 1,500 ft. in the Morganton vicinity. The chief rivers of the Piedmont are the Yadkin, Catawba and Broad. The Piedmont rivers, being shallow and swift and having many waterfalls, are not good for navigation but are excellent for the development of power. Textiles, tobacco and furniture manufactures first developed in the Piedmont, and this region remains the centre of North Carolina manufacturing.

Appalachian Mountains.—The third physical division in the state is the mountain region, a part of the Appalachian system. There are two large chains of mountains, the Blue Ridge (*q.v.*) on the east and the Great Smoky mountains (*q.v.*) on the west. Connecting these two chains are several cross ridges. One of these, the Black mountains, contains Mt. Mitchell (6,684 ft.), the highest peak in the eastern part of the United States. The state has the largest mountain area in eastern America. In the "Land of the Sky," as this beautiful region is sometimes called, there are 43 peaks of over 6,000 ft. and 125 others of more than 5,000 ft. The mountain valleys are usually narrow and deep, though few descend to less than 2,000 ft. above sea level. The beautiful scenerv. pleasant climate and good roads have made this region one of the great summer resorts of the nation.

From the Black mountains, the streams flow as from a ridge pole, some to the Atlantic, others to the Mississippi and finally to the Gulf of Mexico. West of the Blue Ridge the Hiwassee, the Little Tennessee and the French Broad rivers flow west or northwest into Tennessee. Farther north are the headwaters of the New river, which finds its nay to the Ohio. On the southeastern slope of the Blue Ridge rise the Broad, the Catawba and the Padkin, which first flow northeast, then. finding a passage across one of the ridges of the Piedmont plateau, turn to the southeast and across the boundary line into South Carolina, in which state their waters reach the Atlantic.

Climate.—The climate of North Carolina varies from that of the southeast corner, which approaches the subtropical, to that of the mountain region, which is like the medium continental type except that the summers are cooler and the rainfall greater. The mean annual temperature for the state (below an elevation of 4,000 ft.) is about 59° F.; for the Piedmont plateau region, 60° F.; for Southport, in the southeast corner of the state, 64° F.; and for Highlands, at an elevation of 3,817 ft. in the southwest corner, 50° F. Extremes have ranged from −19° F. at Highlands to 107° F. at Chapel Hill, Orange county. The average precipitation for the state is about 50 in. a year, nearly all of it in the form of rain. For the Coastal plain region it is 48 in.; for the Piedmont plateau region 47 in.; and for the mountain region 54 in. On the east slope of some of the mountains the rainfall is exceedingly heavy. The winds are variable and seldom violent, except along the coast during the subtropical storms of late summer and early autumn.

Soil.—In the Coastal plain the soil is generally sandy, but in all parts of this region more or less marl abounds; south of the Neuse river, the soil is mostly a loose sand, north of it there is more loam on the uplands, and in the lowlands the soil is usually compact with clay, silt or peat; toward the western border of the region the sand becomes coarse and some gravel is mixed with it. The entire Piedmont region is underlain by crystalline rocks, such as granite and schists. The soils are, for the most part, red sandy loams, gravelly and sandy in spots.

Vegetation.—The growing season, free from killing frost, ranges from 240 days along the coast to 200 in the mountains. Because of its great variety of climate and soils, North Carolina has the greatest variety of plant life of any state in eastern America. Tree species range from subarctic spruce and balsam fir in the high mountains to subtropical palmetto in the Wilmington-Southport area. North Carolina is one of three states having the greatest variety of hardwoods. It is the second largest lumber producing state in the south and the fifth largest in the nation. Pines are found throughout the state, especially in the east. Near the coast grows the carnivorous Venus's-flytrap.

Animal Life.—Among the most prevalent wild animals are rabbits, squirrels, raccoon, opossum, deer, bear, muskrats. foxes and wildcats. The commonest birds are cardinal, wren, mockingbird. chickadee and also many varieties of woodpeckers and warblers. Quail, doves, robins, wild turkeys, geese and duck also are plentiful. Many migratory game birds winter in North Carolina and swans, geese and ducks nest near the coastal waters.

Inland-water fish such as bluegills, crappies, bass and sunfish are found in many ponds and lakes throughout the state. Brook and rainbow trout also thrive in the mountain streams. Shad, herring, croakers and many other varieties of fish are to be found in the sounds and other waters of eastern North Carolina. Oysters, clams, shrimp and scallops are abundant along the seaboard.

State and National Parks, Historic Sites, Forests and Game Refuges.—By the early 1960s the state had acquired and developed almost a score of parks and recreational areas, among which are Mount Mitchell, Fort Macon near Beaufort, Hanging Rock in Stokes county, Morrow Mountain in Stanly county, Cliffs of Neuse in Wayne county, William B. Umstead park in Wake county, Town Creek Indian mound in Montgomery county and Tryon's palace at New Bern.

The United States government contributed greatly to recreational development by the creation of four large national forests—Pisgah and Nantahala in the mountains. Uharie in the Piedmont and Croatan in the Coastal plain. It also established the Great Smoky Mountains National park (*q.v.*), containing about 500,000 ac. in North Carolina and Tennessee. National military parks and historic sites are Guilford Courthouse (near Greensboro), Moores Creek (near Wilmington), Fort Raleigh (at Roanoke Island) and Wright Brothers National memorial (at Kitty Hawk). The Cape Hatteras National Seashore recreational area, composed of approximately 28,500 ac. in public beach and dune lands, is the first and only such area in the national park system.

HISTORY

The history of North Carolina may be divided into four main periods of unequal length and significance: the period of discovery and early colonization (1524–1663); the period of proprietary rule (1663–1729); the period of royal rule (1729–76); and the period of statehood (from 1776).

Discovery and Early Colonization.—The first Europeans to explore the coast of North Carolina were the French led by Giovanni da Verrazano in 1524. Two years later, Lucas Vasquez de Ayllon led a Spanish expedition from Santo Domingo and planted a temporary colony of over 500 people near the mouth of the "Rio Jordan," probably the Cape Fear. In 1540 Hernando de Soto's expedition from Florida penetrated the mountains of North Carolina before turning west and discovering the Mississippi river. Neither the French nor Spaniards made further efforts to colonize this region.

It nas the English who permanently colonized and held North Carolina. After receiving from Queen Elizabeth I a patent for colonization in the new world, Sir Walter Raleigh in April 1584 sent Philip Amadas (or Amidas) and Arthur Barlowe to discover a suitable site for a colony bordering on Florida, then in the possession of Spain. Amadas and Barlowe returned in September with a glowing account of the coast of North Carolina, and on April 19, 1585, a colony of 108 men under Ralph Lane sailed from Plymouth in a fleet of seven small vessels commanded by Sir Richard Grenville. The colony was established at the north end of Roanoke Island on Aug. 17 and about a week later Grenville returned to England for supplies. Threatened with famine and with destruction by hostile Indians, the entire colony left for England on June 19, 1586, on Sir Francis Drake's fleet. Only a few days after their departure Grenville arrived with supplies and more colonists, 15 of whom remained when he sailed away. Although greatly disappointed at the return of the first colony, Raleigh dispatched another company, consisting of 121 persons under John White, with instructions to move the plantation to the shores of Chesapeake bay. The new company arrived at Roanoke Island on July 22, 1587, and were forced to remain there by the refusal of the sailors to carry them farther. Of the 15 persons left by Grenville not one was found alive. White's granddaughter, Virginia Dare (b. Aug. 18, 1587), was the first English child born in America.

Governor White soon returned to England for supplies, and having been detained there until 1590 he found upon his return no trace of the colony except the word "Croatoan" carved on a tree; hence the colony was thought to have gone to friendly Indians of that name. The fate of the "Lost Colony" has remained one of the mysteries of history (see ROANOKE ISLAND).

Geographical conditions determined that the first permanent settlement of North Carolina was from Virginia rather than from Europe directly. The first permanent English settlement in America was made at Jamestown, Va., in 1607. Within a relatively short time people from this settlement were beginning to explore what is now northeastern North Carolina, and the area was also beginning to attract attention in England. In 1629 King Charles I granted Carolana (Carolina) to Sir Robert Heath, who did not succeed in planting a colony. The region north of Albemarle sound was first settled in the 1650s. probably as early as 1653, by persons moving south from Virginia in quest of good farm land. This settlement attracted attention in England, where a group of courtiers applied to Charles II for a patent to the territory south of Virginia including the Albemarle settlements.

Proprietary Rule.—In 1663 Charles II granted the territory between the 31st and 36th parallel. and extending from sea to sea, to the earl of Clarendon, the duke of Albemarle and six other favourites. These were the same boundaries as those in the Heath patent, which was now declared void because of failure to settle. By a second charter issued to the eight lords proprietors in 1665 the limits of Carolina were extended to 29° and 36° 30'. The proprietors established Albemarle county and divided it into precincts which chose representatives to an assembly which, with the court system, council and governor appointed by the proprietors, constituted the government. The first assembly met in 1665. In 1669 the proprietors adopted the Fundamental Constitutions of Carolina, written by John Locke, but this elaborate and feudalistic form of government failed to work and was eventually dropped. The proprietors failed to give Albemarle county competent officials or a stable, efficient government, and the colony grew slowly. The hardy, individualistic settlers drove several incompetent governors from office. Albemarle county ceased to exist by that name in 1689 when the proprietors appointed Philip Ludwell governor of "that part of our Province of Carolina that lies north and east of Cape Fear." Two years later a reorganization of government provided for a governor of all Carolina, resident at Charleston, who should rule the northern settlement through a deputy. From 1712 until 1729 the proprietors appointed governors to rule "Korth Carolina" as a separate province, though the boundary between Korth Carolina and South Carolina was not agreed upon until 1735 nor fully surveyed until 1815. The Sorth Carolina-Georgia boundary was not surveyed until 1819.

Settlers had troubles with the nonresident proprietors over quitrents and other matters relating to land tenure; with Virginia, which forbade shipment of Carolina tobacco through its ports and disputed over the boundary until its joint survey in 1728; and with England, whose trade regulations and taxation of tobacco led to Culpeper's rebellion in 1677. In 1708 the Cary rebellion broke out because of the taxation of Quakers and other dissenters for support of the established church. The colony suffered heavily from the Tuscarora War (1711–13) and was able to defeat and remove the Tuscarora to New York only by timely military aid from South Carolina. The trade of the colony suffered from pirates who frequented the coast, and the governors made little effort to stamp out piracy. This handicap to commerce was practically removed in 1718 when an expedition from Charleston captured Stede Bonnet and when another expedition from Virginia killed Edward Teach, commonly known as Blackbeard.

Owing to all these troubles and to inadequate transportation facilities, Korth Carolina's growth was extremely slow. All the other English colonies began with the founding of a town, but North Carolina had no town until after 1700. Bath, the oldest town in the state, was settled by French Huguenots from Virginia and was incorporated in 1706. In 1710 New Bern (*q.v.*) was settled by Swiss and Germans. In 1722 a village on Queen Anne's creek was named Edenton in honour of Gov. Charles Eden. Beaufort was begun about the same time. About 1727 Brunswick was laid out on the lower Cape Fear by Maurice Moore of South Carolina, and the attractive and fertile valley of the Cape Fear mith its superior navigation was settled quite rapidly. Newtown, incorporated as Wilmington in 1739. soon became the chief port. The estimated population of the colony at the close of the proprietary era was 35,000; they covered the area from Virginia southward beyond the Neuse river and in the Cape Fear valley.

Royal Rule. — In 1729 North Carolina became a royal colony when King George II purchased the shares of seven of the eight lords proprietors for £17,500, plus £5,000 for arrears in quitrents. Lord Carteret, later earl of Granville, refused to sell, and a strip of land in North Carolina lying between latitude 35° 34' and the Virginia line (36" 30′), known as the Granville district, was laid off as his one-eighth share of Carolina. Granville held the land in this area and collected quitrents, but he had no governmental jurisdiction. His land policy in the Granville district was a source of serious friction with inhabitants, and his ownership of the land deprived the colonial government of badly needed revenue.

The passage of North Carolina to the crown caused no significant change in governmental structure or powers, though it brought the colony more closely into line with British imperial administration. Royal government was characterized by greater stability, stronger administration and better enforcement of law and order than had prevailed under the proprietary regime. The transfer of the province to the crown marked the beginning of a significant era in North Carolina — its first real period of progress. The history of the colony for the next 40 years was characterized by a steady and rapid growth in population; settlement of the whole Cape Fear valley and the Piedmont; expansion of agriculture, industry and trade; some improvements in transportation and the beginnings of a postal system; a higher standard of living, reflected in better homes, finer furniture, more and better tools and implements and more comfortable living conditions; rapid growth of dissenting sects, notably Presbyterians and Baptists; founding of many churches, a few schools and some libraries; and publication of the first books and newspapers in the colony.

As settlement expanded many new counties and towns were founded. among the latter being Halifax, Campbellton (present Fayetteville; *q.v.*), Hillsboro, Salem, Salisbury (*q v.*) and Charlotte (*q v.*). There was a great increase in the production and trade of tobacco, naval stores (tar, pitch. turpentine and rosin) and rice with England, New England and the West Indies. The first printing press was set up at New Bern in 1749. and two years later appeared the first book and the first nenspaper. the *North Carolina Gazette*, edited by James Davis, the public printer.

During the royal period, Scotch-Irish, Germans, Highland Scots, English and a few other national stocks poured into North Carolina. Between the battle of Culloden (1746) and the American Revolution, perhaps 20,000 Highland Scots settled in the Cape Fear valley, comprising the earliest and largest settlement of Highlanders in America. About 65,000 Scotch-Irish, who came largely by way of Pennsylvania, and 25,000 Germans (Moravian, Lutheran and Reformed), also by way of Pennsylvania, settled throughout the Piedmont counties. Negro slaves increased from 6,000 to more than 40,000, being found mostly on eastern plantations engaged in the production of tobacco, rice and naval stores. The population of 35,000 in 1729, confined to the Coastal plain, increased to nearly 300,000 in 1775 and extended from the coast to the Blue Ridge mountains and to the Watauga-Holston valleys beyond. When North Carolina became an independent state in 1776, about one-third of its people were of English, stock; nearly one-third were Scottish, either Highlander or Scotch-Irish; one-fifth were Negroes; and about one-tenth were Germans.

Geographic, ethnic, economic, social and religious differences produced a deep-seated east-west sectionalism. The colonial government was dominated by the east, and even county government was controlled by the royal governor through his power to appoint local officers. County officials were often corrupt, inefficient and oppressive. The back country people suffered from excessive taxes, dishonest officials and exorbitant fees. They also complained bitterly about multiple office holdings. An association called the Regulators sought vainly to obtain reforms. Then they refused to pay taxes and fees, punished public officials and interfered with the courts. The War of the Regulation ensued, in which the insurgents were crushed by Gov William Tryon mith the support of the eastern-dominated government at the battle of Alamance, May 16, 1771.

The political history during the royal period is, like that of other colonies, the story of a constant struggle between representatives of the people and representatives of the crown. There were bitter disputes over questions of government, trade, finance and religion. In 1765–66 armed patriots prevented the enforcement of the Stamp act in the colony. The people formed associations pledged not to purchase British goods in protest against the import duties levied under the Townshend act of 1767. In 1774 they sent aid to Boston after its port was closed by the British following the Boston Tea Party.

In Aug. 1774 the first provincial congress met at New Bern in defiance of Gov. Josiah Martin and elected delegates to the first Continental congress. A second provincial congress met in April 1775, and in the next month royal rule ended in North Carolina when Governor Martin fled from New Bern to a British ship in the Cape Fear river. A committee representing the militia companies of Mecklenburg county on May 31, 1775, adopted a series of resolutions which declared that the royal commissions in the several colonies were null and void, that the constitution of each colony was wholly suspended and that the legislative and executive poners of each colony were vested in its provincial congress subject to the direction of the Continental congress; and the resolutions requested the inhabitants of the county to form a military and civil organization independent of the crown of Great Britain which should operate until the provincial congress should otherwise provide or the British parliament should "resign its unjust and arbitrary pretensions with respect to America." The Mecklenburg declaration of independence, which it is alleged was passed on May 20 by the same committee, is of doubtful authenticity, though the date appears on the state flag by legislative act. The Whig (patriot) victory at Moores Creek bridge, Feb. 27, 1776, thwarted Governor Martin's efforts to re-establish royal authority.

Independence. — The first sanction of independence by any colony was the Halifax resolution adopted by the fourth provincial congress on April 12, 1776, and the same body immediately proceeded to the consideration of a new and permanent form of government. Their labours ended, however, in another provincial government by a council of safety, and the drafting of North Carolina's first state constitution was left to a constitutional convention that assembled on Nov. 12, at Halifax.

In the American Revolution, North Carolina furnished ten regiments of Continental troops and many thousands of militia. It sent military aid to South Carolina and Virginia and to Washington's army in the north, while it also helped to defeat the Cherokees and suppress the numerous Tories who made the revolution a civil war in North Carolina. A British invasion was turned back on Oct. 7, 1780, by the destruction of Maj. Patrick Ferguson's army at King's mountain. Cornwallis' invasion of the state culminated in the battle of Guilford Courthouse on March 15, 1781. Though it was a technical British victory, Cornwallis retreated to Wilmington from where he marched north to his fate at Yorktown.

Statehood. — During the confederation, 1781–89, North Carolina, like other states, met its federal obligations to the central government only when it wished to do so. The state sent delegates to the Constitutional Convention of 1787 at Philadelphia, but the state convention, at Hillsboro, called to ratify the constitution for North Carolina, did not meet until July 21, 1788, when ten states had already ratified. The document was strongly opposed because it contained no bill of rights and on the ground that it would provide for such a strong central government that the state governments would ultimately be sacrificed. At the conclusion of the debate the convention declared itself unwilling to ratify the constitution until a bill of rights had been added and it had been amended in several other particulars so as to guarantee certain powers to the states. But a second convention met at Fayetteville in Nov. 1789 and the constitution mas speedily ratified (Nov. 21).

In 1789 also the University of North Carolina mas chartered by the state legislature (opened to students in 1795) and the state ceded its western lands (Tennessee) to the United States. In 1792 a permanent capital was located at Raleigh and a capitol building was completed in 1794. The first banks were established in 1804 at New Bern and Wilmington. Superior courts were provided for each county in 1806 and a supreme court was created about the same time, though district judges for it were not provided until 1818. In the second war with Great Britain (1812–15), North Carolina's quota of 7,000 soldiers served on the southern frontier and along the Canadian border.

East-West Struggle. — The period from 1789 to 1835 was marked by a contest between the dominant eastern and the western counties. The west urged that equal county representation in the legislature be replaced by representation based on population. This was stubbornly resisted, and the west assumed a threatening attitude as the east opposed its projects for internal improvements for which the west had greater need. Finally in Jan. 1835 the legislature passed a bill for submitting to popular vote the question of calling a constitutional convention. In the election that followed in April, every eastern county gave a majority against the convention, but the west voted strongly for it and carried the election. In the convention, the east made some concessions, such as the popular election of the governor, the disfranchisement of free Negroes, the abolition of borough representation in the legislature, the choosing of state senators from districts according to public taxes. and the apportioning of members of the lower house (commoners) to counties according to population based on the federal ratio. The electorate gave its approval to the revision, and nith this the agitation over representation ceased.

Whigs and Democrats. — The period 1835–60 was an age of progress in the state. After the constitutional reforms of 1835 broke the political dominance of the east, the new progressive Whig party controlled the state government from 1836 to 1850 and adopted the program of public education and internal improvements that had been proposed by Archibald D. Murphey 20 years earlier. The Democratic party, generally dominated by the planter class, grew weary of successive defeats because of its negative program of opposition to Whig policies It captured control of the state in 1850 because of its able young leaders (notably W. W. Holden and David S. Reid), its advocacy of free suffrage (abolition of 50-ac. requirement to vote for state senators), and the weakening of the Whig party as a result of the slavery controversy and the failure of the Whigs to press forward with the progressive program they had launched.

The Democratic party controlled the state from 1850 to 1862. Once in pooer it gradually adopted and extended the progressive program inaugurated by the Whigs In the generation before 1860 the state government completed a new capitol in 1840 (the first one had burned in 1831), gave millions of dollars of aid for building of plank roads and a 900-mi. network of railroads, established (1839–40) and provided the major financial support for a state system of free public elementary schools for white children, established institutions for the care of the blind, deaf and insane, expanded the state system of taxation and made some liberal changes in the criminal law and in the legal status of women. The state university grew rapidly; many private academies were founded as well as colleges for women; and the leading denominations established colleges for men. Nenspapers increased in numbers and circulation, and there was a beginning of indigenous authorship. Bright-leaf tobacco was developed, and there mere many improvements in farming methods and increases in crop production (particularly cotton and tobacco) There was also a significant beginning of manufactures, notably cotton textiles. This age of progress-and prosperity was brought to an end by the Civil War.

Civil War and Reconstruction. — The fundamental points of difference between North Carolina and South Carolina were exemplified in the controversy over slavery. South Carolina led the extreme radical element in the south and was the first state to secede (Dec. 1860). North Carolina held back, worked for a compromise, sent delegates to the Washington peace convention in Feb. 1861 and did not secede until May 20, 1861, after President Lincoln's call for troops to preserve the union. Entering the war reluctantly, the state furnished troops in excess of its voting population and of its relative population in the Confederate states. While making its full contribution of men, money and supplies to the Confederacy, the state, under the political control of the Conservatives after 1862 with Zebulon B. Vance as governor. sharply criticized the policies of the Jefferson Davis administration, contending that the Confederacy was encroaching upon the prerogatives of the states. The northeastern part of the state was captured by Federal troops in 1862 and held throughout the war. The battles of Ft. Hatteras. Plymouth. Ft. Fisher (the "Gibraltar of America") and Bentonville, Sherman's invasion in March 1865 and Johnston's surrender to Sherman near Durham on April 26, 1865, were the most notable events of the war in North Carolina. Wilmington remained the most important blockade-running port in the Confederacy until the fall of Ft. Fisher in Jan 1865. About 40.000 North Carolina soldiers died in battle and from disease. The war had bled North Carolina white and left it with a depressing heritage of defeat.

Reconstruction was a difficult experience in North Carolina as in other southern states. In 1865 Pres. Andrew Johnson appointed W. W. Holden provisional governor until an election could be held. The convention of 1865 repealed the ordinance of secession, declared slavery abolished, repudiated the state war debt and scheduled elections for the establishment of a constitutional state government. Jonathan Worth, nho was elected governor, was an honest and capable official, but the government established shortly thereafter in accordance with the views of congress was corrupt, inefficient and tyrannical. Carpetbaggers, Negroes and native whites known as scalawags were in control of affairs, while many people of wealth, refinement and education were disfranchised. The Republican party, organized in the state in 1867, took the lead in nriting and adopting the constitution of 1868—a very liberal document—and captured control of the state government. Gov. W. W. Holden (elected 1868) mas so unpopular and tyrannical that he mas impeached, convicted and removed from office by the legislature in 1871. Under his successor, Tod R. Caldwell, there was some improvement in the condition of affairs, and in 1875 a constitutional convention at Raleigh, with the Democrats slightly in the majority, amended the constitution, their work being ratified by popular vote at the state election later in the year. The native white element completely regained possession of the state with the election of Zebulon B. Vance as governor in 1876.

Late 19th Century.— For the next 20 years the Democratic party gave the state respectable, cheap government and kept the Negro from office and political influence; but under control of the conservative element, sometimes known as Bourbon Democrats, it neglected the needs of the great mass of farmers, catered to railroads and other business interests and sought to perpetuate itself in power by appeals to party loyalty and race prejudice rather than by meeting the social, educational and political needs of the state. Cotton, tobacco and furniture manufactures grew rapidly after 1880. Business prospered but agriculture was in a sad plight, as it was throughout the nation generally. Finally, the organized farmers of the state formed the Populist (People's) party, which in 1894 fused with the Republicans and carried the state; tno years later, Daniel Russell, a Republican, was elected governor. The race question dominated the elections of 1898 and 1900. when the Democrats came again into power; and in 1900 a constitutional amendment (the literacy test and the so-called "grandfather clause") virtually disfranchising the Negro was adopted.

20th Century.— In the midst of this period came World War I, in which the state contributed over 86,000 persons to the armed services and $160,000,000 in bond purchases. A decade of significant highway, educational and other economic and social developments folloned. being succeeded in turn by the depression of the 1930s, which brought widespread hardship and severe curtailment of education and other public services. The state government extended relief to the counties by assuming substantially the full cost of highways in 1931 and of public schools in 1933. By 1940 the state was beginning to enjoy another period of progress. Meanwhile, state-wide prohibition, in effect since 1908, mas superseded in 1933 by a system of state-supervised county liquor stores.

In the 1940s the national defense program and World War II had important effects on North Carolina. Some of the country's largest military installations were located in the state, among them Ft Bragg and Camps Lejeune, Butner, Davis, Mackall, and Cherry Point. More than 362 000 North Carolinians served in the armed forces and more than 7.000 lost their lives. Residents of the state subscribed over $1,800,000,000 in various bond drives Almost $2,000,000,000 nas spent in the state by the armed forces for manufactured nar supplies, not including subcontracted materials, and North Carolina delivered more textile goods to the army than did any other state.

The state established a pension and retirement system for teachers and other state employees in the 1940s, provided a nine months' term for public schools and launched a vast medical care program, providing for a four-year medical school and hospital at the state university and hospitals throughout the state. Legislative appropriations nere made to the North Carolina Art society and to the North Carolina Symphony society, the first instances of state financial aid to art and music. In 1959 the State Art museum at Raleigh had the most outstanding art collection in the south. In 1949 the voters of the state approved a bond issue of $200,000,000 for secondary road construction. Bond issues to the extent of $75,000,000 for construction of public school buildings were approved by the voters in 1949 and 1953.

Rapid industrialization, accompanied by urbanization, made manufacturing the chief source of the state's wealth and gave it pre-eminence in the nation in tobacco, cotton textiles and wooden furniture. Industrial expansion and diversification after 1950 were almost phenomenal. In national politics the state ment Republican tor the first time since Reconstruction nhen it voted for Herbert Hoover in 1928, but in 1932 the state returned to the ranks of the Democratic "solid south."

Among the most significant later developments in the state were the creation in 1956 of the state board of higher education; the reorganization of the state government by the creation of a department of administration; the revision of the corporate tax structure; the creation of the Research Triangle (University of North Carolina at Chapel Hill, Duke university in Durham and North Carolina State college at Raleigh) and the development of the Research park; and the adoption of the Pearsall plan to cope with the problem of desegregation in the public schools.

GOVERNMENT

North Carolina has been governed under the charters of 1663 and 1665 (1663–1729), under commissions and instructions from the crown (1729–76) and under the constitutions of 1776 and 1868, with numerous amendments. The present constitution, as amended, prescribes that no convention of the people of the state may be called by the legislature unless by the concurrence of two-thirds of all the members of each house, followed by an affirmative vote of a majority of the electors voting on the question; and that an amendment to the constitution may be adopted also by a three-fifths vote of each house, followed by an affirmative vote of the majority of electors voting on the question. The suffrage provisions containing the famous "grandfather clause" (in art. vi, sec. 4) were adopted in the form of a constitutional amendment, ratified in 1900, and in effect July 1, 1902. This amendment required that any applicant for registration must be able to read and write any section of the constitution; the grandfather clause, however, provided that no person who was entitled to vote on or before Jan. 1, 1867, or his lineal descendant, should be denied registration by reason of his failure to possess the educational qualifications, provided that he registered prior to Dec. 1, 1908. In effect, the amendment disfranchised Negroes. In June 1959 the supreme court of the United States upheld this literacy test.

Executive.— The constitution provides for an executive department consisting of a governor (not eligible for immediate re-election), lieutenant governor, secretary of state, treasurer, auditor, superintendent of public instruction, attorney general, commissioner of agriculture, commissioner of labour and commissioner of insurance, all elected by popular vote for terms of four years. An ex officio council of state is adviser to the governor. A utilities commission of three members. a commissioner of revenue, a highway and public works commissioner, a board of education, a board of higher education and other boards and commissioners are appointed by the governor. From 1776 to the constitutional revision of 1835, the governor nas elected by the legislature for a one-year term; from 1835 to 1868 he was chosen by the voters for a two-year term; after 1868 he was chosen for a four-year term. The North Carolina governor has no veto power, the only instance of this kind in the nation. Yet the governor exercises vast power by control of appointments and by virtual control of state expenditures, as head of the budget bureau.

Legislature.— The general assembly comprises a 50-member senate elected by the voters in 33 senatorial districts and a 120-member house of representatives, each of the 100 counties having one representative, with the extra 20 distributed among the most populous counties. Sessions of the general assembly are held biennially, beginning on the first Wednesday in February of the odd-numbered years. It usually remains in session from 60 to 90 days.

Judiciary.— The state's judiciary consists of a supreme court with a chief justice and six associate justices elected by popular vote for eight-year terms; 31 superior court judges and solicitors, elected by the people (judges for eight-year terms and solicitors for four-year terms), who hold courts in the counties of the 31 superior court districts; and various inferior statutory courts. Minor civil and criminal cases are tried before a justice of the peace or municipal judge.

Local Government.— The governing body in each of the state's 100 counties is the board of county commissioners— either three or five— elected by popular vote for two-year terms. Other important elective county officials are the sheriff, clerk of superior court, register of deeds, treasurer, coroner and board of education.

There are many appointive offices, among the most important being a superintendent of schools and a superintendent of public welfare. Most of the revenues for county government are derived from taxes on real and personal property.

The three forms of city government in the state are: (1) mayor and council: (2) commission; and (3) city manager. The latter system is the most prevalent among the larger towns and cities.

Finances. — North Carolina was one of the few states in the union in the early 1960s that had no state tax on property. State revenue is derived chiefly from other state tax sources. including a general 3% sales tax, individual income taxes, corporate income taxes. motor fuel taxes and license taxes. Major state expenditures. in order, are for public schools and institutions of higher learning, roads and highways, and health. welfare and safety. The assessed value of property is about $7,000,000,000.

POPULATION

The population of North Carolina in 1790 was 393.761; in 1830 it was 737,987; in 1870. 1,071,361; in 1910, 2,206,287; in 1940, 3,571,623; in 1950, 4,061,929: and in 1960, 4,556,155. This last figure represented an increase of 27.6% over the population in 1940 and of 12.2% over 1950.

North Carolina: Places of *5.000* or *More Population* (1960 census)*

Place	Population 1960	1950	1940	1920	1900
Total state	4,556,155	4,061,929	3,571,623	2,559,123	1,893,810
Albemarle	12,261	11,798	4,060	2,691	1,382
Asheboro	9,449	7,701	6,981	2,559	992
Asheville	60,192	53,000	51,310	28,504	14,694
Belmont	5,007	5,330	4,356	2,941	145
Burlington	33,199	24,560	12,198	5,952	3,692
Canton	5,068	4,906	5,037	2,584	230
Chapel Hill	12,573	9,177	3,654	1,483	1,099
Charlotte	201,564	134,042	100,899	46,338	18,091
Clinton	7,461	4,414	3,557	2,110	958
Concord	17,799	16,486	15,572	9,903	7,910
Dunn	7,566	6,316	5,256	2,805	1,072
Durham	78,302	71,311	60,195	21,719	6,679
East Wilmington	5,520	1,623	—	—	—
Elizabeth City	14,062	12,685	11,564	8,925	6,348
Fayetteville	47,106	34,715	17,428	8,877	4,670
Forest City	6,556	4,971	5,035	2,312	1,090
Gastonia	37,276	23,069	21,313	12,871	4,610
Goldsboro	28,873	21,454	17,274	11,296	5,877
Graham	7,723	5,026	4,339	2,366	2,052
Greensboro	119,574	74,389	59,319	19,861	10,035
Greenville	22,860	16,724	12,674	5,772	2,565
Henderson	12,740	10,996	7,647	5,222	3,746
Hendersonville	5,911	6,103	5,381	3,720	1,917
Hickory	19,328	14,755	13,487	5,076	2,535
High Point	62,063	39,973	38,495	14,302	4,163
Jacksonville	13,491	3,960	873	656	309
Kannapolis	34,647	28,448	—	—	—
Kings Mountain	8,008	7,206	6,547	2,800	2,062
Kinston	24,819	18,336	15,388	9,771	4,106
Laurinburg	8,242	7,134	5,685	2,643	1,334
Leaksville	6,427	4,045	1,886	1,606	688
Lenoir	10,257	7,888	7,598	3,718	1,296
Lexington	16,093	13,571	10,550	5,254	1,234
Lincolnton	5,699	5,423	4,525	3,390	828
Lumberton	15,305	9,186	5,803	2,691	849
Monroe	10,882	10,140	6,475	4,084	2,427
Mooresville	6,918	7,121	6,682	4,315	1,533
Morehead City	5,583	5,144	3,695	2,958	1,379
Morganton	9,186	8,311	7,670	2,867	1,938
Mount Airy	7,055	7,192	6,286	4,752	2,680
New Bern	15,717	15,812	11,815	12,198	9,090
Newton	6,658	6,039	5,407	3,021	1,583
North Belmont	8,328	3,948	—	—	—
Owens	5,207	—	—	—	—
Oxford	6,978	6,685	3,991	3,606	2,059
Raleigh	93,931	65,679	46,897	24,418	13,643
Reidsville	14,267	11,708	10,387	5,333	3,262
Roanoke Rapids	13,320	8,156	8,545	3,369	1,009
Rockingham	5,512	3,356	3,657	2,509	1,507
Rocky Mount	32,147	27,697	25,568	12,742	2,937
Roxboro	5,147	4,321	4,599	1,651	1,021
Salisbury	21,297	20,102	19,037	13,884	6,277
Sanford	12,253	10,013	4,960	2,977	1,044
Shelby	17,698	15,508	14,037	3,609	1,874
Smithfield	6,117	5,574	3,678	1,895	764
Southern Pines	5,198	4,272	3,225	743	517
Statesville	19,844	16,901	11,440	7,895	3,141
Tarboro	8,411	8,120	7,148	4,568	2,499
Thomasville	15,190	11,154	11,041	5,676	751
Washington	9,939	9,698	8,569	6,314	4,842
Waynesville	6,159	5,295	2,940	1,942	1,307
West Concord	5,510	—	—	—	—
Williamston	6,924	4,975	3,966	1,800	912
Wilmington	44,013	45,043	33,407	33,372	20,976
Wilson	28,753	23,010	19,234	10,612	3,525
Winston-Salem†	111,135	87,811	79,815	48,395	13,650

*Populations are reported as constituted at date of each census. †Winston city and Salem town were consolidated under the name of Winston-Salem in 1913.

Note: Dash indicates place did not exist during reported census, or data not available.

The population per square mile in 1960 was 86.4, as compared with 82.7 in 1950, and with 49.6 for the U.S. in 1960.

Of the 1960 population. 1,801.921, or 39.5%, lived in incorporated places of 2,500 or more. as compared with 30.5% in 1950. The state has five standard metropolitan statistical areas, which are Asheville, Durham, Greensboro-High Point, Raleigh and Winston-Salem. These areas had a total population of 840,638 or 18.5% of the total population of the state in 1960.

The number of occupied dwelling units (or households) in 1950 was 1,019,000. The average population per household had declined from 4.5 in 1940 to 4.0 in 1950.

The population of the State was distributed by colour and nativity in 1950 as follows: 73 0% native white; 0.4% foreign-born white; and 26.6% nonwhite, nearly all Negro. There were 99.8 males per 100 females in the native white population. and 95.4 in the Negro population; 5.6% of the population was 65 years old or over; and 55.0% of the population 14 years old and over was in the labour force. Of the total number of employed males. 31.1% mas engaged in agriculture. 8.1% in construction, 26 5% in manufacturing and 18 0% in transportation and trade.

Most of the nhite population of North Carolina is of English, Greek or German stock, and it is the only state whose population contains less than 1% of foreign-born persons.

EDUCATION

Public Schools. — The public-school system of North Carolina made remarkable and well-rounded progress after 1900. The total school expenditures between 1901 and 1929 increased from $2.87 per capita of enrollment to $42.53. As a result of the depression, public school expenditures dropped. but they rose rapidly in the decades during and after World War II. There are more than 3,000 public schools with 36.000 teachers and 2,000 principals and supervisors and more than 1,000,000 enrolled pupils. School attendance is compulsory between the ages of 7 and 16 inclusive. The length of school term and salary scale for white and Negro teachers are identical; in fact, the average Negro teacher's salary is higher because a larger percentage of Negro teachers hold class A certificates. From 1917, with the aid of federal funds, the state supported vocational education, particularly agriculture and home economics, in the public schools.

In the years following the supreme court ruling concerning racial segregation in the public schools (1953), some desegregation occurred under the pupil assignment law of 1956. Under the Pearsall plan the state constitution was amended in 1956 to permit state and local funds to be spent for private school tuition grants for children whose parents object to their attending integrated schools, and to allow local school units to close public schools if conditions should become "intolerable." Local school boards in several cities and counties admitted Negro-pupils to schools that formerly were all white.

Higher Education. — There are 36 senior (four years or more) colleges and universities in North Carolina, one-third state-supported, the other two-thirds private or church-related schools. The state also has about 25 junior college's, some of which are community colleges receiving local and state support, the others private or church-related institutions.

University of North Carolina. — Chief among the state institutions of higher learning is the University of North Carolina at Chapel Hill, chartered in 1789 and opened in 1795, one of the oldest state universities in the country and the first to begin operation in the south. Other branches of the consolidated university are North Carolina State College of Agriculture and Engineering (founded 1887) at Raleigh and Woman's College of the University of North Carolina (1891) at Greensboro. By 1860 the University of North Carolina had become the largest university in the south and one of the best. It remained open during the Civil War, though the student body was very small. but, unable to weather the Reconstruction period, it was closed from 1870 to 1875. It struggled during the latter part of the 19th century and had a vigorous growth after World War I. In 1931 the consolidated university, comprising the three institutions, came into being, and by the early 1960s the combined enrollment was almost 17,000 students. The university's colleges and schools at Chapel Hill include arts and sciences, city and regional planning, library science, social work, law, medicine, dentistry, nursing, pharmacy and public health. Its library totals nearly 1,000,000 volumes. Korth Carolina State college includes schools of agriculture, design, education, engineering, forestry and textiles. The Woman's college has schools of liberal arts, education, home economics and music, and commercial and nursing education departments.

Other State Institutions —Other state-supported colleges are East Carolina college (1907) at Greenville, Western Carolina college (1889) at Cullowhee and the Appalachian State Teachers college (1903) at Boone. State-supported Kegro institutions include the Agricultural and Technical college (1891) at Greensboro, the Winston-Salem Teachers college (1892). the North Carolina College at Durham (1910) and state teachers' colleges at Fayetteville (1877) and Elizabeth City (1891). A school for the Lumbee Indians of Robeson county is located at Pembroke.

Private *Institutions.*—Among the nonstate-supported institutions of higher education Duke university. formerly Trinity college (Methodist), at Durham, is the greatest. It received from James B. Duke the sum of $6,000,000 for building and an endowment fund estimated to be from $80,000,000 to $100,000,000, one of the largest foundations for education and hospitalization in the world (see DURHAM). Well-known church-related colleges are Wake Forest college (Baptist; 1833) at Winston-Salem; Davidson college (Presbyterian; 1837) at Davidson; Greensboro college (Methodist; 1838) at Greensboro; Lenoir Rhyne college (Lutheran; 1891) at Hickory; Catawba college (Reformed; 1851) at Salisbury; Meredith college for women (Baptist; 1891) at Raleigh; Elon college (Christian; 1889) at Elon; High Point college (Methodist; 1924) at High Point; Salem college for women (Moravian; 1772) at \$'inston-Salem ; Belmont Abbey college (Roman Catholic; 1878) at Belmont; Guilford college (Quaker; 1837) at Guilford College; Atlantic Christian college (Disciples of Christ; 1902) at Wilson; and Flora MacDonald college for women (Presbyterian; 1896) at Red Springs. Institutions for Negroes include Shaw university (Baptist; 1865) at Raleigh; Johnson C. Smith university (United Presbyterian; 1867) at Charlotte; Livingstone college (Methodist; 1879) at Salisbury; St. Augustine's college (Episcopal; 1867) at Raleigh; and Bennett college for women (Methodist; 1873) at Greensboro.

HEALTH AND WELFARE

The chief state-supported institutions in 1960 consisted of hospitals for the white insane at Raleigh, Morganton and Butner and a hospital for Negro insane at Goldsboro; the Caswell Training school for mental delinquents at Kinston; the North Carolina Orthopedic hospital for crippled children at Gastonia; the Korth Carolina hospital for the treatment of spastic children at Durham; sanatoriums for the treatment of tuberculosis at Black Mountain, McCain and Wilson; the Stonewall Jackson Training school for delinquent white boys at Concord; the Eastern Carolina Industrial Training school for delinquent white boys at Rocky Mount; the Morrison Training school for delinquent Negro boys at Hoffman; the training school for Negro girls at Rocky Mount; the North Carolina State Home and Industrial School for Girls and Women at Samarcand; and the Central prison at Raleigh.

The state has a very effective public health program, headed by the state board of health, established in 1877. All of the state's 100 counties have local health departments. North Carolina was the first state to pass a law (1959) making poliomyelitis vaccination compulsory.

THE ECONOMY

Agriculture. — North Carolina is a state of small farms, the average size being only about 66 ac.; Texas is the only state having a larger number of farms. The leading crops are tobacco, cotton, peanuts, corn, soybeans and a great variety of other crops, fruits and vegetables. North Carolina produces about two-fifths of the U.S. tobacco crop, chiefly bright-leaf flue-cured tobacco used in the manufacture of cigarettes and pipe tobacco; tobacco is grown in 90 of the 100 counties. The annual cash income from tobacco rose from $125,000,000 in 1939 to $523,000,000 in 1953 and to $755,000.000 in the late 1950s. Principal income sources (in descending order) were tobacco (almost ten times more than the next item), dairy products, broilers (second among the states in production), cotton lint, eggs and forest products. North Carolina agriculture is being diversified rapidly; by the early 1960s livestock accounted for almost one-third of farm income, as compared with about 16% in 1939.

In 1900 North Carolina was seventh among the southern states in the value of all farm crops. After 1920 it usually ranked 2nd in the south and from 5th to 13th in the nation. Nearly all farms are electrified. The state leads the nation in the number of 4-H club members.

The percentage of farms operated by tenants dropped from 44% in 1940 to 36.9% in 1954. Nearly 70% of Negro farmers are tenants. as compared with less than 35% of white farmers.

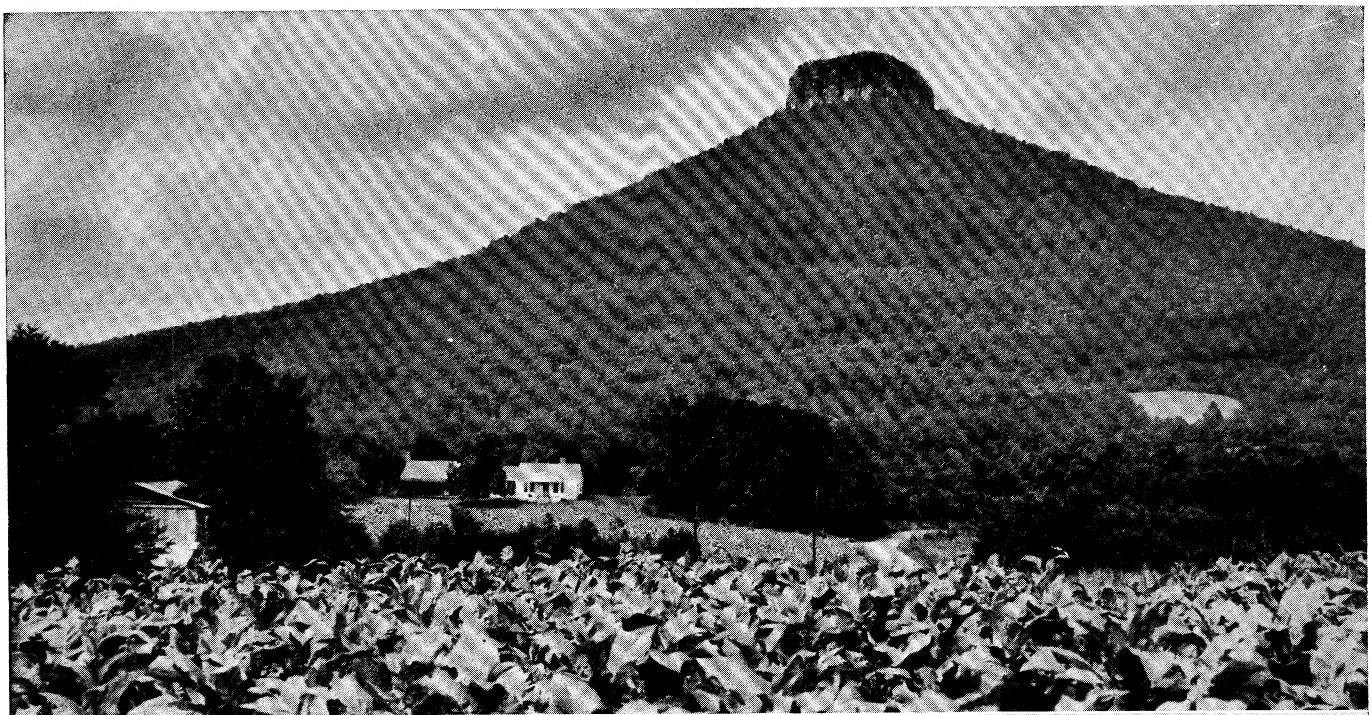
Lumbering.—Woods and forests cover more than one-half the area of North Carolina, the total amount of standing saw timber approximating 50,000,000,000 bd.ft. Of this timber, about 40% is pine and other softwoods; the remainder hardwood. On rich forest resources are based the state's major paper, furniture and pulp products industries, which collectively rank third, after textile and tobacco manufactures. The annual pulpwood cut is approximately 1,000,000 cords, while the lumber yield rose from 544,000,000 bd.ft. in 1889 to 1,994,000,000 bd.ft. by 1950, in the latter year representing about 5% of the national total. More than two-thirds of the state's counties co-operate uith the state division of forestry, and in the early 1960s more than 16,000,000 ac. were receiving protection.

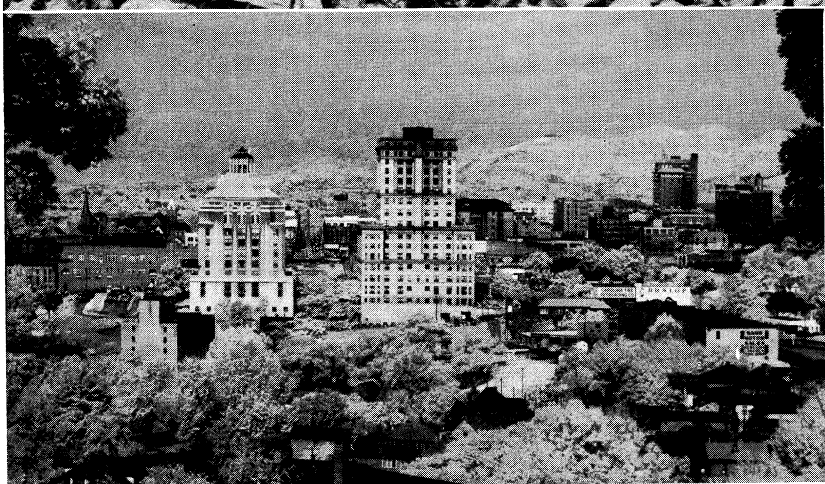
Fisheries. — In the sounds along the coast, in the lower courses of the rivers that flow into them and along the outer shores fishing is an important industry. The total value of the North Carolina fisheries runs to about $10,000,000 a year, the most important items being food fish, shrimps, menhaden and oysters. Chief oyster and crab fisheries are located in Pamlico sound, creeks and inlets; shrimp fisheries are concentrated in Pamlico sound, rivers and creeks, and offshore in the Atlantic.

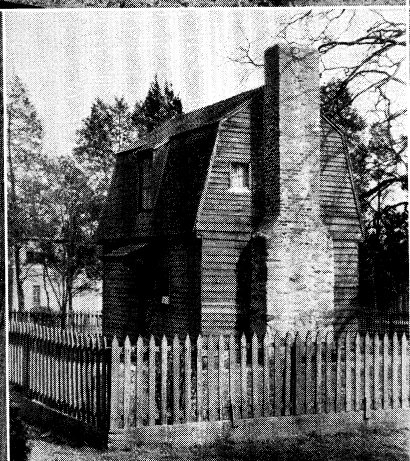
Minerals. — More than 300 different rocks and minerals are found in North Carolina, about 75 of them commercially valuable. From 1800 to 1848 North Carolina was the leading gold producing state, having mined approximately $60,000 000 worth of the precious metal. After 1900 the state normally ranked from 36th to 38th among the states in the total value of its annual mineral production. It is noted chiefly for its nonmetallic minerals. Mineral products (in descending order, according to value) include building stone (by far the most important), sand and gravel, feldspar, mica, clays, talc and pyrophyllite and tungsten. The state usually ranks first in the nation in the production of feldspar and mica; second in talc and vermiculite; and third in tungsten.

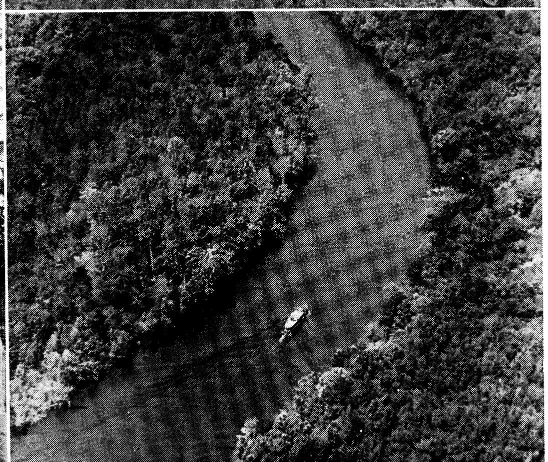
Manufactures. — The value of manufactures in North Carolina after World War II rose to exceed that of farm products. North Carolina is the leading industrial state of the south and one of the dozen foremost industrial states of the nation. In all such indexes as number of plants, labour force, total salaries and wages paid, value of raw materials used, total value of output and total value added by manufacture. North Carolina ranks from 10th to 14th among the states. Its leading manufactures (listed in descending order, by value of output) are textiles, tobacco, food products, furniture, chemicals, lumber, electrical machinery and pulp and paper. In manufacture of textiles, tobacco and household furniture North Carolina leads all other states.

The textile industry employs almost half of all workers engaged in manufacturing. Gaston, Mecklenburg and Guilford counties have been the leaders in textile manufacture, Gaston county having more cotton mills than any other county in the United States. Hosiery mills have been concentrated in the Piedmont, with Winston-Salem. Asheboro, Burlington and Durham being four of the largest producers. Most of the state's tobacco products are manufactured in Winston-Salem, Durham, Reidsville and Greensboro. High Point has been the leading centre of furniture manufacture, but other important centres are Thomasville, Lexington, Lenoir, Statesville, Newton-Conover, Hickory, Mount Airy,









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SCENES IN NORTH CAROLINA

Top: Pilot mountain, a curious rock formation (about 2,500 ft. high) near Mount Airy. In the foreground is a field of tobacco, the state's leading crop

Centre left: Asheville, resort city in the southern Appalachian highlands, western North Carolina

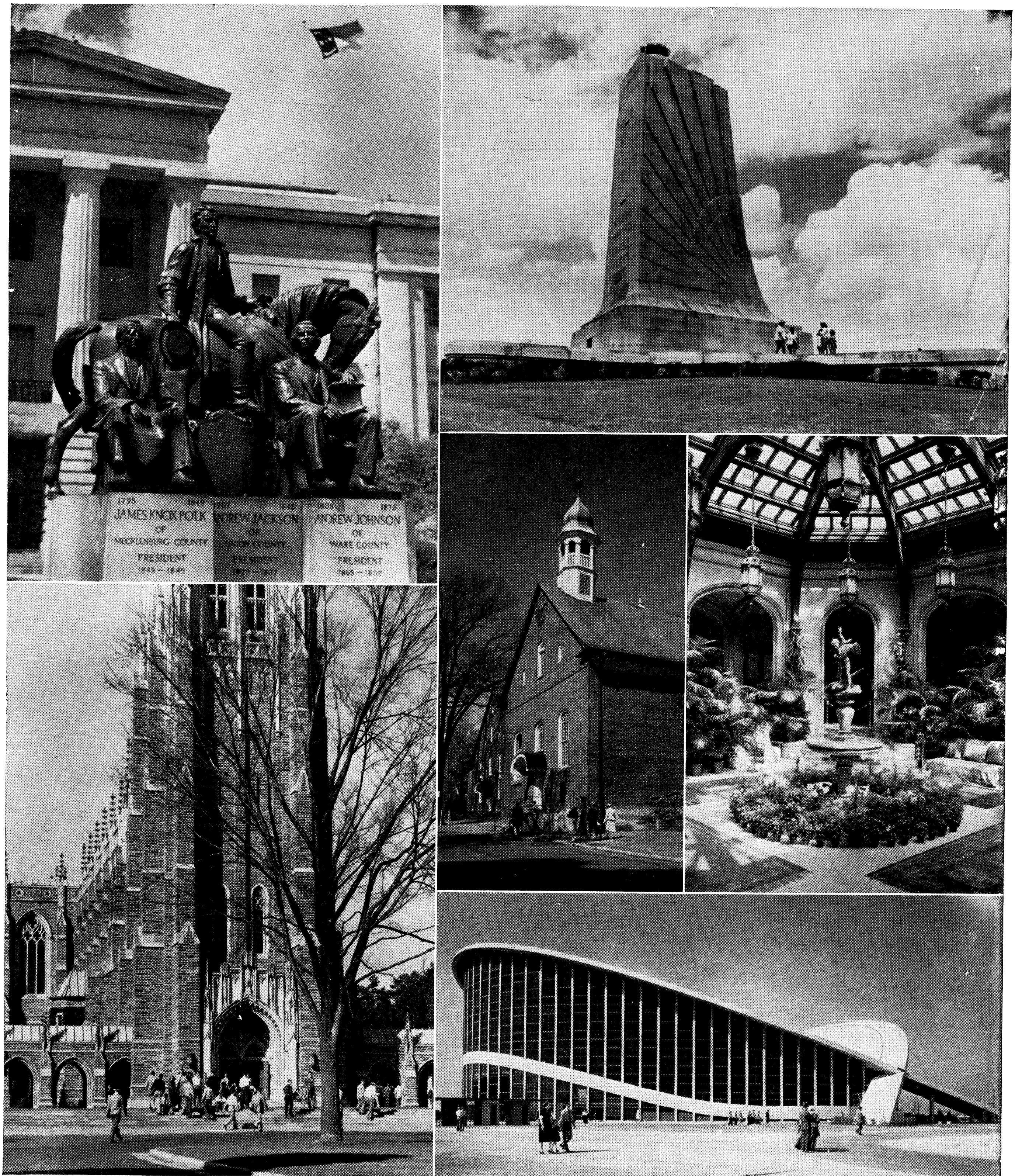
Centre right: Wild ponies of Ocracoke Island, Pamlico sound. According to local legend, the ponies are descendants of animals brought by early colonists

Bottom left: Greenfield lake, near Wilmington

Bottom centre: Birthplace of Andrew Johnson, Raleigh

Bottom right: View along Cape Fear river near Wilmington, part of the Intracoastal waterway

NORTH CAROLINA



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VIEWS OF NORTH CAROLINA

Top left: Statue of three U.S. presidents born in North Carolina; the capitol 'building, Raleigh, is in tile background
Top right: Wright memorial at Kitty Hawk, site of the first powered aeroplane flight, ***1903,*** by Wilbur and Orville Wright
Centre: Home Moravian church at Winston-Salem, centre of the Moravian faith in the southern U.S., opened in ***1800***
Centre right: The conservatory in Biltmore House, the George Vanderbiit estate near Asheville, completed in ***1895***
Bottom *left:* The chapel at Duke university, Durham
Bottom *right:* State fair arena at Raleigh

Sanford and a number of other towns.

Transportation and Communication.— Railway building was begun in North Carolina in the 1830s, and the state's first two railroads, the Wilmington and Weldon and the Raleigh and Gaston, were completed in 1840. By 1860 nearly 900 mi. had been built with state aid, the most important road being the North Carolina railroad, extending from Goldsboro to Charlotte; this road is still owned by the state, though leased to the Southern railway. Great expansion. accompanied by consolidation of many small lines into larger systems, occurred between 1880 and 1900. Railway mileage in the second half of the 20th century, however, was slowly declining.

After 1920 great progress was made in highway construction and in the development of a state system of highways. By the early 1960s the state was maintaining a system of more than 70,000 mi. and registered motor vehicles numbered annually more than 1,500,000. There were six regularly scheduled airlines and more than 100 airports and airfields.

In 1911 the Inland or Intracoastal waterway, built with federal funds. was completed between the Neuse river and Morehead City; the whole project was completed in 1936. The state has two ports of entry for ocean-going vessels: Wilmington and Morehead City.

The state has about 160 radio stations and 15 television stations; nearly 50 daily newspapers and more than 150 other newspapers; and there are over 1,000,000 telephones in use.

See also Index references under "North Carolina" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained irom the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year,* American edition.

(A. R. N.; H. T. L.)

NORTH CAROLINA, UNIVERSITY OF, one of the oldest state universities in the United States, was chartered in 1789 and began instruction in 1795 at Chapel Hill, N.C. See NORTH CAROLINA: *Education.*

NORTHCLIFFE, ALFRED CHARLES WILLIAM HARMSWORTH, 1ST VISCOUNT (1865–1922), the most successful newspaper publisher in the history of the British press and the creator of popular modern journalism, was born at Chapelizod, Dublin. July 15, 1865, the eldest of a family of 14. His father, Alfred Harmsworth (1837–1889), was an impecunious schoolmaster who after the birth of his second child was persuaded by his wife's social ambitions to give up a teaching post in Dublin and move to London to read for the bar, becoming in due course an unsuccessful barrister of convivial temperament whose large family was brought up in genteel but often acute poverty interrupted by bouts of Bohemian extravagance. His mother, who died in 1925 aged 87. was the guiding force in the family, exercising over her first-born (the description of himself with which he signed his daily letters to her) an emotional dominance which made other intimate personal relations difficult for him.

Of the seven sons, the three eldest all became members of the house of lords: Alfred. Harold, 1st Viscount Rothermere (*q.v.*), and Cecil Bisshopp (1869–1948), 1st Baron Harmsworth of Egham. The fourth, Robert Leicester (1870–1937), was made a baronet.

The Harmsmorths moved to London in 1867. and after an unhappy interlude at Stamford grammar school. Alfred mas educated until he mas 16 at a struggling private school owned by the father of A. A. Milne. the writer. He showed considerable talent as founder and editor of the school magazine but no gift for sustained study. After several attempts to "get rich quick" by inventing and selling a silk hat reviver and an all-purpose pill, and after having a position with the amiable son of a peer as secretary-companion on a continental tour, he embarked on free-lance journalism as a contributor to popular papers such as *Comic Life, Scraps, Young Folk Tales* and *Youth,* of which last he became editor at a salary of £2 a week. In 1885, after a temporary breakdown in health. he went to Coventry as editor of *Bicycling News,* owned by the firm of Iliffe, at £2 10s. a week, and began to contribute to *Tit-Bits,* the phenomenally successful popular weekly of informative scraps for the new reading public created by the Education act of 1870. The success of *Tit-Bits,* which has some claim to be regarded as the initiator of the revolution in popular journalism in which Northcliffe himself played such a leading part. fired him with the ambition to start a similar paper of his own to be called *Answers to Correspondents.* He tried to interest Iliffe's in the scheme. They turned it down but promised to print it for him on credit for a few weeks if he could get someone to back him, and in 1887 he left to seek his fortune in London. There. with a few hundreds put up by the son of a Dublin friend of his mother's, he began to publish cheap booklets (most of them written by himself) on careers. a cure for biliousness and any other subject likely to attract popular interest. He had little financial success until an introduction to an ex-army officer with a rich wife enabled him to raise enough money to take advantage of Iliffe's offer in 1888. (This was soon after his marriage to Mary Elizabeth, daughter of Robert Milner, a West Indian merchant.)

Answers to Correspondents, soon shortened to *Answers,* was the foundation of Northcliffe's career. It was not, however, an immediate success and mas only saved when a simple puzzle brought to the office by an American visitor proved a hit. A competition offer of £1 a week for life for guessing the amount of gold coin in the Bank of England on a certain date established it in public favour. By this time Alfred had been joined by his brother Harold (who had been ordered by his mother to resign a safe job as a civil service clerk to help her first-born through the financial tangle uhich threatened his enterprises). The combination of Alfred's genius for sensing the public taste and Harold's financial ability and capacity for attracting advertising by exploitation of the idea of the net sales certificate proved irresistible. *Answers* was followed by a host of other cheap popular periodicals, chief among them *Comic Cuts* ("Amusing Without Being Vulgar") and *Forget-Me-Not*, for the new reading public of women. These formed the basis for what became in .Amalgamated press the biggest periodical publishing empire in the world.

But although Alfred Harmsworth enjoyed wealth his primary passion was journalism. In Aug. 1894 he seized the chance presented to him by an ambitious young journalist, Kennedy Jones, who had, with a friend, acquired an option on the nearly bankrupt *London Evening News*, bought the paper for £25,000 and launched into newspaper publication. The flair that had brought such results aith cheap weekly magazines proved equally effective with newspapers. The character of the *Evening News* was changed overnight. Long news reports and long leading articles were banished, a column for women was started and a daily short story introduced. About £300,000 had previously been sunk in the paper without success, mostly by the Conservative party. Within a year Harmsworth had a circulation of 160,000 copies and was making a substantial profit. For the first time in his life he found himself cultivated as a political influence by men who would have taken no notice of the owner of *Comic Cuts*. He enjoyed the experience. He next conceived the idea of a chain of halfpenny morning papers in the provinces and made a start by buying up two papers in Glasgow and merging them into the *Glasgow Daily Record*. His touch with a Scottish public proved, however, less sure, and he decided to embark instead on the experiment of a popular national daily published in London. The *Daily Mail*, first published on May 4. 1896, was the result. It was a sensational success. Announced as "The penny neaspaper for one halfpenny" and "The busy man's daily journal," it struck a new note that was exactly suited to the new reading public. "Explain, simplify, clarify," Harmsworth told his staff. All news stories, leaders and feature articles were kept short, and articles of interest to women, political and social gossip and a serial story were made regular features. Although nens headlines remained, at first modest in size, far more nere used than in any previous paper. With its first issue the *Mail* established a world record in daily nenspaper circulation and this lead it never lost while Northcliffe lived. He moved on to new triumphs. He bought the *Weekly Dispatch* when it was nearly bankrupt and turned it (as the *Sunday Dispatch)* into the biggest selling Sunday paper in the country, founded the *Daily Mirror* (1903), which, after a false start as "a paper for gentlewomen," found success in exploiting a wholly new market as a picture paper with a circulation rivaling that of the *Mail*, saved the *Observer* from extinction (1905) and in 1908 reached what he believed to be the pinnacle of his career by securing control of *The Times*.

Northcliffe (he was created a baronet in 1903 and raised to the peerage as Baron Northcliffe in 1905) was the most successful popular journalist of his own or any other day because he knew instinctively what the new, semieducated public wanted. He was one of them himself: he thought as they did. although at a level infinitely more charged with energy and imagination. He lacked the power of sustained thought or abstract judgment but he had a passionate curiosity about practical things, an insatiable appetite for facts and was genuinely excited by everything new. Lord Robert Cecil called the *Daily Mail* "A newspaper for office boys written by office boys." but Northcliffe knew that his readers were office boys on the way up. "Remember," he told his staff, "you are writing for people with £1,000 a year—or at any rate people who hope and think they'll be £1,000-a-year men tomorrow." Success lay, he believed, in flattering readers by letting them see "their onn opinions and prejudices echoed in a newspaper," and since most of these opinions and prejudices were his own he found this easy. He was a popularizer of genius. As the element of megalomania in his character swelled with success he came to believe that the genius that had brought him immense circulation also gave him the right to speak for the nation. He believed in his power to sway public opinion by, in his own words, "telegraphing a message to millions with damnable retention," and he undoubtedly had great influence on the social habits of the new middle class. But although he came to believe that he controlled immense political power through his newspapers (an opinion confirmed by many around him) there is little evidence that his direct impact on public events was large. Thus, although he performed a valuable service by his exposure of the shell shortage in the early days of World War I, his attacks on Lord Kitchener, which led to the *Daily Mail's* being publicly burned on the stock exchange, probably delayed changes on which the cabinet had already decided. He tended to be used as a megaphone by men more politically adroit than himself. Thus, although he claimed to have brought about the downfall of Asquith, he was unable to exercise any influence over the composition of the new administration and his final break with Lloyd George at the end of the war, when Lloyd George contemptuously rejected his demand to be consulted on the membership of the cabinet in return for his ne spapers' support, had no perceptible effect on the results of the postwar election. He did valuable wartime service as head of the British war mission in the United States (June–November, 1917), for which he received a viscountcy, and (from Feb. 1918 until the end of the war) as director of propaganda in enemy countries, but failed to secure foi himself the official place at the Versailles peace conference on ahich he had set his heart.

He wanted power. What he got was big business, setting in motion forces that changed the direction of much of the press away from its traditional informative and interpretative role to that of the commercial exploiter and entertainer of mass publics who had always to be given what would excite and amuse them. The financial reward was enormous, not only from sales but from the advertising revenue the great new circulations were able to attract, and Northcliffe spread some of this wealth in higher wages and better conditions for all who worked on newspapers. But he failed to achieve the power he craved because he lacked the ultimate quality of the great journalist, the patience to persuade. For this reason, although he brought *The Times* financial support at a time nhen it was crippled by losses, by dissension among minority shareholders and by an out-of-date 18th-century constitution, and transformed it from a 19th-century relic into a modern newspaper, *The Times* was, in a deeper sense, one of his failures. He tried to turn it into an instrument of personal policy. not seeing that to do so would be to destroy the very foundation of its authority.

He was destroyed by the nature of his own success. Always unpredictable, he became the victim of a megalomania that destroyed the balance of his judgment and led him into extravagances of autocratic decision that made it difficult even for those who most admired him to work with him. He mas persuaded to go on a prolonged tour of the world as a rest cure but a complete breakdown followed and on Aug. 14, 1922, he died in London of ulcerative endocarditis.

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(F. Ws.)

NORTHCOTE, JAMES (1746–1831), English painter, known largely for his historical paintings, but also a portraitist of considerable skill, was born at Plymouth on Oct. 22, 1746. In 1773 he went to London and mas admitted as a pupil into the studio and house of Reynolds, attending also the Academy schools. He was elected associate of the Academy in 1786 and full academician in the following spring. He died on July 13, 1831.

Sorthcote's output, especially of portraits, was prodigious;

there are a number of examples in the National Portrait gallery, London. His sitters included many notable persons, among them Samuel Taylor Coleridge and John Ruskin. Northcote was one of the chief painters employed by John Boydell (*q.v.*) for his Shakespeare gallery, some of his works on this commission being "The Murder of the Young Princes in the Tower," "The Burial of the Young Princes" and "Prince Arthur and Hubert." Northcote wrote lives of Reynolds (1813) and of Titian (1830), whose lifelong admirer he was, and two series of Fables.

NORTH DAKOTA, the "Flickertail state," is one of the north central group of the United States lying in an area designated by the U.S. geological survey as the centre of the North American continent. It is bounded on the north by the Canadian provinces of Manitoba and Saskatchewan, on the east by Minnesota (from which it is separated by the Red river), on the south by South Dakota and on the west by Montana. Extending 341 mi. from east to west and 212 mi. from north to south, it has a total area of 70,665 sq.mi., of which 1,208 sq.mi. are water surface, and it ranks 17th among the states in size. The state capital is at Bismarck (*q.v.*). North Dakota entered the union in 1889, the 39th state in order of admission. The wild prairie rose is the state flower and the state tree is the American elm. The state bird is the western meadow lark. The name of the state is derived from dakota, a Sioux word meaning "allies."

PHYSICAL GEOGRAPHY

Physical Features.— The land surface of North Dakota consists largely of rolling prairies and plains, slowly rising half a mile in altitude from east to west to form a series of three successive steps or plateaus. The eastern or lowest part is made up of the flat valley of the Red river, once the bed of Lake Agassiz, formed by a retreating glacier. The area varies in width from 40 mi. near the Canadian border to 10 mi. near the South Dakota line. On the western edge of the Red river valley the land rises sharply. marking the beginning of the central plateau, sometimes referred to as the drift plain or prairie. It varies in elevation from 1,650 it. in the Pembina mountains to 1,350 ft. in the south nhere the hills rise again to become the Couteau des Prairies in Sargeant county in the southeast corner of the state. The drift prairie is a rolling fertile plain varying in width from 70 mi. in the south to more than 200 mi. along the Canadian border, broken by low ridges of hills. shallow coulees and numerous small lakes. Devils lake, the largest natural body of water in the state, and the Turtle mountains lie in the northern part.

Rising 300 to 400 ft. above the drift plain and cutting across the state diagonally in a northwest-southeast direction is the third area, the Missouri plateau. Between the escarpment and the Missouri river the plateau is known as the Couteau du Missouri and west of the river as the Missouri slope. The surface is irregular and rolling, dotted with old lake beds, some of which contain large deposits of sodium sulfate, valuable clays and large beds of lignite coal. The Missouri slope is the most unusual area of the state. In it are located the badlands of the Little Missouri river where a fantastic array of buttes and mesas characterize the landscape. Vividly exposed layers of bright coloured clay and scoria indicate that the various buttes were at one time connected. The highest point in the state is Black butte. 3,468 ft. above sea level. In the western part the Killdeer mountains rise about 700 ft. above the surrounding region.

Climate.— North Dakota has a continental climate with a wide range of temperature. The mercury often reaches 100" F. during the summer and falls at times to 30" below zero during the winter months. The average temperature for June, July and August is 65.7°, and for December, January and February, 9.7". A relatively low humidity, averaging 68%, makes the extremes less noticeable. The sections vary greatly in precipitation, ranging from 22 in, in the southeastern corner to about 14 in. in the southwestern portion. Most of the rainfall comes in the late spring and summer during the growing season. The state is subject to alternating wet and dry years, with crop yields ranging from very good to almost complete failures. Long, severe winters are typical, with an average snowfall of 30 in. Blizzards are common on the drift plain and cyclonic action during the summer months produces much of the precipitation.

Soil.— The soils of the state may be roughly divided into three general types based on their origins: the lake-bottom soils in the east, the glacial soils in the central section and the residual soils of the western portion. Small areas of alluvial land are to be found along the Missouri, James and Sheyenne rivers. In the Red river valley the soils are of the rich black loam type, 20 to 30 ft. in depth: formed in lake beds from which the water long ago disappeared. The soil change from the lake-bed area to the glacial-drift types of the central region is abrupt. The drift left by the Wisconsin glacier plus a dense grass cover produced the soils of central North Dakota. The top layer is black or dark brown loam below which lies the glacial debris of sand, gravel and boulders that is exposed in places. Farther west the soil is thinner and lighter in colour. Boulders are common and often show through the earth surface; there also are outcroppings of sandstone and shale, indicating evidence of glaciation.

Vegetation.— Because of its semiarid climate North Dakota has only about 600 sq.mi. of wooded area. In the Red river valley, Turtle mountain and Devils lake regions, such trees as the box elder, green ash, poplar and cottonwood are common. Juneberry, chokecherry and wild plum trees, high-bush cranberries and wild grape bushes grow abundantly along the eastern streams. In the Missouri and Little Missouri regions are found the broadleaf cottonwood, willow, ash and elm, as well as bushes of the buffalo berry and the flowering currant. Of the Rocky mountain types of trees, some stunted yellow pine and red cedar are to be found in the badlands and on the buttes of the Little Missouri. The tall Indian and blue grasses of the east are replaced by grasses of medium height in the central area and by the shorter, grayish varieties of buffalo and grama grasses in the west. Wild flowers, the yellow violet, cornflower, blue and yellow flax, black-eyed Susan, yellow goldenrod, sunflower and wild prairie rose, grow in great profusion throughout the state.

Animal Life.—In early times large numbers of buffalo, elk, deer and antelope roamed the North Dakota area, providing a permanent source of food, clothing and shelter for the native Indian tribes. With the coming of the railroad and the final defeat of the Indians in the 1880s, large numbers of these animals were destroyed for their hides and for sport. Scattered remnants of the once great herds took refuge in the badlands where state laws saved them from annihilation. In the fur-trading period the most valuable animals mere the beaver, mink, otter! fisher and marten and less-valuable pelts were obtained from the weasel. black-footed ferret, skunk, red fox and raccoon. Other animals sometimes killed for their skins included the black and grizzly bear, mountain lion or cougar and buffalo wolf. Trapping of furbearing animals is still an important activity in North Dakota and is often followed by farmers during the winter months. Small animals common in the state are the coyote, chipmunk, squirrel, ferret and the tiny, agile yellow gopher or flickertail from which the state gets its nickname.

Among the many songbirds in the state are the sparrow, oriole: blue jay, robin, black-billed cuckoo, blackbird and meadow lark,. Many waterfowl nest in the state each year. The most important upland game bird is the pheasant and the town of Mott in Hettinger county. in the southwest corner of the state, is called the pheasant capital of the state. There are extensive migratory bird and animal refuges scattered throughout North Dakota. Perch, black and rock bass, pickerel, pike, sunfish and catfish are found in the larger lakes and rivers, where the state has prepared them as game fish. Suckers and carp are also common.

State and National Parks.—The best-known park in North Dakota is the Theodore Roosevelt National Memorial park of 70,374.30 ac., lying in the scenic badlands of the Little Missouri river. The park is visited by more than 170,000 persons annually. The Fort Abraham Lincoln State park of 750 ac., located just west of Bismarck on the western bluffs of the Missouri river, contains the sites of two early military posts and a Mandan village. The 'Turtle River and Lake bletigoshe State parks and the International Peace garden, partly in the state and partly in Manitoba, are popular with tourists. The 15-room château of the French nobleman the marquis de Mores, built in 1883 at Medora where he attempted to set up a meat-packing establishment, was given to the state in 1936 with its original furnishings.

HISTORY

The first white men to visit North Dakota were members of an expedition from Ft. La Reine (Portage la Prairie, Man) led by Pierre Gaultier de Varennes, sieur de la Verendrye. They reached a Mandan earth lodge village in 1738, possibly the Menoken site, 13 mi. E. of modern Bismarck.

Two sons of Verendrye crossed the Missouri near Sanish in 1742 and explored the country to the southwest in an attempt to carry out their father's dream of establishing an overland trade route to the Pacific. After reaching the Big Horn mountains they abandoned their search and recrossed the Missouri at Old Crossing.

After the English occupation of Canada in 1763 the Hudson's Bay company and the Northwest company, operating from Ft. Garry (Winnipeg), established trading posts on the Missouri at the mouth of the Knife river where they were found by the Lewis and Clark expedition that wintered at Ft. Mandan in 1804–05. The purchase of the Louisiana territory by the United States in 1803 and the success of the Lewis and Clark expedition made St. Louis a rendezvous for American fur traders who exploited the fur resources of the upper Missouri. The American Fur company built, among others, Ft. Clark in 1826 and Ft. Union in 1829. The War of 1812 put an end to British attempts to extend the Canadian frontiers southward. By the treaty of Paris of 1818 the international boundary was fixed at the 49th parallel as far west as the Rocky mountains.

The first white settlement in North Dakota was made by a band of settlers from Lord Selkirk's colony of Scottish Highlanders in Manitoba, aho settled at Pembina in 1812. When Maj. Stephen H Long explored the Red river valley in 1823, he reported the population as numbering 350. Ft Snelling (St. Paul) was established in 1823, and a brisk trade between this fort and Ft. Garry soon developed along both sides of the Red river Ft. Abercrombie was built in 1858 and Ft. Pembina in 1863, and these forts became the rendezvous for commercial and military operations in the northwest, as well as rallying points for settlers.

Between 1850 and 1870 there was considerable difficulty with the Dakota (*q.v.*) Indians, whose lands in Minnesota had been largely appropriated by the whites and ahose buffalo herds on the Dakota prairies were fast being depleted. The Minnesota outbreak of 1862 was folloned by campaigns which finally drove the hostile Dakotas to the badlands west of the Missouri (see MINNESOTA: History). All eastern North Dakota was then open for occupation, and the completion of the first railroad to the eastern border in 1871 inaugurated the settlement period in earnest. The following decade saw intensive development in the Red river valley. and by 1880 settlement was spreading into the drift plain, especially along the line of the Northern Pacific railway nhich in 1873 had reached the Missouri at Bismarck. West of the Missouri the country was made attractive by the extension of the Northern Pacific, nhile the completion of the Great Northern railway across the northern part of the state in 1887 opened that region to settlers.

The region forming North and South Dakota, which after 1861 had been known merely as Dakota territory, was divided in 1889 into a northern and southern half. A convention met in North Dakota in July and framed a constitution which nas accepted by the people in an election held on Oct. 1. Pres. Benjamin Harrison declared the state's admission to the union on Nov. 2, 1889. The population was then almost 175,000.

The period 1890–1915 was one of constant growth. Competing railway lines strove to forestall each other in tapping promising grain territory. Once there they did their best to bring settlers into the newly opened region by conducting land excursions. Nearly 18,000 immigrants annually made new homes in the state. Settlement of the drift plain was practically completed and homesteaders invaded the good land beyond the Missouri river. The inrush continued with little abatement until after World War I when, because of the general depression in agriculture, it practically ceased. The economic distress of North Dakota's farmers during the depression was greatly increased by severe drought and dust storms betueen 1929 and 1935. During World War II all agricultural production records were broken.

In politics North Dakota is normally Republican, but its farmers and other dissatisfied groups have shown a tendency to desert the party in times of agricultural distress and form separate factions that usually promised more direct and radical remedies. It was one of the states involved in the Populist movement of the 1890s. In 1915 a number of Republican party members who were dissatisfied with the method of marketing grain organized the Nonpartisan league with A. C. Townley, a Socialist, as the head of the organization. By 1918 the league had elected a governor and a majority in both houses of the legislature.

In 1920 the Nonpartisan league lost much of its prestige, and many people from all parties opposed its program. Forgetting party lines, leaders of this opposition group formed the Independent Voters association (I.V.A.), ahich was influential in government during the remainder of the decade. In 1932 the league again came into control with the election of William Langer (1886–1959) as governor. Removed from office in 1934 for allegedly seeking political contributions, Langer won an appeal from conviction and was re-elected governor in 1936.

To combat the league the Democratic party and conservative Republicans formed a coalition in 1938 and elected John Moses, a Democrat, governor. Langer, however, was elected to the U.S. senate as a Republican in 1940 and was re-elected three times, the last time as an independent. Conservative Republicans, attempting to develop a strong party in 1943, adopted the name Republican Organizing committee (R.O.C.) and elected Fred G. Aandahl governor for three terms. Aandahl was succeeded by Norman Brunsdale and John E. Davis, both Republicans. In 1960 the Democrats shoned some signs of resurgence with the election of Quentin N. Burdick to the U.S. senate and of William L. Guy as governor.

In most presidential elections after 1900 the state voted for Republican candidates but it supported Democratic candidates Woodrow Wilson in 1912 and 1916 and Franklin D. Roosevelt in 1932 and 1936. The majority for Roosevelt in 1932, 71%, was matched only by that for Republican Dwight D. Eisenhower in 1952.

GOVERNMENT

The constitution of North Dakota provides for a government operating on the state, county, township and municipal levels. The elective executive officers of the state are the governor, lieutenant governor, secretary of state, auditor, treasurer, superintendent of public instruction, commissioner of agriculture and labour, commissioner of insurance. tax commissioner, attorney general and three public service commissioners. Each of the elected officers serves a term of two years. except the public service commissioners who are elected for six years and the tax commissioner who is elected for four years. The governor appoints other state officials and the members of numerous boards and commissions.

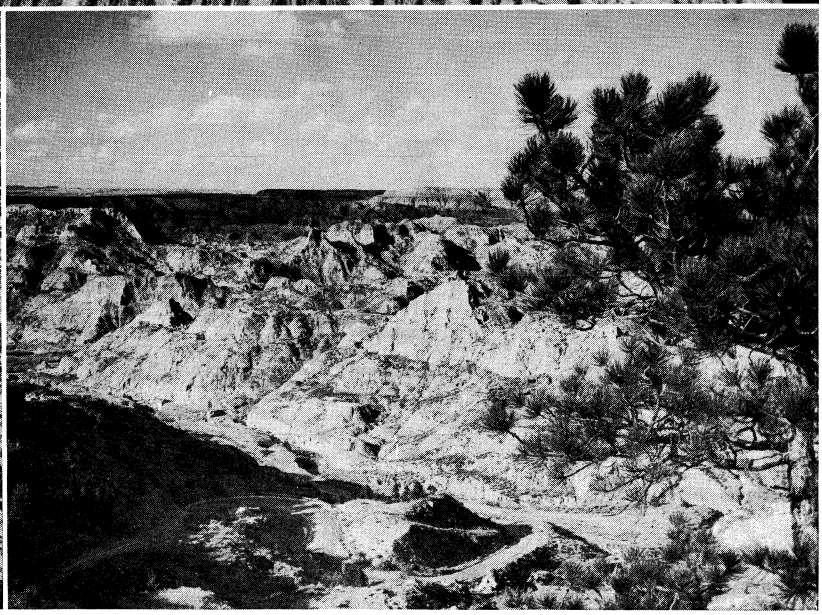
The legislative assembly consists of a house of representatives of 113 members elected for two-year terms and a senate of 49 members elected for staggered terms of four years.

The state judicial system consists of a supreme court of five members elected for ten years and six district courts with judges elected for six-year terms

The county is an important administrative unit. Each of the 53 counties in the state elects county commissioners for four-year terms and a sheriff. auditor. register of deeds, treasurer and state's attorney for terms of tuo years.

The township acts as a local unit of government for the county. Municipal governments are of the commission and mayor-council types.

State tax collections in the late 1950s amounted to between $35,000.000 and $40,000,000 annually. About 40% came from the retail sales tax. 20% from an income tax and the balance from taxes on cigarettes, beer, liquor, oleomargarine, motor vehicle registration, oil and gas production and from the use tax.



BY COURTESY OF (BOTTOM LEFT) GREATER NORTH DAKOTA ASSOCIATION; PHOTOGRAPHS, (TOP) W. P. SEBENS, (BOTTOM RIGHT) EWING GALLOWAY

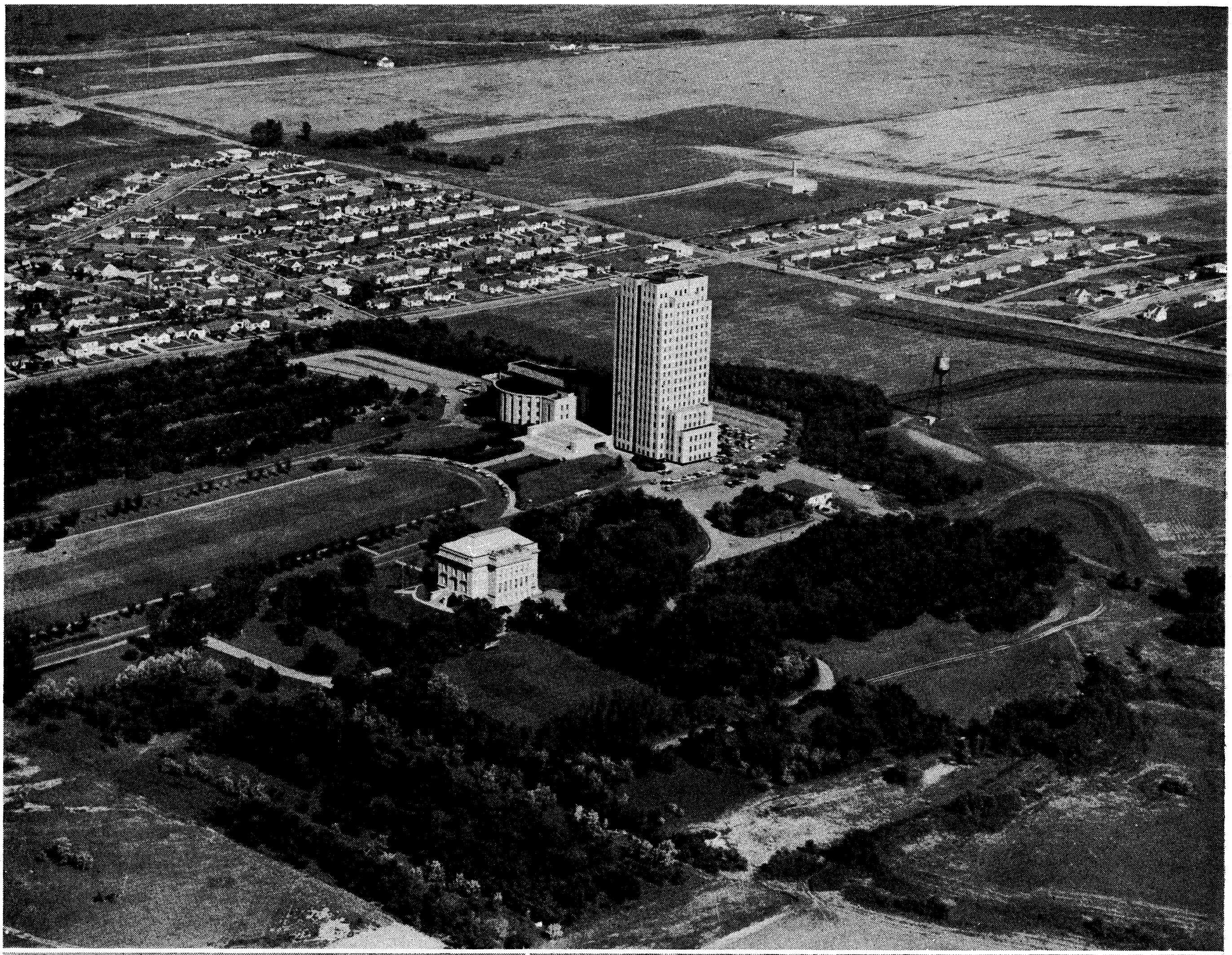
SCENES IN NORTH DAKOTA

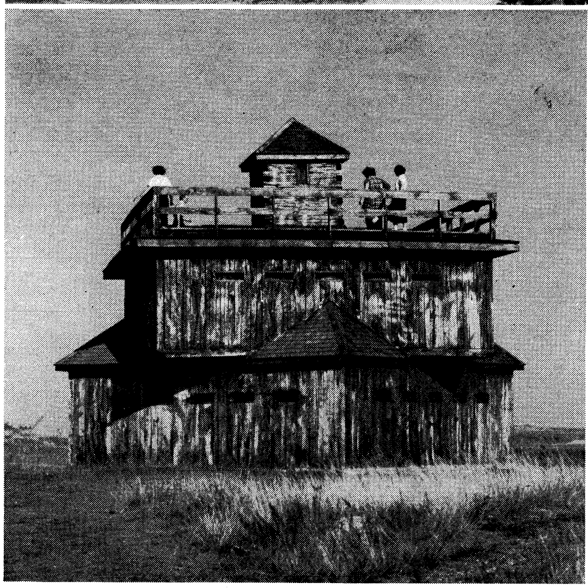
Top: Wheat harvesting in the Red River valley, the "black earth" agricultural belt in the eastern part of the state

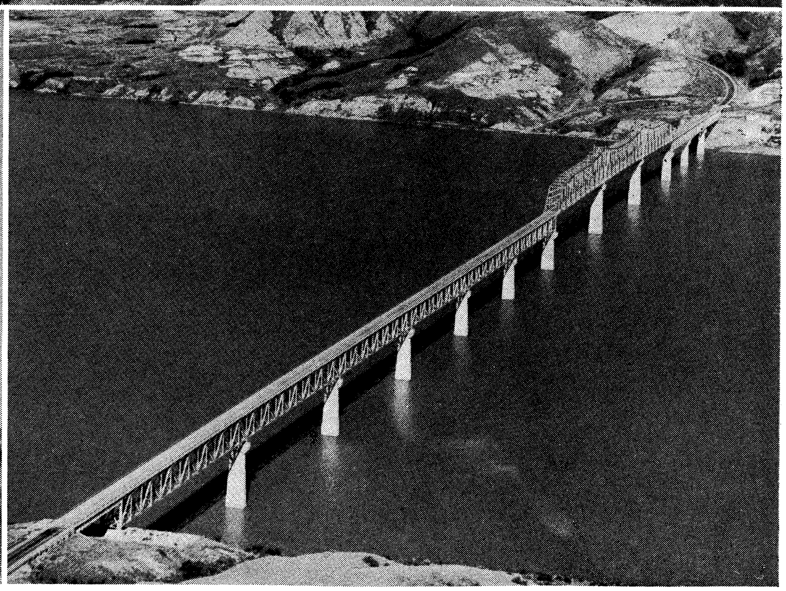
Bottom *left:* Statue of Sakakawea on the grounds of the state capitol, Bismarck. Sakakawea, or Sacagawea, a Shoshone Indian known as the Bird Woman, accompanied the Lewis and Clark expedition to the Pacific, 1804–05

Bottom right: Scene in the Bad Lands, an area of eroded sandstone and clay in the western sector of the state, part of the Theodore Roosevelt National Memorial park

NORTH DAKOTA







BY COURTESY OF (BOTTOM LEFT) GREATER NORTH DAKOTA ASSN.: PHCTOGRAPHS (TOP) W. P. SEBENS FROM OSBORN'S STUDIOS, (BOTTOM RIGHT) W. P. SEBENS

THE STATE CAPITOL AND OTHER SCENES IN NORTH DAKOTA

Top: The capitol building, Bismarck. The 19 story building was designed in 1932 by J. B. de Remer and W. F. Kurke, North Dakota architects

Bottom left: Blockhouse at Fort Abraham Lincoln State park. Gen. George Custer led his troops from this fwt to the battle of Little Big Horn in 1876

Bottom right: Four Bears bridge, near the upper end of the Garrison reservoir, is known as the "bridge with 19 names." Because of jealousy between the Mandan and Hidatsa Indians, plaques were fixed at each end of the span bearing a list of names of rival tribal chieftains as associate titles of the bridge

POPULATION

The population of the North Dakota area increased from 2,405 in 1870 to 577,056 in 1910 and to 680,845 in 1930. With the agricultural depression of the 1930s people began to leave the state in considerable numbers, and the population dropped to 641,935 in 1940 and to 619,636 in 1950. In 1960 the population of the state was 632,446. The population per square mile in 1960 was 8.9, as compared with 49.6 for the United States as a whole.

While the population is largely rural, the percentage of people living in areas considered urban increased from 16.6% in 1930 to 35.2% in 1960. The state had one standard metropolitan statistical area, which is Fargo-Moorhead. This area had a total population of 106.027 in 1960, 66,947 in North Dakota In 1960 12.0% of the population was 65 years old and over; and 36.5% of the population 14 years old and over was in the labour force.

*North Dakota: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	632,446	619,636	641,935	646,872	319,146
Bismarck	27,670	18,640	15,496	7,122	3,319
Devils Lake	6,299	6,427	6,204	5,140	1,729
Dickinson	9,971	7,469	5,839	4,122	2,076
Fargo	46,662	38,256	32,580	21,961	9,589
Grafton	5,885	4,901	4,070	2,512	2,378
Grand Forks	34,451	26,836	20,228	14,010	7,652
Jamestown	15,163	10,697	8,790	6,627	2,853
Mandan	10,525	7,298	6,685	4,336	1,658
Minot	30,604	22,032	16,577	10,476	1,277
Valley City	7,809	6,851	5[illegible]	4,686	2,446
Wahpeton	5,876	5,125	3,747	3,069	2,228
Williston	11,866	7,378	5,790	4,178	763

*Populations are reported as constituted at date of each census.

Large numbers of immigrants moving into the state prior to World War I resulted in a large representation of foreign groups, among the more important of which were Norwegians, Russians, Canadians and Germans. In 1960, 93.3% of the population of the state was native white and 4.7% was foreign-born white. There were 11,736 Indians in the state in 1960, largely from the Hidatsa (*q.v.*), Mandan, Arikara (*q.v.*), Chippewa (see OJIBWA) and Sioux (see SIOUAN INDIANS) tribes.

EDUCATION

The state department of public instruction under an elected superintendent supervises elementary and secondary schools. In the late 1950s there were more than 2,500 public elementary schools in the state and more than 375 secondary schools. Nearly 125,000 students were enrolled in the public schools, with an average school term of 8.75 months. The more than 6,500 teachers had an average annual salary of more than $3,000. Schools are supported largely by local taxes, although seven-twelfths of the state sales tax is distributed to the various districts through an equalization fund. A revolving fund of $5,000,000 was provided by the state in 1923 to aid needy school districts in the construction of buildings. The money is loaned to the districts and is repayable in 20 years with interest.

North Dakota has nine state institutions of higher learning, under a seven-member board of higher education appointed by the governor. The system was established by constitutional amendment in 1939. The University of North Dakota at Grand Forks, founded in 1883 under the Territorial act. includes colleges of science, literature and arts, education, engineering, business and public administration, and nursing, schools of law and medicine, a graduate school and the university college. In the late 1950s the university had an enrollment of more than 3,500 full and part-time students and a faculty of more than 250. Student participation was offered in radio and closed-circuit TV programming.

Also under the board of higher education are the University of Agriculture and Applied Science (founded 1889) at Fargo, which includes the state agricultural experiment station and six branch stations located throughout the state; the Normal and Industrial college (1889) at Ellendale; state teachers' colleges at Mayville (1889), Valley City (1889). Minot (1913) and Dickinson (1916); and two junior colleges, the School of Forestry at Bottineau (1906) and the State School of Science at Wahpeton (1903).

Jamestown college, a private coeducational institution affiliated with the Presbyterian Church, was founded in 1884 at Jamestown.

HEALTH AND WELFARE

Nearly $14,000,000 was spent to construct and equip new federally aided medical facilities in North Dakota in 1946. The cost of operating the state's 60 general hospitals more than doubled between the late 1940s and late 1950s.

The state correctional and charitable institutions include a state hospital for the insane at Jamestown, a school for the deaf at Devils Lake, an institution for the feeble-minded at Grafton, a state training school at Mandan, a school for the blind at Grand Forks, a penitentiary near Bismarck and a tuberculosis sanitarium at San Haven near Dunseith. The population of these institutions numbered more than 3,000 in the early 1960s. They are under the general control of a state board of administration; the work of the state agencies for the care of children, the aged and the physically handicapped is co-ordinated through the state welfare board. A home for soldiers at Lisbon is under a special board.

THE ECONOMY

Living **Conditions.**—A large percentage of the people of North Dakota live on farms or in small villages. The standard of living is relatively high as indicated by retail sales, home ownership, wealth and property distribution. More than 45% of the farm homes have telephones and 88% have electricity. One family in four has its own power plant. More than 60% have refrigerators or deep freezes: radios are a common household fixture and bv the mid-1950s there were approximately 1,200 television sets in use. More than 90% of the farmers own tractors and 80% have automobiles.

The number of nonagricultural workers rose substantially during the 1950s, the largest increases occurring in mining construction, manufacture of nondurable goods and in general trade and finance. Hourly wage increases in manufacturing were slightly below national levels. Because of the lack of industrialization, the labour supply considerably exceeds the demand. In 1947 the state legislature passed a "right to work la " that was amended in 1949. In the late 1950s the percentage of homes of the state that were mortgaged was about half the national average.

Agriculture. — North Dakota has had an agricultural economy since statehood and from 1950 produced an annual average of $650,000,000 in new wealth from its farms. The trend is toward larger farms—in the period 1950–55 there was a reduction of almost 3,500 farms in the state, with the average size increasing from 629 to 676 ac. In the late 1950s it was estimated that there were 60,000 farms in the state, with an average size of 740 ac. Investment per farm increased comparably. Spring wheat accounts for about 50% of the cash value of North Dakota crops, other products in order of their importance being barley, flaxseed, durum wheat, oats, potatoes. soybeans, sugar beets, corn and hay. Income from livestock and livestock products rose steadily in importance, with cattle and calves accounting for more than half. Dairy products were second, followed by hogs and poultry. Pig production increased rapidly after the development and promotion of pelleted barley as a new hog food by the North Dakota agricultural experiment station. North Dakota farmers have pioneered in the organization and operation of co-operative marketing and purchasing associations. After World War II co-operative marketing increased and there was some expansion of consumer co-operative activities.

Water Development. — An extensive water-development program was undertaken in North Dakota under the Missouri River Basin Development program authorized by congress in 1944. Participated in by both federal and state governments, the program was designed to provide irrigation, power, water supply and recreational activities for the people of the state. Garrison dam on the Missouri is one of the largest earth-filled dams in the world. Other dams included in the program were Dickinson and Heart Butte dams on the Heart river, Jamestown on the James, Baldhill on the Sheyenne and Homme on the South branch of the Park.

Industry. — Handicapped by climate, distances from eastern markets and centres of population, high transportation costs, and with local raw materials limited largely to agricultural products, industry in North Dakota has grown slowly. Manufacturing establishments tend to be small and to produce low-cost items. Flour mills are scattered throughout the state. Various meat-packing activities are carried on in different parts of North Dakota. Grand Forks, located in the potato area, has several industries based on that crop; and Dickinson, in the coal-mining region, produces 35,000 tons of lignite briquettes annually. The processing of dairy products is increasing in importance.

Mining.—Lignite deposits in the western two-thirds of the state are estimated to cover 32,000 sq.mi.; almost 90% of them are workable. Coal-mining operations have been carried on in western North Dakota since the time of the earliest ranching. Most of the commercial lignite mines are of the strip type. The bringing in of an oil well in April 1951 in the northwestern part of the state opened a new area of activity, and by the late 1950s more than 1.175 wells were in operation in about 60 fields, most of them in the western and northwestern parts of the state. About 1,100 cu.ft. of wet gas are produced for each barrel of oil. There are extensive deposits of clay, sodium sulfate, salt and sulfur.

Transportation and Communication.—The state is served by four large railroad systems operating over more than 5,000 mi. of track. The Great Northern system serves the northern section of the state and the Northern Pacific covers the southern part. The Minneapolis, St. Paul and Sault St. Marie, more often called the Soo line, covers most of the northern and eastern sections, while the tracks of the Chicago, Milwaukee, St. Paul and Pacific are located in the southwest corner of the state.

North Dakota has more than 10,000 mi. of all-weather roads and more than 2,000 mi. of paved highways. Two trunk airlines serve the state along with three local service carriers.

The first newspaper in North Dakota, the *Bismarck Tribune*, was established in 1873. In 1874 the *Fargo Forum* was founded as the *Fargo Express* and five years later the *Grand Forks Herald* began publication. In the early 1960s the state had about 120 newspapers, about 100 of which were weekly, and 18 periodicals. The first broadcasting station, WDAY, was established in Fargo in 1922 and in the 1960s there were 12 radio stations and 10 television stations in operation.

See also references under "North Dakota" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (H. E. B.)

NORTH EAST FRONTIER AGENCY, a wild tangle of sparsely populated, mountainous country in the extreme northeast of India, stretches broadly from the plain of the Brahmaputra river in Assam northward to the main crest line of the Assam Himalayas and eastward to an irregular line passing through a series of lofty peaks in the mountain country which became known as the "hump" during the airlift from Assam to China in the early part of World War II. Geographically, the agency is a part of Assam (*q.v.*). Its population is (1961) about 350,000; the area is approximately 31,570 sq.mi. but the frontiers have never been demarcated.

The agency (abbreviated N.E.F.A.) comprises five frontier divisions. Kameng in the west adjoins Bhutan; eastward of this is Subansiri and then Siang frontier division (*q.v.*). At the blind eastern end of the Assam valley is Lohit, while Tirap division lies to the south on the Burmese border.

The entire area is intersected by rivers; the greater part has a heavy rainfall and is thickly forested and inhabited by tribesmostly of Mongoloid stock such as the Monba, Mishmi, Abor, Miri, Dafla and Aka, each occupying roughly defined tribal areas. In general they are animists and practice shifting cultivation. The agency is administered by the governor of Assam as agent of the president of India. He is assisted by an adviser resident in Shillong (the agency headquarters), but the ultimate responsibility rests with the central government of India. The northern boundary, known as the McMahon line, was defined at the Simla conference of 1913–14 and follows for the most part natural features. Prior to that the British-Indian government had made various agreements with the tribes of the territories (such as the Abor) and set up the Balipara frontier tract in the west and the Sadiya frontier tract in the east, which together constituted the North East Frontier Agency (1912–13). After the independence of India in 1947, China made claims to practically the whole area covered by the four divisions of Kameng, Subansiri, Siang and Lohit, arguing that the McMahon line had never been accepted by China and was the result of British "aggression." In letters to prime minister Pandit Nehru, Chinese preniier Chou En-Lai quoted a map in the 1929 edition of *Encyclopædia Britannica* showing the disputed territory as Chinese, with the boundary following the alignment of Chinese maps. The *Times* atlas issued shortly after World War I and the *Times Handy Atlas* of 1935 show the bulk of the territory as part of Tibet despite the jurisdiction which had undoubtedly been exercised by the British-Indian government for at least a quarter of a century. The position had been complicated when the Balipara and Sadiya tracts were established, by the transfer of undisputed Assamese territory to the new frontier divisions. If the Chinese claims were allowed, the Indo-Chinese border would follow roughly the margin of the Assam plain, a frontier almost impossible to defend.

Education is of a basic type: there are three schools in the agency, cottage industries training and production centres have been opened in many places, and there are three sericultural farms. The agency contains 30 hospitals and a health training and research centre trains rural health workers. The difficulty of communications is one of the major problems of the agency. By the 1960s several airfields and airstrips for light planes had been commissioned. The various administrative centres and outposts are linked by radio.

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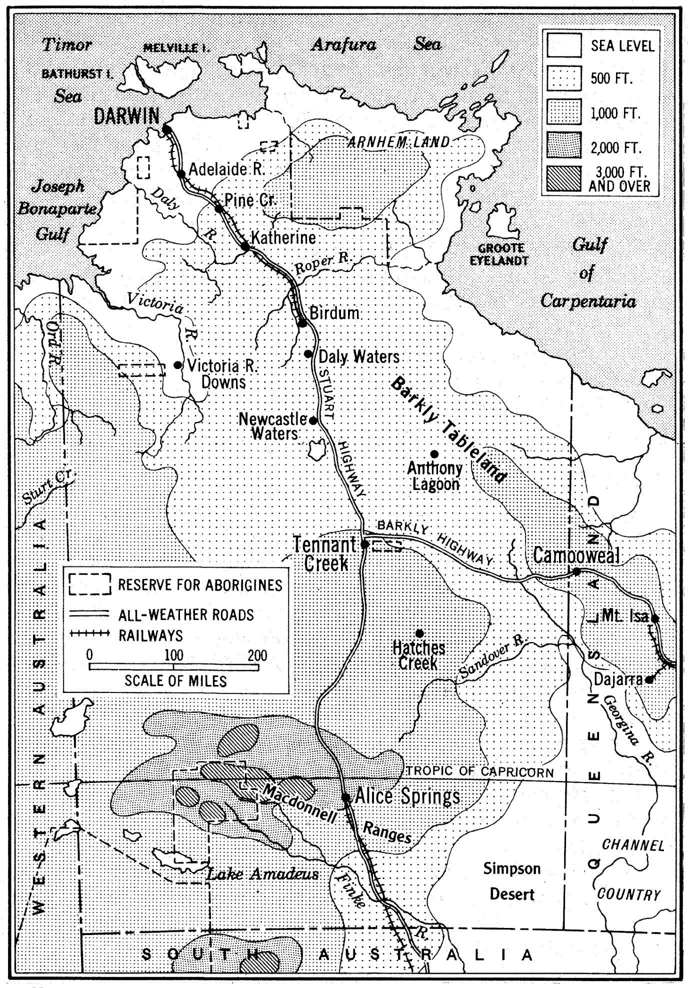
NORTHERN IRELAND: see IRELAND, NORTHERN.

NORTHERN TERRITORY OF AUSTRALIA. This area, of 523,620 sq.mi., extends from lat. 26° S. to the northern coast of Australia and from long. 129° E. to 138° E., lying almost wholly north of the Tropic of Capricorn.

Physical Features.—Physically much of the country is featureless. The indented coast, nearly 1,000 mi. long, is low, flat and generally thickly fringed with mangroves. Occasional sandstone marl and ironstone headlands, seldom as high as 100 ft., separate the sandy beaches and mud flats of the river estuaries.

The largest rivers are the Victoria, entering the Timor sea near the northwest boundary of the territory, the Daly farther toward Darwin, the Roper flowing to Limmen bight on the western side of the Gulf of Carpentaria, and the-McArthur about 120 mi. farther east. They flow from an area with lower rainfall to one with higher rainfall and, though they are substantial streams in the wet season, they may be reduced to little more than a string of water holes during the dry season. Part of the highlands forming the watershed of these rivers is the Barkly tableland whose northeastern edge runs roughly parallel with the coast of the gulf, at a distance of about 100 mi. from it. This tableland which, with the Victoria river district, contains the best grazing lands of the territory, is really the northeastern extension of the Great Plateau or Australian shield which stretches across Western Australia and covers more than half the continent. The plateau aspect of the Barkly is seen only from the north and east; on the southwest there is a gradual rise from about 700 ft. to over 1,000 ft. and



NORTHERN TERRITORY: RELIEF FEATURES AND LAND TRANSPORTATION

then a fairly rapid falling away to the low plain bordering the gulf. South of this area with normal drainage to the coast, lies a shallow basin centred on Lake Woods, a marshy swamp which may be an extensive sheet of shallow water in the wet season. A further slight upward warp to the south separates the Lake Woods drainage area from that of Lake Eyre, in northeastern South Australia. None of the territory rivers rising in the highlands of central Australia reach Lake Eyre and most have water in them only after rains. These tree-fringed courses usually have beds of water-bearing sand. The Macdonnell ranges trending east and west and formed chiefly of gneisses and schists, rise to peaks of about 5,000 ft.

Throughout the Northern Territory soils are poor. Arnhem Land, east of Darwin, is formed of eroded tableland and ranges which extend southeast along the seaward side of the Barkly tableland. these occur again just inside the Western Australian border, separating the better lands of the Victoria river and its tributaries and those of the Ord river and the Sturt Creek basin, in Western Australia. Associated with these streams and on the Barkly tableland are heavy textured gray and brown soils and some red brown earths. Over the rest of the territory are desert soils of various types, sand plains for the most part. with sand hill country to the southeast and southwest and desert loams stretching north and south through the central part from near Tennant Creek to. and including most of, the central Australian area.

Climate. — The main characteristic of the climate throughout the Northern Territory is the markedly seasonal character of the rainfall. . The whole of the territory has a dry minter; *e.g.*, Darwin averages less than $\frac{1}{2}$ in. total for the four months from May to August and Victoria River Downs averages less than 1 in. for the six months from May to October. The rainfall of the Alice Springs area — averaging only between 9 in. and 11 in. per annum — is more regular than is usual in these arid lands; elsewhere the rainfall in the wet season shows great variations from year to year. Darwin's annual average is 59 in., whereas the southeast corner of the territory falls to an average as low as 5 in. (Simpson desert).

Vegetation and Fauna. — The climate and the generally poor soils resulting from it give rise to tropical savanna vegetation over most of the area. The northern lowlands are covered with tall tropical grasses of little value and sparse tree growth. Farther inland, especially on the Barkly tableland and parts of the Victoria river district, there are better grasses, particularly Mitchell (perennial species of Astrebla) and Flinders (annual *Iseilema* spp.) and some edible shrubs. Between the Barkly tableland and the ranges of the Alice Springs area, lies a wide belt of sandy country mainly covered with spinifex (Triodia) and low scrub; the Alice Springs ranges and uplands carry chiefly mulga scrub (Acacia aneura), spinifex and other sparse grasses. The fauna of the Northern Territory is basically the same as that of the rest of Australia. Higher *Theria* are rare. but there are many marsupials, crocodiles, birds, fresh-water tortoises, snakes and frogs. There are also many varieties of fresh-water fish and littoral mollusca. Beetles and butterflies are strongly represented. Buffaloes, introduced from Timor in the early 19th century, were formerly numerous and are shot for their hides.

History. — For the early history of the Northern Territory see AUSTRALIA, COMMONWEALTH OF, History. From 1863 to 1911 the territory was part of the state of South Australia, but on Jan. 1, 1911, it was handed over to the commonwealth government. In the 1920s it was divided into Central Australia and Northern Australia, but these were reunited as the Northern Territory in 1931. The Northern Territory has not the position of a state, but is governed by an administrator and legislative council.

Population. — The 1954 census showed a nonaboriginal population of 16,469. Full-blood aboriginal population of the territory was estimated at 12,314 and part aboriginal at 2,000. Disparity among the sexes has always been high among the Europeans and there are about twice as many males as females. There are only two substantial centres of population, at Darwin (8,071 in 1954) and Alice Springs (2,785). Excluding aborigines, 97% of the population is Christian. with the largest number of adherents belonging to the Church of England and to the Roman Catholic Church. (See also ABORIGINES.)

Education.—There are schools for Europeans and part aborigines, built by the commonwealth and staffed by teachers from South Australia, in Darwin, Alice Springs, Katherine, Tennant Creek and Pine Creek. Schools have been built at Elliott, Hatches Creek, Croker Island (for half-caste children), Adelaide River and Batchelor. In the mid-1950s 1,826 children were attending these schools. Beginning in 1949 several schools were established for aborigines and arrangements were made for aboriginal pupils to proceed to normal secondary schools in the territory. Correspondence technical courses are also available. A secondary school at Alice Springs provides courses to the intermediate standard of the University of Adelaide. Several exhibitions, including fares home once a year. are offered from this school to any approved secondary school in Australia. Local transport is provided to collect pupils for the schools at Darwin and Alice Springs. The School of the Air was inaugurated in 1950 with practical education programs for children in isolated areas. Alice Springs has hostels for school children, conducted by different religious denominations, and the commonwealth government pays a boarding allowance to pupils living at the hostels.

Government and Administration. — The Northern Territory (Administration) act of 1947 provided for the constitution of a legislative council consisting of an administrator and seven official and six elected members. The territory elects one member to the house of representatives, who can take part in all debates but may only vote in certain special cases when his electorate is affected.

Social Services. — The commonwealth department of health is responsible for four general hospitals in the Northern Territory— at Darwin, Alice Springs, Katherine and Tennant Creek. The Flying Doctor service was extended under the Aerial Medical service for treatment in outlying areas and a mobile dental clinic operates in remote parts All facilities are available to aborigines and in addition medical aid posts are maintained on all government and mission stations.

Agriculture. — Poor soils. low rainfall and poor irrigation possibilities make it improbable that the Northern Territory will ever develop large agricultural areas. Various attempts have been made to grow sorghum, peanuts, vegetables, cotton, tobacco. bananas, rice, coconuts and other commercial and useful plants. All will grow in favoured areas but success has not been great. In the latter 1950s the Commonwealth Scientific and Industrial Research organization (C S.I.R O.) research station at Katherine was conducting experiments in the hope of producing a satisfactory pasture plant for the summer rainfall region and also to determine the suitability of cotton groning. During 1954 and 1955 experiments in rice growing were made in an area at Humpty Doo station east of Darwin, making use of the natural floodwaters of the Adelaide river. Following this a company, Territory Rice Ltd., was formed with United States and at least 25% Australian capital to develop a large rice-grouing project. An agreement between the company and the commonwealth government in 1956 gave the company an option over 750,000 ac. of subcoastal plain from East Darwin to the Arnhem Land border, along the Adelaide, Mary, and the West, South and East Alligator rivers.

Pastoral Industries. — The cattle industry is widespread and conducted almost everywhere on the open range method with large unfenced runs. little control of the animals or attention to breeding. A cattle population of about 1,000,000 is maintained. Sheep are pastured mainly in the Alice Springs district. From this area the railway takes stock south to market. From the Barkly tableland cattle are walked to the railhead at Dajarra in Queensland or to the "Channel country" of southwest Queensland; in either case they are usually fattened for a further period before being marketed. The cattle country of the north stretches from the Kimberleys in north Western Australia to the Queensland coast, and that of the Northern Territory is very similar to that of the summer rainfall area of Western Australia and Queensland, except that, with better transport, Queensland's industry is more advanced.

Mining. — In 1953 uranium mining commenced at Rum Jungle, 50 mi. south of Darwin, and a new treatment plant produced uranium oxide in 1954. Further valuable discoveries were made near Pine Creek and Katherine. Extensive deposits of high-grade bauxite were found on Wessel Islands off the northeast coast of Arnhem Land. Principal minerals found are gold, copper ore, mica and wolfram. In addition small quantities of tin, silver-lead, ochre and tantalite were mined. Tennant Creek is the principal centre for gold production. Maranboy, south of Darwin, is the chief tin producing area. Mica comes mainly from the Harts range, east of Alice Springs. Hatches Creek has a treatment plant for wolfram mined in the district. Mother-of-pearl shell was discovered in Darwin harbour in 1884.

Transport and Communications. — Mail is distributed from Darwin to the northern part of the territory; the southern part is served from Adelaide. Telephone communication is available from Darwin to the capital cities. The transcontinental telegraph runs from Adelaide to Darwin. Radio equipment links most of the pastoral homesteads with flying doctor bases. Air lines link Darwin with all capital cities and small planes serve inland towns and stations. Railways are undeveloped. A narrow-gauge line runs 316 mi. from Darwin to Birdum and in the south from South Australia (Port Augusta) to Alice Springs. During the 1950s diesel locomotives were introduced and provided faster service. During World War II roads were built from Alice Springs to Darwin (Stuart highway, 954 mi.) and from Tennant Creek to Mount Isa in Queensland (Barkly highway, 403 mi.). Western Australian government shipping service vessels from west coast ports make calls at Darwin.

NORTHFIELD, a city of Rice county in southeastern Minnesota, U.S., on the Cannon river, is located approximately 35 mi. S. of Minneapolis–St. Paul. It is in an area long known as a breeding centre of purebred Holstein cattle, and for poultry raising and grain farming. Manufactures include snow fences, road culverts, pool tables and plastic bags. Founded in 1855 by settlers of New England origin, Northfield was incorporated in 1871. Its historical claim to fame rests in the defeat by Northfield citizens of the Jesse James and Younger brothers' gang who attempted to hold up its local bank on Sept. 7, 1876. During the fray, two members of the gang were killed and Bob Younger was wounded. Two weeks later the Youngers were captured and imprisoned.

The city is the seat of two liberal arts colleges. Carleton college. founded in 1866 by the Congregational churches, is now without denominational restrictions. It features a selective curricular program for all fields but especially in science and mathematics. St. Olaf college, founded by the Evangelical Lutheran Church in 1874, serves as a centre of Norse culture and its choir has won world-wide acclaim for its a *cappella* singing. Near the town can be seen numerous Indian burial mounds. For comparative population figures *see* table in MINNESOTA: *Population.*

(JE. C. T.)

NORTH HOLLAND, a Netherlands province, lying between the North sea and the IJsselmeer (Zuider Zee) and bounded southward by the provinces of South Holland and Utrecht. The present area, including the islands of Texel, Vlieland and Terschelling, in the West Frisian group, and Marken and Urk in Zuider Zee, the isle of Wieringen having been incorporated with the mainland, as starting point of the Afsluitdijk (closing dike) which drains the Zuider Zee and connects the provinces of North Holland and Friesland, is 1,016 sq.mi., with pop. (1957 est.) 2,014,446, showing an increase during the 20th century from 905 per square mile to 1,983 per square mile. Three natural divisions can be recognized: (1) foreshore and sand dunes, (2) inner dunes and the *geest* grounds, (3) low fens and clay lands. The dunes form a long, smooth, unbroken protection for the other regions, and the absence of deep inlets explains the absence of commercial towns. Ijmuiden is *a* small town. and its recent creation was solely dependent on its position at the exit of the artificial North sea canal from Amsterdam. Nevertheless, the broad, gently sloping, sandy beach is admirable for sea bathing and permits the beaching of the characteristic flat-bottomed fishing boats used at Zandvoort and at smaller fishing villages. Bergen aan Zee, Egmond aan Zee and Wijk aan Zee are gay little unconventional resorts. In the second zone, behind recently planted woods, especially along the margin of the *geest* grounds, from about 5 mi. N. of Haarlem to 10 mi. S., hyacinths, tulips, narcissi and crocuses, in exact squares of brilliant and varied colours, attract numerous tourists each springtime, while market gardens provide valuable and continuous products for home and foreign trade.

This part of North Holland was early inhabited and contains many old towns and villages. Some of the most interesting are Haarlem (pop. 167,264). the seat of government of the old counts of Holland and the scene of the great resistance of 1573 — one of the most glorious failures in history. Near to Haarlem are the extensive red brick ruins of Brederode castle, the seat of an old and illustrious family. Nearer to the south border is Bennebroek, the site of a 10th-century nunnery. Alkmaar (*i.e.,* all water) (pop. 42,060), though originally belonging to the lowland zone. also has important historical associations, including its personal success against the Spaniards in the Eighty Years' War. Near Alkmaar are Schoorl, a village in the 9th century; Bergen, also of considerable antiquity; Heiloo, stated to be the site of a church built by St. Willibrord in the 8th century; and the villages of Beverwijk and Velsen. Other possessions of the same apostle still remain, while Egmond, near by, was famed for its great abbey. Nearer Helder (pop. 46,102) is Schagen, a flourishing village in the 12th century, a lordship in the 15th, but of no special importance today.

The third division comprises much the largest area, that lying at or below sea level. Considerable land reclamation has been effected. To the north of the former Y (or IJ) the famous Purmer and Beemster lakes were drained in the beginning of the 17th century; but several sea polders to the north of these were added to the mainland only in the first half of the 19th century. This region is traversed by the 46-mi. North Holland canal (1819–25), between Amsterdam and Helder. The Y, formerly an inlet of the Zuider Zee, was drained, and the direct east-to-west 15-mi. North sea ship canal was cut in its stead (1865–76); in the south, Haarlem lake (72 sq.mi.) was drained between 1840 and 1853. The landscape in this lowland division is more typically Dutch than elsewhere. The province is very poor in minerals. Consequently cattle rearing and cheese manufacture (chiefly Edam) are the main industries, but agriculture and even market gardening are also practised in the heavier clay lands of the polders. Purmerend, the natural focus of the Purmer, Wormer and Beemster polders, with street and canals too narrow to contain the present market-day produce; Alkmaar, the great cheese town with a famous weigh house; and Enkhuizen, one of the "dead cities" of the Zuider Zee, are the chief market centres. The security offered by the Zuider Zee for trade and fishing was the prime factor in the commercial development of North Holland, and the cities of Medemblik, Enkhuizen, Hoorn, Edam and Monnikendam, though now of little more than local importance, possessed a large foreign commerce in the 16th and 17th centuries. This prosperity later concentrated itself upon the Y (that is, upon Amsterdam; *q.v.*) and upon the series of industrial settlements situated on its offshoot, the Zaan, of which Zaandam, pop. (1957 est.) 46.814, with oil, saw, corn, cement and paper mills, is the most important.

Of the islands, Marken is rapidly learning how to commercialize its own quaintness, though it is not yet entirely spoiled. Microscopic Urk has a population (5,282 [1957]) largely dependent on the North sea fishery Texel is noted for sheep and their products, wool and green cheese, and also for sea birds' eggs. which are exported to Amsterdam. Vlieland and Terschelling are but slightly populated and relatively unimportant.

NORTHINGTON, ROBERT HENLEY, 1ST EARL OF (*c.* 1708–1772), lord chancellor of England, was the second son of Anthony Henley, a Whig member of parliament. Robert was educated at Westminster school and St. John's college, Oxford, and was called to the bar in 1732. In 1747 he was elected member of parliament for Bath, of which he became recorder in 1751. In the same year he became a king's counsel. He acquired a lucrative practice at the bar and in 1756 was appointed attorney general. In the following year, he was promoted to the office of lord keeper of the great seal, being the last person so designated. He was given the title of Baron Henley in 1760 so that he could preside as lord high steward at the trial of Earl Ferrers for murder.

He became lord chancellor on the accession of George III in 1761, and in 1764 he was created earl of Northington. He was a member of the group known as "the king's friends," and was instrumental in procuring the dismissal of the marquess of Rockingham and the recall of Pitt to office in 1766. He joined this government as lord president of the council, but was increasingly incapacitated by attacks of the gout. He resigned office in 1767 and died at his home in Hampshire on Jan. 14, 1772.

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NORTH MIAMI, a residential city of southern Florida, U.S., is located about 11 mi. N. of Miami on Biscayne bay. Until 1921 it was a farming area known as Arch Creek, but during the land boom of the 1920s real estate was sold and resold there, although little building was done. Incorporated as Miami Shores in 1926, it was renamed North Miami in 1932 when the Florida legislature created another Miami Shores.

In 1952 the city received a charter and adopted a council–manager form of government, with some functions being transferred to metropolitan administration (*see* MIAMI). The population, which was less than 2,000 in 1940, increased more than fifteenfold during the next 20 years. The city's rapid development was primarily due to the growth of Miami during this period but was due also to an increasing amount of light industry in North Miami itself. For comparative population figures *see* table in FLORIDA: *Population.* (C. W. TE.)

NORTH PLATTE, a city of southwest-central h'ebraska, U.S., is located about 250 mi. W. of Omaha at the forks of the Platte river; the seat of Lincoln county. In the vicinity is Ash hollow. site of the battle of Blue Water (1855) between Sioux Indians and U.S. troops under Gen. W. S. Harney. North Platte was founded as a division point of the Union Pacific railroad main line in 1866, and was incorporated in 1871 The city is a shipping point for grain and cattle, ahile the irrigated region also produces sugar beets and hay. Industries include railroad shops, flour mills, the processing of dairy products and the manufacture of insulating materials. "Scouts Rest," the ranch of Col. William F. ("Buffalo Bill") Cody. is located northwest of the city.

For comparative population figures *see* table in NEBRASKA: *Population.* (O. E Y.)

NORTHROP, JOHN HOWARD (1891–), U.S. biochemist, winner of the 1946 Nobel prize in chemistry with Wendell M. Stanley and James B. Sumner for pioneering research in the crystallization of enzymes and related substances, was born July 5, 1891, at Yonkers, N.Y.

Columbia trained (B.S., 1912; M.A., 1913), he received his Ph.D in 1915 and studied as Cutting traveling fellow with Jacques Loeb at the Rockefeller Institute for Medical Research on theories of life duration. He became a member of the institute in 1924. In 1949 he was named research professor of bacteriology at the University of California, Berkeley.

Early work by Northrop on fermentation to produce acetone and ethyl alcohol during World War I led to the study of enzymes essential for digestion, respiration and general life processes. He showed that enzymes obey chemical laws. In 1930 Northrop prepared pepsin in pure crystalline form. With Moses Kunitz he succeeded in crystallizing the enzymes trypsin and chymotrypsin as well as their precursors trypsinogen and chymotrypsinogen. With Roger M. Herriott he isolated crystalline pepsinogen. He studied proteins of meat, viruses and antibodies. From the intestines of mammals, h'orthrop isolated a bacteriophage, a virus which destroys bacteria.

Northrop also made studies on starch, the kinetics of bacteriophage, agglutination of bacteria and temperature effect on insects. and purified diphtheria antitoxin (1941). He published *Crystalline Enzymes* (1939) and edited the *Journal of General Physzology* of the Rockefeller institute. He served in the U.S. army chemical warfare service in World War I as captain, and in World War II he was consultant to the National Defense Research committee. (V. Bw.)

NORTH SEA, a sea occupying a shallow basin between Great Britain and continental Europe. It extends southward from the edge of the continental shelf north of the Shetland Islands to the Straits of Dover, covering an area of about 220,000 sq.mi. Its bed slopes gently down from south to north as a rule. The southern areas are very shallow, with many low ridges of sand barely covered at low tide. Off the Holderness coast the Silver Pits and other east-west trenches show depths of more than 50 fathoms in places. The Dogger bank, a submerged plateau, rises abruptly to the north of these depressions and occupies about one-third of the width of the sea. Depths over the bank vary from 8 to 20 fathoms and are less than 10 fathoms over 250 sq.mi. of its area. The nets of trawlers fishing on the Dogger have brought up masses of peat, sometimes containing teeth and bones of prehistoric land animals, showing it to have been a wooded area after the close of the Ice Age. To the north the bed slopes very gently, though cut by several depressions, until the continental edge is reached. In the northeast the Norway deep or Gut is a remarkable feature. It begins off Alesund as a break in the edge of the continental shelf and extends southeastward as a narrow trench, parallel to the Norwegian coast, into the Skagerrak as far as Oslo. Its depth increases toward its head, depths of more than 400 fathoms being recorded in Skagerrak. Its edge rises very steeply on the Norwegian side but much more gently on the west.

History.—The North sea basin was formed by slow submergence during Tertiary times. Toward the close of the Pliocene period its southern margin lay along the northern edge of the Dogger bank and the north Yorkshire moors, a long estuary penetrating far to the south between them. This was probably the outlet of an ancestral Rhine to which the early Thames and other rivers of eastern England flowed over a marshy plain. During the glacial period most of the basin was repeatedly covered by ice sheets, and thick deposits of drift were laid down over the former plain. At the close of that epoch the Dogger bank, Holderness and a wide coastal plain beyond the present shores were all exposed. On these surfaces woodlands and peat swamps developed whose remains form the forest beds exposed at low tide at many points along the present coasts. It was on this land surface that the river systems of today were developed. A later rise of sea level led to the covering of this surface and brought about the formation of the Wash and the Humber and many of the minor estuaries on the English and continental shores. The present coastal limits, in their broad outlines at least, were finally determined in the period extending from Middle Stone Age to Bronze Age times. The Straits of Dover were probably first opened during the Ice Age.

Coasts.—The North sea coasts of Norway and Scotland are usually cliffed except along the more penetrating inlets. That these have been cut so often in highly resistant rocks is an indication of the long period during which wave action has continued at or about their present position. South of Berwick and the Skagerrak the coasts are composed of softer rocks, and cliffs, where present, might be of relatively recent formation even when, as in northeastern England, they are of considerable height. On the English side of the North sea, south of Flamborough head, low cliffs, often of boulder clay and fronted by sandy beaches, are characteristic. The continental shores are usually low and flat and backed by wide marshes, sometimes protected by coastal sand dunes and sometimes by artificial dikes. A slow but persistent down-warping seems to be taking place over all the southern areas of the sea and causing a relatively rapid shift of the coast line except where it is protected. Such floods as those of Jan. and Feb. 1953 are almost certainly indicative of this transgression of the sea upon the land.

Temperature and Salinity.—Thanks to the great influx of land water from the Baltic and from the many rivers which enter the North sea directly, its waters are less saline (34.5 *pro mille* on the average) than those of the Atlantic. Baltic water entering it has a salinity of less than 30 *pro mille*. Coastal waters are fresher than those of the central areas where tidal turbulence produces thorough mixing. Because of snow melt and higher winter rain, salinity is lowest in winter and spring. In summer and autumn, warmer Atlantic water of more than 3j *pro mille* salinity enters the basin from the north and through the Straits of Dover. These movements affect the migrations and spawning dates of fish. Sea temperatures are always high enough to prevent freezing.

Tides.—Tides from the ocean enter the North sea in three main streams: (1) around the north of Scotland and advancing southward along the east coast of Britain; (2) from the English channel and moving along the Dutch and German shores; (3) along the Norwegian coasts toward the Skagerrak. A counterclockwise circulation, though with several minor eddies, is thus produced. The flood tide of the Scottish system reaches the Thames estuary at the same time as the next succeeding high tide coming up-channel, and the interference of the two waves produces local complications. Thus the range of tidal levels off the Thames is increased and the range between Yarmouth and the Helder decreased by their interaction. Tidal ranges on the British coasts are about double those on the Dutch and German and nearly four times those on the Norwegian coasts.

Fisheries.—The waters of the North sea are extremely rich in many forms of marine life. Especially are they so in the microscopic forms of plant and animal life, known collectively as plankton, on which either directly or ultimately all fish depend for their food. The amazing abundance of this food supply is attributed to many factors—the mingling of Atlantic waters with local waters differing from them in temperature; the plentiful supplies of food substances derived from the land; the turbulence of the sea because of storms, and tidal and other currents, all contributing ta its aeration; and the shallowness permitting the penetration of sunlight to the sea bed. In consequence, few other seas rival the North sea in the quantities of food fishes it supports. The chief varieties are herring, cod, haddock, plaice, sole and turbot. Herrings are found off the British coasts between June and November when they gather in great shoals in the surface waters. Mackerel appear in the same waters earlier in the year. Cod are caught mainly on the Dogger bank (*dogger* in Dutch signifies cod) and in the colder northern waters. The flat fish prefer the shallower seas except in winter when they move to such deeper waters as those of the Silver Pits. At other times they are found mainly in the southern and eastern regions from the Thames estuary to Denmark.

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NORTH SHIELDS, seaport, Northumberland, Eng., within the borough of Tynemouth (*q.v.*), which adjoins it on the east. It lies immediately above the mouth of the Tyne, opposite to South Shields. $7\frac{1}{2}$ mi E. of Xewcastle by a branch of the North Eastern Region railway. It is a town of modern growth. Coal and coke are largely exported, and corn, timber and esparto grass are imported. There is an extensive fish quay. There are marine engineering (engines, chain cables, anchors), salt. rope, earthenware and stained glass works and some shipbuilding is carried on.

The town was specially affected by the depression of the 1930s, more than 27% of the insured population being unemployed in June 1934.

NORTH TONAWANDA, a city of Niagara county in western New York, U.S., is situated on the north bank of the State Barge canal where it joins the Niagara river, 10 mi. N. of Buffalo. Settled astride Tonawanda creek in 1809, North Tonawanda and its sister city of Tonawanda (*q.v.*) became the western terminus of the Erie canal when, in 1823, a portion of the creek was used in its construction. Originally a single community, North Tonawanda and Tonawanda quarreled over taxes and separated in 1855. North Tonawanda was incorporated as a village in 1865 and chartered as a city in 1897. Its location on the canal led to its development as a transfer point for lumber moving from the upper Great Lakes down the canal to the Atlantic coast. Lumber is still the major commodity in the business of the city, which also produces plastics, cast iron, paper products, boats, metal products, roofing materials, abrasives, office supplies and electronic components. For comparative population figures on North Tonawanda (part of the Buffalo standard metropolitan statistical area) *see* table in NEW YORK: *Population*. (R. T. R.)

NORTHUMBERLAND, EARLS AND DUKES OF. The earldom, and later the dukedom, of Northumberland are famous by their connection with the house of Percy (*q.v.*).

In the year 1377 Henry de Percy, 4th Baron Percy, officiated as marshal of England at the coronation of Richard II and was created earl of Northumberland. With his son Sir Henry Percy (q v.). the celebrated "Hotspur," the earl played a leading part in the history of the period, especially in bringing about the deposition of Richard II and the accession of Henry IV. The quarrel of Northumberland and his son with King Henry over the ransom of their Scottish prisoners taken at Homildon hill on Sept. 14. 1402 has been immortalized by Shakespeare. The king forgave him, on his swearing renewed fealty, but as a result of his involvement in later plots after Hotspur's death, he forfeited his titles in 1406. He was not present at the battle of Shrewsbury in July 1403, when Hotspur was killed, but he was slain, heading a fresh rebellion, at Bramham Moor on Feb. 19, 1408.

The 1st earl of Northumberland was succeeded by his grandson. Hotspur's son. HENRY (1393–1455), who was restored to the earldom and the Percy estates in 1316. He was killed at the battle of St. Albans in May 1455. The title then descended in the male line till the death of the 6th earl in 1537. During the Wars of the Roses the Percys took the Lancastrian side, nhich led to the attainder of Henry, the 3rd earl (1421–1461), during the time of the Yorkist triumph. his forfeited title being conferred in 1464 by Edward IV on John Neville. Lord Montagu (*q.v*). by a patent which was cancelled a few years later The earldom, and the barony of Poynings which his father had obtained by marriage, were restored in 1470 to Henry Percy, son of the 3rd earl, nho attached himself to Edward IV, acquiesced in the accession of Richard III and submitted to Henry VII. by whom he was received into favour. His grandson Henry Algernon. the 6th earl (1502?–1537), left no direct heir and his nephew, Thomas Percy, was debarred from the succession by an attainder passed on his father for his participation in the Pilgrimage of Grace. In 1549, however. Thomas was restored in blood and in 1557 became by a new creation earl of Northumberland. 7th of his line. Meantime, in 1551, John Dudley, earl of Warwick, was created duke of Northumberland (see below), but his title was forfeited by attainder in 1553.

The earldom restored to the house of Percy by the creation of 1557 continued in the male line till 1670. The 7th earl mas beheaded in 1572 for leading the northern rebellion of 1569, in which he was joined by the earl of Westmorland. Their aim had been to secure the release of Mary Queen of Scots and the free exercise of the Catholic religion. By the earl's attainder the baronies of Percy and of Poynings and the earldom of Northumberland of the older creation were forfeited, but because of a clause in the patent the newer earldom of Northumberland and the other honours conferred in 1557 passed to his brother Henry (1532?–1585), who was twice imprisoned on suspicion of plotting in favour of Mary. He was found shot dead in the Tower in 1585.

Henry's son, another Henry (1564–1632). after serving in the Low Country wars. also spent almost 16 years in the Tower after the gunpowder plot (1605). This Henry's son. ALGERNON PERCY, 10th earl of Northumberland (1602–1668), became a peer in his father's lifetime as Baron Percy in 1626. Northumberland played a distinguished part in the civil war. He mas a friend of Strafford, but gave evidence at his trial which, though favourable on the important point of bringing the Irish army to England, was on the whole damaging. He afterward became leader of the popular party in the house of lords. He was a member of the committee of safety and later of the committee of both kingdoms. He took an active part in the attempts to come to terms with the king, whom he visited at Oxford in 1643 and at Uxbridge two years later. Northumberland helped organize the new model army, and in 1646 was entrusted by parliament with the charge of the king's younger children.

He led the opposition in the house of lords to the proposal to bring Charles I to trial. 'During the Commonwealth he took no part in public affairs. At the Restoration he was called to the privy council by Charles II, and with his habitual moderation deprecated harsh proceedings against the regicides. His second wife, Elizabeth (d. 170j), daughter of Theophilus Howard. 2nd earl of Suffolk. brought him Northumberland house in the Strand, London (demolished in 1874). On the death of his son Joceline, the 11th earl, in 1670, the male line became extinct.

George Fitzroy (1665–1716), third son of Barbara, duchess of Cleveland and wife of Roger Palmer, earl of Castlemaine. by Charles II. was created earl of Northumberland in 1674 and duke in 1683. This dukedom became extinct on his death at Epsom on June 28. 1716.

Elizabeth Percy, daughter of Joceline, the 11th earl, married Charles Seymour, 6th duke of Somerset. Her son Algernon, the 7th duke, was in 1749 created Baron Warkworth and earl of Northumberland, with remainder to his son-in-law, Sir Hugh Smithson, Bart., son of Langdale Smithson of Stanwick, Yorkshire. Sir Hugh Smithson (1715–1786) took the name and arms of Percy on inheriting the earldom in 1; jo. In 1766 he was created Earl Percy and duke of Northumberland, and in 1784 he was further created Baron Lovaine of Alnwick, with special remainder to his second son. Lord Algernon Percy. He took a prominent part in politics as a follower of Lord Bute. and was one of George III's confidential advisers. holding the office of lord lieutenant of Ireland from 1763 to 1765. and that of master of the horse from 1778 to 1780. He was a man of cultivated tastes. and spent much money on Alnwick castle and his other residences.

His wife. Elizabeth (1716–1776), inherited in her own right her father's barony of Percy. The duke was succeeded by his eldest son Hugh. His second son Algernon: Lord Lovaine, was created earl of Beverley in 1790.

Hugh, 2nd duke of this line (1742–1817), first inherited his mother's barony of Percy in 1776. He was present at the battle of Minden. and although in parliament he had opposed the policy that led to the American war. He went to Boston in 1774 as colonel commanding the jth fusiliers, a regiment since then known as the Northumberland fusiliers. He succeeded to the dukedom in 1786. His son Hugh. 3rd duke (1785–1847), was lord lieutenant of Ireland (1829–30), and was pronounced by Sir Robert Peel "the best chief governor that ever presided over the affairs of Ireland." Both he and his brother Algernon, 4th duke (1792–186j), who was created Baron Prudhoe in 1816, died without issue. The barony of Percy devolved on their great-nephew, the duke of Atholl. and the dukedom passed to George (1778–1867), eldest son of Algernon, 1st earl of Beverley, and so to his son, the 6th duke (1810–1899), and to his grandson, the 7th duke (1846–1918). He was succeeded by the 8th duke (1880–1930), the 9th duke (1912–40) and the 10th duke, brother of the 9th duke (1914–).

See Edward Barrington de Fonblanque, The ***House of Percy***, 2 vol. (London, 1887); G. E. C(okayne), ***Complete Peerage***, vol. ix (London, 1936). (R. B. WM.; X.)

NORTHUMBERLAND, ALAN IAN PERCY, 8TH DCKE OF (1880–1930), was born on April 17, 1880, a son of the 7th duke. He succeeded to the title in 1918. As one of the largest coal owners in the north of England. he was summoned to appear as a witness before the Sankey Coal commission (1919) and came much into public notice owing to his prolonged controversy with Robert Smillie, the leader of the miners, and subsequently to his anti-Communist campaign. In 1924 the duke acquired an interest in *The Morning Post* newspaper, sold by Lady Bathurst. He died Xug. 23. 1930.

NORTHUMBERLAND, JOHN DUDLEY, VISCOUNT LISLE, EARL OF WARWICK, and DUKE OF (1504?–1553), was the eldest son of Edmund Dudley (*q.v.*) by his second wife Elizabeth. daughter of Edward Grey, viscount Lisle, and coheiress of her brother John, viscount Lisle. His father was attainted and executed in 1509. About 1511 his mother married Sir Arthur Plantagenet, the illegitimate son of Edward IV. In 1523 Sir Arthur was created Viscount Lisle in his wife's right and his rise in Henry VIII's favour brought young Dudley into prominence. In 1512 he was restored in blood. and in 1538 he was made deputy to his stepfather. who was governor of Calais. He does not appear to have suffered by Lisle's temporary disgrace and imprisonment in the Tower. After Lisle's death early in 1542 Dudley was created Viscount Lisle on March 12. made warden of the Scottish marches in November and lord great admiral of England in 1543 in succession to his future rival. Edward Seymour, earl of Hertford. He was also created a knight of the garter and sworn of the privy council. In 1544 he accompanied Hertford to the capture and burning of Edinburgh. On the capture of Boulogne in September Lisle was given command of the town and of the Boulonnais. In 1545 he directed the operations of the fleet in the Solent which foiled the French attack, and he was sent to Paris to ratify the peace concluded in 1546.

Lisle had thrown in his lot with the reforming party, and he took an active share in the struggle at Henry VIII's court for control of affairs when Henry should die. Hertford and Lisle were described by the Spanish ambassador as holding the highest places in Henry VIII's affections and as being the only noblemen of fit age and ability to carry on the government. The Howards were infuriated by the prospect and the earl of Surrey's hasty temper ruined their prospects. Lisle quarrelled bitterly with Bishop Gardiner, served as commissioner at Surrey's trial, and was nominated one of the body of executors to Henry's will from which Norfolk and Gardiner were excluded. On Henry's death (1547) Lisle was raised to the earldom of Warwick and promoted to lord high chamberlain of England, again in succession to Hertford. who became duke of Somerset and protector. He accompanied Somerset on his Pinkie campaign and materially contributed to the winning of that victory.

Nor did Lisle exhibit any sympathy with the intrigues of the protector's brother. Thomas Seymour; his subtler policy was to exasperate the brothers and thus weaken the influence of the house of Seymour. He helped to bring the admiral to the block in March 1549, and then used the widespread dislike of the Protector's social policy to bring about his deposition. Warwick detested Somerset's ideas of liberty and his championship of the peasantry against the inclosure movement. One of his own parks was ploughed up as a result of a commission of enquiry which Somerset appointed, and when the peasants rebelled under Robert Ket. Warwick gladly took the command against them. His victory at Dussindale (Aug. 27, 1549) made him the hero of the landed gentry, and in Sept. 1549, he organized the general discontent with the protector's policy into a conspiracy. He played upon the prejudices of Protestants and Catholics alike, holding out to one the prospect of more vigorous reform and to the other hopes of a Catholic restoration, and to all gentry the promise of revenge upon the peasants.

The coalition thus created effected Somerset's deposition and imprisonment in Oct. 1549; and parliament carried measures of political coercion and social reaction. But the coalition split upon the religious question. Warwick threw over the Catholics and expelled them from office and irom the privy council, and the hopes they entertained were rudely dashed to the ground. But it was difficult to combine coercioh of the Catholics with the proscription of Somerset. The duke was therefore released early in 1550 and restored to the privy council and his daughter was married to Warwick's son John. Warwick himself assumed no position of superiority over his colleagues, and he was never made protector. But he gradually packed the council with his supporters and excluded his enemies from office and from access to the king. The council, in fact. became politically impotent, though its administrative efficiency was improved. His plan was to dominate Edward's mind and then release him from the trammels of royal minority.

Warwick abandoned the Tudor designs on Scotland and made a peace with France in 1550 by which it recovered Boulogne and was left free to pursue its advantage in Scotland. Nor did the betrothal of Edward to Henry II's daughter Elizabeth prevent the French king from intriguing to undermine English influence in Ireland. In domestic affairs Warwick pushed on the Reformation with none of the moderation shown by Somerset. The difference between the two policies is illustrated by the change effected between the first and second Books of Common Prayer. Warwick, however, was widely distrusted and the more arbitrary his government grew, the more dangerous became Somerset's rivalry. A parliamentary movement had early been started for Somerset's restoration. Warwick therefore kept parliament from meeting and the consequent lack of supplies drove him into the seizure of church plate, sale of chantry lands and other violent financial expedients. At length he resolved to get rid of his opponent, his opposition was magnified into conspiracy, and in Oct. 1551. after Warwick had made himself duke of Northumberland and his ally Dorset. duke of Suffolk, and had scattered other rewards among his humbler followers. Somerset was arrested. condemned by the peers on a charge of felony and executed. Jan. 22. 1552.

Parliament was permitted to meet on the following day. but for the next 18 months Northumberland grew increasingly unpopular. He saw that his life was safe only as long as he controlled the government and prevented the administration of justice. But Edward VI was slowly dying, and Northumberland's plot to alter the succession was his last desperate bid for life and power. Its folly was almost delirious. Edward had no legal authority to exclude Mary, and the nation was at least nine-tenths in her favour. Northumberland bullied the council and overawed London for a few days, but the rest of England was in an uproar, and as he rode out to take the field against Mary, not a soul cried "Godspeed." A few days later he returned as Mary's prisoner. Tried for treason, he professed himself a Catholic in the delusive hope of pardon, but was executed on Aug. 22, 1553.

Northumberland was a competent soldier and one of the subtlest intriguers in English history. He showed some grasp of economic problems and he attempted to reform the coinage, debased by his predecessors. But he was without principles and the violence of his pretended Protestantism was partly responsible for the reaction of Mary's reign. His best-known son was Robert Dudley, earl of Leicester, Queen Elizabeth's favourite.

See A. F. Pollard, *England under Protector Somerset* (London, 1900), *Thomas Cranmer and the English Reformation,* new ed. (London, New York, 1926), *Political History of England,* vol. vi (London, 1910); Institute of Historic Research, *Bulletin,* vol v, 108–109 (London); S T. Bindoff, *Tudor England* (Harmondsworth, 1950). (R. B WM.; X)

NORTHUMBERLAND, JOHN NEVILLE, EARL OF (1428?–1471), was the third son of Richard Neville, earl of Salisbury, and brother of Warwick "the kingmaker" (*q.v.*). In 1453 he was a ringleader in the conflicts between the Nevilles and Percys which were the real beginning of the civil war. This rivalry, which involved an ambition to control the Scottish march, dominated John Neville's career. Thus. despite close personal ties with Henry VI, he supported Edward IV. On his behalf. Neville, warden of the east march irom June 1463. beat down there the last traces of Lancastrian resistance on English soil in a series of engagements, including Hedgeley Moor (April 1464) and Hexham (May 1464). In return he was created earl of Northumberland, May 1464. Neville, a hesitant man, did not involve himself in Warwick's intrigues against Edward IV in the summer of 1469. However, when the king, suspicious of him, restored his earldom of Northumberland to the Percys, he joined the rebels, and that was the immediate cause of Edward's flight abroad in Oct. 1470. Entrusted with the defense of the north by Warwick, Neville did not attack Edward IV when he landed in Yorkshire (March 1471), perhaps because the Percys also stood aside. He did finally join his brother at Coventry, and was killed with him at Barnet, April 14, 1471.

See C. L. Scofield, *The Life and Reign of Edward IV,* 2 vol. (London, 1923). (GV. T.)

NORTHUMBERLAND, the northernmost and fifth largest county of England bounded south by Durham and west by Cumberland. The geographical area is 2,018.7 sq.mi.; with a population (1951) of 798.424. In the southeast the coalfield and industrial area centre on Newcastle; on the east the coastal plain. 10–15 mi. wide, stretches from Tynemouth to the Scottish border; in the southwest lie the north and south Tyne valleys and the northwest is bounded by the Tweed river and the Cheviots which cover 200 sq.mi. and rise to 2,676 ft. Between the Cheviots and the Pennines the lower line of the Tyne gap gives an important way for east–west routes. The greater rivers flow eastward except the Till which flows north to join the Tweed.

Physical Features. — The strata decline eastward and southeastward to the sea from the central core of the Cheviot massif composed of lava and agglomerates thrown up in Tertiary times by the Cheviot volcano. It is surrounded by two newer formations —cementstone hills from Deadwater on the north Tyne to Cornhill and a sandstone range including Chillingham and Rothbury forest. On the southeast lies the Scremerston coalfield covering the Tyne valley north of Wark and parts of Redesdale and Bewcastle fells. The coastal plain between Berwick and Alnmouth is Carboniferous Limestone which is separated from the coalfield in the southeast by a narrow belt of Millstone Grit. A sheet of basalt, the Great Whin Sill, resulting from volcanic activity, outcrops at points along the 70 mi. of coast from north of Bamburgh to Teesdale. Masking the geological structure are glacial deposits, chiefly of boulder clay.

History. — In the Neolithic Age settlements existed in the lower levels of the limestone area running northeast from Hexham to Alnwick. The evidence of beaker pottery suggests that migrants from across the North sea settled at the beginning of the Iron Age. The Roman hold on Northumberland dates from A.D. 122 when the emperor Hadrian had a wall built from the Tyne to Solway firth. In 547 Ida laid the foundations of the kingdom of Bernicia, which later extended from the Tyne to the Forth. by building the fortress of Bamburgh which became the seat of the Saxon kings. His grandson. Aethelfrith the Destroyer, established the predominance of the Angles in 603 by defeating the combined forces of Strathclyde Britons and Scots at Degsastan and in 605 annexed the neighbouring kingdom of Deira. Henceforth the region between the Forth and the Humber was known as Northumbria (*q.v.*) and for about 80 years its kings were the most powerful rulers of the

Anglo-Saxon states.

The north was ruthlessly harrowed by William the Conqueror but the Normans later refounded Lindisfarne. Tynemouth and Hexham and established new monasteries, while they built castles which protected the county against invasion from Scotland or over the North sea. The county is not mentioned in Domesday but the account of its issues appears in the Great Roll of the Exchequer in 1131. Under Edward I it extended from the Tees to the Tweed, though it included franchises or liberties exempt from the ordinary jurisdiction of the shire. These were annexed one by one—Tynedale in 1495–96, Hexham in 1572, and Norhamshire, Islandshire and Bedlingtonshire, which had lost their jurisdictional powers in 1536, became part of the county for civil purposes in 1844. The county assizes have been held in Newcastle since 1140. From 1843 they have been held there jointly with those of the county of Newcastle, which had been a separate county with its own assizes from 1400. The shire court was held at either Newcastle, Alnwick or Morpeth until 1549 when it was statutorily established at Alnwick.

The first reference to the division of the county into wards is in the Hundred Roll for 1295. Two members sat for Northumberland in the parliament of 1290 while in 1295 Bamburgh. Corbridge and Newcastle each returned two. In 1882 Northumberland (originally included in the diocese of Durham) became a separate diocese with the see at Newcastle.

Its political history until the Act of Union in 1603 is largely a record of border warfare. During the civil war of Stephen's reign David I of Scotland, who claimed Northumberland, invaded it in 1136, 1137 and 1138. Henry II recovered it by the treaty of Chester (1157) but the Scots claimed it periodically until the treaty of Newcastle (1244). Following Edward I's decision of the Scottish succession in favour of John Baliol in 1290, Redesdale, Coquetdale and Tynedale were ravaged in 1295 and Robert Bruce invaded the county in 1314, defeating the English at Bannockburn. The principal invasions of the 14th century were in 1333, ending with the battle of Halidon hill in 1346. when David of Scotland was taken prisoner at Neville's cross. and 1388 when Henry Percy was taken prisoner and 1,500 of his men killed at the battle of Otterburn or Chevy Chase.

During the Wars of the Roses the Scots recaptured Berwick in 1461, but it was recovered finally in 1482, having changed hands 13 times during the border wars. In 1462, Alnwick, Bamburgh and Dunstanburgh mere garrisoned in support of the Lancastrian cause. In the battle of Flodden (1513) James IV of Scotland was slain. In 1569, under the earls of Westmorland and Northumberland, the Catholic north rose against Elizabeth I in favour of Mary Queen of Scots. Newcastle, which was garrisoned for the king in the civil war, was captured by the Scots in 1644 and Charles I imprisoned there in 1646.

Antiquities.— The 226 ancient monuments of the county include Bamburgh, Dunstanburgh, Norham and Warkworth castles, Warkworth hermitage. Lindisfarne priory, parts of the Elizabethan ramparts at Berwick-upon-Tweed and the Roman station at Corstopitum, ½ mi. W. of Corbridge (*q.v.*). Other castles are Alnwick, Prudhoe, Morpeth, Ford, Chillingham, Langley and Wark. There are abbeys founded by the Normans at Alnwick, Brinkburn. Hulne (first English Carmelite friary), Blanchland and Newminster. Of the churches of Northumberland, the abbey of Hexham (*q.v.*) is one of the finest in the north and the oldest in Northumberland. The most impressive stretch of the Roman wall still standing is on either side of Housesteads (*Borcovicium*), the best-preserved of the 17 forts that once guarded the wall. In the park at Chesters are the remains of a Roman fort (*Cilurnum*) and an important collection of Roman antiquities.

Agriculture, Industries and Communications.— Sheep and cattle were increasingly important in the middle ages and the first agricultural exports of the county were wool and hides. William Camden (17th-century) describes the land as rough and unfit for cultivation and Arthur Young mentions 600,000 ac. lying waste in 1773. Improvements, intensified during the Napoleonic wars, made possible the export of grain from Berwick and Alnmouth though the repeal of the corn laws (1846) brought this to an end. In the latter 1950s one acre in 20 could be classified as good quality, nearly 45% as medium quality and about one-half as mountain and rough hill pasture. The total area under crops and grass, excluding rough grazings, was approximately 595,000 ac. Wheat occupied less than 2%, barley nearly 6% and oats 7½%. Clover and temporary grasses accounted for one-sixth, just over one-half was permanent grass and about three-quarters rough grazing. There were roughly 4½ times as many sheep as cattle. The National Trust owned 14,252 ac. in 1955.

The most important mineral resource is coal. It was mined in Roman times and the coal trade of the Tyne developed rapidly from the 13th century. Shipbuilding, for which the Tyne is famous, began in order to provide vessels to carry coal. Lead was for centuries supplied from the Allendale mines and exported as early as the 12th century. Silver and iron mines are mentioned in a charter of Richard I and in 1240 the monks of Newminster had an iron forge at Stretton. In the 12th century a salt pan is mentioned at Warkworth, in the 13th century salt manufacturing took place at the mouth of the Blyth and was the principal occupation in North and South Shields in the 15th century. Northumberland freestone, mainly from quarries at Doddington, Baxter and Blackpasture, was exported to Scotland. The Tyneside glass industry goes back to the reign of James I when Sir Robert Mansell invented a method of using coal in its manufacture and brought over workmen from German Lorraine. Tanning was important in mediaeval times but only one leather works was active in the mid-1950s. Linen and wool were spun throughout the county and tweeds are still woven in the woollen mills on the Wansbeck and Rede. The Tyne salmon fisheries, famous in the reign of Henry I, were mentioned as late as 1649 by W. Grey in his *Chorographia or a Survey of Newcastle upon Tine*. Modern industries of Tyneside include ironworks, blast furnaces. chemical works, manufactories of electrical apparatus and machines and pottery.

The two principal roads are the Great North road and the west road from Newcastle to Carlisle. Roads serving the industrial and urban area of the southeast include the coast road from Newcastle to Tynemouth which carries heavier traffic than any other route in the county. The main London to Edinburgh (North Eastern Region) railway runs through Newcastle north through Berwick-upon-Tweed and an important line runs west from Newcastle to Carlisle. The principal harbour facilities are those of the Tyne and the port of Newcastle. Blyth (coal trade) can take ships up to 12,000 tons and there are smaller harbours at Amble and Berwick. The civil aerodrome at Woolsington belongs to the corporation of Newcastle upon Tyne.

Population and Administration.— In 1951 the population of the administrative county was 440,136. The southeast is the most densely populated area comprising the mining region and industrial Tyneside. The latter was particularly affected by the depression of the 1930s and was included in the "special area" over which a commissioner was appointed by act of parliament in 1934. There are 2 county boroughs. Newcastle upon Tyne {pop.. 1951, 291,724) and Tynemouth (66.564). 5 municipal boroughs. including Berwick-upon-Tweed, a county of itself, 11 urban districts, 10 rural districts and 154 parish councils.

For parliamentary purposes Tynemouth. Wallsend, Newcastle upon Tyne (four members), and Blyth are constituencies outside the three county divisions which each return one member. The county is in the northeastern circuit and assizes are held at Newcastle. There is a court of quarter sessions for the county at Newcastle and a separate court for the borough of Newcastle and there are 14 petty sessional divisions. The county boroughs have their own police forces.

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NORTHUMBRIA was one of the most important of the Anglo-Saxon kingdoms. reaching at its greatest extent from the Humber and the Ribble to the Firth of Forth and the Ayrshire coast. Its name is derived from Old English *Norþanhymbre* which in a Latinized form was used by Bede to signify all those people of English race who lived to the north of the Humber. The kingdom emerged from the coalescence of two originally independent states, Bernicia to the north and Deira to the south. with the boundary between them marked by the Tees. The inhabitants of these two states were known in Old English as Bernice and Dere, names which seem ultimately to be of Welsh rather than English origin. The nucleus of Deira lay in the east riding of Torkshire where many pagan burials have yielded objects indicating that the earliest English settlements took place there long before the time of its earliest recorded king, Aelle, who was reigning in the second half of the 6th century. The kingdom of Bernicia was in origin no more than a pirate settlement established by Ida on the rock of Bamburgh in 547, and so it remained for about 50 years during the reigns of the next six rulers, one of whom, Theodoric, is said to have been besieged in Lindisfarne by a Welsh army led by Crien, king of Rheged.

A rapid expansion occurred during the reign of Aethelfrith (c. 593–616), of whom Bede said that he conquered more British territory than any other English king. In 603 he defeated Aidan, son of Gabran, ruler of the Scottish kingdom of Dalriada, at an unidentified place called Degsastan. Shortly after this he won possession of Deira, thereby creating the kingdom of Northumbria, and he also led a raid deep into Welsh territory to win another victory near Chester.

In 616, however, Aethelfrith was killed in a battle fought near the river Idle against Raedwald of East Anglia, who was supporting Edwin, the representative of the Deiran dynasty. On the eve of Easter 627 Edwin was baptized in York and so became the first Christian king of Northumbria. He was active in warfare against the Welsh, conquering the kingdom of Elmet, besieging Cadwallon (Ceadwalla), king of Gwynedd, in the island of Priestholm off the coast of Anglesey and laying both Man and Anglesey under tribute. but in 632 Edwin was himself defeated and slain by Cadwallon in Hatfield Chase. Northumbria fell apart momentarily but in 633 Oswald restored the Bernician dynasty by overthrowing Cadwallon in a battle fought near the Roman wall. During Edwin's reign the Bernician royal family had sought refuge among the Picts and Scots and several of them. including Oswald, were converted there. Shortly after his restoration Oswald invited Scottish monks to Northumbria and monasteries were established at Lindisfarne and elsewhere.

Northumbria continued to expand rapidly toward the north during the reign of Oswald (633–41) and of his successor Oswiu (641–70) and it is probable that Northumbrian rule had reached the Forth by or soon after 650. Abercorn became the seat of a Northumbrian bishopric about 680 and Dunbar the seat of an English earl at about the same date. Before the accession of Egfrith (670–85) the Northumbrians had imposed their rule on Pictish territories between the Forth and the Tay, but in 685 Egfrith, after leading an army across the Tay, was defeated and killed in a battle fought at Dunnichen Moss in Forfar. After this defeat the Northumbrian frontier fell back to the Forth where it remained until mid-9th century. The rate of Northumbrian expansion toward the western sea between Clyde and Ribble is difficult to determine. In 750 Eadbert, king of Northumbria, added parts of Ayrshire to his kingdom but it is probable that possession of these lands soon reverted to the British kingdom of Strathclyde whose capital lay at Dumbarton. A Northumbrian bishopric was established at Whithorn in Wigtownshire shortly before 731 and Carlisle may have been reached as much as 100 years earlier.

In Lancashire, estates adjacent to the Ribble formed part of the endowments of the church at Ripon soon after the middle of the 7th century. Northumbria's southern boundary was marked by the Humber on the east and the Ribble on the west. In its central sector it lay roughly along the line of the existing boundary between Yorkshire and Derbyshire. South of this border lay the kingdom of Mercia which became a formidable power during the reign of Penda (d. 654). On several occasions Penda invaded Northumbria. once penetrating as far north as Bamborough, and it was at the hands of Penda that Oswald met his death in 641. At times during Penda's reign the southern part of Northumbria became a dependency of Mercia. but in 654 a Mercian army, supported by contingents from East Anglia and Wales, was defeated by Oswiu in a battle fought near an unidentified river called Winwaed and Penda was killed. Northumbria's military strength was at its greatest in the 7th century during which the supremacy of three of its rulers, Edwin, Oswald and Oswiu, was recognized by the southern English kingdoms as well as in Northumbria. In the century which followed the death of Egfrith the importance of Northumbria was less in matters political and military than in the intellectual and artistic achievements represented by the works of Bede, the Lindisfarne Gospels and the Bencastle Cross. The monarchy was greatly weakened by internal disorders and many of the 8th- and 9th-century kings had short reigns and met violent deaths.

The overgrowth of monasticism led to a further weakening of Northumbria's pou'er. The transfer of lands to the church made it difficult for the nobility to provide adequately for their sons and many spurious monasteries were founded in which noblemen and officers of government lived with their wives and families, thereby avoiding the burdens of taxation and military service which would otherwise have fallen upon them. Bede foresaw that if this process were allowed to continue the military strength of the kingdom would not be great enough to enable it to defend itself, and so it proved when the great Danish army which had landed in East Anglia in 865 advanced upon York in the following year. The capture of York by the Danes was the first episode in a process which lasted for two centuries and which reduced the extent of the kingdom to the size of the modern county of Northumberland. After campaigning in different parts of the country for nine years a large part of the Danish army, led by Halfdan, settled down to permanent homes in an area corresponding broadly with the modern Uorkshire. English kings continued to reign at Bamborough but they were of no importance politically In the early years of the 10th century Northumbria's southwestern quarter, from the Solway to the Ribble, came under attack from Scandinavian invaders, approaching from Ireland and the Isle of Man. Entering the estuaries of the Dee and the Mersey, they established themselves not only in Lancashire, but also in Westmorland and Cumberland and along the northern shores of the Solway firth. Some of these newcomers sought to win control of the Danish settlements in '170rkshire and during the first half of the 10th century a succession of Norse kings ruled in York. Meanwhile, farther north. the amalgamation in about 850 of the formerly independent kingdoms of the Picts and the Scots created the kingdom of Scotland which began to exert pressure toward the south. In this way Lothian was gradually absorbed into Scotland.

The Tweed first came to be formally recognized as the boundary between Northumbria and Scotland about 975 and there were times when it seemed likely to be pushed further south to the Tyne or even the Tees. The situation in the northwest at this time is very obscure but it seems probable that the rulers of the kingdom of Strathclyde took advantage of Northumbria's greatly meakened position to push their frontier south to Carlisle and perhaps farther.

The dismemberment of the kingdom of Northumbria was accompanied by changes of a different kind in the midlands and south where a succession of great West Saxon kings—Alfred, Edward the Elder and Aethelstan—not only consolidated their position south of the Thames but also, by absorbing the once independent states of the midlands, brought the kingdom of England into existence. At a gathering at Bakewell in Derbyshire in 920 Edward the Elder received the submission of all the people of Northumbria, whether English, Danes, Norsemen or others. The supremacy of his successor, Aethelstan. was recognized at a similar gathering held in 927 near the river Eamont. In 934 Aethelstan invaded Scotland and in 937, at an unidentified place called Brunanburh, he defeated a coalition of Scots, British and Norsemen. After Aethelstan's death in 939 the Norsemen regained control of York for a short time, but his successor Edmund later made good the loss and with the expulsion of Eric Bloodaxe from York in 954 the line of Scandinavian rulers there came to an end. From this date there ceased to be any independent kings in Northumbria, which then became an earldom within the kingdom of England. During the 11th century it was held successively by Eric of Norway, by Siward who stoutly defended it till his death in 1055 and by Tostig. one of the sons of Godwine, earl of Wessex. In 1065 the Northumbrians rebelled against the rule of Tostig and he was replaced by Morcar, brother of Edmin, earl of Mercia, but in 1066 Tostig returned, entering the Humber with a large fleet commanded by Harold Hardrada, king of Norway. The invaders were engaged by Edwin and Morcar who were defeated after a hard battle. A few days later Harold, king of England, arrived from the south and in a battle fought at Stamford bridge, about three weeks before the Norman victory at Hastings, Tostig and Harold Hardrada were both killed and their army routed.

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NORTHWESTERN UNIVERSITY, a privately controlled, coeducational institution of higher learning, established in 1851 through a charter from the Illinois general assembly. The university maintains two campuses on the shores of Lake Michigan: one in the Chicago suburb of Evanston and the other on Chicago's near north side. See EVANSTON.

NORTHWEST FRONTIER, the tract of country in the extreme northwest of the Indian subcontinent, lying between the Indus and Afghanistan north of Baluchistan. It has been of prime importance in the history of the subcontinent. From 1901 to 1955 it was administered as the NORTH-WEST FRONTIER PROVINCE, first of British India, then of Pakistan. In the latter year the province, and its attached tribal and states agencies, were divided between the Peshawar and Dera Ismail Khan divisions of the new province of West Pakistan. The former province included (1) the comparatively narrow strip between the Indus and the hills, constituting the settled districts of Peshawar, Mardan, Kohat, Bannu and Dera Ismail Khan; and (2) the cis-Indus district of Hazara. The attached mountainous areas occupied by independent tribes and petty principalities were partly administered with the settled districts (as in the case of Amb and Phulera states, with Hazara) and partly controlled through six frontier agencies: Malakand (including the principalities of Dir, Swat and Chitral), Mohmand, Khyber, Kurram, h'orth Waziristan and South Waziristan. The approximate area was 39,259 sq.mi., including the tribal areas (after 1947 called "frontier regions"), 24,986 sq.mi.

Physiography. — The mountains of the Hindu Kush, running from east to west, form the northern boundary of the region and are met at the northeastern corner of Chitral by the continuation of an outer chain of the Himalayas after it crosses the Indus above the Kagan valley. From this chain minor ranges run in a southwesterly direction the whole length of Bajour and Swat to merge into the Mohmand hills and connect the mid-Himalayas with the Safed Koh. To the east the Safed Koh extends its spurs into Kohat district. The Salt range crosses the Indus in the cis-Indus district of Mianwali and forms the boundary between the Bannu and Dera Ismail Khan districts, merging eventually in the Waziri hills.

Dera Ismail Khan district is one of the hottest areas in the Indian subcontinent, while over the mountain region to the north the weather is temperate in summer and intensely cold in winter. There are two seasons of rainfall over the area: the monsoon season. when moisture is brought up by winds from the Arabian sea and the Bay of Bengal, and the winter season, when storms advancing eastward from Persia and the Caspian districts cause widespread rain and snowfall.

History. — The importance of the h'orthwest Frontier consists in its position athwart the main land invasion routes into India, which have facilitated a blending of cultures that is eloquently testified, for example, by the Gandharan sculptures of the vale of Peshawar, Greco-Roman in form, Buddhist in subject matter.

The origin of the predominating inhabitants of modern times, the Pathans, is obscure. It is clear that many tribes of foreign origin were early gathered around the nucleus of the true Pathans. with whom they became blended. In the 15th century they began to descend from the hills to the plains, and soon came into collision with the Mogul empire. In the 17th century the settlers in the plains wrested terms from Aurangzeb which left them almost as independent as their brothers in the hills (see PATHAN). The invasion in 1738 of Nadir Shah is a landmark in the history of the frontier. From his death to the rise of Ranjit Singh, the frontier districts remained an appanage of the Durrani empire. Little control was exercised by Kabul, however, and the country was administered by local chiefs or Afghan sirdars. The Sikh invasions began in 1818. After the second Sikh War, by the proclamation of March 29, 1849, the frontier districts were annexed by the British. Then the settled districts were taken into the Punjab, while the independent tribes were controlled at different times by the Punjab government and the government of India.

As a result of Lord Lytton's minute of April 22, 1877, a frontier commissionership, including Sind, was sanctioned by the home government. The outbreak of the second Afghan War caused the project to be postponed, but it was eventually brought to completion on Oct. 25, 1901, by Lord Curzon. This omitted Sind altogether and, with the exception of the cis-Indus tract of Hazara, confined the new province to the Pathan trans-Indus district north of the Gomal.

The history of the province proper from its inception until the partition of the subcontinent in 1947 was comparatively uneventful. In the tribal areas. however, the people continued turbulent and many military expeditions against them were needed. The frontier became a traditional introduction to warfare for generations of British officers. Economic development was slow. During the years before partition a surprising feature of political life in this overwhelmingly Moslem area was the widespread popular support of the Indian National congress, or rather of its local counterpart, the nationalist "red shirt" organization. This was led by Khan Abdul Ghaffar Khan, known as the "Frontier Gandhi," whose outstanding personality won him the respect even of many Moslem league supporters, and whose "civil disobedience" activities earned him seven years of detention and exile (1948–55).

Frontier support for congress against league was not unconnected with agitation among the tribes for an independent Pathan state variously called Pashtunistan, Pakhtunistan and Pathanistan. Pakistan claimed that by 1955 good government and measures for their economic advancement had turned most of the tribes people against Pashtunistan. But that year was notable for an intensification of Afghanistan's attempts to promote Pathan separatism. In this they were encouraged by the U.S.S.R., whose territory was separated from the northern tip of the Pakistan frontier region only by the ten-mile-wide Afghan valley of Wakhan. (See also INDIA: History; PAKISTAN; PUNJAB.)

Population. — The first census of Pakistan (1951) gave the population of administered area as 3,252,747, that of the tribal areas as 2,647.158. The country is mainly agricultural. The great majority of the population are Pathan by race and Mohammedan by religion. The predominant language is Pushtu (*q.v.*).

Agriculture and Industry.—The limit of profitable cultivation had, by mid-20th century, almost been reached. The principal crops are maize and bajra in the cold weather; wheat, barley and gram in the spring. Rice and sugar cane are largely grown on the irrigated lands of the Hazara, Peshawar and Bannu districts, and the well- and canal-irrigated tracts of Peshawar district produce fine crops of cotton and tobacco. In the agencies the valleys of the Swat, Kurram and Tochi yield much rice.

Small industries. mainly developed after partition, include light engineering, printing. sugar manufacture. canning, vegetable oil processing, flour milling, tanning and pharmaceutical manufacture. Cottage handicraft produces carpets and other woollen goods and footwear. Rock salt is worked in Kohat. Sawmilling and match manufacture were being promoted in the 1950s in North Waziristan.

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NORTHWEST ORDINANCE, adopted July 13, 1787, has properly been described as one of the greatest achievements of the congress of the United States under the Articles of Confederation (*q.v.*). Based on a plan advanced by Jefferson in 1784 and a committee report of 1786, it provided for the government of the territory northwest of the Ohio river. It outlined an orderly scheme under which the new territories would advance from a stage of government in which federal appointees were in complete control, through an intermediate stage wherein limited autonomy obtained, to statehood and admission to the union on a basis of equality with the other states. The act also guaranteed civil and religious rights and prohibited slavery in the Northwest Territory (*q.v.*). It has been called the basis for the most successful colonial system devised in modern times. The basic policies of the ordinance thereafter governed the expansion of the United States.

See also UNITED STATES: History. (V. C.)

NORTHWEST TERRITORIES, official name of that part of Canada lying outside and to the north of the provinces but excluding the Yukon territory (*q.v.*). The territories extend from the northern limits of North America south to the 60th parallel of north latitude west of Hudson bay; farther east the boundary is drawn to include the islands in Hudson bay, Hudson strait and Ungava bay but to exclude the mainland of Labrador-Ungava. To the west, the boundary with the Yukon territory corresponds roughly with the watershed of the Mackenzie-Yukon rivers; and to the east the boundary is the limit of territorial waters except in the northeast where it lies midway between Canada and Greenland in the narrow seas extending from Smith sound to Robeson channel. Canada also claims sovereignty over any islands that remain to be discovered in the Arctic ocean in the triangular sector formed by the north pole at the apex and the meridians 60° west and 141° west. Such islands would also lie in the territories.

The political unit of the Northwest Territories evolved from "Rupert's Land and the North-Western Territory." which were acquired by Canada from the Hudson's Bay company in 1870, and from the British possessions farther north which were annexed ten years later. With the creation of new provinces and the extension of older ones, the Northwest Territories were reduced in area, until by 1920 they reached their present area of 1,304,903 sq.mi. They are divided for administrative purposes into three districts: Keewatin, which was formed in 1876, when it included large parts of Manitoba and northwestern Ontario; and the districts of Mackenzie and Franklin, which were created in 1895. The boundaries were drawn so that all the islands except those in Hudson bay lay in Franklin, the land tributary to Hudson bay was included in Keewatin and the area adjacent to the Mackenzie river, formed the district of Mackenzie.

Physical Geography. — Climate and scenery vary widely in the territories which contain both the highest mountains in eastern Korth America 'and some of the broadest lowlands. Dominating the geography and forming a fundamental division is the tree line. More accurately described as a zone of transition, the tree line extends from the delta of the Mackenzie to Hudson bay, near Churchill. Man. To the north and east are the treeless barren grounds that by geographical definition constitute the arctic; to the southwest and covering less than a quarter of the territories is a section of the Canadian boreal forest.

Although trees are not found in the arctic, woody shrubs, particularly the willow, are widespread. Close to the tree line they may reach a height of 10 ft. in sheltered valleys and may form extensive thickets. Such luxuriant growth is frequently found from Bathurst inlet to the Mackenzie delta, but is more limited around Lake harbour. southern Baffin Island. Arctic vegetation is extremely varied. In the west rich grasslands are common while on some of the far northern islands, on the plateaus and on the limestone plains vegetation is absent. Marshland is significant in places, notably on Southampton Island and east of Foxe basin. Wherever there is plant life the short arctic growing season leads to a brief but often spectacular flowering period after the snows melt; at this time the tundra is covered with colour. The rate of plant growth is slow and, although the vegetation often appears rich, it requires a long period of recuperation after being cropped by animals.

Trees extend into the barren grounds along such rivers as the Thelon and Coppermine, often giving a false impression of the timber resources; the higher exposed land between the rivers may retain its tundra vegetation for 100 mi. or more southwest of the tree line. Although the boreal forest in the south of Mackenzie district is a coniferous forest dominated by white and black spruce. there is an admixture of deciduous trees including poplar, aspen, and paper birch. Spruce attains considerable size along the Mackenzie but only in the better drained areas south of Great Slave lake are the stands large enough for commercial exploitation.

The climate of the territories shows considerable differences bet een the Mackenzie lowlands and the remainder of the area. The former is relatively warm in summer; mean July temperatures of 60° F. are found along the Mackenzie river as far as the Arctic circle. At least once a year the temperature exceeds go° along the southern part of the river and a high of 103° was recorded at Fort Smith. The summers are generally pleasant with long periods of sunshine and limited precipitation (four to five inches in the four months June to September), although this is the wettest part of the year. The winters in contrast are long, dark and cold. The mean temperature in the three months January to March varies from −15° to −20° F. with occasional readings each year below −50°. Winds are light, however, and the snowfall is not heavy.

The climate of the rest of the territories is more rigorous. The dividing line between the two regions is frequently strongly marked, particularly in the spring when the temperature may drop 20° over a distance of 100 mi. northeast from the Mackenzie lowland. The arctic sector of the territories has little summer; temperatures remain in the 30's and 40's except at some inland points. The weather is generally cloudy and continuing light rain is common. Winter begins when the mean temperature falls below freezing point, generally in the first half of September, and lasts until it rises above the same point sometime in late June or July. The winters are therefore long, with continuous darkness for many weeks in the northern islands. Temperatures are rarely lower than those of the Mackenzie valley but are frequently accompanied by strong northwesterly winds. Snowfall in the central arctic and far north is light but increases rapidly toward the east coast where over zoo in. have been recorded in some winters.

Over three-fourths of the territories is in the arctic but because of the low snowfall there are no large ice fields except in the highlands of Baffin, Bylot, Devon and Ellesmere islands, where ice caps and innumerable small glaciers are found; at only a few points does the ice reach the sea, being mainly restricted to the plateaus. Elsewhere there are only minute glaciers, the most westerly being on Melville Island. On the mainland permanent ice in the Northwest Territories is restricted to the local glaciers in the Mackenzie mountains.

Mean annual temperatures throughout the territories are far below freezing point and in consequence the ground is permanently frozen except south of Great Slave lake, where there are scattered areas of permanent frost (usually contracted to permafrost). The depth of the permafrost is not known, although it is probably in excess of 1,200 ft. in the northern islands. The thickness of the active layer (the upper layer of ground that thaws in summer) varies, depending on many factors, but in general it is many feet in the southwest of the territories and only a few inches in the north. Permafrost causes many construction difficulties. The problems are generally most severe in fine-grained soils such as silts, particularly common in the western Canadian arctic and the lower Mackenzie valley. This was one of the major factors which made it necessary to move the town of Aklavik, from a site in the Mackenzie delta to higher ground to the east of the delta (1954–58). Permafrost is also present in the eastern part of the territories but the problems associated with it are less severe there because of the nature of the soil.

Sea, lake and river ice conditions are serious throughout the Northwest Territories; shipping comes to a complete halt in October and November. All the seas including Hudson bay are completely frozen over in winter. The first open water appears off the east coast in May but it is not until late July that shipping can move with any certainty. Hudson bay. Hudson strait and the seas adjacent to the northwest mainland become virtually clear of ice by late summer but elsewhere pack ice remains; many of the channels between the Queen Elizabeth Islands and the Arctic ocean are never passable. The Mackenzie, the only river that carries any appreciable traffic, is open from June to mid-October, although toward the end of the season low water often restricts navigation.

Physiographically the territories may be divided into five major regions. On the west, bordering Yukon territory, are the Mackenzie, Franklin and Richardson mountains, which are the northern extension of the Rocky mountains. The average height of the peaks is about 6,000 ft. with a few summits over 7,000 ft. To the east forming the second region are the Mackenzie lowlands which have developed on horizontal sedimentary rocks, mainly limestone and sandstone. Although the lowlands are for the most part plains with numerous lakes and poorly drained areas. they also contain small groups of hills such as the Cariboo and Horn mountains. The Mackenzie river flows in the lowlands except between Wrigley and Fort Good Hope where it occupies a deep valley between the Franklin and Mackenzie mountains. Two large lakes, Great Bear and Great Slave, are found in the east part of the Mackenzie lowlands on the edge of the third region, the Canadian shield.

The Canadian shield occupies virtually all the remainder of Mackenzie and Keewatin districts. It is formed of crystalline rocks in places overlain with basaltic lavas. notably on the south side of Coronation gulf, and with sandstones. particularly along the Thelon river. The scenery varies from rock hills along the western margin and on the northwest side of Hudson bay to broad sand and clay-covered plains in the centre. In the district of Franklin the shield forms a fourth region where it rises in Baffin. Bylot, Devon, and Ellesmere islands to make a mountainous, deeply dissected fiord rim to the continent. Physiographically associated with this region, although geologically distinct. are the mountains of northern and western Ellesmere and Axel Heiberg islands. The remainder of the arctic archipelago may be considered scenically one region although in detail it is complex. In a pre-Ice Age era the island and channels were apparently one land mass drained by rivers flowing in broad valleys. Subsequently the sea partially drowned the land to produce a maze of channels separating some of the largest islands in the world, including Baffin Island (183,810 sq.mi.) and Victoria Island (81,930 sq.mi.). The land is underlain by arches of shield rocks, broad horizontal areas of limestones and sandstones and more restricted folded rocks. Today they form low hills, plateaus and plains, often covered with thick layers of shattered rock and clay.

History. — The earliest records of exploration in the Northwest Territories are those of Martin Frobisher. who in 1576 examined the southeast coast of Baffin Island in a search for a Northwest passage. When other voyages in the next 55 years failed to discover the passage, interest in the arctic ceased. In 1670 the Hudson's Bay company was granted a trading charter and established posts around the southern shore of Hudson bay. Apart from short voyages on the west side of the bay early in the 18th century, the company undertook no arctic exploration. The first account of the interior of northern Canada was published after Samuel Hearne on his third attempt (1770–72) had walked 2.000 mi. from Churchill to the vicinity of Coppermine on the Arctic ocean in a search for native copper. Meanwhile French traders from Montreal were advancing along the prairie rivers. When trading recommenced after the conquest of French Canada in 1760, their successors were able to begin the exploration of the Mackenzie river system. By 1788 Peter Pond had mapped the waters of the upper Mackenzie and had established a trading post on Great Slave lake. The following year Alexander Mackenzie of the Northwest company descended to the mouth of the river that bears his name. Trading rivalry along the Mackenzie river was intense until 1821, when the Hudson's Bay company absorbed the Northwest company.

European penetration into arctic Canada in the 19th century was mainly concerned with renewed exploration for the Northwest passage. The search for the lost Franklin expedition of 1846 led to the mapping of many of the arctic islands and the discovery of the Northwest passage (see FRANKLIN, SIR JOHN). By this time temporary shore whaling stations had been established on Baffin Island and small semipermanent settlements soon followed.

After the Dominion of Canada obtained the Hudson's Bay territory in 1870 and the northern islands in 1880, there were a number of federal government expeditions. The Northwest Territories have been mapped from air photographs, though detailed exploration continues.

Resources. — Until relatively recently wildlife was the only important natural resource of the Northwest Territories. Animals provided the main source of food and clothing for the native peoples, and the furs and ivory, whalebone and blubber from sea mammals were the only objects of commercial value. The most important large land mammals were the barren-ground caribou and the musk oxen in the arctic, and the woodland caribou and wood buffalo and moose in the forest. At the end of the 19th century the barren-ground caribou was found throughout the arctic sector of the territories; it was hunted by Eskimos from spring to fall and by the 'Indian in the minter when parts of the caribou herds migrated to the edge of the boreal forest. The introduction of firearms among the native peoples led to a rapid decrease in the caribou. They vanished from many of the islands; on the mainland, herds which numbered 1,750,000 at the beginning of the 20th century had been reduced to 200,000 by the beginning of the second half of the century. The caribou Eskimos of central Keewatin, who depended entirely on the caribou for food, were reduced to starvation and relocation became essential for their survival.

In 193j a herd of 2,370 reindeer was driven from Alaska to the east side of the Mackenzie delta in an effort to introduce a domesticated animal into the Eskimo economy. The experiment had only limited success. Growth was slow and after 20 years there were about 6.000 reindeer. The original herd was split into four; three herds were maintained by the federal government for the benefit of the native population and a fourth was privately owned in the latter 1950s. A controlled herd of 1,200 wood buffalo was maintained in Wood Buffalo park south of Great Slave lake. Excess animals are slaughtered annually for meat.

Musk oxen were once numerous but in the 19th century, after buffalo robes were no longer obtainable, musk oxen skins increased in value and they were hunted extensively. In view of their possible extermination on the mainland, musk oxen were given total protection in 1927 and their numbers increased thereafter, particularly in the Thelon game sanctuary. They continued to be numerous in the unpopulated far northern islands.

Among the smaller mammals the white fox has been most significant. Found throughout the Canadian arctic, it has been the main article of commercial value since the beginning of the 20th century when the first fur trading settlements were established north of the tree line. Rapid changes in the value of fox pelts in sympathy with world demand and unrelated to natural fluctuation in fox numbers made it an unstable base for Eskimo economy. Indians trap muskrat. mink, beaver and some other fur-bearing animals along the Mackenzie river. Fur production for the territories in the 1950s was valued between $500,000 and $750,000 annually.

The original economic motive bringing Europeans into the Canadian north was the search for sea mammals, particularly the whales, but overfishing and falls in world prices reduced that activity to negligible proportions. Seals, walrus and in some areas white whales are still important to coastal Eskimos. Fish have always been a limited source of food for Eskimos and Indians. Beginning in 1945 attempts were made to establish commercial fisheries. The most immediately successful was at Great Slave lake. where in the late 1950s from 7,000,000 to 9,000,000 lb. of whitefish and lake trout, valued at about $2,000,000 was taken annually.

Land suitable for agriculture is limited and is found only in the Mackenzie valley. In 1956 there were only six farms of more than three acres and the cultivated area was less than 100 acres.

Undoubtedly the most valuable resources of the Northwest Territories are the minerals. By analogy with the section in southern Canada. the Canadian shield was expected to contain rich deposits of metallic minerals, and the sedimentary rocks of the Mackenzie lowland and the arctic islands, petroleum and natural gas. By the second half of the 20th century, however, there had been widespread prospecting only in the vicinity of the Mackenzie valley where river transportation could be used in any development.

Oil was discovered at Norman Wells on the lower hfackenzie river in 1914 but was not produced on a commercial scale until 1920. Production increased at Norman Wells after newly established mines along the Mackenzie river created a market. During World War II a 400-mi. pipeline was built across the hfackenzie mountains to Whitehorse, Yukon territory; in 1944 production reached a peak of 1,223,675 bbl. Thereafter oil was supplied only to the Mackenzie valley and the western arctic; annual production during the 1950s was about 1,000,000 bbl.

The next mineral resources to be developed were the pitchblende ores at Port Radium at the east end of Great Bear lake in 1930. At first radium was the main product with coppes, silver and cobalt subsidiary. The mine closed for a short period in the early part of World War II. When it reopened a few years later the main product was uranium, which was later mined north of Great Slave lake. The Port Radium uranium mine was closed again in 1960 when ore reserves were used up. In 1933 gold was discovered at Yellowknife on the north arm of Great Slave lake and production began five years later. These mines became the most important in the Northwest Territories, and they form the economic basis for the largest town, Yellowknife (1956 pop. 3,500).

Nickel and copper mining began in 1957 in the arctic at Rankin inlet on the west side of Hudson bay. Other nickel deposits are knonn in the same area, as well as copper and nickel near Coppermine and iron ore on Baffin Island Commercial development of these areas is hindered by high transportation costs. Hydroelectric plants were constructed on the Snare river, 94 mi. N.W. of Yellowknife and at Bluefish lake, 15 mi. N. of the same town.

Government. — The Northwest Territories are governed in part directly by the federal government from Ottawa and in part by a territorial legislative body. the council of the Northwest Territories; this has approximately the same responsibilities as a Canadian provincial government. The council is composed of 9 members, 5 of whom are senior government officials appointed by the governor general-in-council; the remaining four are elected by the residents of four constituencies in the Mackenzie district. The administration of the territories is the responsibility of the commissioner who acts under instructions from the governor general-in-council and the minister of northern affairs and national resources. The council meets twice during the year, once in Ottawa and once at a settlement in the Northwest Territories.

Population and Settlement. — The population of the Northwest Territories in 1961 was 22,998, of which about one-fifth was Indian and one-third Eskimo. The Indians and about 1.500 Eskimos live in Mackenzie district. The Indians for the most part occupy settlements along the Mackenzie river; fur trapping, fishing and hunting are their principal occupations. The Eskimos are more widely distributed. being found throughout the arctic section of the territories, except for some of the far northern islands, and in the Mackenzie delta. When Europeans first visited the Canadian arctic they found Eskimos in isolated seminomadic groups around the coasts, where they lived on sea mammals, and in the interior of Keewatin, where they were dependent on caribou and fish. The population was possibly twice that of the 1950s and 1960s.

The earliest European settlements were established by fur trading companies in regions where natives were known to congregate, particularly in the winter and early spring in areas where trapping was thought to be rich, or at places which the native could easily reach. In the northwestern forest all settlement was along the Mackenzie river and its tributaries; in the arctic (with the exception of Padlei, in southern Keewatin), the posts were located at points that could be reached by ships. Many of the Mackenzie settlements were founded in the early 19th century but the oldest existing arctic settlements are only 50 years old.

The white population of the Northwest Territories increased slowly. The first government representatives were the Royal Canadian mounted police; as the responsibilities of government expanded, nursing stations and hospitals were created. In the late 1950s there were 11 hospitals in the larger communities; traveling medical, dental, and X-ray units visited the smaller settlements at least once a year. The first schools were operated by missionaries; by mid-century there were 30 federal schools, some of which were boarding schools.

At first the settlements had little effect on the distribution of the population, which had to remain on the traditional hunting grounds in order to obtain sufficient fur-bearing animals and food. As the settlements grew, however, they attracted more and more Indians and Eskimos who came to live permanently in the vicinity, often in wooden cabins. Food was still partly obtained by hunting but was augmented by purchases with family allowances and government relief. By 1939 the growth of mining towns in the Mackenzie lowland had already begun to influence the population distribution in the west. In the arctic it was not until 1955 that government policy and military developments led to significant population changes.

During World War II the construction of airfields in the eastern arctic at Coral Harbour, Southampton Island, and at Frohisher Bay. Baffin Island, made access to these areas much easier and led to the employment of some Eskimos. However, it was not until the building of the Distant Early Warning (DEW) line—a network of installations across the 70th parallel which report and plot aircraft operations in the polar regions—that a widespread demand developed for Eskimos who could speak some English and had manual skills. Many moved into the construction camps and earned high wages. After the DEW line building program was completed some Eskimos remained on the sites; others found their may to northern settlements where further employment was available. The most important of these settlements in the eastern arctic is Frobisher Bay. The Frobisher Bay airfield, operated by the Canada department of transport, is used by transpolar flights to Europe from the west coast of North America. Frobisher Bay, the largest town in the North American arctic, became the administrative centre in the eastern arctic. A second town in which federal government planning was active was a new town, Inuvik, built to replace Aklavik in the Mackenzie river delta.

No Eskimos were living in the far northern islands when they were first explored, although there had been in prehistory. In the 1960s settlement in the islands was restricted to four weather stations supported from a main base created in 1946 at Resolute Bay. Cornwallis Island. Some Eskimo families had been relocated in the northern islands from impoverished areas farther south.

The largest communities in the whole of the Northwest Territories are not, however. a direct outgrowth of the trading settlements. They are the mining towns of Yellowknife, Port Radium, and Rankin Inlet. as well as some of the more complex settlements along the Mackenzie river.

Transportation. — Economic development of the Northwest Territories has been hampered by the transport facilities. Until about the middle of the 20th century the usual form of transportation was by water; in Mackenzie district this meant the Mackenzie river system. Traffic for the western arctic originates at railhead at Waterways, Alta.. and is carried north from there by tug and barge, with transshipment by road around a 16 mi. stretch of rapids between Fort Fitzgerald and Fort Smith at the border of the Northwest Territories. From there, boats can reach Tuktoyaktuk on the Arctic ocean, where there is a second transshipment for ports in the western arctic. The shallowness of the channels in this area restricts shipping to schooners and small vessels. All coastal settlements in the eastern arctic are reached by sea and until the end of World War II were visited only once a year by ships. Expansion of the settlements and the rapid growth of military installations. particularly those associated with the DEW line, resulted in convoys of ships escorted by icebreakers penetrating northern waters. Harbour facilities are lacking and all unloading is by lighter.

In the Mackenzie district an all-weather transportation route was opened in 1949 with the completion of the Mackenzie highway from Grimshaw, Alta., to Hay River on Great Slave lake. Construction was continued thereafter to extend that road around the north end of Great Slave lake to Yellowknife and northward into adjacent mining areas. During the winter months tractor trains operate from many western settlements moving supplies and heavy equipment to isolated points.

Passenger transportation into the Northwest Territories has been provided increasingly by aircraft. Construction of all-season airstrips in many parts of the territories permitted scheduled flights by various companies along the length of the Mackenzie valley, to Cambridge Bay on Victoria Island, and to Frobisher Bay in Baffin Island. Where large aircraft are not warranted smaller airplanes on wheels. skis or floats operate from various centres, including Fort Smith, Yellowknife, Hay River, Aklavik and Frobisher Bay. The far northern weather stations and some of the DEW line sites are serviced entirely by aircraft.

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NORTHWEST TERRITORY, the name given in 1787 by the congress under the Articles of Confederation (*q.v.*) to that region of the United States lying west of Pennsylvania, north of the Ohio river, east of the Mississippi and south of the Great Lakes. Virginia. New York, Connecticut and Massachusetts had claims to the territory which they ceded to the central government between 1780 and 1800. These lands constituted the first public domain of the United States. The congress adopted two laws for the management of the territory which were of fundamental importance in the growth of the Republic. The Land Ordinance of 1785 first outlined federal land policy, established the rectangular survey and reserved one section in each township for the use of the common schools. These elements were extended so far as possible to new territory subsequently acquired as the United States expanded to the Pacific. The Northwest Ordinance (*q.v.*) of 1787 provided for the government of the territory. These two acts, designed explicitly for the Northwest Territory. laid the foundation for the continental colonization policy of the United States. Ultimately five states—Ohio, Indiana. Illinois. Michigan and Wisconsin were organized from the territory and a small part, the land lying between the St. Croix and Mississippi rivers, was incorporated into Minnesota. (V. C.)

NORTHWICH, a market town, urban district and parliamentary division of Cheshire, Eng., 17½ mi. E.N.E. of Chester by road, at the junction of the Weaver and Dane rivers. Pop. (1951) 17.489. Area 3.4sq.mi.

Northwich's streets are narrow and irregular. with some houses at fantastic angles because of subsidence resulting from the pumping of brine. Its brine springs have been used since Roman times: and the chemical industry. developed from the older salt trade, is a large concern. The centre of the salt trade moved to Winsford. several miles away, and the old Salt union has become the Salt division of Imperial Chemical Industries. There are also steel and iron works. leather. carpet and clothing factories.

NORTON, CAROLINE ELIZABETH SARAH (1808–1877), afterward Lady Stirling-Maxwell, English writer, was born in London in 1808. One of the three beautiful granddaughters of Richard Brinsley Sheridan, daughters of his son Thomas, the "three Graces" of London society in the reign of George IV, she began to write before she was out of her teens. Her two sisters Helen and Georgina became respectively Lady Dutierin and duchess of Somerset. At the age of 17, Caroline published a merry satire, *The Dandies' Rout,* illustrated by herself; this was followed by *The Sorrow's of Rosalie* (1829) and *The Undying One* (1830), a version of the legend of the Wandering Jew. She married in 1827 the Hon. George Norton, brother of Lord Grantley. The husband's persecutions culminated in 1836 in an action brought against Lord Melbourne for seduction of his wife, which the jury decided against Norton without leaving the box. The case against Lord Melbourne was so weak that it was suggested that Norton was urged to make the accusation by Melbourne's political enemies. in the hope that the scandal would prevent him from being premier when the princess Victoria should succeed William IV. In 1853 legal proceedings between Mrs. Norton and her husband were again entered on, because he not only failed to pay her allowance but demanded the proceeds of her books. Mrs. Norton made her own experience a plea for addressing to the queen in 1855 an eloquent letter on the divorce laws, and her writings did much to ripen opinion for changes in the legal status of married women. George Meredith, in *Diana of the Crossways,* used her as the model for his "Diana."

Mrs. Norton was not a mere writer of elegant trifles; her *Voice from the Factories* (1836) was a most eloquent and rousing condemnation of child labour. *The Dl-earn, and other Poems* appeared in 1840. *Aunt Carry's Ballads* (1847). dedicated to her nephews and nieces. are written with charming tenderness and grace. Later in life she produced three novels. She wrote a preface to *The Rose of Jericho,* a translation from a German fable by her mother, Mrs. Sheridan. Mrs. Norton's husband died in 1875, and in the last year of her life she married Sir W. Stirling-Maxwell. She died June 15, 1877.

See Jane G. Perkins, *The Life of Mrs. Norton* (1909).

NORTON, CHARLES ELIOT (1827–1908), U.S. scholar and man of letters, was an idealist and reformer by temperament, who exhibited remarkable energy in a wide range of activity. Born in Cambridge, Mass., on Nov. 16, 1827, and graduated from Harvard in 1846, he opened a night school in Cambridge; was director of a housing experiment in Boston; worked zealously as an editor for the Union cause; was coeditor (1864–68) of the *North American Review* and one of the founders of the *Nation* (1865). From 1874 to 1898 he lectured on the history of art at Harvard, where he mas one of the most popular teachers of the day and an "oracle of the humanities." A friend of many literary greats, including Carlyle, Emerson, Ruskin, Longfellow and Lowell, he contributed valuable editions of their letters and other biographical material.

Norton also wrote on art and edited collections of poetry, notably the poetry of John Donne (1895, 1905). Probably his best literary work was his prose translation of the *Divine Comedy* (1891–92). His *Letters . . . With Bibliographical Contment* were edited by Sara Norton and M. A. De Wolfe Howe (1913). Norton died on Oct. 21, 1908.

See E. W. Emerson and W. F. Harris, *Charles Eliot Norton* (1912); T. W. Higginson, *Carlyle's Laugh* (1909).

NORTON, JOHN PITKIN (1822–1852), U.S. agricultural chemist and educator, was born in Albany. N.Y., on July 19.1822. Norton attended Yale university, New Haven, where he studied chemistry, and was a student of James F. W. Johnston at Edinburgh and Gerardus J. Mulder at Utrecht.

After Norton was named professor of agricultural chemistry at Yale university in 1846. he played an important part in organizing the department which later became the Sheffield scientific school. He died at Farmington, Conn.. Sept. 5, 1852.

NORTON, THOMAS (1532–1584), English poet and playwright who, with Thomas Sackville, wrote *Gorboduc,* the earliest English tragedy, was born in London in 1532. Educated at Cambridge and admitted to the Inner Temple, London. in 1555, he contributed to *Tottel's Miscellany* (1557) and to Thomas Sternhold and John Hopkins' rhyming psalter (1562). He wrote *Gorboduc* in 1560; it was first printed in 1565 (*see* SACKVILLE, THOMAS; ENGLISH LITERATURE). He also translated John Calvin's *Institutes of the Christian Religion* (1561) and Alexander Nowell's *Catechism* or *First Instruction of Christian Religion* (1570).

Norton became member of parliament for Berwick in 1562 and entered into political and religious controversy. writing numerous anti-Catholic pamphlets. His punishment of the Catholics, as their official censor from 1581 onward, earned him the nickname of "rackmaster-general." At last he was deprived of office and thrown into the Tower of London. He died soon after his release: on March 10, 1584, at Sharpenhoe. (P. Dw.)

NORTON-RADSTOCK, an urban district (1933) comprising Midsomer Norton, Radstock, Westfield, Writhlington, Haydon and Clandown; in the parliamentary division of North Somerset, Eng., on the river Somer 10 mi. S.W. of Bath. Pop. (1951) 11,937. Area j.3 sq.mi. Norton's annual fair dates from 1248. The two parish churches of St. John the Baptist, Norton, and St. Nicholas, Radstock, contain traces of earlier Norman buildings. The foundation stone of a new church, St. Peter's, at Westfield, was laid in 1952.

The district's chief industries are coal mining; making of gloves, footwear and paper bags; wagon repairing; printing; timber construction and agriculture.

NORWALK, a city of Fairfield county, Conn., U.S., is located 14 mi. W.S.W. of Bridgeport on Long Island sound at the mouth of the Norwalk river. The site, purchased from the Indians in 1640 by Roger Ludlow and Daniel Patrick, was first settled in 1649 by a small group of colonists from Hartford.

In 1779, during the American Revolution, Norwalk was burned by Loyalist forces under Gen. William Tryon, colonial governor of New York, and it was from Norwalk that Nathan Hale crossed Long Island sound to Huntington, L.I., where he was captured by the British and executed as a spy. The manufacture of hats, long the town's principal industry, was begun before the Revolution. In the 19th century Norwalk was an important centre for shipbuilding and the production of earthenware, coaches! wagons, sleighs, tallow candles and shoes. Later textiles, clothing, electric and electronic equipment, typewriters and rubber products were added to the list of manufactures. From the time of first settlement Norwalk oysters were famed for both quality and quantity. After 1880, however, the oyster fishery declined because of overexploitation of the oyster beds and inadequate legal regulation of the industry. The rapid industrialization of the 20th century and the pollution of the waters by industrial wastes brought Norwalk's oystering virtually to an end.

The town of Norwalk, organized in 1631, contained two cities, Norwalk (incorporated as a borough in 1836 and as a city in 1893) and South Norwalk (incorporated in 1870), as well as the villages of Rowayton, East Norwalk, West Norwalk, Cranbury, Winnipauk, Silvermine and Broad river. In 1913 all this territory was consolidated and incorporated as the city of Norwalk. Pop. (1960) 67,775; standard metropolitan statistical area 96,756. (Gl. W.)

NORWAY (Xorge), a kingdom of northern Europe, occupying the western and smaller part of the Scandinavian peninsula. Its eastern frontier marches with that of Sweden, except in the extreme north, where Norway abuts on Finland and the Soviet Union. On the north, northwest and west, the boundaries are the Arctic ocean, Norwegian sea (Atlantic ocean) and North sea respectively. The Skagerrak washes it on the south and southeast. The southern extremity of the country is the island of Kråga near Mandal in 57° j7' N., the northern is the island of Cape Knivskjell (71° 11′ N.), west of the North cape on the island of Mageroy. Of the mainland, the northernmost promontory is Nordkyn, in 71° 8′ N., the southernmost, Lindesnes in 57° 59′ N. The most western island, Steinsoy, lies off the mouth of the Sogne fjord (4° 30′ E.), and the easternmost point is Hornoy (31° 10′ E.) near Vardo. The direct length of Norway (southwest to northeast) is about 1,100 mi. The extreme breadth (about 61° N.) is 267 mi.; the average is about 60 mi., but the Swedish frontier approaches within 5 mi, of a head branch of Ofoten fjord, and the Finland frontier within 22 mi. of Lyngs fjord. The length of the coastline is difficult to estimate; disregarding indentations it is about 1,647 mi., but including the fjords and greater islands it is probably 12.000 mi. The total area is 125,064 sq.mi. Including Spitsbergen (Svalbard) and Bear Island (Bjornoya), the state territory of Norway amounts to 149,022 sq.mi.

The Spitsbergen group of islands, with Bear Island, Kvitoya, King Karl's Land and Hopen, constitute Svalbard (23.958 sq.mi.), lying between lat. 74° and 81° N. and long. 10° and 35" E. Svalbard is part of the kingdom of Norway; administratively it is an independent unit under a governor. The population in 1950 was 3,761, mostly coal miners. Small islands under Norwegian dominion are Jan Mayen in the arctic and Bouvet and Peter I in the antarctic. Queen Maud Land, on the antarctic continental coast between 20° W. and 45° E., is also under Norwegian sovereignty.

Physical Features. — The main highland mass of the whole Scandinavian peninsula is a much eroded plateau which, probably because of its forming. in the main, the watershed between the rapid western rivers and the normally longer and slower eastern rivers of Sweden, has received the name of Kjolen (the Keel). Although the plateau as a structural feature may be considered to extend from southwestern Norway to North cape and even beyond into Spitsbergen, its ridgelike character is most marked where it coincides most closely with the Swedish boundary; *i.e.,* north of 63° N. The high plateau consists of early Palaeozoic rocks which represent one of the oldest structural elements in Europe. An Archaean zone stretches along the west coast from Bergen to Hammerfest, interrupted toward the north by overlying patches of Palaeozoic deposits. Gneiss predominates, but other crystalline rocks occur subordinately. The Lofoten Islands consist chiefly of eruptive granite, syenite and gabbro. South of a line drawn from the head of the Hardanger fjord to Lake Mjosa is another great Archaean area.

A line drawn from the Nase to the North cape coincides roughly with a marked change in the character and structure of the Palaeozoic rocks. East of this line even the Cambrian beds are free from overfolding, overthrusting and regional metamorphism. They lie flat upon the Archaean floor, or have been faulted into it in strips, and they are little altered except in the neighbourhood of igneous intrusions. West of the line the rocks have been folded and metamorphosed to such an extent that it is often difficult to distinguish the Palaeozoic rocks from the Archaean. They form in fact a folded mountain chain of ancient date which has subsequently been worn down and then faulted up. No volcanic rocks of recent date are known in Norway. This faulting largely accounts for the almost unique character of the river and coastal topography of Norway. Differential erosion, partly glacial, has caused many of the highland masses to form prominent mountain summits not only on such islands as the Lofoten chain, but on the plateau itself. The average height of Norway is probably about 1,600 ft. and may be compared with approximately 1,000 ft. for Europe as a whole. This high figure for Norway is achieved not so much from the height of individual summits as from the absence of extensive lowlands; southeastern Norway is the lon est part and even this is of a hilly nature. In the area northwest of the Norway-Finland boundary a few peaks reach slightly more than 4,000 ft., but immediately south of the junction of the three countries the general height increases considerably, though the most lofty summits are entirely Norwegian only in the extreme north of this area. (See Sweden.) Here Jaggevarre (6,053 ft) lies between Lyngs and Ulls fjords, and Kistefjell (5,361 ft.) provides right-bank water for the Barduelv, which runs westward north of Torneträsk. Sulitjelma (6,279 ft.) lies actually on the frontier. Nearer the coast and centred approximately on the Arctic circle is the great ice field of Svartisen, through which projects Snetind peak (5,246 ft.). The only important peaks immediately south of this are Okstindene (6,273 ft.) and the rather better known Börgefjell (5,502 ft.). At about lat. $63\frac{1}{2}$° N. is the southern limit—Trondheim fjord — of a remarkable depression which runs for more than zoo mi. southwest to northeast dividing the narrowest part of Norway into almost equal eastern and western strips. Its exit is at Salt fjord (near Bodo) and it is characterized by numerous rivers, some draining north, others south; the depression is of the greatest importance for internal communication, including railway routes. Due east of Trondheim fjord the plateau is lowest and narrowest, again offering a relatively easy communication route already utilized by a railway. Also from this fjord southward is a valley line and a railway route to the upper Glomma valley and down this to Oslo.

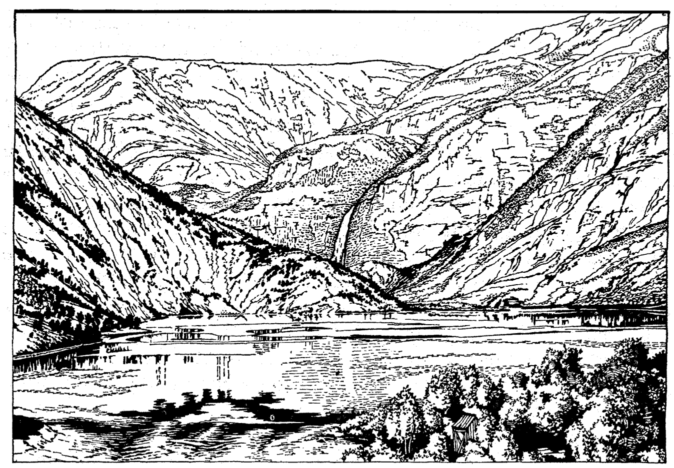
South of the Trondheim "narrowing" the plateau swings westward, becoming higher, wider and more definitely Norwegian. The Sogne fjord (61° N.) and its branches reach out toward a giant horseshoe of the highest ridges in Norway; northward are the Jostedalsbre; the Jotunheim lies north and northeast; the Hardangervidda is southeast and Vossevangen (Voss) lies south. Northeast of the Jotunheim beyond the deep cleft of Gudbrandsdal and its northwestern counterpart Romsdal. is Dovrefjell, and southeast of this Rondanefjell. South of the Hardangerfjell, beyond Hardanger fjord, is the lake-sprinkled Hardangervidda, the most expacsive tract of open high plateau in Europe; southeastward this plateau merges into the lower hummocky Telemark mountains which are drained south and southeast to the Skagerrak. The most lofty summits occur in the Jotunheim with Galdhopiggen (8,097 ft.) as the highest Norwegian mountain, though if the 100 ft. or so of snow on the top of Glittertind is included, then this reaches to 8,140 ft.; nearly 30 peaks in all exceed 6,500 ft. in the Jotunheim mass. The other mountain areas are lower, though the Dovrefjell and the Rondanefjell have Snohetta (7,500 ft.) and Rondvaasbu (7,162 ft.) as their respective summit masses.

Glaciers.—The relatively insignificant Norwegian glaciers of today have unimportant effects compared with the glaciation consequent on the presence of the enormous ice fields in the last Ice Age To these latter glaciers is owed much of the smoothing of islands and the fjord character of the coast. The rounded nakedness of the mountains, the U-shaped valleys. the shelflike ledges over which the rivers plunge to produce the "white coal" of Norway and the pockets of finely divided fertile soils in rock basins are all direct legacies. The level terraces and raised beaches which exist on some of the coasts and prove such desirable sites for settlement are mainly composed of glacial debris once deposited below sea level but now elevated by land oscillation. Today Norway still contains the largest European ice field—the Jostedalsbre. This is about 500 sq.mi. in extent: from it glaciers run to within 150–200 ft. of sea level. Jotunheim, though glaciated, has the icecap broken by deep valleys, also as it lies farther east the precipitation is lower and the summer temperatures higher—tno factors seriously affecting the size of icecaps. Between Hardanger fjord and its branch Sor fjord is Folgefonn—110 sq mi.—and the most southerly considerable area in Norway. Second in point of size to the Jostedalsbre but not inferior in interest is Svartisen—280 sq mi. in area, from which glaciers descend almost to sea level. In about lat. 70° a small glacier, the Engabre, actually enters the sea in Jokul fjord (a branch of Kvaenangen fjord) and gives birth to miniature icebergs. The Seiland glacier (46 sq.mi.), on the island of the same name south of Hammerfest, is the most northerly Norwegian example. The snow line in Norway varies in height with aspect and amount of precipitation, but it is everywhere fairly low—ranging from below 3.000 ft. in Seiland to slightly above 5.000 ft. in southern Norway.

Coast.—The Nonvegian mountains fall abruptly to the sea, and the coastline almost throughout is cliffbound. The land features are continued as numerous islands, estimated at 150,000, which fringe the mainland. This island fringe, occurring also in a modified form along the Swedish coast, is, in Nonvay, termed the Skjaergård (skerry fence). This fringe and the fjord coast are most fully developed from Stavanger nearly as far as the North cape, but only between Stavanger and Flekkefjord can the coast be considered smooth and moderately free from islands. Here, particularly north of Egersund, a narrow lowland. abundant in peat bogs. is fringed by a flat, open coast, dangerous to shipping. The channels within the island line are of incalculable value to a people largely dependent on coastwise navigation. In fact, the voyage northward from Stavanger may be made in quiet waters almost throughout. Only at rare intervals, as off the port of Haugesund, or when crossing the mouth of some large fjord, need the open sea be encountered. At some points large steamers follow the carefully marked deep water channel, between cliff edges which seem to overhang the vessel on either side. Small vessels, fishing or trading between the fjordside villages, navigate narrow ramifying "leads" (leder) where the sole danger is the tidal current. often exceedingly strong. The largest island is Hinnoy (Lofoten and Vesterålen group). about 850 sq mi, in area.

Many islands, chiefly northern, are of great elevation; thus the jagged granite peaks characteristic of the Lofotens reach about 4,000 ft. Other interesting islands are Hornelen, near the mouth of Nord fjord. rising nearly sheer for 3,000 ft. above the sea; the well-named Torghatten ("the market hat"), north of Namsos, completely pierced. 400 ft. above the sea, by a vast natural tunnel, which on occasion reaches upward of 200 ft. in height and 80 ft. in width; the quaintly shaped small Hestmannoy ("horseman island"), intersected by the Arctic circle, justly named from its form. Bare rock is the dominant feature of the coast and islands, save where a few green fields surrounding a farmstead occupy a miniature level terrace. The oscillation of the land relative to sea level is illustrated by marine terraces. 600 ft. above the present sea level, near Trondheim, and by the numerous former beachlines of north Norway, which are occasionally in pairs at different heights. Nevertheless, at some points (as on the Jaeren coast) glaciated "giants' kettles" may be observed even below the level of high tide thus indicating the greater level of the land toward the close of the glacial epoch.

Fjords.—Oslo fjord. opening from the north angle of the Kattegat and Skagerrak, differs from the great fjords of the west. Its shores are neither high nor precipitous. It is shallower and wider and is surrounded by the most extensive lowland in Norway. It is studded with numerous small islands. Thence, past Lindesnes, to Bokn fjord there are many small fjords, 300 fathoms in extreme depth, but even the intermittent inner lead which can be traced to Flekke fjord ceases to exist beyond. Bokn fjord is broad and island-studded, but throws off several inner arms, of which Lyse fjord, due east of Stavanger, is 25 mi. long and half a mile wide, with precipitous walls. It is the most beautiful and mysterious fjord in southwestern Norway. Hardanger fjord (355 ft. extreme depth) penetrates the land for 105 mi. and is frequently visited, for it lies near to shipping routes which converge on Bergen, but its beauty is exceeded by that of Sogne fjord and Nord fjord farther north. Sogne is the largest and deepest fjord of all; its head is more than 124 mi. from the sea; its maximum width scarcely exceeds 2 mi., and the main channel is joo–660 fathoms deep. Some of the northern arms intersect the snow-clad



THE LISTER FJORD. A NARROW ARM OF WATER CREEPING INLAND TOWARD THE GLACIERS OF THE JOTUNHEIM, IN NORWAY

Jostedalsbre and their dark blue waters have a surface layer showing a milky tinge imparted by glacier-fed streams. Nord fjord (340 ft. in extreme depth) touches the northern side of the Jostedalsbre and is popular with tourists. Stor fjord opens inland from Aalesund; it is more than jo mi. long and is nild and imposing. Trondheim fjord (300 ft. in extreme depth), the next great fjord northward, broadens inland from a narrow entrance, but lacks grandeur as the elevation of the land is reduced at the Trondheim "narrowing." Immediately north of Trondheim the fjords, though long, are not so extensive and the coastline loses its grandeur, but north of Salt fjord. which lies beyond the great Svartisen ice field, the scenery is unsurpassed. Salt fjord is connected with Skjerstad fjord by three narrow channels where the water, at ebb and flow, forms powerful rapids. The Lofoten Islands and Vesteraalen are separated from the mainland by the Vest fjord (340 ft. deep), which is continued inland by Ofoten fjord, on which is situated Narvik, the railhead town for the line from Sweden.

The main fjords north of Vesterblen have a general northerly direction; among them is Lyngs fjord near Tromso, with high flanking cliffs. The softer and looser schists are more prevalent in the north, hence the fjords are wider, branched and interlaced, particularly in Finnmark. The Alta fjord (225 ft. extreme depth) is remarkable for the vegetation on its shores. From Lofoten north there is a chain of larger islands: Senja. Kvaloy, Ringvassoy, Soroy, Seiland and Mageroy, thus extending to the most northerly point, but hereafter the Skjaergård ends abruptly. The coast to the east is of widely different character; flat mountain wastes descend precipitously to a sea destitute of islands, save Vardo, with two low islets at the eastern extremity of Norway. The chief fjords are Porsanger and Tana, opening north, and Varanger opening east. North of the last fjord the land is low and the landscape monotonous; on the south of it a few islands and branch fjords break the smoothness of the coastline.

Lakes and Rivers.—Both in respect of rivers and of lakes Norway is well supplied. As a rule, the rivers are short and have a small basin; and the lakes are long, of little area, but of great depth. for many give soundings showing their beds to be well below the present sea level. In this connection, Mjosa, the largest Norwegian lake, 141 sq.mi. in area at an altitude of 397 ft., has a maximum depth of 1,453 ft. (nearly 1,100 ft. below sea level); Tyrifjord (alt. 207 ft., area 51 sq.mi.) has its maximum depth 700 ft. below sea level; Tinnsjo (alt. 605 ft., area 38 sq.mi.) with its bed more than 800 ft. below sea level; but the most remarkable case is Hornindalsvatnet, 6 mi. beyond the head of Nord fjord—20 sq.mi. in area, 180 ft. in altitude; its maximum depth is 1,414 ft. below sea level. Many of the high-level lakes are also of great depth; *e.g.,* Bygdin—area 18 sq.mi., alt. 3,484 ft., greatest depth 705 ft. The total number of lakes, tarns and pools is very high: in all they probably cover nearly 5,000 sq.mi. (4% of the entire country). In many cases the low-lying lake near the head of a fjord is separated from sea water by a narrow but steep-sided neck of land which on further land subsidence would resemble the submerged sill which is so characteristic of the underwater topography of the fjords. The majority of the river-valley lakes resemble mere expansions of the width of the river and possess strong currents; hence they are valuable for internal transport less as routes for water-borne traffic than as providing through lines for land communication in the difficult mountainous sections of the country. Store Le on the frontier in the southeast is somewhat exceptional, for it provides a water-transport link between a Norwegian canal system and a Swedish. The majority of the rivers run swiftly between steeply sloping valley walls, particularly in their upper and middle courses, where they are of little or no value for any form of navigation though they are extremely useful as gigantic flumes for the gravity carriage of timber. They are utilized as waterheads for hydroelectric schemes by which more than 2,000,000 kw. had been developed by 1951.

The unexploited sources were still enormous at mid-century (more than 8,000,000 kw. by the early 1950s). The development of this source of natural wealth is facilitated by the numerous rapids and falls on the rivers. As Norway fully realizes the financial value of its remarkable scenery and of its anglers' haunts, the mode of utilizing this smokeless power in the industrialization of any area is always a matter for careful consideration. A limiting factor in the "white coal" schemes is the seasonal character of many Norwegian streams which run low in winter on the freezing of their upper courses and rise rapidly during the period of maximum rainfall—here the lakes are of supreme value as safety valves controlling spring thaw water and autumnal rain water. Nevertheless, disastrous floods are not unknown. The lakes themselves in the north and interior freeze for varying periods each year, but in the south, where the majority of the large lakes are situated, it is only during very severe winters that these reservoirs become icebound.

The principal river of Norway is the Glomma, abbut 365 mi. long, which rises about 2,300 ft. above sea level in the highlands south of Trondheim fjord. It is a swift stream with numerous falls, and even within eight miles of its mouth, in Oslo fjord, there is a series of seven falls of which Sarpsfoss (74 ft. high and 120 ft. wide) is the best known. The river, which runs mainly north to south, drains about 16,000 sq mi., pierces the richest timber area and provides an important railway route from Oslo to Trondheim. Above Öyeren (35 sq mi.), the largest lake of the numerous ones in its course, the Glomma makes a remarkable bend (at Kongsvinger). Here, in postglacial times, the river which formerly ran due south to Vänern lake (Sweden) make a sudden swing to the west capturing the upper waters of the Lbgen, formerly an independent stream. (The old bed still carries occasional floodwater from Glomma to the lake.) The Lbgen, more than 200 mi. long, has, for a Norwegian river, a large upper basin receiving water from the Jotunheim and the Dovrefjell. Its sources lie near Romsdals fjord, and a direct railway runs from Oslo along its lower course (Vormen river), past the shores of Lake Mjosa, up the Gudbrandsdal, over the watershed and down through Romsdal (another railway line links Trondheim with the head of Gudbrandsdal). Other important streams entering Oslo fjord are the Tistedalselv and the Drammenselv. The Tistedalselv reaches the eastern seaboard after draining through a series of long, narrow lakes connected by rapids. The Drammenselv, a large river with. a considerable basin extending into Hemsdalsfjell, Valdres and Filefjell. enters on the western seaboard. Its upper tributaries, the Randselv and the Adalselv (plunging over Honefoss), unite to form the Storelv which expands into the Tyrifjord lake. Below this the real Drammenselv begins and receives, on the right bank, the Hallingsdalelv which flows through Lake Kroderen—all these valleyways afford important but not easy routes, and though the rivers are not navigable for any long stretches yet steamers are employed on the lakes. Numerous streams drain southward from the plateau and lake district of Hardangervidda, one of these, the Lbgen is noted for its falls (*e.g.,* Hammerfoss and Labrofoss), and for its wealth in salmon. From the Telemark district runs the Skienelv (152 mi.) flowing through the very deep Tinnsjo and the slightly larger, deep Norsjö; the former lake receives the river Mbne, on which is the famous Rjukanfoss (460 ft. high). The most notable falls occur in the courses of the shorter and more rapid western streams. Some of the most striking, in order from the south, are: Voringfoss (597 ft.) on the Bjoreia and Skjeggedalsfoss (525) on the Tysso—these two are in the Hardanger fjord area. Around Sogne fjord are several, of which Vettisfoss (853 ft.) on the Morkedola is probably the most interesting. The famous Seven Sisters falls are in a branch of the Stor fjord, while the Namsenelv (116 mi.), a popular salmon river entering Namsen fjord, has Fiskumfoss (138 ft.) and several others. The Arctic ocean rivers have gentle gradients, occasional rapids but no important waterfalls. Two longer ones are the Altaelv (124 mi.), which drains into the Alta fjord, though unfortunately its valley affords no route of importance; and the Tanaelv (205 mi. long—third longest river in Norway), which drains a considerable area in Norway and Finland, though the absence of lakes results in summer floods increased by the presence of ice dams. The lower river is wide (about 2,000 yd.) and tidal for six or seven miles and is ascended by small vessels. River boats are used along certain river stretches below and above the Storfoss rapids which occur about 45 mi. from the mouth of the river and have a fall that averages 23 ft. in 1,000 yd.

Climate.—The striking and unique feature of the climate of Norway is the presence of the largest positive temperature anomaly on the surface of the globe, which results in such unusual conditions as average temperatures within the Arctic circle which are higher than those of places farther east and 20° of latitude farther south. Again, Hammerfest, a thriving settlement of more than 3,000 inhabitants, is actually north of King William Land, which witnessed the tragedy of the Sir John Franklin polar exploration party. This temperature anomaly is consequent on the warm water and air drift across the Atlantic ocean onto the shores of Norway. January is the coldest month, and southeastern Norway then has a mean temperature of below 32" F. (Oslo 24.6°), but the coldest parts in this area are the Glomma valley, between Tynset and Roros (near the Swedish border). At the latter place (altitude 2,067 ft.) the January mean is 13.1° and an absolute minimum of approximately 90° F of frost has been recorded. Even this intense cold has been exceeded at stations near the Norway-Swecien boundary in Lapland Along the coast of western and northern Norway winter temperatures are higher, the January mean being 35° in Bergen, 30° in Bodo and 23° in Vardd.

In these coastal districts February is on the average rather colder than January. The number of days on which frost occurs varies between 45 at Ona and 240 in certain parts of Finnmark; North cape has about 190. The fjords are not penetrated by the cold water from the open ocean and are always ice-free except for patches along shallow coastal stretches during unusually severe winters. Summer temperatures range between slightly below 50° in the extreme north (Tromso 52.5° F. July average), and 62 5° at Oslo in July. Roros, with much greater altitude, has 52 5° average in the same month. The southeast of Norway is the warmest part in summer. At Bergen the warmest month is also July (57 5° average). Absolute maxima are high, and the following have been recorded: Skudenes. 84°; Bergen 86°; Oslo 94 4°; and even Karasjok, in Lapland, has recorded 88°. The annual range increases from west to east generally and from south to north along the coast.

Though the southwest wind is usually prevalent over Norway and very marked in summer, yet the winter high-pressure area causes outflowing winds—northeast on the Skagerrak, south and southeast on the western coast and southwest on the northern. Gales are freauent on the western coast, averaging three to four per month in winter and about one to two per month in summer. In the interior and east, gales are comparatively rare. Gales from the southmest bringing rain are the most common; next in frequency are gales from the northwest bringing snow. Calm weather is rare on the western coast but frequent in the interior. December and January are the stormiest months. Hailstones and thunderstorms are not of frequent occurrence in any part of Norway.

The number of days on which rain or snow falls is greatest on the northwestern and northern coasts, least in the southeastern districts and the interior of Finnmark. In the former area, precipitation occurs on 150–200 days in the year. On Dovrefjell and the southeastern coast the average is about 100 days. Snowfall occurs least frequently in the south (*e g.*, at Mandal, 25 snowy days out of 116 on which precipitation occurs), increasing to 50 at Oslo and Dovrefjell. to 90 at Vardö and to 100 at the North cape. Hence in the north and in the upland tracts snow occurs at least as frequently as rain. Snow may fall in any month on the coast as far south as the Lofotens. The amount of precipitation exceeds 100 in. per annum in the mountains a few miles from the coast north and south of Sogne fjord. On the outer islands there is a slight decrease; inland the decrease is rapid and great. In the extreme south of the country the average is about 39 in. There is a diminution eastward along the northern coast and a further rapid decrease toward the northern interior. where the average is 16 in., but strongly marked local variations are observed.

BY COURTESY OF NORWEGIAN GOVT. RAILWAYS
WOMEN DRESSED IN THE NATIVE COSTUME OF GUDBRANDSDAL AND SETESDAL

The amount of cloudiness is great. The coast of Finnmark has more than three cloudy days to one clear day; in the interior of the country clear and cloudy days are about equally divided. Summer fog is frequent on all coasts but fog is rare in winter. though occasionally experienced in the southeast. Sometimes, in severe winters, a frosty fog ("smoke frost") appears on the western fjords, caused by the piercingly cold land wind passing over the relatively warm water.

Norway was one of the first countries to establish a meteorological service, the Meteorological institute in Oslo being set up in 1866. There are meteorological observatories at Bergen, on Jan Mayen Island and on Bear Island. in East Greenland and on the mountain peaks of Fanaråken and Gausta. There are also 550 stations where meteorological observations and measurements are taken. Weather forecasts nine times a day are made regionally by the institutes at Oslo, Bergen and Tromsö.

The *Midnight* Sun—Part. at least, of the sun's disk is above the horizon at the North cape continuously from May 13 to July 31 and at Bodo, in lat. 67° 17′ N., from June 1 to July 13. Even at Trondheim there is practically no night from May 23 to July 20, while the long twilight gives the extreme south of Norway no real darkness from the end of April to the middle of August. In winter, on the other hand. the sun does not rise above the horizon at the North cape for more than two months and there is only a twilight at midday. In the extreme south midwinter night is $17\frac{1}{2}$ hours long.

Flora and Fauna.—The forests of Norway consist chiefly of conifers. The principal forest regions are in the southeast and south. In the Trondheim area and in Nordland there are extensive forests of pine and spruce with the pine on the drier, higher and less congenial parts. In southeastern Norway the conifer tracts extend from sea level to 2,500 to 3,000 ft.; in the inland parts of the Trondheim region the upper limit sinks to 2.000 ft.; while on the coast the upper limit is only from 600 to 1,200ft.; farther north the sprcce disappears and the pine limit falls to 700 ft. about 70° N. Above and north of the conifers is the birch belt; next follow various species of willows and the dwarf birch and last of all, before the snow line, the lichen belt, in mhich the reindeer moss is always conspicuous but a few flowering plants, shrubs and trees of the willow belt sometimes extend close up to the snow line. Even among the conifers there is a sprinkling of other trees—lowland birches, aspens and rowans in the high north, while in the southern and less elevated districts the lowest zone of forests includes the ash, elm, lime, oak, beech and black alder; but the beech is much rarer than in Sweden and. in fact, flourishes only near the Skagerrak; there and elsewhere the extreme coastal region is destitute of forest. The richest flora is found in the inland fjord valleys, but the Dovrefjell is the district in mhich arctic flora may be studied in great variety and within narrow limits. Marine flora is very finely developed on the coastal banks. There are 2,000 varieties of flowering plants.

The great forests were once the haunt of the bear, the lynx and the wolf. The bear and the lynx are now almost exterminated. The wolves decreased very suddenly in southern Norway about the middle of the 19th century, probably because of disease. and continued to decrease thereafter in the north; but they are still found in the Roros district and northward to Finnmark where they are abundant. Wolves are the worst enemy of the reindeer. The elk occurs in the eastern forests and near the coast in the Trondheim district, but is now becoming rare. The red deer is confined chiefly to the western coast; its principal haunt is the island of Hitra, off the Trondheim fjord. It is usually regarded as a survival of the oak age. On the high fjells are found the wild reindeer, glutton, lemming and the fox. The wild reindeer is now very rare in Finnmark, though large tame herds are kept by the Lapps. The lemming is noted for its curious nonperiodic migrations; at such times vast numbers of these small animals spread down country, even swimming lakes and fjords. They are pursued by beasts and birds of prey, and even the reindeer kill them for the sake of the vegetable matter they contain. Hares are very common all over Norway up to the snow line, and the badger and hedgehog also occur in the south and southeast. The beaver, formerly widespread, decreased seriously, but strict protection has saved it and it is fairly plentiful in the southern valleys.

Game birds are fairly abundant in most districts. Black grouse are widely distributed in the region of conifers and birches south of Finnmark. Hazel grouse are found mainly in the spruce forests of the southeast and east and fairly generally in the north, as are capercaillie, but the former is lacking in the west and the latter is found near certain fjords only. Woodcock and snipe are moderately plentiful. The partridge, an immigrant from Sweden, occurs principally in the east and southeast. A severe winter causes a marked scarcity of them. A very large proportion of the Norwegian avifauna consists of migratory geese and ducks, various birds of prey, golden plover, etc. These birds leave in autumn by three well-defined routes—one from Finnmark into Finland, one by the Oslo valley and one by the western coast, where they congregate in large numbers on the lowlands immediately south of Stavanger—but certain high arctic birds as the king eider, Spitsbergen guillemot and the little auk move on to the northern coast of Norway from higher latitudes at the end of summer. The arctic type of bunting, the snowy owl and the rough-legged buzzard are exceedingly numerous. In some localities the puffin and kittiwake form great colonies (fugleberg, "bird cliffs").

The common seal is very frequent; and arctic seals visit the northern coasts; among these the harp, or Greenland, seal is believed to be particularly destructive to the fisheries. A large number of the best European food fisheries occur along the coasts, including cod, herring, mackerel, sprat and flatfish. Various species of whales visit the coast; the most important is the rorqual, or finner; the largest is the blue whale. which appears off the coast of Finnmark from June to August. Other finners are the true finner and the smaller fish whale. The most important of other types of whales are the bottlenose, the humpback and the caaing whale. Of fresh-water fish the Salmonidae are by far the most valuable. Next to these, perch, pike, grayling and minnow are most common.

Southern Norway is richer than western Norway in insects and the north has numerous characteristic arctic types.

Norway is much frequented by British anglers. The Salmonidae have penetrated considerable distances inland, and though the trout is the only one to reach many of the upland lakes yet it is very abundant there. Most of the owners of water rights have a full appreciation of the value of good fishing to sportsmen, especially when netting rights are given up for the sake of rod-fishing.

(0. J. R. H; X.)

HISTORY

Prehistory.— Norway can be shown to have been inhabited for about 14,000 years, since the withdrawal of glaciation to the central highlands of the country. The primitive dwelling sites represent a culture derived from the palaeolithic cultures of western and central Europe and introduced from the southwest via Jutland, from Poland via the Baltic and from Russia via the White sea. Further cultural elements were added with every new accession of population, the different groups probably representing more or less different races which, however, have left neither skeletal remains nor traces of their language or languages.

BY COURTESY OF CAMMERMEYERS FORLAG

NORWEGIAN HORSEMEN IN THE BRONZE AGE. FROM A ROCK CARVING IN BAAHUSLEN. FORMERLY SOUTHERN NORWAY

Among these primitive hunters there gradually appeared distinct settlements of farming colonists from Denmark and Sweden; and by about the beginning of the Christian era the native hunters had come to adopt these farmers' way of life, language and religion and had in turn enriched the farmers' culture with their own experience in fishing, fowling and hunting. The two peoples were now completely assimilated.

All the ancient place names in Norway are of Germanic origin, and the first runic inscriptions, from the 3rd century A.D., show an archaic type of Germanic that was certainly the mother language of the later Scandinavian dialects.

Earliest History.— Before the consolidation of the kingdom the principal parts of Norway were markedly distinct. Viken, the country around Oslo fjord, was dependent on Denmark, under local kings. The inland regions were divided into several small kingdoms, open to influences from Sweden and united by the common Eidsiva-thing at Eidsvoll. The coast in the south and the west clearly enjoyed cultural relations with Flanders and France and formed from c. A.D. 700 an aristocratic confederation, with the common Gula-thing on Sogne fjord. The eight counties (*fylker*) round the Trondheim fjord had their primary political centre in the Oere-thing at Trondheim, where later kings of Norway, from the time of Haakon the Good, received the homage of the people. The northernmost province, Hálogaland, was a monarchy ruled by an ancient dynasty, later to be called the jarls of Lade.

The first exact date in Norse history is 813, given by a Frankish annalist with the information that Vestfold, on the Oslo fjord, was subject to the king in Jutland. The first Norse Vikings to come to Great Britain are described in the Anglo-Saxon chronicle, under the year 787, as "norðmanna of Hareðalande"; viz., Hordaland in Norway. Graves and place names attest Norse settlements in the Scottish isles from c. 800, and Dublin was fortified in 839.

The Dynasty of Harald **Haarfager.**—While the nobles of southern and western Norway were engaged in Scotland and Ireland Harald Haarfager (Fairhair), ruler of several scattered territories, took the opportunity to conquer the whole confederation of Gula-thing by the victory in Hafrsfjord (872; sometimes dated 20 years later). Apparently he acted in alliance with the jarl of Lade, who had annexed Trondelag to his possessions. After the conquest Harald resided in estates confiscated from exiled nobles, and parts of Viken were assigned to his sons. The purpose of the conquest was simply to acquire larger means of subsistence, to increase the king's retinue of warriors and to maintain his sons.

Harald Haarfager, as Harald I, was undisputed king of all Norway. He had designated as his successor Eric I Bloody Axe (Eirik Blodóks, c. 930–*c.* 935), his son by his Danish queen, who was moreover married to the sister of the king of Denmark. Chosen as most highborn, perhaps because of reminiscences of Vestfold's vassalage to Denmark. Eric started his reign by killing two of his eight brothers and within a few years had got rid of all but one, the youngest, Haakon (Hakon), who was reared at the court of the English king Aethelstan. Later tradition reports that Eric reigned for five years and then left the country, on Haakon's arrival from England. He was killed at Stanmoor, Cumberland, in 954.

Sigurd, jarl of Lade, had summoned young Haakon and now had him received as king in several parts of the country. The considerable concessions that he had to make to claims for local independence won him his surname of "the Good." Haakon I was the first missionary king of Norway, but he totally failed to convert his people. The saga assigns to him the credit of organizing the naval levy all along the coast, the first important step toward the political consolidation of the kingdom. At the time this force, or leidang, was required against Eric's sons, who, assisted by Danish forces, made repeated attacks to regain the kingdom. The levy proved efficient, but Haakon was mortally wounded in the battle at Fitjar (c. 960; possibly as early as 945).

The next king was Harald II Graafell (Grey Fur), the eldest surviving son of Eric. He resumed his father's efforts to assert himself as lord of the whole country and killed two petty kings (his father's cousins) in Viken and Sigurd, jarl of Lade. Reputed a hard oppressor of the people, he became the more unpopular because he prohibited the public worship of the gods—no surprise was felt when the harvest was bad and fisheries failed. The reign was not likely to last long: one of his brothers was killed during a revolt in Trondelag, another in Hordaland. and Harald himself in a battle (c. 970) against Haakon, son of Sigurd of Lade.

This Haakon now succeeded as jarl of Lade and took over the Gula-thing counties as a fief of Denmark, while Denmark annexed all eastern Norway. Haakon Jarl assisted his Danish lord in a war against the emperor Otto II in 974 but refused to convey Christian missionaries into Norway. A contemporary scald praises him as the pious champion of the ancestral faith, the restorer of temples and worship. He repulsed Danish attacks with his *leidang* and remained for about 25 years the sovereign of western and northern Norway, like Haakon the Good, though he preferred his ancestral title of jarl. He was killed in 995 at a peasant riot in Trondelag, coincidentally with the arrival of a fresh royal pretender from England.

Olaf I Tryggvesson was a descendant of Harald Haarfager. Bred from boyhood in Russia, he had become a Viking chieftain and had been the leader of the invasion of England in 991. On the conclusion of peace, he had been confirmed a Christian by the bishop of Winchester and adopted by Aethelred II, who probably incited him to convert Norway. He landed in 995, was recognized as king all along the coast and ensured acceptance of Christianity everywhere, partly by negotiation, otherwise by cruel force. He extended the mission even to Iceland and Greenland. As he encroached upon the Danish dominion in Norway he provoked a war and was slain in the battle of Swold (1000). Norway remained divided between the jarl of Lade and the king of Denmark.

Olaf II Haraldsson, another descendant of Harald Haarfager, had been a Viking from his boyhood till his landing in Norway in 1015, at the favourable moment when Eric jarl of Lade had gone with Canute of Denmark on his expedition to England. Olaf was the first king who really ruled all Norway, including the inland counties. He organized a regular royal administration by *lendmenn* (selected from the old aristocracy as military and judicial officials) and *armenn* (mean-born servants of the king who managed his estates). He completed the christianization and started the organization of the church. But he was not popular, being too severe in maintaining his royal power.

Olaf was let undisturbed as long as Canute was seriously engaged in England but was expelled when Canute had further leisure to invade Norway (1028). After two years he returned and was killed in the battle at Stiklestad (1030). Canute made his son Sweyn (Svein; 1028–35) king of Norway. But soon rumours were spreading that Olaf was a saint: his body was enshrined in the cathedral, Sweyn was exiled, and Olaf's son Magnus I was called back as king (1035–47). Magnus became king also of Denmark in 1042 and crushed a Slav invasion of Jutland by the victory at Lyrskog. He came to be known as Magnus the Good. But soon Sweyn II Estrithson, nephew of Canute, revolted against him, and Magnus died during a campaign in Denmark, the last descendant of Harald Haarfager.

The Dynasty of Harald III Hardraade.—Harald Sigurdsson, uterine brother of Olaf II, who had escaped from Stiklestad and taken service in the imperial bodyguard in Constantinople, had in 1046 returned to Norway, where Magnus complied with his demand to share the kingdom as Harald III. For several years he continued the war for Denmark, but finally had to leave it in Sweyn Estrithson's possession. In Norway his reign caused much unrest and gave rise to his epithet Hardraade (harðráðr), "the hard ruler." He was killed at Stamford bridge on his expedition to England in 1066.

Harald III's son Olaf III Kyrre (*i.e.,* the Quiet; 1066–93), who shared the kingdom with his brother Magnus II till the latter's death in 1069, made formal peace with Denmark and was never involved in war. He gave the dioceses fixed territories and permanent seats, which led to the rise of the first Norse towns and to the development of trade. Olaf's son Magnus III Barfot (Barefoot; 1093–1103) formed a striking contrast to the father, engaging in three expeditions to Scotland to establish Norse sovereignty over the Orkneys and the Hebrides (with Man). He got his epithet because he assumed the Celtic dress, with a kilt. He met his death in Ireland and was succeeded by his sons Olaf IV? (1103–IS), Eystein I (1103–22) and Sigurd I Jorsalafar (1103–30; so-called because of his visit to Jerusalem). These kings reigned jointly, paying special attention to the church. They imposed the tithes to better the clergy's income, founded the first Norse monasteries and built cathedrals. The clergy of the Scottish isles was incorporated into the church of Norway.

The unity of the kingdom had been made sacred by Olaf II's martyrdom, but all royal princes still had equal right to the succession. Thus Harald IV Gylle, Gille or Gilchrist, from Ireland, who after submitting to ordeal by fire had been acknowledged by Sigurd Jorsalafar as a bastard son of Magnus III Barfot, was able when Sigurd was dead to capture and blind the legitimate prince Magnus IV and to reign for a year till he was himself killed (1136) by a fresh pretender, who likewise failed and was executed. Similar tragedies recurred for the next 100 years, causing continual wars between rival parties of *lendmenn* and provinces. The troubles reduced the royal authority but invigorated the church by giving rise to the institution of the Norse archbishopric (1151) and of the right of testamentary donations, Peter's pence, etc., and, particularly, to the privileges granted to it in order to obtain the coronation (1163) of Magnus V Erlingsson, which made the king, now St. Olaf's vassal, recognize the tithe dues and also the independence of clerical jurisdiction.

Magnus V was long successful till (1177) he met his last antagonist, Sverre, born in the Faeroes, who claimed to be a grandson of Harald Gilchrist. After bitter fighting for several years Sverre in 1184 was recognized king of all Norway, though there were rebellions even up to his death 1202. Sverre radically reformed the administration. He established the *hird,* comprising both court officials and men resident on their estates, as a new aristocracy and reserved for its members the career of sysselmenn in local administration, in the place of the *lendmenn.* Of equal importance was the institution of *lagmenn* ("lawmen") as instructors of the juries, the first step toward creating royal judges.

The troubles lasted till 1217, when Sverre's grandson Haakon IV Haakonsson, aged 13, became king with Duke Skule as regent. They suppressed the last rebellion in 1227, after which Haakon reigned in peace for 36 years. Haakon made Norway a model state: the administration was modernized by creating the chancellor's office and the royal council; trade flourished, and blood feuds were prohibited. The northern frontier was regulated by a treaty with the Russians, and constant diplomatic relations were maintained with foreign courts, most of all with England. Iceland and Greenland voluntarily agreed to the union with Norway; but Haakon's expedition to Scotland failed to vindicate Norse suzerainty over the Hebrides, and he died at Kirkwall in 1263. His son Magnus VI Lagaboeter (Law-Mender; 1263–80), who ceded the Hebrides to Scotland in 1266, is renowned for his code of national laws, besides special laws for the towns and the *hird.* His efforts to reach a compromise with the church led to bitter controversies during the minority of his son Eric I1 (1280–99). In conflict with Liibeck, Eric had to give way when a blockade was imposed, but a long war with Denmark ended to his advantage. His brother and successor Haakon V (1299–1319) was a vigorous personality who dispossessed the aristocracy of influence and noble titles, surrounding himself with new men. He replaced the ancient naval levy by regular taxes, professional mercenaries and frontier castles. He made energetic efforts to restrain Hanseatic penetration into Norwegian cities. At his death the national male line of the royal family became extinct.

The Union of Kalmar, 1397.—Haakon V was succeeded in 1319 by the three-year-old Magnus VII, the son of his daughter Ingeborg and Duke Eric, son of Magnus I of Sweden. At the same time the boy was elected king of Sweden in the place of the exiled Birger, last king of the Folkunge dynasty. But this union of Norway and Sweden was personal, not political. The two countries were governed each by its separate regency: a conference in Oslo concluded nothing more than an alliance. The Norse regency was especially watchful to prevent the king's mother from intermingling the affairs of the two kingdoms. King Magnus' Swedish policy, after his coming of age, provoked rebellions in Norway;

and Magnus was forced to recognize his infant younger son Haakon as king of Norway in 1343 and to surrender the kingdom to him when he in turn came of age in 1355. Meanwhile the Black Death (*Svartedanen;* 1349–50) decimated the population, most of all the clergy, and caused lasting political disorganization.

Haakon VI (1355–80) however married Margaret, daughter of Valdemar IV of Denmark, the last of the royal line descended from Sweyn Estrithson and Canute. Their son Olaf (IV or V), who had been elected king of Denmark in 1375, succeeded to Norway in 1381 but died, at the age of 17, in 1387. Then his mother Margaret was elected "the mighty lady and the right sovereign" of the three Scandinavian kingdoms, a position unique in the whole history of those countries. But she soon found it more convenient to conform to national traditions by presenting her great-nephew Eric of Pomerania as candidate for the three crowns. In Norway he was acknowledged heir to the kingdom at Oere-thing in 1389, and he was crowned at a general Scandinavian meeting in Kalmar in 1397, where Margaret opened the discussion of her plan for a political union of the three countries. A committee of spiritual and temporal lords drafted a treaty of union which, however, was apparently never ratified, as the draft was not sealed by the Norse lords present.

Margaret remained the regent of the three kingdoms till her death in 1412.

The following list of sovereigns of Norway from the 9th to the 15th century may be found useful (dates before A.D. 1000 are approximate):

Harald Haarfager	*c.* 870–*c.* 930	Inge I Krokrygg	1136–61
Eric I Blodóks	*c.* 930–*c.* 935	Sigurd II Munn	1136–55
Haakon I	*c.* 935–*c.* 960	Eystein II Haraldsson	1142–57
Harald II Graafell	*c.* 960–*c.* 970	Haakon II Herdebreid	1161–62
Haakon Jarl	*c.* 970–*c.* 995	Magnus V Erlingsson	1162–84
Olaf I Tryggvessön	*c.* 995–1000	Sverre Sigurdsson	1184–1202
Eric Jarl	1000–15	Haakon III Sverresson	1202–04
Olaf II Haraldsson	1015–28	Gutorm Sigurdsson	1204
Sweyn Knutsson	1028–35	Inge II Baardsson	1204–17
Magnus I the Good	1035–47	Haakon IV Haakonsson	1217–63
Harald III Hardraade	1046–66	Magnus VI Lagaboeter	1263–80
Olaf III Kyrre	1066–93	Eric II Magnusson	1280–99
Magnus II Haraldsson	1066–69	Haakon V Magnusson	1299–1319
Magnus III Barfot	1093–1103	Magnus VII Ericsson	1319–55
Eystein I Magnusson	1103–22	Haakon VI Magnusson	1355–80
Sigurd I Jorsalafar	1103–30	Olaf IV or V Haakonsson	1381–87
Olaf (IV?) Magnusson	1103–15	Margaret	1387–89
Magnus IV the Blind	1130–35	Eric III (of Pomerania)	1389–1440
Harald IV Gille	1130–36		

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Danish Rule.—Eric of Pomerania continued Margaret's unitary policy, with the consequence that, since support for the crown came primarily from Denmark, lands, offices and sees throughout Scandinavia were generally assigned to Danes. National resentment at this led to Engelbrekt Engelbrektsson's rebellion in Sweden, which was followed by a Norwegian rising in the Oslo district under Amund Sigurdsson in 1436. But the Danish nobility itself then turned against Eric, who was deposed in 1439, and Norway came to accept his nephew and successor Christopher of Bavaria (Christopher III of Denmark) as king in 1442. Henceforth till 1814 the Danish kings ruled Norway: her fleet and army decayed, and her language gradually gave place to Danish; Germans plundered her coasts and monopolized her commerce, and after 1450 Danes began to appropriate the higher posts in her administration. When in 1448 Karl Knutsson was chosen king by the Swedes and Christian of Oldenburg by the Danes, it was by force that Norway fell to the latter. The Norwegians protested, but the next year the Swedes assented to a separation. Christian I (1450–81) gave estates and offices in Norway to his Danish subjects and pawned her ancient possessions, the Orkneys and Shetland Islands, to the king of Scotland as security for a dowry which remained unpaid. His son Hans (1481–1513; jointly recognized by Denmark and Norway in 1483) purchased the obedience of the Norwegian nobles by concessions to their power. The imposing union continued in name, but the weakness of the nation and its government was strikingly illustrated when the Germans in Bergen besieged a monastery in which a high official had taken refuge.

After the downfall of Hans's son Christian II (1513–23) the position of Norway was changed for the worse. She was ruled for a century and a quarter by Danish officials; her churches and monasteries were sacked by Danes, and Danes were installed as pastors after the Reformation, which the Norwegians were compelled to accept in 1539. Soon Norway was dragged by Denmark into the so-called Seven Years' War of the North (1563–70). However, the power of the Hanseatic league in Bergen was broken. The rule of the Oldenburg dynasty proved neglectful rather than tyrannical, and under it the mass of the peasants was not flagrantly oppressed. Christian IV (1588–1648), who founded Christiania (Oslo), may almost be said to have discovered Norway anew. He reformed its government and strove to develop its resources, but his policy involved the loss of Jemtland and Herjedalen, which were ceded to the Swedes by the peace of Brömsebro (1645). The Danish war of revenge against Charles X of Sweden resulted in further loss by Norway. By the peace of Roskilde (1658) she was compelled to renounce Trondheim and Baahus, and although the former was restored by the peace of Copenhagen (1660) her population fell below 500,000. From the middle of the 17th century, however, the Dutch and English made their influence felt, and the political status of Norway could no longer be regarded as a purely Scandinavian affair. The establishment of hereditary autocracy in Denmark by Frederick III in 1660 conferred many benefits upon Norway. The Norwegian peasant remained a freeman while his counterpart in Denmark was a serf. Norwegian law was revised and codified under Christian V (1670–99), who was well served by the Norwegians in his attempt to regain the lost provinces from Charles XI.

Under the sons of these monarchs, Frederick IV and Charles XII, Norway was once more compelled to pay for Danish aggression. Her shipping was destroyed, and in 1716, when driven from continental Europe, Charles XII fell upon her. Only his death, in 1718, averted the danger. During this war Peder Wessel, the greatest among a long series of Norwegian heroes who served in the Danish fleet, won undying fame: in 1716 he was ennobled under the name of Tordenskjold (*q.v.*), by which he is best known. Before the close of the 18th century increasing prosperity developed the national consciousness of Norway. The growth of the timber trade with England gave rise to a great increase in wealth and population. In a century and a half the number of the Norwegian people was doubled, so that by 1814 the population was 900,000. In 1788 the oppressive law that grain should be imported into Norway only from Denmark was repealed. Thanks moreover to Danish policy, Norway actually drew financial profit from the wars of the French Revolution.

In 1770, freedom of the press was introduced by the reforming zeal of Christian VII's German doctor J. F. Struensee, who exercised at this time a more real power in Denmark-Norway than did his insane master. The national aspirations of Norway were then at once voiced, though at first they went little further than the demand for a Norwegian university, which was to be conceded by Frederick VI in 1811. The crisis destined to break the union did not develop until 1807, when George Canning's coup against the Danish fleet drove Christian VII to abandon neutrality and to embrace the cause of Napoleon. Norway, whose interests and sympathies were closely linked with Great Britain, suffered great and immediate damage from a British blockade and was more or less cut off from Denmark, so that a separate administrative commission had to be set up. In 1809 the head of this commission, Prince Christian Augustus of Augustenburg, was elected by the Swedes as heir to Charles XIII of Sweden in pursuance of a plot, originated by the Norwegian national leader, Herman Count Wedel-Jarlsberg, to transfer the allegiance of Norway to that country. Christian Augustus, however, relinquished his connection with Norway immediately after his election, and the scheme was finally frustrated by his death in May 1810, whereupon the choice of Saeden fell upon Napoleon's marshal Jean Bernadotte, in the hope that so distinguished a solider might recover Finland (taken by Russia in 1808). But Bernadotte was too wise to attempt this and planned to annex Norway instead. With this object he forced Frederick VI, by the treaty of Kiel (Jan. 14, 1814), to renounce his sovereignty over Norway in favour of the king of Sweden. In return for support against his former master Napoleon, the allied great powers had given their support to Bernadotte's policy.

Union with Sweden.—The treaty of Kiel was, however, immediately repudiated by the Norwegians, who contended that it violated the principles of international law by purporting to dispose of an entire nation without its consent and claimed the right to determine their own sovereignty. A representative assembly, convened at Eidsvoll, prepared and adopted on May 17, 1814, a national constitution based on the democratic models of the U.S., France (1791) and Spain (1812) and unanimously elected as king of Norway the viceroy Christian Frederick, who later succeeded to the throne of Denmark as Christian VIII. A Swedish invasion followed, but negotiations were almost simultaneously opened, and it was agreed that Norway should retain her independence and her new constitution, subject to a merely personal union under the Swedish king. Christian Frederick abdicated and left the country, and the terms drawn up in the convention of Moss (Aug. 14) were ratified by an extraordinary *storting* in November.

Charles XIV John.—The settlement thus reached held from the first the seeds of conflict and misunderstanding. Even Bernadotte, who succeeded to the dual monarchy as Charles XIV John on Charles XIII's death in 1818, believed that circumstances would soon bring about the complete absorption of Norway in Sweden. as he had originally planned—a view rendered plausible enough by the poverty and trade depression in Norway which followed the end of the Napoleonic wars and reduced the national finances to a parlous condition. The inevitably severe taxation made the new *storting* unpopular and led to a local rising of the peasantry in 1818, promoted by Halvor Hoel, a wealthy farmer in Hedemarken; this. however, was easily crushed. Swedish opinion generally continued to regard Norway as a conquered country and the treaty of Kiel as the title deed to it. Such an attitude naturally inflamed the outraged national sentiment of Norwegians and made them more than ever determined to guard and to emphasize their newly won independence. Moreover, the Norwegian constitution, based on Montesquieu's theory of complete separation between executive, legislature and judiciary, promoted conflict rather than collaboration between the first and second of these poners. The king, as head of the executive, controlled, among other things, the foreign affairs of both his kingdoms on which he was advised by a Swedish foreign minister; and his Norwegian councillors, whom he chose with little or no regard for public opinion as expressed in the *storting*, were excluded from membership or even from attendance in the legislature. Thus, uhile the *storting* grew increasingly democratic, executive power still rested with a bureaucracy appointed by the crown. The king was principally resident in Sweden and represented in Norway by a viceroy who was generally a Swede, so that Swedish influences predominated in all questions where the interests of the two countries differed.

Such a case arose in the "Bodö affair" of 1818–21, when an English merchant. who had been arrested on charges of smuggling and other irregularities (of which he was certainly guilty), launched a claim against the Norwegian authorities and, with the help of forged and falsified documents, succeeded. through British diplomatic pressure on the king and his Swedish advisers, in securing heavy damages which the Norwegian government was reluctantly compelled to pay. But even earlier the inevitable conflict had begun. When the Norwegian *stortings* of 1815 and 1818 passed a bill for the abolition of titles of nobility, the king at once exercised his constitutional right of veto and it ultimately became law without his sanction on its being passed by a third successive *storting* (1821). A further dispute arose over the settlement with Denmark of Norway's share in the joint national debt of the two countries. Charles John, with British mediation, concluded in Sept. 1819 a convention with Denmark, by which Norway was made liable for no more than 3,000,000 specie dollars (about £700,000). These terms, however, were accepted by the *storting* with a tardy recalcitrance that nearly occasioned a fresh intervention by the powers and made the king doubt the Norwegians' sincerity and, apparently, contemplate a coup d'état. In July 1821 he assembled a force including 3,000 Swedish troops near Christiania (Oslo), ostensibly for manoeuvres, having previously circularized the powers (June 1) with a note courting their sympathy for an attempt to force a revision of the constitution. Induced to abandon this idea, he submitted his proposals for revision to the *storting*, which however unanimously and repeatedly rejected them, thus coming to be regarded as the defender of the constitution against a would-be autocrat.

Trouble also arose over the king's attitude to the celebration of May 17 (on which day Christian Frederick had become king) as the anniversary of Norwegian independence, which he considered as a demonstration of disloyalty toward, himself. His attempts to prohibit these celebrations culminated in 1829 in the "*torveslag*" or "battle of the market place," when an inoffensive gathering of both sexes was charged by soldiers on the orders of the Swedish viceroy.

In addition to these conflicts between the executive and the legislature, an antagonism soon developed in the *storting* itself between the views of representatives of the old governing class and the growing democratic aspirations of the peasantry. The constitution of 1814 was based on the democratic principle that the choice of a sovereign rested with the people, and the Eidsvoll assembly had had to be a widely representative gathering in order to bring home to the world the strength of national opinion on the issues involved. Nevertheless for some time afterward political power remained in the hands of the old official class, which indeed was the only one at that time experienced in the arts of government. The seeds of democracy, however, began to germinate after the "July revolution" in France and the similar disturbances throughout Europe (1830). From 1833 the peasant representation in the *storting* acquired a competent leader in Ole Gabriel Ueland, and an opposition developed to challenge the supremacy of the bureaucracy in the legislature as well as in the executive. The first important victory for democracy was won in 1837, when, after considerable difficulty in obtaining the royal assent, the local government of the country was placed on a popularly elected basis —a measure which contributed more perhaps than anything else to awaken and educate the political consciousness of the general population.

The tension between the king and the *storting* reached its climax in 1836, when Charles John arbitrarily dissolved the legislature and the latter retaliated by impeaching and fining a minister who had supported the king's decision. From this date to the close of his reign Charles John became more conciliatory, acquiring before his death (March 8, 1844) remarkable popularity with his Norwegian subjects. An important step toward this change 'was made in 1836, when the post of *stattlzolder* or viceroy was conferred on Count Wedel-Jarlsberg. But chief among the royal concessions was the permission, granted in 1838, for merchant ships to fly the Norwegian flag in all waters, its use having been previously severely restricted. The question of the general use of the national flag, destined later to emerge in another form, was under consideration by a mixed committee of Norwegians and Swedes at the time of the king's death.

Oścar I.—Charles XIV John's son and successor Oscar I (1844–59) soon showed his desire to meet the wishes of the Norwegian people, decreeing that in all documents concerning her internal government Norway mas to stand first in the royal title; that Norway and Sweden should each carry its own national flag as the naval flag, with the mark of union in the upper corner; but that the merchant flag should bear the same mark of union.

The condition of the country had now considerably improved, and King Oscar's reign was marked by the carrying out of important legislative work and reforms. New roads were made, the first railway built, steamship routes established. lighthouses erected and trade and shipping developed. The abolition of the English Navigation acts in 1850 opened up a great future for the Norwegian merchant fleet.

In 1826, by the treaty of St. Petersburg, the frontier with Russia in the polar region had been definitely delimited; but in 1851 Russia demanded for her frontier Lapps the right to fish on the Norwegian coast and to settle upon a portion of the coast on the Varanger fjord. The Norwegian government refused, and serious complications might have ensued if the attention of Russia had not been turned in another direction. During the Crimean War the king concluded a treaty with England and France by which these countries guaranteed Norwegian and Swedish territory against Russia. Relations with Russia therefore became strained; but after the peace of Paris in 1856 and the accession of Alexander II the Russian ambassador at Stockholm restored harmony.

Charles XV.—Because of the king's ill-health his son was appointed regent in 1857. Two years later he succeeded as Charles XV. This gifted, genial and noble king desired to inaugurate his reign by proof of his willingness to acknowledge the claims of Norway, but he did not live to see his wishes carried out. According to the constitution, the viceroy might be either a Norwegian or Swede. Since 1829 no Swede had held the post, and since 1859 no appointment had been made. But the paragraph in the constitution still existed, and the Norwegians naturally wished to have this stamp of "provinciality" obliterated. A proposal to abolish the office was passed by the *storting* in 1859. The king had privately promised that he would sanction the proposed change in the constitution; but a violent outcry arose in Sweden. Under pressure the king eventually refused to sanction the resolution; but he added that he shared the views of his Norwegian counsellors and would, when "convenient," himself propose the abolition.

In the following year the Swedish government pressed the demands of the Swedish estates for a common parliament which, according to population, would contain two Swedish members to every Norwegian. The Norwegian government did not seem at all disposed to entertain the proposal; but some dissensions arose with regard to the form of its reply. The more obstinate members of the ministry resigned, and others, of a more pliable nature, were appointed under the presidency of Fredrik Stang, minister of the interior from 1845 to 18j6. Both the new and old governments agreed that no proposal for the revision of the Act of Union could then be entertained. The king, however, advocated a revision based upon full equality. In 1863 the *storting* assented to his appointment of a second Union committee. It was not until 1867 that its report was made public, and it could not be discussed by the *storting* before 1871. Meanwhile, Denmark's troubles over Schleswig-Holstein (1863–64) threatened to draw the two kingdoms into war. The king favoured a defensive alliance with Denmark. but the *storting* would only consent if an alliance could also be effected with at least one of the western powers.

In 1869 the *storting* passed a resolution by which its sessions were made annual instead of triennial. The first yearly *storting* in 1871 had once more to consider revision. The Norwegians steadily postulated: (1) the full equality of the two kingdoms; and (2) no extension of the bonds of the union. However, the new draft implied the supremacy of Sweden and introduced important extensions of the bonds of the union. Strangely enough, the new Stang ministry accepted it, and it was even supported by some of the most influential newspapers under the plausible garb of "Scandinavianism." In these circumstances the Lawyers' party, under the leadership of Johan Sverdrup, and the Peasant party, led by Sören Jaabaek. allied themselves to defend the constitution of 1814. Thus was founded the great national party of the Venstre ("the left"). The proposed revision in 1871 was rejected by an overuhelming majority.

In 1872 a private bill proposed that ministers should be admitted to the *storting* and take part in its proceedings. After stormy debates, Sverdrup carried the bill by a large majority, but the government, jealous of the new Liberal party, advised the king to refuse his sanction. In the preceding half century the government party had several times introduced a similar bill, but the opposition had feared lest the superior skill in debate and political experience of the ministers should turn the scale too readily in favour of government measures. Now, on the contrary, the opposition had gained more experience and had confidence in its own strength; but the government saw in the proposed reform the introduction of full parliamentary government, by which they could not remain in office unless supported by a majority. The Liberals carried a vote of censure against the government, but the king declared that the ministers enjoyed his confidence. Three, however, resigned, and enthusiastic public meetings were held all over the country in support of the proposed reform.

Oscar 11.—In Sept. 1872, Charles XV was succeeded by his brother Oscar II, who in the following year sanctioned the abolition of the office of viceroy, the president of the ministry being afterward recognized as the prime minister. In 1874 the government, in order to show the people their good will, laid before the *storting* a royal proposition for the admittance of the ministers to the national assembly. But this was to be accompanied by other constitutional changes, such as the royal right of dissolving the *storting* and the providing of fixed pensions for former ministers, as a guarantee against the majority's misusing its new power. The bill was unanimously rejected by the *storting*, who in the same year and again in 1877 passed a modified version of the bill of 1872. On both occasions the king refused his sanction. The *storting* accordingly resorted to the procedure provided by the constitution to carry out the people's will: in 1880 the bill was passed for the third time, by 93 votes out of 113.

To the general surprise, the king again refused his sanction, declaring that his right to the absolute veto was "above all doubt." Sverdrup, the Liberal leader and president of the *storting*, therefore proposed that the bill, which had been passed three times, should be declared to be the law of the land. This was carried by a large majority on June 9, 1880, but the king and his ministers declared the resolution invalid. The faculty of law at the Christiania (Oslo) university with one dissentient upheld the king's right to the absolute veto in questions concerning amendments of the constitution, although they could not find that it was expressly stated in the fundamental law of the country. The ministry also advised the king to claim a veto in questions of supply, which still further increased the ill-feeling in the country against them.

The prime minister, Stang, now resigned, and C. A. Selmer became his successor—an appointment which indicated that the conflict was to be continued. In June 1882 the king came to dissolve the *storting* and astonished the people by censuring their representatives in a speech from the throne. In the elections the Liberals won 83 seats to the Conservatives' 31. The ministry, however, showed no sign of yielding and when the new *storting* met in Feb. 1883 the *odelsting* (the lower division of the national assembly) decided to impeach the whole of the ministry. They were charged with having acted contrary to the interests of the country by advising the king to refuse his sanction: first, to the amendment of the law for admitting the ministers to the *storting;* second, to a bill involving supply; and third, to a bill by which the *storting* could appoint additional directors on the state railways.

After ten months' trial, the *riksrett* sentenced Selmer and seven of his ministers to be deprived of their offices; while three, who had either recommended the king to sanction the bill for admitting the ministers to the *storting* or had entered the cabinet at a later date, were heavily fined. The excitement in the country rose to fever height. It mas generally believed that the king would attempt a coup d'état. Fortunately, after some hesitation, he issued (March 11, 1884) an order in council announcing that the judgment mould be carried into effect King Oscar however, in his declaration upheld the constitutional prerogative of the crown, and in April asked Christian Homann Schweigaard, one of the ministers who had been fined, to form a ministry. His "April ministry" sent in its resignation the following month; a similar nomination failed, and the king was at last compelled to appoint

Sverdrup. Thus the first Liberal ministry in Norway came into being (1884). The *storting* passed a new resolution admitting ministers and this received formal sanction. During the following years a series of important reforms was carried through.

In June 1889 Sverdrup resigned, and a Conservative ministry was formed by Emil Stang, Fredrik Stang's son. After two fruitful years this was wrecked on the diplomatic question. In 1814 nothing had been settled about the conduct of diplomatic affairs; in 1835 a resolution was issued which in effect gave Norway a right of inspection of business transacted on her behalf by the Swedish foreign minister with the king. The Swedes were milling to grant equal representation in a joint council, but on the assumption that the minister of foreign affairs should continue to be a Swede, and this the Norwegians would not accept. In 1891, after a deadlock, the Stang ministry resigned, and a Liberal ministry under Sverdrup's successor J. V. C. Steen, was appointed.

A new deadlock was produced by the resolve of the *storting* in 1892 to establish a separate consular service for Norway, which provoked the king's veto and the resignation of the ministry. By a compromise the ministry returned to office, on the understanding that the question was postponed. In 1893, the *storting* again passed a resolution for the establishment of the proposed consular service, but the king again refused his sanction. Upon this the Liberal ministry resigned (May 1893), and the king appointed a Conservative government, with Stang as its chief. At the end of 1894, when the triennial elections took place, the majority declared in favour of national independence on the great question then before the country. In 1895, after more than four months without a responsible government, a coalition ministry was formed, with G. F. Hagerup as prime minister. A new committee of Norwegians and Swedes spent more than two years in fruitless labour on the question of separate diplomatic representation. At the elections in 1897, 79 Liberals and 35 Conservatives were returned, and in Feb. 1898 Hagerup was replaced by Steen. Soon afterward the bill for the general adoption of the national or "pure" flag was carried for the third time and became law without the king's sanction. In 1898 universal political suffrage for men was passed by a large majority, but the proposal to include women received only 33 votes. Women received local-government franchise in 1901 and were to be granted a wide but restricted parliamentary suffrage in 1907. Universal political suffrage was not extended to them till 1913.

In Jan. 1902, on the initiative of the Swedish foreign minister Alfred Lagerheim, another joint committee on the consular question was appointed. It unanimously reported that "it was possible to appoint separate Norwegian consuls exclusively responsible to Nonvegian authority and separate Swedish consuls exclusively responsible to Swedish authority." Further negotiations resulted in the so-called communiqué of March 24, 1903, announcing an agreement for separate consular services. In due course the Norwegian government submitted to the Swedish their draft of the proposed regulations, but received no reply for several months. The friendly Lagerheim resigned, and in Nov. 1904 E. G. Bostrom, the premier, suddenly submitted to Norway new conditions for the establishment of separate consuls. These placed the Norwegian consuls under the Swedish foreign minister, who could remove them. Hagerup proceeded to Stockholm, but no satisfactory agreement could be reached. The Norwegians felt themselves compelled to take matters into their own hands. On March I, 190j, Hagerup resigned and was succeeded by Christian Michelsen and a ministry from both parties. It was resolved to establish a Norwegian consular service not later than April 1, 1906.

During the king's illness the crown prince vainly attempted to reopen negotiations. In April Bostrom resigned, apparently to facilitate negotiations. On May 23 the *storting* unanimously passed the bill, but on May 27, despite the entreaties of his Norwegian ministers, the king refused his sanction. The Norwegian ministry immediately resigned. The king refused their resignation, but they declined to withdraw it. On June 7 Michelsen informed the *storting* that, since an alternative government could not be formed, the personal union with Sweden was dissolved. The resigning ministry was unanimously authorized to exercise the authority vested in the king. The king sent a telegraphic protest to Michelsen and to the *storting*, and an extraordinary session of the *riksdag* (Swedish parliament) on June 20 appointed a special committee on the crisis. On July 25 it reported to the *riksdag* that Sweden should negotiate on the issue raised. if requested by a newly elected *storting* or a referendum. The report was unanimously adopted on July 27, and next day the *storting* decided on a general plebiscite. On Aug. 13 there were 368,211 votes for severance of the union and 184 against it. It was thereupon agreed that representatives of Nonvay and of Sweden should arrange for the separation. After more than three weeks' negotiation, agreement was reached on Sept. 23. This provided for a neutral zone on both sides of the southern frontier, the Norwegians undertaking to dismantle some fortifications within that zone. The agreement was to remain in force for ten years, renewable for a similar period, unless one country gave notice to the contrary. On Oct. 27, after ratification by *storting* and *riksdag*, the king relinquished the crown of Norway. Failing acceptance by a Bernadotte, it was conferred upon Prince Charles of Denmark by a second popular vote (259.563 against 69,264) and by the *storting* with no dissentients. On Nov. 25 the king, now Haakon VII, and Queen Maud, the youngest daughter of Edward VII of England, entered the Norwegian capital.

(W. F. RE; G. M. G-H.)

Haakon VII.—The truce to party politics created by unanimity on the question of terminating the Swedish union did not long survive the retirement of Michelsen in Oct. 1907. The coalition government continued for five more months. under the leadership of its former foreign minister Jorgen Lovland, but for the next 12 years the Liberal (Venstre) party generally maintained its predominance, though the elections of 1909 brought it a temporary setback in consequence of a split on the question of the Concession laws, which constituted the main political issue in the earlier years of this period. These laws were designed to control the power of foreign capital and, in the minds of the more radical politicians, of capital generally. They made the industrial exploitation of the natural resources of the country subject to a government concession, with eventual reversion to the state of the property involved, together with the plant and buildings erected upon it, without compensation. In consequence of the secessions from his party, Gunnar Knudsen's Liberal government, which was in power from 1908 to 1910, was succeeded by a coalition of Conservatives and moderate Liberals, under Wollert Konow and Jens Bratlie, till 1913, after which Knudsen ruled without a break until 1920.

The industrial developments with which the Concession laws mere concerned were, however, symptomatic of a fundamental change in the economic life of the country, which fortuitously coincided with the restoration of Norwegian independence in 1905 and had far-reaching political and social consequences, including a disturbance of the existing balance of political forces. It was in 1905 that Sam Eyde founded Norsk Hydro, the great Norwegian nitrate organization, based on the use of hydroelectric poner. The harnessing of Norway's enormous resources of water power started an industrial revolution with a suddenness which created problems and conflicts of capital and labour not previously experienced. Industrial disputes promoted the growth of organized labour and of a political Labour party the strength of which had hitherto been negligible. In these circumstances the dominance of the old Liberai party could not long continue.

World War I.—On the outbreak of World War I the three Scandinavian countries at once proclaimed a policy of neutrality primarily designed to preclude any possibility of hostile action between them. They co-operated closely, and numerous conferences were held between their representatives. Norwegian shipping. however, rendered most valuable services to Great Britain, and from 1917 such services were the subject of a comprehensive agreement with the Norwegian Shipping association. Losses of life and tonnage were heavy, but the profits earned were extremely large. The wave of speculation which ensued brought temporary prosperity to a new and undesirable class of capitalists and thus further embittered the relations between capital and labour.

1919–39.—The Labour party, at this stage, was of an extreme revolutionary type, and in 1919 it joined the Third International. Its growth in numbers, which in 1921 gained it 29 seats in the storting, reduced the Liberal forces to approximate equality with the Conservatives, though these old parties were still each considerably stronger than the Socialists: this situation led to a succession of short-lived governments, alternating between Conservative and Liberal, between 1920 and 1928.

In 1923 the Labour party withdrew from the Third International, and a Communist party was formed by its recalcitrant left wing. This split, however, did not entail any substantial loss, and in 1927 Labour became the strongest single party in the storting, with 59 seats. Its policy was still extreme enough to excite fear and suspicion in bourgeois circles, and when in Jan. 1928 it first assumed power as a minority government it only survived for a fortnight, being replaced by a Liberal administration under Johan Ludwig Mowinckel, who remained premier till 1935, except for a break in 1931–32, when an Agrarian government under Peder Kolstad was in office. Kolstad died in March 1932, and the leadership passed to Jens Hundseid until the fall of the government in Feb. 1933. The elections of 1933, however, gave Labour 69 seats, and from 1935 they remained securely in power, under Johan Nygaardsvold, though without an over-all majority until 1945.

After the settlement of the Concessions question, the principal domestic issue in the decade following World War I turned on the prohibition of intoxicating liquors, which had been introduced as a temporary expedient during the war and the continuance of which was supported by a referendum in Oct. 1919. The experiment proved unsatisfactory, leading to widespread smuggling and other evasions of the law, besides producing a trade conflict with Spain and Portugal which caused heavy loss to the fishing industry. The measure was repealed, except in relation to spirits, in 1923; the prohibition of spirits was likewise abandoned in 1927.

In external affairs the most important events were the recognition of Norwegian sovereignty over Spitsbergen (Svalbard) from 1925, and a dispute with Denmark over Norwegian rights in East Greenland, which was decided in favour of Denmark in 1933, by the Permanent Court of International Justice. For the last ten years preceding World War II Norway was seriously affected by the world economic crisis, and widespread unemployment promoted the progress of socialism.

World War II and After.—In the years following World War I, Norway had been a loyal and active member of the League of Nations, in the work of which Fridtjof Nansen played a conspicuous part; but the experience of the Italo-Abyssinian conflict shook the country's faith in the security offered by this organization, and on July 1, 1936, Norway, together with its associates in the "Oslo group," repudiated the obligation to assist in the enforcement of sanctions under the covenant. The Norwegian government announced in April 1938 its intention to abstain from participation in the event of war.

On the outbreak of World War II in 1939 the Scandinavian countries together proclaimed their reversion to a policy of strict neutrality. This policy seemed at first sight to be more disadvantageous to the western allies than to Germany, which was able to use a long stretch of sheltered territorial waters for the conveyance of Swedish iron from the Norwegian port of Narvik. During the Russo-Finnish campaign of 1939–40, in which Norwegian sympathies were strongly pro-Finnish, France and Great Britain tried to induce Norway to abandon her neutrality sufficiently to allow the transit of Allied troops through Norway to Finland, but the request was refused. In Feb. 1940 British naval forces entered Norwegian territorial waters to rescue a number of Allied prisoners from the German vessel "Altmark," which had taken refuge in the Jossing fjord. On April 8 the Allies went further and announced the mining of various points in Norwegian territorial waters, with the object of preventing their use for the safe conveyance of German supplies. It was not, however, from the west that Norwegian neutrality was seriously threatened: on April 9, 1940, the country was suddenly invaded by Germany.

This event found the Norwegian people completely unprepared. During the interwar period, the defenses of the country had been neglected by all political parties for a variety of reasons. Faith in the protection afforded by the League of Nations and the prevalent view that the reduction of armaments was a virtue played an important part in the earlier stages. With the rise to power of the Labour party, motives of economy or of diverting expenditure from military to social objects combined with the ingrained pacifism of the older Socialists, who were also afraid that the army might be used in internal conflicts to the detriment of the working class, to produce a similar result. Halvdan Koht, the foreign minister. while he tried to the last to maintain a strictly neutral policy, was also obsessed with the idea that this neutrality was threatened from the west rather than from Germany and he accordingly ignored a number of warnings that reached him during the final days preceding the invasion.

The project of a German occupation of Norway was, however, under consideration in Germany as early as Oct. 1939, where it was strongly pressed by the admiralty. By the middle of Jan. 1940 the plan was adopted by Adolf Hitler, who had been more or less converted after an interview with the Norwegian traitor Vidkun Quisling in the previous month.

The destruction of the German cruiser "Bliicher" by the Oscarsborg batteries in the narrows of the Oslo fjord threw out the German timetable sufficiently to enable the king and his government to escape from the capital to Elverum. where an extraordinary meeting of the *storting* voted full powers to the government to act during the emergency. The German demands, which included the appointment of Quisling to the premiership, were rejected by the king and his ministers, and active resistance by the improvised forces available at once began. This was continued for about two months, but by the beginning of June dangers on other fronts compelled the withdrawal of the assistance meanwhile provided by the Allies The king and government moved to England at the same time. and active hostilities in the country came to an end. From London, nevertheless, the king and his ministers retained continuous contact, through the radio. with the loyal elements in Norway, while they had from the first succeeded in diverting practically the whole Norwegian merchant fleet to the service of the Allies. thus securing them a considerable advantage.

The Germans were remarkably slow in grasping the extent of the antagonism that they had aroused in the Norwegian population and made a particularly serious mistake in the support which they insisted on giving to Quisling and his party, who were despised by all but a negligible fraction. The people rapidly grew more and more united in opposition to the occupying power. In the temporary depression induced by the fall of France, indeed, there was a dangerous moment when the presidential board of the stortzng was prevailed upon to request the abdication of the king and the resignation of the government; but when this demand was met with a dignified refusal a bolder spirit quickly developed, and in September Germany was compelled to abandon the hope of giving to the occupation any appearance of voluntary acceptance by the Norwegian people. A German Reichskommissar (Josef Terboven, 1898—committed suicide on May 9, 1945) was appointed, under whom various members of Quisling's party were given administrative charge of the different departments of state. On Feb. 1, 1942, Quisling (1887—shot Oct 24, 1945) himself was raised to the position of "minister president" over a puppet government of his supporters; but this move effected no real change in the situation.

A home front growing spontaneously from the unco-ordinated efforts of individuals became increasingly organized under a central leadership whose members were soon in continuous touch with the Norwegian government in England. The directives issued through secret channels by this organization to the people found a ready and loyal response which obstructed in no small degree the plans of the occupying power and its puppets, while a large number of "illegal" newssheets spread Allied propaganda and kept the population informed on the facts of the situation. Resort to guerrilla warfare or to unauthorized acts of sabotage was wisely discouraged, though a secret military organization existed and was approved. The home front was drawn indifferently from all political parties and classes of the nation and thus fostered a new spirit of unity that ignored political antagonisms.

Immediately after the liberation of the country in May 1945 the wartime government headed by Johan Nygaardsvold resigned and was temporarily succeeded by a coalition under the premiership of Einar Gerhardsen. A general election on Oct. 8 returned the Labour party again to power, with 76 seats out of 150. The Communists enjoyed a fleeting prestige at the close of the war, and won 11 seats. but they lost them all in the subsequent election of Oct. 10. 1949, in which the Labour party increased its representation to 85. Gerhardsen continued as prime minister until Nov. 1951, when he was relieved for a time by his colleague Oscar Torp, resuming the premiership in Jan. 1955.

Domestic policy in these years was mainly concerned with the problems of finance and reconstruction inherent in the postwar situation, which were for the most part approached on lines laid down in an agreed program of all parties at the close of hostilities. In its external affairs, however, Norway made a striking departure from its traditional attitude of neutrality. For the first few years, indeed, the aspiration of all the Scandinavian states was to build a bridge between the conflicting ideals of the western world and the U.S.S.R., while avoiding association with a power bloc on either side. As early as the close of 1947, however, Norway began to entertain serious misgivings, and the Communist coup in Czechoslovakia in the following February convinced it of the impracticability of this "bridge-building" policy. The three Scandinavian states thereupon discussed the alternatives of association with the North Atlantic Treaty organization (NATO) and a neutral defensive alliance between themselves (as preferred by Sweden); but early in 1949 agreement proved impossible. and Norway joined NATO, a course in which it was followed, with more reluctance, by Denmark.

The elections of Oct. 12, 1953, followed an important amendment of the electoral law, which abolished the preponderance of rural over urban representation laid down in the constitution of 1814. Another election took place on Oct. 7, 1957. The Labour party won 78 seats, gaining 1; the Conservatives obtained 29, gaining 2; the Agrarians 15, gaining 1; the Christian People's party 12, losing 2; the Liberals retained their 15 seats, but the Communists lost 2 and retained 1.

In 1955 Norway celebrated the conclusion of 50 years of national independence and the jubilee of its king, to whose firm though strictly constitutional leadership the whole nation recognized its indebtedness. On Sept. 21, 1957, King Haakon died at the age of 85. His 54-year-old son was immediately sworn in as the new monarch. King Olav V.

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(G. M. G.-H.)

POPULATION

The population of Norway at the census of 1950 was 3,278.546 as compared with 2,814,194 at that of 1930. Table I shows its distribution over the zo counties (*fylker*).

With an average population per square mile of only 26, Norway is the most thinly populated political unit in Europe. Towns are few and, apart from Oslo (whose boundaries were greatly

Table I.—*Census, 1930 and 1950*

County	Area in sq. mi.	Population 1930	Population 1950 Rural	Urban	Total
Southern:					
Östfold	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Akershus	1,895	236,939	180,177	2,834	183,011
Oslo (city)	175	253,124	...	434,047	434,047
Hedmark	10,635	157,942	159,403	13,664	173,067
Opland	9,778	137,710	147,707	12,714	160,421
Buskerud	5,718	143,073	116,538	39,662	156,200
Vestfold	903	134,107	108,548	46,034	154,582
Telemark	5,905	127,754	95,605	40,766	136,371
Aust-Agder	3,562	73,816	56,781	19,007	75,788
Vest-Agder	2,817	81,233	61,957	34,973	96,930
Western:					
Rogaland	3,525	[illegible]	[illegible]	80,689	211,408
Hordaland	6,022	164,376	198,047	...	198,047
Bergen (city)	14	98,303	...	112,845	112,845
Sogn og Fjordane	7,149	91,808	95,884	1,796	97,680
Möre og Romsdal	5,821	[illegible]	154,183	[illegible]	191,438
Sör Tröndelag	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nord Tröndelag	8,657	96,016	100,230	9,630	109,860
Northern:					
Nordland	14,797	186,920	190,626	31,075	221,701
Troms	[illegible]	[illegible]	[illegible]	15,178	117,498
Finnmark	18,782	53,308	54,481	9,994	64,475
Total	125,064	2,814,194	2,223,726	1,054,820	3,278,546

extended in 1948) and Bergen, none has a population of more than 100.000. According to the census of 1950 Trondheim had 56,669 inhabitants, Stavanger 50,647, Drammen 27,297 and Kristiansand 25,815. In 1948 the adjoining district of Aker was incorporated with Oslo, thus increasing the population of the capital to 434,047 (in census of 1950) and the area to 175 sq.mi. Most of the built-up areas are found along the coast: in the lowlands of the east (*Östlandet*), in the area around Trondheim (Trondelag) and in the larger valleys. The most sparsely populated area is the north, particularly the county of Finnmark, where most of the 20,000 Lapps are found. By mid-20th century less than one-tenth of the Norwegian Lapps (Snmer) were reindeer keepers; most had deserted their nomadic existence and settled as farmers and fishermen along the coast.

The population of Norway in 1801 was less than 1,000,000 but from 181j there was a fairly rapid increase, much of it, however, absorbed by emigration, chiefly to the United States. Between 1836 and 1936 the total number of emigrants was 860,694. After 1931 emigration declined considerably, in view of immigration restrictions in the United States and increased economic opportunities at home.

The number of live births rose steadily from 41,321 (the smallest figure recorded in the 20th century) in 1935 to 70,727 in 1946. In 1956 it was 64,600. The excess of births over deaths was 35,121 in 1956. The live-birth rate in 1956 was 18.7 per 1,000 inhabitants, the death rate 8.5. The marriage rate, at 9.5 per 1,000 inhabitants reached its peak in 1946. In 1956 there were 1,724,000 men and 1,738,000 women—an excess of women over men of 14,000 as compared with 70,356 in 1930. The percentage of illegitimate live births fell from 7.1 in 1930 to 3.45 in 1956.

The age distribution of the population after World War II was strongly influenced by the great variation in the birth rate, the fall from 1920 to 1935 and then the subsequent rise. While the population as a whole has increased steadily, it is the proportion of old people that increased most.

Table II shows the number of persons with dependents engaged in various occupations, according to two censuses.

POLITICAL AND ECONOMIC CONDITIONS

Government and Law.—Norway is a constitutional and hereditary monarchy. The constitution or fundamental law

Table II.—*Employment*

Occupation	1930		1950	
Agriculture and forestry	838,848	(29.81%)	712,707	(21.74%)
Fishing and hunting	196,772	(6.99%)	181,557	(5.54%)
Industry and handicraft	783,547	(27.84%)	1,122,944	(34.25%)
Commerce	294,961	(10.48%)	290,889	(8.87%)
Communications	252,963	(8.99%)	302,379	(9.22%)
Administration, teaching, defense, etc.	156,177	(5.55%)	323,253	(9.86%)
Other occupations and none, or unstated	290,926	(10.34%)	344,817	(10.52%)

(grunnlov) was adopted by the constituent assembly at Eidsvoll on May 17, 1814, and altered in detail at various times since. Executive power is vested in the king, exercised through a council of state consisting of the prime minister *(statsminister)* and at least seven other councilors *(statsrciderj.* The councilors are the heads of the ministries *(departententer)* of foreign affairs, industry, agriculture, social affairs, communications, justice. trade, fisheries, defense, finance, church and education. and municipal affairs and public works. The councilors sit in the parliament *(storting)* but do not vote. The king has no power to dissolve parliament, the life of parliament being fixed at four years. The 150 members of parliament *(stortingsmenn)* are elected directly by the people in electoral districts so arranged as to correspond to Norway's 20 counties.

The franchise is enjoyed by all Norwegian citizens, men and women, over 21 years of age who have resided five years in the country. Candidates must have resided ten years in the country and must be over 21 years of age. Since 1953 candidates need not be resident in the constituency in which they stand for election. Substitutes as well as members are elected. Parliament is elected in October every fourth year, meets in Oslo on the first weekday after Jan. 10 each year and remains assembled as long as may be found necessary. After the opening, parliament divides itself into two sections! the *lagting* consisting of 38 members and the *odelsting* of the remainder. 4 bill is first introduced in the *odelsting* and, if passed, is sent to the *lagting.* If the two sections do not agree, a joint session is held and a decision made by a two-thirds majority of the combined votes. A bill can become law without royal assent if passed by two ordinary sessions of parliament after two separate and successive elections, these sessions having to be separated by at least two other ordinary sessions of parliament, provided no divergent legislation has been passed between the first and last passage of the bill. Budget proposals and other financial and political questions not taking the form of bills are dealt with by parliament as a single body. There are a number oi standing committees where most questions are discussed before reaching the full assembly.

The country is divided into 20 counties *(fylker; see* Table *I)*, including the cities of Oslo and Bergen. There are 64 urban and 680 rural districts run by councils *(kommuner)* elected every fourth year. The electoral system for local councils is the same as the parliamentary system. Each council elects a presidency of one-quarter of its members. The chairmen of rural district councils in each county constitute the county council *(jylkesting)* presided over by the county governor *(fylkesmannj.* The scope of municipal affairs in Norway is very wide. Revenue derives from local income tax, municipal trading profits and state grants.

Justice. — *An* outstanding characteristic of Norwegian legal procedure is that civil cases are usually brought first before the town or county mediation council *(forliksråd)* from which an appeal lies to the town and county courts *(by-og herredsrettene)* which are also tribunals of first instance. The town and county courts have a professional judge, sometimes assisted by two lay judges. There are five courts of appeal *(lagmannsretter)* in Oslo. Bergen, Trondheim, Skien and Tromso, composed of three professional judges; and a supreme court *(hoyesterett)* in Oslo, whose decision is final. Criminal cases are tried either in the *lagmannsrett* with three judges and ten jurors or in summary courts *(forhörsrett)* with one professional judge or in town and county courts with a professional judge usually assisted by two lay judges. The *lagmannsrett* is for more serious offenses; the others for minor offenses. Punishment takes the form of imprisonment and fines, capital punishment being abolished for all except certain military and treasonable crimes. There is a state police force subordinate to the ministry of justice.

Defense. — The king is supreme commander of the armed forces. Under the ministry of defense is a defense staff with combined control of all land, sea and air forces. There is a system of local command areas for the three services. A considerable reconstruction of the armed forces was started in 1945 and accelerated after 1949, when Norway joined NATO. Compulsory military service in peacetime was fixed at 12 months; it was increased to 16 months in 1954 for army recruits and 18 months for the navy and air force. In 1955 the standing army strength mas estimated at 22.000 men; but about 200,000 men could be mobilized at short notice in all branches. including the national guard. The army could mobilize field units corresponding to about two divisions. with many of the men trained in Germany (where Norway after World War II maintained an occupation brigade of about 4,000). The national guard was formed in 1946 and soon had a membership of about 100,000, mostly volunteers. The air force had about 200 jet fighters and other aircraft The navy in 1955 had as its main strength 5 destroyers, 12 frigates, 8 submarines and a number of corvettes, minesweepers and motor torpedo boats. Coastal artillery, with powerful batteries left by the Germans. was concentrated in particular areas, and antiaircraft artillery was strengthened. The defense budget, which was kr. 66,906,000 in 1938–39, went up to kr. 948,000,000 in 1956–57.

Religion, Education and Social Services. — The endowed state religion, to which the king must conform, is Evangelical Lutheran. There were 123,314 dissenters at the census of 1950, as compared with 91,459 at that of 1930 The king, with the advice of the ministry of church and education, appoints the clergy of the established church. Norway is divided into eight bishoprics *(bzspedommer)*, with sees at Oslo, Trondheim, Stavanger, Hamar, Kristiansand, Bergen, Tromso and Tonsberg; and these into 91 archdeaconries *(prostier)* with subdivisions into 539 clerical districts *(prestegjeld)* and 1,032 parishes *(sogn)*. There are 17 organizations for missionary work abroad.

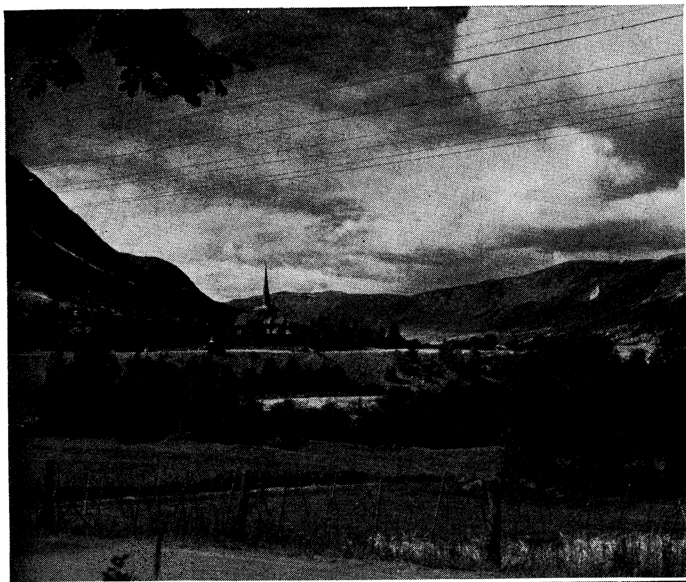
Elementary education has been free and compulsory for all Norwegian children between 7 and 14 years of age since 1860. Above the elementary schools are the secondary modern and grammar schools with three-year and five-year courses. There are also one-year continuation schools. Norway's two universities are at Oslo and Bergen, and there is a university college of technology at Trondheim. Educational institutions of high standing are the agricultural, dental. veterinary, commercial and teachers' colleges. Education is financed jointly by the state and the municipalities, and all instruction is free.

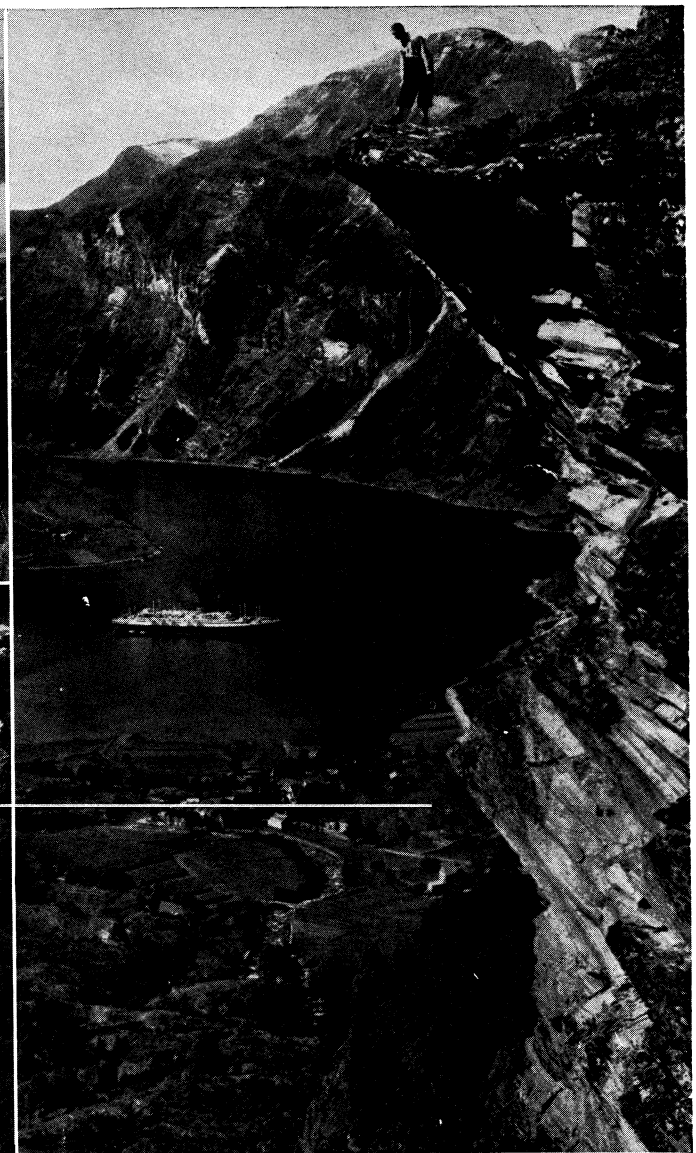
There are national insurance schemes to meet most contingencies Compulsory health insurance was enacted in 1909, and 75% of the population receive medical and pecuniary benefits. Old-age pensions were introduced in 1936 for all citizens 70 or more years of age. There are accident-insurance schemes for industrial workers, seamen and fishermen. Compulsory unemployment insurance was introduced in 1938; family allowances in 1946; and holidays of three weeks with pay for all workers in 1947.

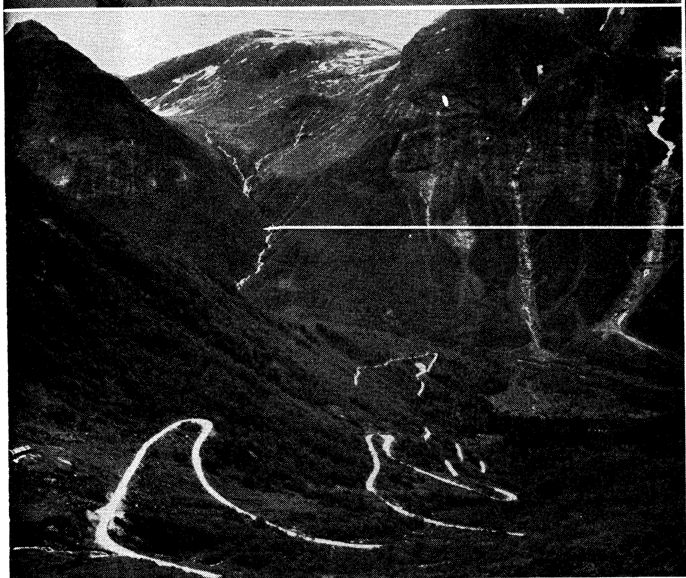
Economics. — For more than 30 years the economic life of Norway had developed on an increasingly industrial scale mhen the dissolution of the union between Norway and Sweden, in 1905, gave it a fresh impetus. Soon an extraordinary expansion set in, aided by the supply of cheap and plentiful hydroelectric power. This industrial expansion was further accelerated after 1945.

Agriculture and Forestry.—Agriculture remained one of the principal resources of the country, supporting 22% of the population in 1950, as against 30% in 1930. According to the agricultural census of 1949, 2.63% of the land area was cultivated. and there were altogether 345,125 farms and holdings, most of them very small and nearly all owned freehold by the farmers. Natural conditions are favourable to fodder growing and livestock keeping, and Norway is self-sufficient for nearly all livestock products. Only half the domestic consumption of cereals is produced in Normay: of 545,000 tons of grain harvested'in 1956, half were of barley and most of the rest oats. More than 1,000,000 tons of potatoes and over 3,900,000 tons of hay and straw mere produced.

Farmers derive an important part of their income from forest holdings. Forests covered about a quarter of the land area. About 80% of the forest area was privately owned, while the state and local authorities owned the rest. There were about 120,000 forest holdings. For centuries sawn and planed timber had been Norway's main forest export, but most of the timber was now exported as pulp and paper. Each year after 1945 about 250,000,000 cu.ft. of timber were cut for sale and about 1,000,000 tons of pulp and 500,000 tons of paper were produced.







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VIEWS OF NORWAY

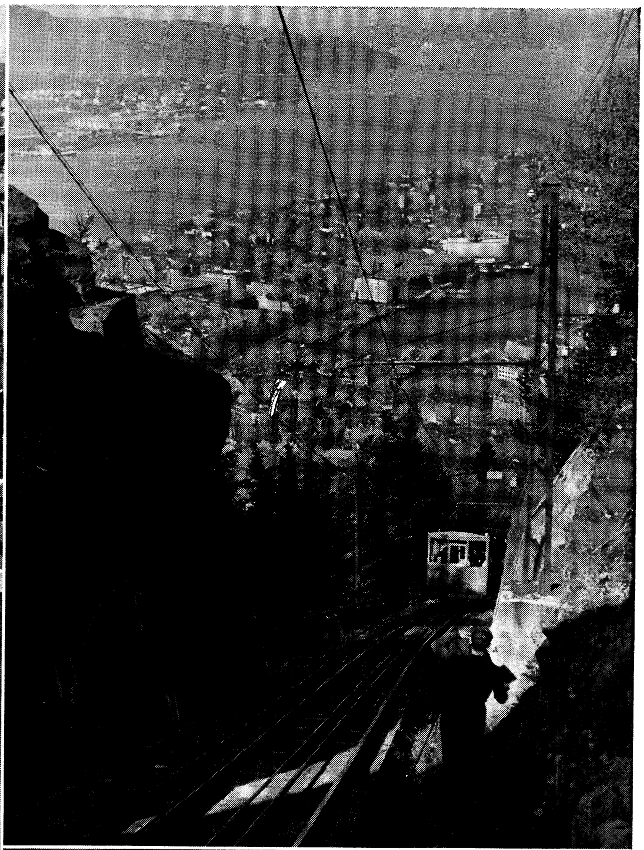
Top left: Lorn, central Norway. In the background is an 11th-century stave church

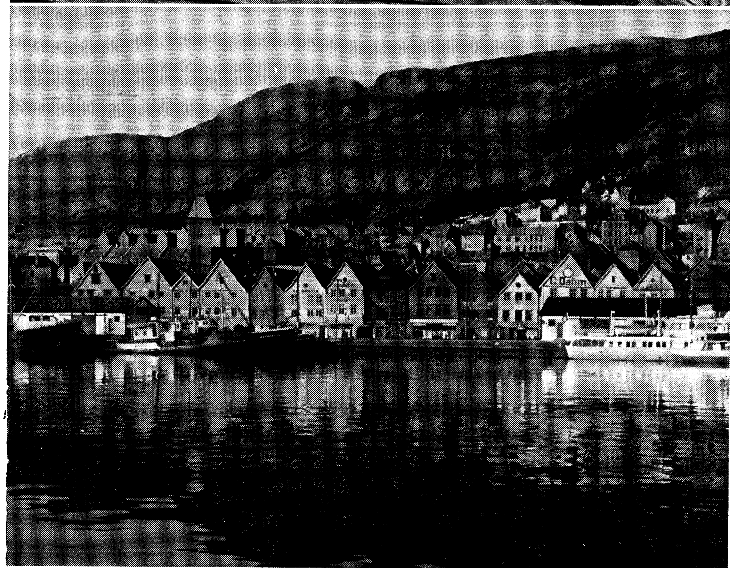
Top right: Gorge near Geiranger, west Norway

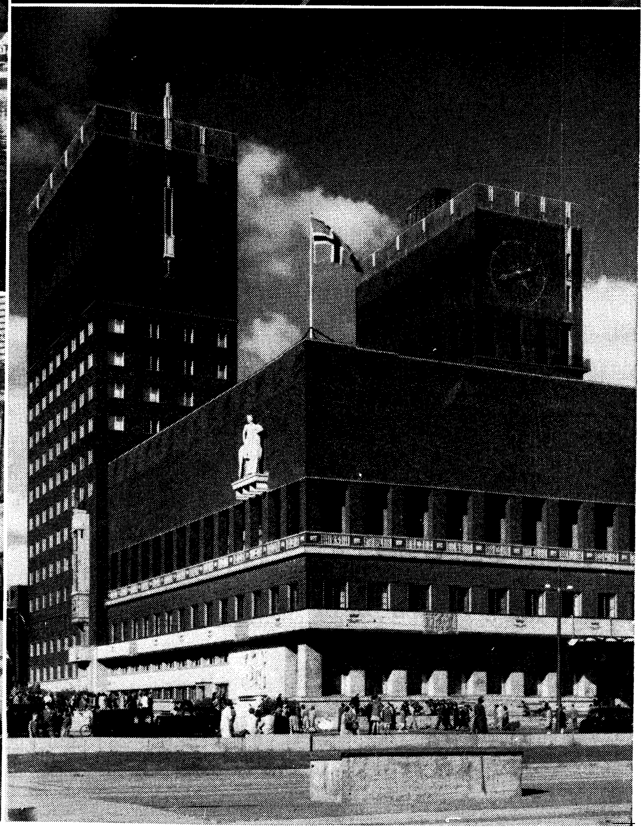
Centre left: Highway twisting through the mountains near Stryn lake, west Norway

Bottom: Cod fishing fleet, Lofoten Islands, off the northwest coast

NORWAY







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OSLO AND BERGEN, NORWAY

Top left: View of Oslo from the parliament building. Tne royal palace is in the left background
Top right: The funicular railway above Bergen
Centre left: The water front, Bergen
Bottom left: Open-air market, Bergen
Bottom right: Town hall, Oslo. Planned for 35 years, the building was opened in 1950 on the 900th anniversary of the founding of Oslo

Fisheries.— According to an official estimate for 1952 there were 94,630 fishermen, of whom 65,956 had fishing as their sole or main occupation. There were 85,851 fishing vessels, of which 11,920 were decked motor vessels, mostly owned by the fishermen themselves. Fishing is carried on for the most part close to the shore. Catches exceed 1,500,000 tons a year and consist mainly of herring and cod. Much of the herring catch is processed into oil and meal. Pelagic whaling was pioneered by the Norwegians in the antarctic early in the 20th century. In the 1956–57 season Norway sent nine expeditions to the antarctic, and production of whale and sperm oil was about 140,000 tons.

Industrial Production.— The expansion of industry in the 20th century was particularly notable in the electrochemical and electrometallurgical spheres. The manufacture of pure nitrogen was 201.814 tons (equivalent to more than 1,250,000 tons of fertilizer products) in 1956, and more than 350,000 tons of ferroalloys and aluminum were produced, nearly all for export. The construction of electrical and other machinery and of ships also made marked headway. The mining industry, extracting mostly iron ore and pyrites. is concentrated mostly in the northern part of the country. Copper and zinc are important by-products, and the output of sulfur in 1956 was 97,000 tons. More iron ore was processed in Norway. with a steel output of 287,000 tons in 1956, as compared with 58,000 tons in 1946.

After 1945 a determined effort was made to' rebuild and strengthen Norway's economy. A high rate of investment, particularly in hydroelectric development, industry and shipping. was instituted. Of Norway's estimated 20,000,000 kw. of exploitable water power, about 5,000,000 kw. had been harnessed by 1957, as against 2,328,000 kw. in 1945. The output of electricity per capita was the highest of any country in the world. As the result of this expansion, the industrial production index for 1956 was 158 as against 100 for 1949 and 78 for 1939. In farming, fishing and forestry, production also improved through mechanization despite the loss of labour to industry. Employment was maintained at a high level, and by 1957 employed persons exceeded 1,000,000.

Foreign Trade.— Norway'sforeign trade, which had always been large in relation to population. increased still more after 1945, and in 1956 the value of imports amounted to kr. 8,644,000,000 and that of exports to kr. 5,516,000,000. The trade deficit was largely financed by freight earnings of the merchant fleet. Principal imports in 1956, in order of value were: ores and metals kr. 1,592,000,000; ships kr. 1,591,000,000; machinery, apparatus and vehicles kr. 1,295,000,000; fuels kr. 996,000,000; and textiles kr. 651,000,000. Exports in the same year included: ores and metals kr. 1,471,000,000; pulp and paper kr. 1,092,000,000; fish and fish products kr. 761,000,000. Marine oil (raw, refined and hardenedj. fertilizers and other chemicals were also important. Relatively few sorts of commodity are exported from Norway: the products of the pulp and paper industry, the electrochemical and electrometallurgical industries and the fisheries together account for more than 70% of them.

On July 1, 1957, the Norwegian merchant fleet amounted to 8,600,000 gross tons (ships over 100 gross tons), about half the tonnage consisting of tankers. This fleet, the third largest in the world, lost hali its tonnage during World War II but was rapidly rebuilt after 1945, with replacements mostly from British and Swedish yards. The majority of the vessels are engaged in overseas traffic between foreign ports. Net foreign earnings by the fleet in 1956 were estimated at more than kr. 2,900,000,000.

State Control *and Ownership*.—After 1945 (when the Labour party secured a parliamentary majority which it retained at the 1949, 1953 and 1957 elections), the economy of Norway was fairly strictly controlled and directed along the lines set out in the annual national budgets. Those budgets set out economic policy in such spheres as investment. consumption, imports, exports, manpower and materials. A system of licences. quotas. price controls and subsidies was used to ensure the desired development of the national economy. The government also influenced economic development by direct or indirect ownership or part-ownership of mines, factories and other concerns in such fields as aluminum: hydroelectricity, chemicals and transport. State monopolies over grain and alcohol had been set up before World War II.

Communications.—Norway, with its long, narrow stretch of land, its fjords. mountains and islands and its sparse population, presents transport problems of especial difficulty. Coastal shipping and ferry connections play an important role. The road system totaled 31.602 mi. in 1956. There were then 230,713 motor vehicles. including 136,110 private cars, 89.803 trucks and 4.800 buses. The first railway, from Oslo to Eidsvoll, was opened in 1854. By 1956 the rail system covered 2.800 mi., of which more than 25% was electrified. Most civil air traffic in Norway was based on Fornebu airport near Oslo. Sola airport near Stavanger, and Flesland airport near Bergen (opened in 1955).

Currency and Finance.— The unit of currency is the krone (100 ore: kr. 1). The value of the krone is fixed at 20 to the pound sterling and (since devaluation in 1949) 7.14 to the U.S. dollar. The gold holdings of Norges bank (Bank of Norway) on Dec. 31, 1957, were $44,900,000, and its foreign exchange holdings totaled $137,900,000. Norges bank, founded in 1816 and state-owned since 1949, is the sole note-issuing institution. Note circulation was kr. j75,000,000 in 1939, but increased greatly during World War II and stood in Jan. 1945 at kr. 3,015,000,000. Germany made drawings on Norges bank amounting to kr. 11,300,000,000 during the war; the "occupation account" was reduced after the war and stood at kr. 5,546,000,000 in Jan. 1957 Reconstruction and economic expansion after the war made heavy demands on liquid funds, and though anti-inflationary measures halved the note circulation for a while. circulation totaled kr. 3,154,000,000 in Nov. 1957. Norges bank's discount rate was reduced after the war from 3% to 2 5%. In 1955, in an attempt to restrict credit and reduce investments, the bank rate was put up to 3.5%.

TABLE 111.—Budgets
(In millions of kroner)

	1938–39	1951–52	1952–53	1956–57
Current receipts . . .	539.7	3,606.8	4,233.1	5,444.9
Current expenditures . .	482.9	2,764.1	3,564.5	4,055.4
Current surplus . . .	106.8	842.7	668.6	789.5
Capital expenditures . .	140.6	747.7	707.2	885.5
Capital receipts . . .	7.3	184.0	152.0	96.0
Capital deficit . . .		563.7	555.2	789.5
Overall balance . . .	–26.j	+279.0	+113.4	0

In the financial year 19j5–56, taxes on income and capital raised kr. 1,334,100,000 of the government revenue. Most of the balance came from indirect taxes. including purchase tax. At June 30, 1956, the national debt amounted to kr. 7,230,400,000 of which kr. 1,723,100,000 represented foreign loans.

BIBLIOGRAPHY.—The Central Statistical Office in Oslo issues much useful material, including Statistisk *Årbok* for *Norge* with subject headings in English as well as Norwegian. The most useful reierence book in English is The *Norway* Year Book (Oslo) with chapters on aspects of Norwegian life. Economic information is found in the bulletins in English issued several times a year by the Bank of Norway and the Norwegian joint stock banks. The compendious annual national budget is available in English summary from the Ministry of Trade, Oslo. The Norwegian Export Council (Oslo) publishes a quarterly magazine in English on Norwegian industries. The Norwegian Joint Committee on International Social Policy issued a number of booklets including Social Insurance in Norway (Oslo, 1949) and *Housing* in *Norway* (Oslo, 1951). Useful are the annual reports from Norway to the UN Food and Agriculture Organization. Other publications are: Royal Agricultural Society, Norwegian *Agriculture* (Oslo, 1951); Norges Industriforbund, *Industry in Norway* (Oslo, 1951); Walter Galenson. Labour in *Norway* (1948); Norwegian Federation of Labour, The Trade Union Movement in *Norway* (Oslo, 1951); O. B. Grimley, Cooperatives in Norway (Oslo, 1950); W. Warbey et *al.*, Modern *Norway* (London, 1950). (O. F. K.)

NORWEGIAN LANGUAGE is one of the Scandinavian languages (*q.v.*). Written Norwegian exists in two distinct and rival norms, known since 1917 respectively as *bokmål* "book language" and *nynorsk* "New Norwegian," but also referred to by their older names of *riksmål* "national language" and *landsmål* "country-wide language." The former which may be called *Dano-Norwegian* since it stems from the written Danish introduced during the union of Denmark and Norway (1380–1814), has been modified in the direction of Norwegian speech by three spelling reforms (1907, 1917, 1938); the latter which may be called New Norse since it was intended by its creator Ivar Aasen (1813–96) to carry on the tradition of Old Norse, was interrupted in the 15th century. Dano-Norwegian and New Norse are legally equal and are taught in all schools in forms regulated by the ministry of church and education under mandate from parliament. A permanent advisory language commission (*Språknemnda*) was appointed in 1952, with an equal number of representatives for each language nominated by various interested institutions. Governmental planning and natural diffusion have gradually reduced the differences between the two norms; and their eventual amalgamation in *samnorsk* "common norwegian" was envisaged—a plan which was met with vigorous opposition.

Spoken Norwegian is divided into urban and rural dialects; the former has spread at the expense of the latter. Urban speech falls into standard and substandard social dialects. Standard urban speech is reasonably uniform throughout the country and serves as a model although some educated people prefer to speak a normalized New Norse or retain their rural dialects. The standard urban dialect is a compromise between traditional Norwegian speech habits and written Dano-Norwegian, as developed by the old official and professional class. Substandard urban dialects are closer to the surrounding rural dialects of each city, being historically the speech of rural-urban migrants. The rural dialects differ from parish to parish, but fall into broad regional types which reflect the paths of communication in medieval and early modern times: western (the fjord country from Romsdal to Setesdal), eastern (from Telemark to the Swedish border and north to the Dovre mountains), Tronder (in the trading area of Trondheim), and northern (the three northernmost counties). New Norse has its strongholds in the western dialects, on which Aasen drew most heavily for his grammatical and lexical framework.

In general, Norwegian is a language with a complex. musical phonology. a greatly simplified grammar and an internationalized vocabulary. While the vocabulary is basically native. it contains a great number of originally Low German words for features of urban culture; in addition it has adopted the usual international words for modern technology and borrows new terms freely. most recently from English. New Norse is somewhat more puristic than Dano-Norwegian and attempts to eliminate especially the German and Danish elements from its vocabulary.

Great variety and flexibility are tolerated and even encouraged in the written language in Norway. Writers often resort to local urban or rural dialects. The most widespread and firmly entrenched is Dano-Norwegian, in which are written all daily newspapers, most translations from foreign languages, and from 80% to 90% of original writing. In the schools about 75% of the children learn it as their primary medium of writing.

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NORWEGIAN LITERATURE. From a linguistic and artistic aspect the literature of ancient Norway is inextricably bound up with Icelandic; Old Norse literature, therefore, is dealt with under Iceland (see ICELANDIC LANGUAGE; ICELANDIC LITERATURE); yet it should not be forgotten that the psychological features revealed through the so-called Eldel- *Edda*, as well as through the sagas, are so typically Norwegian in all essentials that this literature forms the very basis on which the literary fabric of Norway has been raised in the course of centuries. The literature of the Old Norse language came to an end in the beginning of the 14th century simultaneously with the decline and fall of Norway as a sovereign state with a culture of its own. The chief characteristic of this literature. formed as it was in "an age of axes, an age of swords," is the remarkable fighting spirit by which it is pervaded and which quite naturally makes it abound in dramatic scenes and striking personalities; at the same time. in poetry as well as in prose, it is imbued by a serene view of life, which reveals a remarkably high moral standard. Another very distinct feature is its decidedly aristocratic leaning, with a pronounced hero-worshipping tendency. as might be expected in an age when the king generally appeared surrounded by his faithful chieftains and frequently with a young poet before him, singing his praises in glowing terms.

The Literary Revival.—Meanwhile the political union between Denmark and Norway (concluded in 1380) gradually brought Danish nobles and officials to the front in the latter country. with the result that the Old Norse language was replaced by Danish. This development, which constitutes perhaps the most remarkable event in the cultural history of the nation, may be considered as completed by the middle of the 16th century. Accordingly, when about the same time the literary revival set in, which to some extent was a result of the introduction into Norway of the Lutheran Reformation, the new literature came to be composed in the Danish language, which for nearly three centuries was to hold an unchallenged position as the official language of Norway.

The first outcome of the revival of literary interest in Norway was the appearance of the first book ever printed in Norway, an almanac, printed in Christiania in 1643. During the following years Christen Bang (1580–1678) published a number of religious tracts and also a Description *of Christiania* (1651), which at that time had only recently completed the a jth anniversary of its foundation. These curiosities, however, have nothing to do with literature in the true sense of the word, and the first name of importance in Norwegian literature after the spiritual revival in the Reformation century was Peder Claussön (1545–1614), a clergyman by profession and at the same time a highly gifted author who by his translation of Snorri Sturluson (*q.v.*) as well as by his independent works on Norway made a lasting reputation. The next striking personality in Norwegian literature is Petter Dass (1647–1708), whose *Nordlands* Trompet (Clarion) with its lyric-topographical description of the scenery and life of north Norway is still considered one of the gems of Norwegian literature. On the other hand, Dorthe Engelbrechtsdatter (1635–1716), who among her contemporaries enjoyed a great reputation as an author of religious poetry, is now practically forgotten.

Holberg.—Contrasted with these authors, all of whom spent their lives in Norway. Ludvig Holberg (1684–1754) (*q.v.*) early found his way not only out of Norway but out of Denmark. Leaving Norway for ever at the age of 21, after having taken his degrees at the University of Copenhagen, he went to England. where he studied for more than 18 months at Oxford, from which he carried with him an indelible impression of England and the English. Later travels brought him to France, Germany and Italy, but wherever he went he lived in the English world of thought and reasoned on the basis of his Oxford experiences. In this way, thanks to his inborn genius and his unbiased mind, he prepared himself for the life work by which he became the founder of modern Norwegian and modern Danish literature. He revolutionized the conception of life in two kingdoms and paved the way for the intellectual and political liberty of the future. His most famous works next to his comedies are Peder Paars (1719), a heroic poem, the humour and satire of which has stood the test of two centuries; *Niels Klim's* Underground Travel (1741), originally written in Latin, a classic evidence of his mental independence; and finally, from the closing years of his life, his Epistles and *Moral Reflections,* which are the best source of information for Holberg students. Holberg restored the cultural connection between Norway. England and western Europe in general, which had been broken off since the end of the saga period.

English native poets. such as James Thomson and Edward Young, had their counterpart in Norway in Christian Tullin (1728–65), a manufacturer and merchant of importance in the business community of Christiania and a central figure in the extremely sociable life of the city. By his famous poem "The May-Day" (1758), composed on the occasion of a wedding among the "upper ten" of Christiania. Tullin became the first interpreter in Norwegian literature of the long pent-up love of nature which three-quarters of a century later found such splendid expression in the poetry of H. A. Wergeland.

Det Norske **Selskab.**—Meanwhile, the importance of Holberg's work, along with a number of other factors, among them a constantly growing awareness of being an individual nation with historical traditions and cultural and economic possibilities, gradually began to prevail. The centre of this movement was Copenhagen, where the Norwegian students, partly graduates staying there in search of employment, felt themselves aliens in the midst of a display of public sympathy which made the name of Norway and the Norwegians resound in a way bearing promise for the future. In 1772, to mention a particular year of lasting importance in Norwegian literature, the Norwegian poets and other men of letters were so strong in Copenhagen that they formed a society which was to become famous under the name of Det Norske Selskab (the Norwegian society). The two most conspicuous members of this society with whom its name has forever been associated mere Johan Herman Wessel (1742–85) and Johan Nordahl Brun (1745–1816); besides them should be mentioned Claus Fasting (1746–91), Claus Frimann (1746–1829) and his brother Peter Harboe Frimann (1752–1839), as also their younger contemporaries Jonas Rein (1760–1821) and Jens Zetlitz (1761–1821). No student of Norwegian literature who wants to understand the undercurrents in the Norwegian nation in the 40 years before the dissolution (1814) should pass by these poets, among whom Claus Frimann still lives in a few songs of popular reputation. The sovereign talent among them, however, is Wessel (*see* DRAMA: *Norwegian Drama*), the spiritual inheritor of Holberg, a champion in the fight against pedantry and prejudices, a *gamin* spirit full of irony and good humour in the midst of adversities.

Norwegian literature has no finer display of comic fiction than his three immortal poems "The Smith and the Baker," "The Dog-murder" and "The Fork," while a number of his pithy and pointed epigrams long ago became classic. Nordahl Brun's fame with posterity rests less on the poetic value of his works than on the tradition of his striking personality, which in his lifetime made him the very embodiment of the national aspirations of Norway.

The Renaissance of 1814.—In literature this renaissance, in its first stage, was represented by three poets, Henrik Anker Bjerregaard (1792–1842), Mauritz Christopher Hansen (1794–1842) and Conrad Nicolai Schwach (1793–1860). Bjerregaard was famous for his "Sonner av Norge" ("Sons of Norway"), written in 1820, which for half a century was the national anthem of Norway. His merry musical piece "A Highland Adventure" (1824) is inspired by a genuine love of nature and a sound common sense.

Wergeland and **Welhaven.**—The commanding genius of this generation is Henrik Arnold U'ergeland (1808–45), (*q.v.*), who, as has justly been said, contrived within the limits of a life as short as Byron's to concentrate the labours of a dozen ordinary men of letters. As a poet he was inspired alike by an intense love of nature. Besides larger poems, among which may especially be mentioned *The English Pilot* (1844), he wrote in addition a quantity of lyrics with dramas, essays, historical works and journalistic articles—all stamped by his vivid imagination, many of them also by his sound common sense and his high moral standard.

His contemporary Johan Sebastian Cammermeyer Welhaven (1807–73) is primarily known for his highly critical nature, with its keen sense of beauty and harmony. His early poems are associated with his literary clash with Wergeland, but notwithstanding the interest attached to them for their polemic character. the memory of Welhaven as a poet chiefly rests upon his beautiful romances. This Romantic movement was evident about 1840, and it is the same spirit which led to the discovery of the folklore, with its wonderful prose and poetry, in which the soul of the nation and the nature of the country faithfully reflected themselves.

The ideal was that every piece of folklore should be rendered in the form given to it by the people in the course of time, and here the Norwegian nation was particularly fortunate. At the right moment the two friends Peter Christen Asbjørnsen (1812–8j) and Jørgen Moe (1813–82), whose names are forever associated with the Norwegian folk tales which bid fair to challenge the most famous folk tales in any European country, made their appearance in literature. Asbjomsen was a first-rate storyteller with a broad, jovial nature; Moe was a true poet with humour and a rare gift of self-criticism. There was also the Rev. Magnus Brostrup Landstad (1802–80), who in 1853 published his famous collection, *Norwegian Folk-Songs,* the poetical part of the Norwegian folklore of which the folk tales constitute the prose. The former are older than the latter and accordingly differ from them in several ways; but jointly they constitute what up to the middle of the 19th century was the missing link between the *Eddas* and the sagas on one side and the literature of modem Norway on the other.

The **Landsmål** Movement.—Along with this literary revival there also set in a linguistic and historical renaissance of paramount importance to literature as a whole. In 1848 Ivar Aasen (1813–96) published a grammar and in 1850 a dictionary of the Norwegian folk language, whereby the intimate connection between the peasant dialects of the day and the Old Norse language was revealed in the most convincing way. A few years after Aasen's appearance in literature the famous historian Peter Andreas Munch (1810–63) published his mighty work. *History of the Norwegian Nation* (8 vol., 1852–63), an event of paramount importance in the field of literature.

This Romantic movement leading to the foundation of the national stage in Norway, with Bjornstjerne Bjomson and Henrik Ibsen as the two pioneers (*see* DRAMA: *Norwegian Drama),* it is easy to see why both of them turned to the saga period for suitable subjects and characters. At the same time, however, realism had already set in. During the 1850s the Rev. Eilert Sundt (1817–75) started his epoch-making investigations of life and manners in the rural districts, which made the Norwegian peasant appear in a light considerably different from that in which he appeared in the flattering illumination of the former "peasant worship." Accordingly, Bjomson's famous peasant novels, the first of which was *Synnove Solbakken* (1857), of a decidedly poetical turn, must be described as imbued by romanticism more than by realism so far as the outward surroundings are concerned.

The **Big** Four.—In 1855 Camilla Collett (1813–95), Henrik Wergeland's sister, published her famous novel *The Governor's Daughters,* the first true description in Norwegian literature of ordinary life, which dealt a heavy blow to the conventional marriage and education of young girls. In this way Madame Collett became a pioneer in the movement for the emancipation of women in Norway to whom both Bjornson .and Ibsen felt themselves indebted. Next to Madame Collett, the fame of the realistic novel is chiefly developed through Jonas Lie (1833–1908) and Alexander Kielland (1849–1906), who, together with Ibsen and Bjornson, constitute the famous constellation in the golden age of Norwegian literature popularly known as the "big four." Lie is the author of a number of pure, fresh and eminently characteristic novels dealing with various aspects of everyday life within different ranks of society. *The Pilot and His Wife* (1874). *Rutland* (1880) and *Go On!* (1882) should be mentioned in this connection, no less for the spirit of the white sails and foaming sea by which they are imbued than for their intimate humanity in substance and psychological analysis. The latter qualities also are displayed splendidly in *The Comntander's Daughters* (1886) and *Matrimonial Life* (1887), which, together with his beautiful novel *The Family at Gilje* (1883), a masterpiece of historical review and human psychology dealing with life and characters of the 1840s, rank among the crowning works of Lie's extensive authorship. Contrasted with Lie, whose highly impressionistic style not infrequently becomes colloquial to a fault, Kielland is a sovereign master of form and at the same time a keen psychologist with a decided vein of irony and a heart full of compassion for human suffering. His social novels *Garmann and Worse* (1880) and *Skipper Worse* (1882) long ago became classic, as did a number of his short stories, which by their delicacy of style represent the highest attainment of modem Norwegian prose.

Among other authors from the same epoch should be mentioned Kristian Elster (1841–81), who showed great talent in his pessimistic novels *Tora Trondal* (1879) and *Dangerous People* (1881), and Amalie Skram (1847–1905), wife of the Danish novelist

Erik Skram. whose novels. while deficient in literary beauty, are of a considerable crude force and excellent in their local colour, dealing chiefly with Bergen and west coast life. The outstanding feature of all the writings of the 1880s, which may be described broadly as an age of entirely prosaic writers, is the "problem setting," to which there is no parallel in Norwegian literature and to which Bjornson himself contributed in his great novel *Town and Harbour Beflagged* (1884), to mention one of the most typical "problem" novels of the age.

Vinje and **Garborg.**—The *landsmål* literature produced two remarkable authors, Aasmund Olafsen Vinje (1818–70) and Arne Garborg (1851–1924). Vinje was a fine lyric poet and a keen critic, who exercised a great influence on Ibsen in his first period as a dramatist and who, broadly speaking, was one of the most striking literary figures of the 1860s. Garborg, who was brought up under sternly pietistic influences in the southwest corner of Norway known as Jaeren, carried with him from these surroundings a gloomy view of life, but being at the same time a revolutionary spirit and an imaginative thinker with a considerable training, principally as a critic. he seemed predestined to make his appearance in literature. His novel *Peasant Students* (1883) is partly of a polemic nature. Like the rest of Garborg's novels (some of them so important that we might properly speak about the "big five") this was written in the *landsmål,* which at the time to a certain extent was a drawback to their circulation. In 1891, however, he suddenly turned to the *riksmdl* in his extraordinary novel *Tired Men,* an exquisite example of Norwegian prose.

Hamsun.—Meanwhile another author had already made his appearance in Knut Hamsun (1859–1952) (*q.v.*), n-hose powerful romance *Hunger* (1888) marked a new departure in Norwegian literature. He was. in fact, its central figure throughout the 1890s in the midst of a number of authors of an entirely different stamp from those of the 1880s. The most unmistakable genius. however, was Hans Kinck (1865–1926). As a typical feature of the 1890s it should be mentioned especially that the art of poetry, which had been practically banished from Norwegian for a number of years, again had its exponents, chiefly in Niels Collett Vogt (1864–1937) and Vilhelm Krag (1871–1933). The sensitive spirit of the age, however, is revealed nowhere more remarkably than in Sighjorn Ohstfelder (1866–1900), whose exquisite poetry, as it can be studied in his *Posthumous Works,* is rivalled only by his fascinating prose. In both he gives promise of something new in Norwegian literature; the promise was unfulfilled because of his early death. At the same time the *landsmål* poetry witnessed a revival, chiefly through Per Sivle (1857–1904), an excellent national poet whose poems dealt with the episodes and characters of the saga period.

The consummate work in the *landsmål* lyric during the 1890s, however, is Garborg's *Haugtussa* (189j), inspired by the strange and impressive scenery of the Jaeren. Thus, at the end of the 19th century, there was a revival both in the *riksmål* and in the *landsmål* literature.

The first decade of the 20th century will be forever memorable for the deaths of the four greatest writers of the preceding age: Ibsen. Bjornson, Lie and Kielland. Thereby the field of fiction was thrown open to a new generation of authors. who found themselves confronted with problems essentially different from those which had taxed the attention of the former generation. Norway was no longer the country of consuls, shipowners, vicars, rectors, chamberlains and estate owners, representing official views and opinions against which persons not "made of that self metal'! occasionally revolted and always with deplorable result to their own social interests; nor was Norway the country of women suffering in silence under slow torture of an apparently correct marriage, or a country of workers imbued by a patriarchal respect for their employers, based on personal connections from generation to generation. It was a community in which democracy had established itself on a broad basis.

Recent Literature.— No dramatic work of lasting influence has appeared since the age of Ibsen and Björnson, but an examination of the history of the Norwegian novel leaves a more satisfactory impression. Hamsun produced works, generally written in an exquisite style and filled with an exuberant vitality, of which *Pan* (1895) and *The Growth of the Soil* (1917; English translation 1920) rank particularly high.

Kinck. who is by all critics admitted to be an author of rare gifts, has not yet received general recognition either at home or abroad. Yet by his daring metaphors. his exuberant passions. his deep psychology, supported by extensive historical studies, he is one of the most intimate guides to the depths of the Norwegian mind. His Hardanger novel, *The Avalanche* (1919–20), is considered his greatest work. but generally speaking he is at his best in the short story. Another important writer is Trygve Andersen (1867–1920), a self-controlled author with a limited production.

Besides these three poet-artists and classics should be mentioned Johan Bojer (1872–1959), whose novels have become famous in the English-speaking world and elsewhere. A more intimate author is Peter Egge (1869–), a conscientious writer with an artistic style which adds to his original gifts as a narrator and psychologist. These qualities are happily displayed in *Hansine Solstad* (1926). one of the finest novels written during the period.

The most remarkable figure in later Norwegian literature. however, was Sigrid Gndset (1882–1949) (*q.v.*), who held a position of her own by her mighty cycles of historical novels. of which *Kristin Lavransdatter* (3 vol.) shows a remarkable psychological insight and a rare power of appreciating bygone ages.

One of the chief characteristics of Norwegian literature during the first half of the 20th century was the ever-increasing number of local authors who, substituting particular districts for the country as a whole, gave rise to local literature, partly written in the literary tongue of the country known as the *riksmdl,* partly in the *landsmål,* or in a *riksmdl* coloured to a marked degree by local dialects. Conspicuous among these authors were Oskar Braaten, Hans Aanrud (1863–1953), who scored success as a playwright of broad humour in the 1890s, and Johan Falkberget (1879–) —all typical east Norway novelists. Braaten's literary domain, not only as a playwright but as a novelist, was the industrial quarters of Oslo and its surrounding districts. Aanrud was a keen observer of life and manners in the midland countries round Lake Mjösen. Falkberget was intimately acquainted with the miners of the mountain districts of the valley of Österdalen.

Gabriel Scott. in an idyllic novel, *The Source* (1918), found an exquisite expression of the typical Sorland (literally Southerland) nature and Sorland temper as they reveal themselves all through the charming coastland. West Norway country life was ably sketched by Jens Tvedt (18j7–1935), who wrote in the *landsmål.* The particular district of the north Trondhjem country known as the Valley of Namdalen produced in Olav Duun (1876–1939), whose works all dealt with life and manners in his native valley. the most gifted author of modern times writing in the *landsnzdl.* Another significant author in the same language is Kristofer Uppdal (1878–), originally a navvy, whose works are imbued by the ideals of the labour movement.

In poetry Niels Collett Vogt proclaimed his emotions in stanzas of vigorous and beautiful metaphors. Olaf Bull (1883–1933) combined to a rare degree a refined versification with silent resignation and lofty enthusiasm. Herman Wildenvey (1885–) sings out his joys. his cares and his whims in easy verses and metaphors, striking for felicity of phrase. Simultaneously with this lyric flourishing in the *riksmål,* the *landsmål* literature produced the genial lyric poet Olav Aukrust (1883–1929), inspired by a deep sense of spiritual strife and by religious visions.

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NORWICH, GEORGE GORING, EARL OF (1583?–1663), English soldier. son of George Goring of Hurstpierpoint and Ovingdean. Sussex. He was knighted in 1608 and became a iavourite at court. benefiting largely from monopolies granted by Charles I. He became Baron Goring in 1628 and privy councillor in 1639. When the troubles between Charles and his parliament became acute Goring devoted his fortune freely to the royal cause; and the king in Kovember 1644 renewed for him the title of earl of Norwich which had become extinct at his uncle's death. He went with the queen to Holland in 1642 to raise money for the king, and in the autumn of the next year he was seeking arms and money from Mazarin in Paris. His proceedings were revealed to the parliament in January 1644 by an intercepted letter to Henrietta Maria. He was consequently impeached of high treason, and prudently remained abroad until 1647 when he received a pass from the parliament under a pretext of seeking reconciliation. Thus he was able to take a prominent part in the Second Civil War of 1648 *(see* CIVIL WAR. ENGLISH). He commanded the Kentish levies, which Fairfax dispersed at Maidstone and elsewhere, and was forced to surrender unconditionally at Colchester.

He was condemned to death on March 6, but petitions for mercy were presented to parliament, and Norwich's life was spared by the speaker's casting vote. He then joined the exiled court of Charles II, by whom he was employed in fruitless negotiations with the duke of Lorraine. He became captain of the king's guard at the Restoration, and in consideration of the fortune he had expended in the king's service a pension of £2,000 a year was granted him.

He died at Brentford on Jan. 6, 1663.

NORWICH, a city, county and parliamentary borough and the county town of Norfolk, Eng., 109 mi. N.E. of London by road. Pop (1961) 119,904. Caister St. Edmund. 3 mi. S. of Norwich. is on the site of what was a Romano-British town.

According to tradition Uffa made a fortification there about 570. but its history as a royal borough cannot be traced before the reign of Aethelstan (924–940), when it possessed a mint. After being destroyed by the Danes, Norwich enjoyed a period of prosperity under Danish influence and was one of the largest boroughs in the kingdom at the Conquest. Ralph de Guader, earl of East Anglia under William I, formed the nucleus of a French borough with different customs from the English, and after his forfeiture a castle was built and the centre of burghal life gradually transferred to the new community west of it. By 1158, when Henry II granted the burgesses a charter confirming their previous liberties, the two boroughs seem to have amalgamated. A fuller charter given by Richard in 1194 and confirmed by later sovereigns made Norwich a city with the full right of self-government. The citizens obtained a charter in 1404 making their city a county. The cathedral precinct became parcel of the city at the Dissolution and in 1 j j6 the neighbouring hamlets were incorporated in the county of Norwich. The charter of Charles II (1683) remained in force until 1835. The city is governed by 16 aldermen and 48 councillors. The chief magistrate was created lord mayor in 1910. After 1 298 Norwich was represented in parliament by two members; it is now divided into Norwich North and Norwich South. Two annual fairs, existing before 1332, were formally granted to the city in 1482. These have been succeeded by the Maundy Thursday horse and cattle fair, and the pleasure fairs of Easter and Christmas.

The market, which must have existed before the Conquest, was held daily in the 13th century, when citizens enclosed stalls by royal licence. Edward III made Norwich a staple town, and the importance of its trade in wool and worsted dates from his reign. The outer defenses of the castle were levelled and are now the great cattle market.

Norwich Cathedral.— The cathedral church of the Holy Trinity lies between the castle and the river. In 1094 the seat of the East Anglian bishopric was removed by Bishop Herbert de Losinga of Lorraine from Thetford to Norwich. where in 1096 he laid the foundation of the cathedral and dedicated it in 1101, establishing at the same time a Benedictine monastery. As completed before the middle of the 12th century the cathedral was purely Norman; and it still retains its original plan. The lofty Perpendicular spire (315 ft. from the ground), the west window (which has modern glass) and porch, the lierne stone vaulting of the nave, with its bosses telling the story from the Creation to the descent of the Holy Spirit, and the oak choir stalls and *misereres* belong to the 15th century; the vaulting of the transepts and Bishop Richard Nix's chantry are of the 16th century; the fine cloisters were begun in 129; and not completed until 1430. The Xorman nave is divided by 14 piers on each side, making 7 bays, and the triforium is composed of similar arches. The choir. often damaged and repaired from the 12th to the 16th century, is of unusual length, and ends in a Korman apse. Of the original three circular apsidal chapels the northern (Jesus') and the southern (St. Luke's) remain, but a war memorial chapel (1932) replaced the Lady chapel which fell down in the time of Elizabeth I. In 1942 the cathedral was damaged in an air raid, the north transept suffering most. Two richly sculptured gateways lead to the cathedral — the Erpingham gate (1420) and the Ethelbert gate (c. 1300). Life's green, in the precincts, contains the grave of Nurse Edith Cavell (*q.v.*).

The **City.**—Norwich lies in the valley of the Wensum, which joins the Yare immediately below. The ancient city lay in a deep bend of the Wensum, and the walls (1294–1342), with their many towers and 12 gatehouses, of which fragments only remain! were 4 mi. in circuit. These narrow limits, however, were outgrown even by 1671. Of the castle, only the early Norman square keep remains, with four tiers of arcading without, and an ornate doorway into the great tower. The building which had been used as a prison, was acquired by the corporation and opened in 1884 as a museum and art gallery, the latter being especially rich in examples of the Norwich school now housed in the Colman galleries (added in 1951). The museum contains particularly fine collections of natural history, especially Norfolk birds and other animals. prehistoric stone implements and Romano-British relics. The city established in 1608 a public library, the oldest provincial library with a continuous history.

Facing the castle across the big open market place, where the stalls have coloured canvas roofs, is the new city hall (1938) with the little flint and freestone guildhall (1407–13) on one side of it and the large parish church of St. Peter Mancroft (1455) on the other. In the guildhall the council chamber is a specimen of a court of justice of the 16th century with furniture of the period. There too are kept the sword of a Spanish admiral captured by Lord Nelson with his autographed letter presenting it to the city. Around the market place and from there toward Tombland and the cathedral is the chief shopping centre.

The majority of the Norwich churches are of Perpendicular flint work, mostly of the 15th century. Six churches and a synagogue were destroyed in 1942 during an air raid and among them was St. Julian's (now rebuilt) in the yard of which Mother Juliana, the 14th-century mystic, had her cell and wrote *The Revelations of Divine Love*. She mas a nun of the Benedictine priory at Carrow, of which there are few remains. The Stranger's hall, a 15th-century house on Charing Cross, is a museum of English domestic life. In 1925 Miss E. M. Colman, the first lady in England to be a lord mayor, and her sister restored and presented to the city the 14th-century Suckling house. the great hall of the family house of the poet. Sir John Suckling. The city Bridenell. late 14th-century, is a museum of local industries, opened in 1925. The Assembly house (1754) in Theatre street, the best example of Georgian architecture in Norwich. was restored to the city in 1950 and is used as an arts centre. The grammar school, near the Erpingham gate, has a Decorated chapel. with a crypt below, and numbers among its pupils Sir Edward Coke. Lord Nelson, Sir James Brooke, rajah of Sarawak, and George Borrow. St. Andrea's hall and Blackfriars hall are the seven-bayed nave and the chancel of the great Dominican church of St. John the Baptist, rebuilt with the aid of the Erpinghams between 1440 and 1470. They have served since the Reformation as public halls, St. Andrew's hall being the concert hall of the Norfolk and Norwich festival and of the Norwich Philharmonic society. By the river is a big new municipal college and school of art (1953).

The industries of Norwich include foundries, engineering. brewing, brickmaking, tanneries, printing and the production of mustard, starch, malt, vinegar, chocolates, mineral waters, chemicals, footwear, silk, clothing and boxes. There is also a big trade in cattle and corn. Linked to these industries are large old-established banking and insurance institutions.

NORWICH, a city of southeastern Connecticut. U.S., is located 13 mi. N. of New London, at the confluence of the Yantic and Shetucket rivers which there form the Thames; one of the seats of New London county. Norwich is accessible to the sea by way of a Thames river channel capable of handling ships up to about 10.003 tons. Shipbuilding and shipping were important in the 18th century, and from the American Revolution to the American Civil War firearms were made there. Subsequently. however, Norwich became an important centre for the manufacture of textiles, vacuum bottles, metal and leather products, machinery, paper boxes. clothing, plastics and chemicals.

The town n-as founded in 1659 by settlers from Saybrook under the leadership of Capt. John Mason and the Rev. James Fitch. The land was purchased from Uncas, a Mohegan chief and an early friend of the settlers, who is buried under a monument on Sachem street. The city. part of the town of Norwich which also included Norwichtown, Taftville and part of Yantic, was chartered in 1784. In 1951 the city and the town were consolidated and a council-manager form of government was inaugurated.

Norwich is the birthplace of Benedict Arnold and the home of the Huntington family, many members of which were leaders in early American civil and military affairs. Many houses dating from the 17th and 18th centuries still stand. These include the Leffingwell inn (1666) and the Glebe house (1748). For comparative population figures *see* table in CONNECTICUT: *Population.* (W. D. LO.)

NORWOOD, a residential area of London, Eng., partly in Surrey and partly in the county of London (metropolitan borough of Lambeth). The district is hilly and well wooded. It is divided into Upper, Lower, South and West Norwood.

NORWOOD, a city of Hamilton county in southwestern Ohio, U.S., is completely surrounded by the city of Cincinnati (*q.v.*). Norwood, originally Sharpsburg after John Sharp, one of its earliest settlers, began as a crossroads coach stop in 1809. Its position on the upland between the Great and Little Miami rivers, away from the early major routes of commercial travel, resulted in very slow growth compared to nearby valley cities. It was laid out in 1873, incorporated as a village under its present name in 1888 and chartered as a city in 1903. By 1900 it had become a minor railway centre and residential suburb, especially for merchants of Cincinnati. Soon after, it began attracting industries that wished to locate in Cincinnati but found the larger city too crowded. Leading industries include printing and lithographing and the manufacture of automobiles, automobile bodies; paints, machine tools, electric motors. playing cards, women's shoes, office equipment. laundry machinery and cans. Norwood is the seat of Athenaeum of Ohio, a Roman Catholic college for men, founded in 1829 as the Seminary of St. Francis Xavier. For comparative population figures on Norwood (part of the Cincinnati standard metropolitan statistical area) *see* table in OHIO: *Population.* (J. L. TH.)

NOSE, the organ of the sense of smell in man and other animals; it also acts as a filter and a warmer for inspired air.

See OLFACTORY SYSTEM; SMELL AND TASTE.

NOSE, DISEASES OF. Diseases of the nose lead to dysfunction, characterized chiefly by impaired nasal breathing The primary function of the nose is to serve as an air conditioner for all the inspired air before it reaches the lungs, but the nose also serves as an organ of smell! the olfactory sense.

Diseases of the nose are subdivided into acute and chronic rhinitis (rhinitis meaning an inflammatory reaction of the mucous membrane lining of the nose). In the acute form, such as a head cold (see COLD, COMMON), rhinitis is accompanied by a profuse watery discharge, coryza, which always impairs nasal breathing. Unless secondary infection occurs, these symptoms last for a period of usually seven days. Allergic rhinitis, which produces similar symptoms, may be caused by any allergen, such as ragweed or dust, and is commonly called hay fever (*q.v.*). The symptoms of this condition persist and do not subside until the offending allergen is discovered and removed. Chronic rhinitis, which usually is due to repeated attacks of acute rhinitis, produces in the early stages hypertrophy or enlargement of the mucous membrane, termed hypertrophic rhinitis. The hypertrophy leads to impairment of nasal breathing and usually is accompanied by a thick, tenacious discharge. If this condition persists for a long period of time it is followed by atrophy and the presence of dry offensive-smelling crusts: a condition called atrophic rhinitis.

Impairment of nasal breathing frequently is occasioned by irregularities or deformities of the central partition of the nose (nasal septum). occurring as a general rule as the end result of external injury to the nose.

The tip and nasal vestibule of the nose are prone to staphylococcus infection because of the presence of hair follicles inside the nose.

Continued irritation from infection or allergy can give rise to nasal polyps, usually on the middle turbinate. Gradual enlargement of these polyps leads to increasing difficulty in breathing through the nose. *See* also NOSEBLEED; SINUSITIS.

See W. W. Morrison, *Diseases of the Ear, Nose and Throat* (1948); R. L. Cecil and R. F. Loeb (eds.), *A Textbook of Medicine, 9th* ed. (1955). (G. W. MCA.)

NOSEBLEED (EPISTAXIS) is common and usually of little importance in childhood. It may result from local conditions or inflammation, small ulcers or polypoid growths. It can be due to injuries, of which fracture of the base of the skull is serious. Vascular disease, such as high blood pressure. may provoke it, and such diseases as scurvy and hemophilia also may be responsible for it. Usually it is easily controlled by rest, application of cold and pressure. On occasion it may require expert care. (F. L. A.)

NOSSI-BÉ, properly NòSY-BÉ (*i.e.,* "Great Island"), an island about 8 mi. off the northwest coast of Madagascar, in 13° 23' S., 48° 15′ E. It has an area of 129 sq.mi. Nossi-bé is volcanic; the north and south parts of older, the central part of more modern date. There are numerous volcanic craters and crater lakes. (Lòkobé, the highest point, is 1,075 ft. above the sea.) The climate is trying, but European colonization is, nevertheless. highly developed. Pop. (1956) 25.787. Hellville, the chief town (pop. 1956, 7,506) is a port of call for the Messageries Maritimes and a centre for the coasting trade along the western shores of Madagascar. There is excellent anchorage. The soil is very fertile. and there are forests of palms and bamboos. The chief products are coffee, sugar cane, cocoa; vanilla and tobacco. There are numerous sugar factories and rum distilleries. Shellfish. shells, mother of pearl, pearls and sponges are objects of trade.

In 1837 Tsioméko, chieftainess of one of the numerous divisions of the Sàkalàva, was expelled by the Hova and fled to Nossi-bé and to the neighbouring islet of Nossi-komba. She accepted French protection in 1840, ceding such rights as she possessed on the northwest coast of the mainland. The French took possession in 1841. Nossi-bé is under the administration of Madagascar (*q.v.*).

NOSTRADAMUS (1503–1566), a French astrologer of Jewish descent, who is still remembered ior his prophecies. His real name was Michel de Kotrednme or Sostredame, and he was born at St. Rémy in Provence on Dec. 14, 1503. At Avignon he studied philosophy, and then at Montpellier he read medicine, graduating in 1529. He first practised at Agen, and in 1544 established himself at Salon, near Aix, and was noted for fine work during outbreaks of the plague at Aix and Lyons.

Nostradamus began-to make his prophecies about 1547, publishing at Lyons in 1jjj a book of rhymed prophecies entitled *Centuries.* Astrology was at a peak at this time, and an enlarged second edition, dedicated to the king, was published in 1558. The Centuries consisted of quatrains grouped in hundreds, each set of quatrains being called a century.

Some of Nostradamus' prophecies seemed to have become fulfilled, and his fame became such that he was invited to visit Catherine de Médicis and himself received the duke of Savoy at Salon. Charles IX appointed him physician-in-ordinary. He died on July 2, 1566, but his predictions were eagerly read for long after. Much controversy has been aroused because of the indefinite nature of their meaning, and some have been believed to foretell the distant future. The famous 33rd quatrain of the 5th century, for example, has been interpreted as a prophecy of the *noyades* ("drownings") of Nantes under the Committee of Public Safety in 1793:

> "Des principaux de cite rebelle
> Qui tiendront fort pour liberte r'avoir,
> Detrancher masles, infelice meslee
> Cris, hurlemens a Nantes piteux voir."

That is: "The city's leaders in revolt, will in the name of liberty slaughter its inhabitants without regard to age or sex. There will be screams and howls and piteous sights in Nantes." *(See* CARRIER, JEAN BAPTISTE.) The prophecies have been the subject of many commentaries, but in 1781 they were condemned by the Congregation of the Index, the body set up by the Roman Catholic Church for the examination of books and manuscripts.

See E Bareste, *Nostradarnus* (1840) ; C. *A.* Ward, *Oracles of Nostradamus* (1891). (CN. A R.)

NOTARY, or NOTARY PUBLIC. In Roman law the *notarius* was originally a slave or freedman who took notes *(notae)* of judicial proceedings in shorthand. The modern notary corresponds rather to the *tabellio* or *tabularius* than to the *notarius.* In canon law it was a maxim that his evidence was worth that of two unskilled witnesses.

The office of notary in England is a very ancient one. It is mentioned in the Statute of Provisors, 25 Edward III, stat 4. The English notary is an ecclesiastical officer, nominated, since the Peterpence Dispensations act, 1533–34, by the archbishop of Canterbury through the master of the faculties (now the judge of the provincial courts at Canterbury and York), in order to secure evidence as to the attestation of important documents. All registrars of ecclesiastical courts must be notaries. A notary's duties, however, are mainly secular. "The general functions of a notary consist in receiving all acts and contracts which must or are wished to be clothed with an authentic form; in conferring on such documents the required authenticity; in establishing their dates; in preserving originals or minutes of them which, when prepared in the style and with the seal of the notary, obtain the name of original acts; and in giving authentic copies of such acts" (Brooke. *On the Office of a Notary).* The act of a notary in authenticating or certifying a document is technically called a "notarial act." In most countries the notarial act is received in evidence as a semijudicial matter, and the certificate of a notary is probative of the facts certified. But English law does not recognize the notarial act to this extent. An English court will, in certain cases, take judicial notice of the seal of a notary, but not that the facts that he has certified are true, except in the case of a bill of exchange protested abroad. The file of a year's documents is often termed the protocol.

One of the numerous duties of an English notary is the noting and protest of foreign bills of exchange in case of nonacceptance or nonpayment. This must be done by a notary in order that the holder map recover. He also prepares ship protests relating to mercantile matters, and authenticates and certifies copies of documents and attests instruments to be sent abroad. The office of notary is now usually held by a solicitor. In London he must be free of the Scriveners' Company.

In Scotland the office of notary is *munus publicum* and his notarial acts are probative. A roll of notaries public is kept, and under the Law Agents (Scotland) Act, 1873, any law agent is entitled to admission to the roll on payment of additional stamp duty. In addition to noting and protest of bills of exchange, notaries in Scotland have important functions in relation to completion of titles to land. They act as commissioners of the Sheriff Court of Chancery for taking affidavits in the process of service of heirs, they prepare and execute notarial instruments for giving service in land. and they may execute deeds notarially on behalf of persons who cannot write. Notaries also are supposed to keep their protocol books which are probative of the intimation of certain protests by mariners and others. Modern legislation has made serious inroads on the exclusiveness of the notary's functions.

In France, notaries receive all acts and contracts to which the parties thereto must give or desire to give the authenticity attached to the acts of a public authority; they certify the date, preserve the originals and give copies or duplicates. Notaries are nominated by the president of the republic on the recommendation of the keeper of the seals. They cannot act as notaries and also practise as advocates, or hold any magisterial office, nor can they engage in business.

In the more important British colonies and in foreign countries generally notaries are governed by special statutory legislation.

In the United States, the President appoints notaries in the District of Columbia, and the governor alone appoints them in most States. Many states have laws limiting the numbers who may be appointed for a particular county, usually a number in proportion to the population. Notaries are not empowered to act outside their own states, and often not outside their own counties. In most cases their seals must be affixed to the affidavit or other document. They attest deeds and other instruments, take affidavits and depositions and protest bills of exchange. Certain other officials may have notarial functions in addition, such as commissioners of deeds in New York state.

NOTE, a mark, particularly a sign by which a musical sound (also called a note) is indicated in writing *(see* MUSICAL NOTATION). A comment or addition added to a passage in a book, or a communication in writing shorter or less formal than a letter. The term is also applied to an abstract or memorandum of documents, speeches, etc., especially in the process of the transfer of land by fine and recovery *(see* FINE).

The ordinary distinction between note and letter is reversed in diplomacy. *Diplomatic notes* are written communications exchanged between diplomatic agents or between them and the ministers of foreign affairs of the government to which they are accredited. Sometimes, by agreement, a mere exchange of notes has the force of a convention. *Collective notes* are those signed by the representatives of several powers acting in concert. Sometimes *identical notes* are substituted for collective, *i.e.,* notes identical as to form and substance, but signed and delivered separately by the representatives of the several powers. *Circular notes* are those addressed by one power to the other powers generally. *Confidential notes* are directed to inspiring confidence by giving an explicit account of the views and intentions of the plenipotentiaries and their governments. The so-called *nofes verbales* are unsigned, and are merely of the nature of memoranda of conversations, etc. *Notes ad referendum* are addressed by diplomatic agents to their own governments asking for fresh powers to deal with points not covered by their instructions. Diplomatic notes are usually, but not invariably, written in the third person.

For notes of hand or promissory notes *see* NEGOTIABLE INSTRUMENT and BILL OF EXCHANGE, and for notes passing as currency *see* BANKING and POST AND POSTAL SERVICES.

NOTKER, a name of frequent occurrence in the ecclesiastical history of the middle ages. NOTKER BALBULUS (*c.* 840–912) was *a* native of northern Switzerland, and for many years *magister* in the school of St. Gall. He compiled a martyrology and other works, but is famous for his services to church music and for the "sequences" of which he was the composer. He was canonized in 1513. His life is in the Bollandist *Acta Sanctorum,* April 6th. NOTKER LABEO (d. June 29, 1022) was also an instructor at St. Gall. His numerous translations, including those of the Old Testament Psalms, the categories of Aristotle. the *De nuptus Mercurii et Philologiae* of Martianus Capella, and the *De consolatione* of Boethius, into Old High German. may possibly have been the work of his pupils.

NOTRE DAME, UNIVERSITY OF, a Roman Catholic institution of higher learning for men at Notre Dame. Ind , was founded in 1832 by biothers of the Congregation of Holy Cross a religious cominunity originating in France. *See* SOUTH BEND.

NOTTINGHAM, EARLS OF. The English title of earl of Nottingham has been held by different families notably by the hlowbravs (1377 to 1476; merged in the Norfolk title from 1397), the Howards (1597–1681) *(see* below), and the Finches (1681 ; after 1729 united nith that of Winchilsea).

HENEAGE FINCH (1621–1682) first earl of Nottingham in the Finch line lord chancellor of England, was descended from an old family, and was the eldest son of Sir Heneage Finch, recorder of London. He was educated at Westminster and at Christ Church, Oxford, and was called to the bar at the Inner Temple in 1645. Elected for Canterbury to the Convention Parliament which met in April 1660, he was appointed solicitor general and created a baronet in June. During 1661–73 he sat in parliament for Oxford. In 1670 he became attorney general, and in 1675 lord chancellor. He was created Baron Finch in 1674, and earl of Nottingham in May 1681. He died in Great Queen street, London, on Dec. 18, 1682, and was buried in the church of Ravenstone (Raunston) in Bucks.

DANIEL FIYCH (1647–1730), second earl, son of Heneage Finch, entered parliament for Lichfield in 1679, and was first lord of the admiralty, 1681–84, succeeding his father as earl in 1682 As a privy councillor, he signed the order for the proclamation of James II in 1685, but his disapproval of James's ecclesiastical policy led to his becoming leader of those Tories who placed loyalty to the Church of England even before loyalty to the king. He would not, however, sign the invitation to William of Orange, and after James's flight he proposed a regency. Once the revolution was accomplished, he took office as secretary of state (1688–93) and was the prime mover in introducing the Toleration act. This, and a later period of office (1702–04), were terminated by complaints of his lack of fervour in prosecuting the war against France, and in 1711 he joined the Whigs, exacting as the price of his help in bringing down the government their support in introducing the Occasional Conformity bill. On George I's accession in 1714 he became president of the council, but lost office in 1716. In Sept. 1729 he succeeded to the earldom of Winchilsea, with which the Nottingham title became merged. He died on Jan 1, 1730.

NOTTINGHAM, CHARLES HOWARD, 1ST EARL OF (in the Howard line), and 2nd baron Howard of Effingham (1536–1624). English lord high admiral, commanded the fleet in the defeat of the Armada. He was the eldest son of William, 1st baron Howard of Effingham, lord high admiral. He was closely connected with Elizabeth I, his father's sister, Elizabeth Howard, being the mother of Anne Boleyn. In 1559 he was sent as ambassador to France to congratulate Francis II on his accession and in 1569 was general of the horse under the earl of Warwick in suppressing the rebellion of the north. Next year he commanded a squadron sent to watch the Spanish fleet which came to conduct the queen of Spain from Flanders. In the parliaments of 1563 and 1572 he represented Surrey. He succeeded to his father's title of Lord Howard of Effingham in 1573; was installed a knight of the garter in 1575; and made lord chamberlain of the household in 1584, an office which he retained until he became lord high admiral in 1585. He was one of the commissioners for the trial of the conspirators in the Babington plot and of Mary, queen of Scots, in 1586.

When the English naval forces were mobilized against the Armada, Howard hoisted his flag as commander in chief on the "Ark" in Dec. 1587 and in May 1588 sailed with the main fleet from the Thames to join Sir Francis Drake's advance force at Plymouth. Drake became his vice-admiral and John Hawkins his'rear-admiral, These two, with five other officers, formed his council of war and the harmony which his personality and authority imposed upon his more brilliant subordinates was an important factor in the summer's victory. Like them, he was eager to seek out the Spanish fleet upon its own coasts. But when he at length won Elizabeth's consent, adverse winds thrice frustrated him and while he was refitting in Plymouth after the third attempt, the Armada appeared off the Lizard (July 19). In the ensuing actions, the English ships outsailed and outmanoeuvred the enemy, but Howard, at first probably outnumbered and even outgunned, did not dare to close with them. Instead, he harassed them from longer range. plucking "their feathers by little and little." and shepherding them slowly up the Channel. Rasher spirits criticized these tactics, hut, as Sir Walter Raleigh said, "had he entangled himself with those great and powerful vessels, he had greatly endangered this kingdom of England." He was perhaps more open to criticism for lagging behind the rest of the fleet to attack the crippled "San Lorenzo" at Calais on July 29, at a moment when the Armada, its close formation broken by the English fireships, was straggling in disorder past Gravelines. Nevertheless, he contributed nobly to a famous victory and his fame hardly needed the support of the rather one-sided "Relation of Proceedings" (published in *State Papers relating to the defeat of the Spanish Armada*, ed. by Sir J. Laughton [Navy Records Soc., London, 1894]) which was drawn up at his direction.

Howard's next important service was the expedition of 1596 to Cadiz, which he commanded jointly with the earl of Essex. Supported by the council of war, he rejected Essex's proposals for further operations after the capture of the town and next year Essex's anger was increased when the queen created Howard earl of Nottingham (Oct. 1597).

Nottingham was again busy with preparations against invasion in Feb. 1598; and also in the summer of 1599, when he was given the exceptional office of lord lieutenant general of England. In 1601 he took a leading part in suppressing Essex's rebellion and served as a commissioner at his trial. It was to Nottingham that Elizabeth named James I as her successor on her deathbed.

Under the new king Nottingham continued in his office of lord high admiral. He was one of the commissioners to treat with Spain in 1604 and in 1605 went as ambassador extraordinary to receive the Spanish ratification of the peace treaty.

He served on numerous commissions, including those on the union of the two kingdoms in 1604, for the trial of the conspirators of the Gunpowder Plot and of the Jesuit Henry Garnett in 1606, and for reviewing the articles and rules of the order of the Garter in 1611 and 1618, and he attended Princess Elizabeth to Flushing with a squadron on her marriage to the elector palatine in 1613. Nottingham, who, unlike many of the Howards, was a staunch Protestant, was commissioner in Surrey for inquiring after recusants, and in the diocese of Winchester for hearing ecclesiastical causes; he sat on the government commission for discovering and expelling Roman Catholic priests, and was mentioned in 1602 from Douay as one of the three enemies most feared by the recusants. On the report of the commission on the navy in 1618, h'ottingham, who was over 80, vacated his office of lord high admiral (Jan. 1619), though no blame was attached to him for the abuses then exposed.

He died at Haling house, near Croydon, Surrey, on Dec. 14, 1624, and was buried at Keigate, a monument being later placed to his memory in St. Margaret's church, Westminster.

Nottingham married (1) in 1563, Catherine, daughter of Henry Carey, 1st Lord Hunsdon; (2), in 1603, Margaret, daughter of James Stuart, earl of Murray. CHARLES (1579–1642), his second son by his first marriage succeeded as second earl of Nottingham. On his death without male issue, he was succeeded by his half-brother, and when he died childless in 1681 the earldom became extinct. (R. B. WM.)

NOTTINGHAM, a county, municipal and parliamentary borough and the county city of Nottinghamshire, Eng., 121 mi. N.N.W. of London by road. Pop. (1961) 311.645. Area 25.3 sq.mi. Standing on the north bank of the Trent, by which it has access to the sea, Nottingham is also served by the Nottingham canal which communicates via the Erewash with the Cromford canal in Derbyshire.' It is also connected by rail with the docks at Immingham and there is an airport at Tollerton. Its situation on the Trent, where it was crossed by an ancient highway, attracted settlers from the earliest times. St. Mary's hill is an Early British earthwork, and caves anciently used as dwelling places have been hollowed out in the Bunter sandstone of Castle rock, and elsewhere, the best known of which is the Trip to Jerusalem inn which dates from 1189 and is largely inside the Castle rock. There is also a whole brewery inside the rock, where it has been operating for centuries, This rock, on which stands the castle, rises as an abrupt crag in the south of the city. The Anglo-Saxons were in occupation from the 6th century onward and gave their settlement the name of Snotingaham. During the 9th century it was raided by the Danes, who took possession and made it one of their five burghs, and it suffered many changes of occupants until about 918, when it was secured and fortified by Edward the Elder. In 924 he built a second "burgh" opposite the first, connected with it by a bridge across the river. His successor, Aethelstan, established a royal mint in Xottingham, which continued until 1154. In 1068 William the Conqueror ordered the replacement of the wooden Saxon fort by a stone castle, which became crown property governed by a constable. Mention of a new borough occurs in Domesday Book and may refer to the "French borough" which grew up under the Normans. This was separated from the English borough by a wall down the middle of the common market place, to prevent quarrelling. The castle was John's headquarters in one of his attempts to usurp the authority of his brother Richard I. When John became king it was from the castle walls that he hanged the Welsh princes whom he held as hostages. Roger Mortimer, earl of March and Queen Isabella's paramour, was seized there while, in her company by adherents of her son, Edward III. Parliaments were held at Nottingham in 1334, 1337 and 1357 and it was the scene of the conference of the judges with Richard II in 1387 Richard III used the castle as his headquarters before the battle of Bosworth in 148j. From there, also, Henry VII set out to fight Lambert Simnel at East Stoke. In 1642 Charles I finally broke with the parliament by setting up his standard at Nottingham and during the ensuing Civil War the castle was held by each of the two parties more than once. In 1651 it was dismantled by Oliver Cromwell's orders.

Nottingham's first charter (Henry II) confirmed to the burgesses the liberties they had held under Henry I, referred to a market on Saturdays, and forbade the working of dyed cloth, except in Nottingham, within ten leagues of the borough. John confirmed this and granted a guild merchant. Henry III allowed the burgesses to hold the town in fee-farm, and Edward I granted them a mayor and two bailiffs, one to be chosen from each borough. Henry VI in 1448–49 confirmed all preceding privileges, first incorporated the mayor and burgesses, instituted the office of sheriff and granted that the town, except the castle and jail, should be a county of itself. Henry's charter remained, except for temporary surrenders under Charles II and James II. the governing charter of the corporation until the Municipal act of 1835. In 1897, by a charter of Queen Victoria, Nottingham became the county city of Nottinghamshire. It returned two members to parliament from 129j until 188j. when the number was increased to three, and in 1918 it was again increased to four and so remains. In the course of its history several iairs were granted to Nottingham; one, the Goose fair, is still held for three days beginning on the first Thursday in October. A large cattle market is open on Mondays and Saturdays. During the 19th century Nottingham, which had become industrialized, was troubled by the Luddite riots and Chartist demonstrations. The worst disturbance, in which the castle was burned down and much town property destroyed, broke out during the Goose fair of 1831. Order was restored after the Reform bill was passed in 1832, largely due to the efforts of Feargus O'Connor, leader of the Chartists and a member of parliament for Nottingham. who had presented the petition for the repeal of the Corn laws.

The site of the castle was bought by William Cavendish, 1st duke of Newcastle, who in 1764 began building a mansion there. Finished in 1769 it was burned out in 1831 and remained a ruin until acquired in 1875 by the corporation who. after restoring it, opened it in 1878 as the Xottingham and Midland Counties Art museum. The church of St. Mary, the mother church of Nottingham, is a Perpendicular cruciform structure with a central tower. St. Peter's church, the oldest in the city, is partly 12th and partly 1jth-century. The Roman Catholic cathedral of St. Barnabas was designed by A. W. N. Pugin and consecrated in 1844. The grammar school, founded in 1513, was for sometime in disuse, was revived in 1807 and was removed in 1868 to new buildings when it was known as the High school. There is also a High School for Girls. The General hospital was founded in 1781. University college, opened in 1881, was incorporated as Nottingham university in 1948. Its present buildings in University park. the gift of Lord Trent (Jesse Boot) were opened in 1928 and the extended site now covers about 260 ac. The city's council house was opened in 1929 and a new Nottingham and District Technical college was under construction in 1956. The Theatre Royal. the oldest of the four theatres was opened in 1865. The Albert hall is mostly used for music, including the city's choral and orchestral societies' performances. In 1924 the Elizabethan Wollaton hall and park (744 ac.) were bought from Lord Middleton by the corporation and the hall was made the Natural History museum in 1926. The centenary of the Trent Bridge Cricket ground was celebrated in 1938 In 1931, Newstead abbey, the home of the poet Lord Byron, 11 mi. N. of Nottingham, was presented to the city by Sir Julien Cahn.

William Lee, a Nottinghamshire curate, had invented the first machine for manufacturing a looped or knitted fabric in 1589, but it was not until the close of the 18th century, which saw the invention of Richard Arkwright's spinning frames and James Hargreave's spinning jenny, that Nottingham became a centre of the hosiery trade, which it remains today. Out of this grew its fame as a lacemaking town, and Nottingham lace became known all over the world. In 1808 and 1809 John Heathcoat, who had modified the stocking frame for lace, obtained patents for machines for making bobbin net, which inaugurated a new era in lace manufacture. Allied industries are dyeing and bleaching, the spinning and twisting of silk, the spinning of cotton and woollen yarn and the making of clothing. Nottingham's leather industry dates from the 11th century. There are large bren-eries; pharmaceutical, furniture and tobacco factories; foundries; printing and engineering, particularly for lacemaking, hosiery and railways; motor works and the biggest cycle factory in the world. The close proximity of coal mines is another industrial asset.

To the northwest, within the city boundaries, are the industrial districts of Radford and Basford. beyond which lies Bulwell, with collieries, limestone quarries and earthenware manufactories. To the north, Sherwood is a growing residential district; another extends toward Gedling on the east. Southward. across the Trent, West Bridgford is another large residential suburb. To the west is Lenton; and Beeston has become a populous suburb mainly owing to the cycle and motor works.

NOTTINGHAMSHIRE (abbr. Notts). a county of England, bounded north and northwest by Yorkshire, west by Derbyshire, south by Leicestershire and east by Lincolnshire. Its geographical area is 843.8 sq.mi. with a population (1951) of 841,-211. The highest land, in places exceeding 600 ft., is found in the west between Xottingham and Mansfield. The hills die away eastward toward the basin of the Trent and Idle rivers. In the Dukeries, portions of the Sherwood forest, legendarily associated with Robin Hood, are still preserved.

History. — In the limestone caves near Cressu-ell, on the Derbyshire border, implements of the Palaeolithic age have been found along with remains of the mammoth, hyena. cave-lion, and rhinoceros; some recent evidence suggests Mesolithic settlements in the north of the county. The chief evidences of settlement in the Neolithic and Bronze ages come from the more open country of the southeast. In pre-Roman times there seems to have been a crossing of the Trent near the site of Xottingham for the tracks along which salt was distributed from Cheshire and Worcestershire. The presence of river and forest seemed to have caused the Romans to deflect the course of the Fosse way northeastward from Leicester via Newark to Lincoln. and so their occupation has not left extensive material remains in the county. The earliest Xnglian settlers. not later than the 5th century advanced either from Lincolnshire. along the Fosse way, or from Leicestershire down the Soar valley and settled in the fertile districts of the south and east. At the end of the struggle between Northumbria and Mercia the area later Nottinghamshire became part of the Mercian kingdom. Nottingham after the treaty of Wedmore became one of the five Danish boroughs. In the early 11th century Nottinghamshire was included in the earldom of Mercia. on its breakup it was included in the earldom of the Middle English, but in 1049 it again became part of Leofric's earldom of Mercia. The first mention of the shire of Nottingham occurs in 1016. when it was harried by Canute. The boundaries have remained practically unaltered since the time of the Domesday Survey.

In Domesday Book the fief of William Peverel represents the honour of Nottingham, and in 1068 he was appointed constable of the castle which William the Conqueror had raised at Nottingham. The chief lay tenant was Roger de Busli, while the majority of the church lands belonged to the archbishop of Tork and probably the chapter of his minster at Southwell. The Stauntons of Staunton probably held Staunton at the time of Domesday Book and other well-knonn families such as the Pierreponts made their appearance in the county before 1300 Archbishop Thomas Cranmer was a descendant of the Cranmers of Aslockton near Bingham. Of the old castles the principal remains are those at Newark. and a fine motte and bailey earthwork survives at Laxton, the only village in England to retain its open fields as its system of agriculture to the present day. Of the later secular buildings. Wollaton hall and the present Welbeck and Rufford abbeys are the best-known. Nottinghamshire was transferred from the diocese of Lichfield to the diocese and province of York in the 10th or 11th century and remained there until 18; j when it was transferred to Lincoln (province of Canterbury). In 1884 the diocese of Southwell was formed in the province of York and includes Notts and Derbys. After the Conquest several monastic establishments were founded and at the Reformation there were almost 40 religious foundations. Important monastic remains survive at Newstead, Rufford. Thurgarton, Blyth and Worksop, while the collegiate church of Southwell, a pre-Conquest foundation. with its exquisite 13th-century carving, became Southwell cathedral in 1884.

Until 1568 Nottinghamshire was normally united with Derbyshire under one sheriff and until the 19th century the archbishop of York had within Nottinghamshire an extensive secular jurisdiction known as the "Liberty of Southwell and Scrooby" paralleled by the ecclesiastical jurisdiction exercised by the Southwell chapter within the "Peculiar of Southwell."

In the Wars of the Roses the sympathies of the county are uncertain. though Nottingham was one of the most useful stations of Edward IV. In the Great Rebellion of the 17th century most of the nobility favoured the royalist cause. and Newark, garrisoned for the king. was subject to the lengthy siege. Nottingham castle was garrisoned for the parliament. and in 1651 was demolished.

Industries and Agriculture. — The malting and woollen industries flourished in Norman times. The latter declined in the 16th century, and by the 18th century the hosiery manufacture was the leading industry based on the stocking loom invented in Nottinghamshire in 1589. The earliest evidence of the working of the Nottinghamshire coalfield is in 1259, when Queen Eleanor was unable to remain on account of the smoke of the sea coal. Worksop was formerly famous for its liquorice. Numerous cotton mills were erected in Nottinghamshire in the 18th century, and there were silk mills at Nottingham. The manufacture of tambour lace existed in the 18th century, and was facilitated in the 19th century by the manufacture of machine-made net. Coal is mined chiefly around Nottingham, Mansfield and Worksop. Clay, sandstone, limestone, "wet" sand and gravel and gypsum are also extensively quarried: oil is pumped on a limited scale in the Eakring area. Nottingham is the principal centre of the lace and hosiery industries. There are silk, worsted and cotton mills. machinery works and cycle and motor factories. The manufacture of tobacco is considerable at Nottingham and Hucknall.

In 1955, 400,002 ac. were under crops and grass. the most fertile land lying on the alluvium along the Trent. The chief grain crops were wheat! barley and oats and the chief root crop was potatoes. There were 61,090 ac. of clover and rotation grasses for hay and 13.649 ac. of sugar beet. Apples and pears are also grown. The shire raises cattle, chiefly Shorthorns, and dairying is extensively practised (111,352 cattle and calves in 195j). There were 88,875 sheep, the chief breed being Leicesters and various crosses. The National Trust owned 3.784 ac. in the county in 19j5, all at Clumber park.

Communications and Population. — The Midland and Eastern regions of British railways serve the county. The Trent is navigable throughout the county and the Idle between Bawtry and the Trent.

The area of the administrative county is 818.5 sq.mi. with a population at the 1951 census of 535,156. The county contains the city of Xottingham which is also a borough (pop.. 1951, 306,0j5), the municipal boroughs of Retford or East Retford (16,316), Mansfield (51,352), Newark-on-Trent (22,917) and Worksop (31,034), ten urban and six rural districts. For parliamentary purposes Nottinghamshire is divided into six constituencies (Ashfield, Bassetlaw, Carlton. Mansfield, Nenark and Rushcliffe), each returning one member; and Nottingham returns one member for each of its four constituencies. There is one court of quarter sessions for the countv and there are seven petty sessional divisions.

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NOUMENON, a philosophical term put into currency by Kant (*q.v.*) and not much used except in definite reference to his doctrine. In the Kantian system the term "noumena" means things-in-themselves as opposed to "phenomena" or things as they appear to us. According to Kant the human mind is such that it can never penetrate by its speculative powers to things-in-themselves, but can only know phenomena. Thus we have the odd position that noumena: or the contents of the intelligible world, are just the things to which thought can never penetrate. The term, however, is a relic of an early period of Kant's mental development. In his fully mature or critical position he held that the noumenal was inaccessible to the speculative reason, and yet that we are not altogether excluded from it, since the practical reason. *i.e.,* our capacity for acting as moral agents, assures us of the existence of a noumenal world wherein freedom, God and immortality have a real place.

The relation of noumena to phenomena in the Kantian system is a most difficult one; and, in view of the fact that the acutest intellects in Europe have been engaged vainly for more than a century in reconciling the various passages on the subject. the safest conclusion is that they are irreconcilable. The course adopted by Kant's immediate successors in German idealism was to reject the whole conception of noumena, for the reason that what is essentially unknowable has no existence for our intelligence.

Kant, however, protested strongly against this development when it was propounded by Fichte, and held that he had precluded it by his "refutation of idealism": he stood unshakably to the belief in an absolutely real world behind phenomena.

Kant's position may be illogical as he himself stated it, but it is the expression of a sound principle: we must connect it with his general tendency to recognize the dynamic side of things. He saw, n-hat so many of his successors failed to see, that the world as we know it is an expression of pon-er; and he could not imagine whence the power could come if not from a world beyond phenomena. See PHENOMENON.

NOVA AND SUPERNOVA. A nova is a variable star that brightens up for a short time to a luminosity far exceeding that of its normal state. A supernova is a nova of great absolute brightness, and is distinguished by a type of spectrum different from that of common novae.

Novae. — Although the initial stages never have been observed, except for recurring novae, the objects subject to nova outbursts are almost certainly stars. The increase in brightness of a star during a nova outburst may be from a hundredfold to a millionfold. and it takes place within a few days. The brightness after maximum may decline at various rates, and it often fluctuates. After a few years. the brightness of the nova remnant usually becomes steady again. Only a few dozen good light curves of novae are recorded.

Some of the novae of greatest apparent brightness, are Nova Persei 1901, Nova Aquilae 1918 (almost as bright as Sirius) and Nova Puppis of 1942. Around the remnant stars of these novae, gas clouds can still be observed, expanding with velocities of hundreds of kilometres per second. The spectra of these clouds show emission lines of atomic hydrogen, the nebulium lines and λ 3727 of doubly and singly ionized oxygen atoms. The spectral changes from the outburst to the final stages are complex. During the first hours Nova Persei 1901, Nova Herculis 1934 and Nova Lacertae 1936 had continuous spectra with absorption lines, similar to A- and B-type stars. Later on, normal and forbidden emission lines of the elements hydrogen, helium, carbon. nitrogen, calcium, iron, titanium, scandium. chromium, strontium, yttrium and others appear. These lines are widened around their normal places because light comes from shells of gas expanding about the star, the front portions approaching the earth, the rear receding. The dark lines, on the other hand, can originate only in that part of the shell betneen the earth and the disk of the remnant star that furnishes the background light. Since this part of the shell moves toward the earth. a shift toward the violet results. Spectra of the postnova stars are mostly continuous. with no pronounced absorption lines showing. Even 100 years after a nova outburst, however, faint emission lines are present, whose Doppler broadening indicate that gases steam off the remnant stars with velocities of about 200 km. per second. (See DOPPLER EFFECT.)

The absolute magnitudes of novae at maximum brightness can be determined only if the distances are known There are several methods for estimating the distances, such as from the strength of the "steady" absorption lines due to the presence of interstellar gases along the line of sight to a nova. The most reliable distances are obtained from the observation of the angular diameter of the ejected gas clouds and the comparison of their lateral rates of expansion with the spectroscopically observed radial velocities of these clouds. Thus the absolute magnitudes at maximum of Nova Herculis 1934, Nova Aquilae 1918, Nova Persei 1901 and Nova Puppis 1942 were found to be respectively $M_v = -5.5$, -9.0, -9.2 and -10.0. Common novae therefore reach an absolute visual luminosity in the range from 10.000 to 1,000,000 times that of the sun. The total energy emitted during a large nova outburst in the visual range is of the order of 10^{45} ergs, equal to the radiation from the sun during 10,000 years.

Novae in the Milky Way and in the great nebula in Andromeda (Messier 31) appear most often in the densely populated parts, perhaps at the rate of from 20 to 50 per year. A few common novae have also been discovered in small nearby galaxies, such as NGC 205, the faint elliptical companion of Messier 31.

The spectra of recurrent novae such as T Corona Borealis (1866, 1946) and R. S. Ophiuchi (1898, 1933, 1958) differ materially from those of the bright common novae and, their range in brightness from maximum to minimum amounts to less than nine magnitudes. As to the cause of nova outbursts it has been conjectured that they represent the transition from a normal star into an electronically degenerate star whose density is of the order of 10^5 g. per cubic centimetre.

Supernovae.—These become much brighter than common novae. Pending on the determination of a reliable distance scale for extragalactic nebulae, which, in individual cases is probably uncertain by as much as a factor ten, it seems certain that the brightest supernovae at maximum attain an absolute visual brightness several billion times that of the sun. In any event, supernovae often become as bright or brighter than the galaxies in which they appear. For instance, the brightest supernova discovered in the 20th century (in Aug. 1937) was 100 times brighter than the dwarf spiral galaxy (IC 4182), in which it appeared. The total radiation emitted by a bright supernova as visual light during one year is of the order of 10^{50} ergs or more, or equal to the energy radiated by the sun during 1,000,000,000 years.

The light curves of supernovae are varied. Most of those that could be observed sufficiently frequently show a rapid rise during a few days to maximum brightness, near which they may stay for a week or two. The decline in brightness is generally smooth and amounts to 15 or more magnitudes in the course of a few years. The difference between the brightness at maximum and the final stages is much greater than for common novae.

Most, if not all spectra of supernovae have so far defied identification, representing thus one of the most tantalizing puzzles of modern astronomy. Spectroscopic observations reveal at least two types of supernovae. The spectra of bright supernovae, type I, are closely comparable at corresponding times after maximum. They show a bewildering and changing array of wide bands of unknown origin. Some of the fainter supernovae have a type II spectrum that is characterized by a strong ultraviolet continuum and faint emission lines that have been interpreted as atomic hydrogen lines, enormously broadened because of their origin in gas clouds ejected nith velocities of 5,000 to 7,000 km. per second. The spectra of supernovae of the type II somewhat resemble those of bright common novae such as that of Nova Sagittarii 1936.

Altogether about 60 supernovae have so far been definitely identified as such. A concerted search by Fritz Zwicky and J. Johnson at Palomar, from 1936 to 1941, netted 19 supernovae. From this search a frequency of one supernova per galaxy per 360 years was derived, if only 1,200 of the brightest galaxies are considered. Supernovae appear in all types of galaxies. In contradistinction to novae. supernovae appear most often in the thinly populated parts of galaxies.

Three supernovae that have made their appearance in the Milky Way system have been definitely identified from historical records. The supernova of 1054 A.D. in Taurus. which was observed by the Chinese to be brighter than Venus, has given rise to a nebulosity, known as the Crab nebula, the gases of which expand with a mean velocity of about 1,100 km. per second. A blue star of the 16th apparent magnitude, with a completely featureless continuous spectrum. may be the very hot dwarf remnant star from the supernova outburst of 1054 A.D. The Crab nebula is also a strong radio source and the continuous visible radiation is polarized giving rise to a most puzzling basket weave pattern when the nebula is subjected to the method of composite analytical photography.

Tycho's Nova of 1572 and Kepler's Nova of 1604 are the other two historically recorded supernovae in the Milky Way. In neither case could a stellar remnant be found, but some expanding wisps of emission nebulosities have been observed in the locations of the two supernovae.

Large ringlike nebulosities such as the famous Cygnus loop are suspected to be remnants of supernovae whose outbursts date more than 10,000 years ago. In the second half of the 20th century radio surveys have led to the discovery of objects like the strong radio source in Cassiopeia, which is associated with diffuse gaseous condensations showing radial velocities of the order of 5,000 km. per second, which indicates that it might be the remnant of a supernova of type II.

No initial stage of any supernova has ever been seen, and it is not certain whether all initial stages are stars. For instance, a large gas and dust cloud, becoming unstable and collapsing could be the cause of some'supernovae. Another likely cause for some supernovae is the collapse of ordinary stars into neutron stars a few kilometres in diameter and with a density of the order of 10,000,000 tons to the cubic centimetre, equal to the density within atomic nuclei.

The further study of supernovae is of importance because they involve a series of new phenomena that promise to clarify views on the evolution of stars, galaxies and the universe in general. Supernovae also bid fair to serve as distance standards for the mapping of the universe to the limits reached with the largest telescopes.

See C. Payne Gaposchkin, *The Galactic Novae* (1957), "The Novae," *Handbuch der Physik,* vol 51 (1958); F. Zwicky, "Supernovae," *Handbuch der Physik,* vol. 51 (1958). (F. ZY.)

NOVACULITE is a hard, compact, homogeneous, finely granular rock closely resembling chert and consisting of nearly pure silica. The rock has typically a vitreous lustre and white colour. It breaks with conchoidal fracture, and thin edges are translucent. The largest known deposits. Devonian in age, are in the Ouachita mountains of Arkansas and Oklahoma where novaculite occurs as beds from a few inches to ten feet thick, interbedded with shales, forming many of the mountain ridges. It was first quarried in the early 19th century to make whetstones for sharpening fine tools; hence its name, Latin *novacula,* "sharp knife." Indians used novaculite for weapons and implements. Novaculite has been considered to be metamorphosed chert, replacement by silica of a dolomite or limestone, and a deposit of colloidal silica accumulated on the sea floor. (A. W. G.)

NOVALICHES, MANUEL PAVPA Y LACY, 1ST MARQUIS DE (1814–1896), Spanish marshal, was born at Granada on July 6, 1814. In 1833 lieutenant in the guards of Queen Isabella II, he became general of division during the Carlist war (1833–40). Senator in 1845, war minister in 1847, and marquis in 1848, he went out to Manila in 1852 as captain-general of the Philippine Islands, crushed a formidable insurrection in 1854 and carried out many useful reforms. He commanded the reserves in the peninsula during the Moroccan war. twice refused the war portfolio offered him by O'Donnell and Narvaez, and when the revolution broke out in Sept. 1868 accepted the command of Queen Isabella's troops. He was defeated by Marshal Serrano at the bridge of Alcolea on Sept. 28, 1868, and was so badly wounded in the face that he remained disfigured for life. He kept apart during the revolution. The Restoration made him senator, and King Alfonso gave him the Golden Fleece. He died in Madrid on Oct. 22, 1896.

NOVALIS (pseudonym of FRIEDRICH LEOPOLD) FREIHERR VON HARDENBERG (1772–1801), German poet and novelist, one of the pioneers of the Romantic movement, was born on May 2, 1772, on his father's estate at Oberwiederstedt in Prussian Saxony. He studied philosophy at Jena, and law at Leipzig and Wittenberg. At Tennstedt, near Langensalza, he was betrothed to Sophie von Kühn. He became auditor to the salt works at Weissenfels where he heard (1797) of Sophie's death. He expressed his grief in the beautiful *Hymnen an die Nacht,* in which the religious poetry of the Romantics reaches its greatest height. He then entered the Mining academy at Freiberg. in Saxony, to study under A. G. Werner, whom he immortalized as the "Master" in *Die Lehrlinge in Sais*. In the autumn of 1799 he read to the circle of young Romantic poets at Jena his *Geistliche Lieder*. In 1800 he was appointed local magistrate in Thuringia, and after a short illness he died at Weissenfels on March 25, 1801.

His all too short life did not permit him to blend his mystic and philosophical conceptions into a harmonious whole. His longest work was the unfinished romance, *Heinrich von Ofterdingen;* its hero's search for the mysterious blue flower is an allegory of the poet's life. More popular, however, are his shorter lyrics.

There are editions of the collected works of Novalis by E. Heilborn (3 vol., 1901), and by J. Minor (3 vol., 1907; reprint, 1923). His *Briefwechsel* with the Schlegels was edited by J. M. Raich in 1880. *See* also E. Heilborn, *Friedrich von Hardenberg* (1901); T. Carlyle's essay on "Novalis"; Obenauer, *Novalis Gesammelte Studien* (1925); H. Hesse and Isenburg, *Novalis. Documente seines Lebens und Sterbens* (192;).

NOVARA, town and episcopal see! Piemonte, Italy, capital of Novara province, 31 mi. W. by rail of Milan, 538 ft. above sea level. Pop. (1957 est.) 78,989 (commune). Until 1839 circled by Spanish ramparts, Novara is now an open, modern town. The cathedral. except for the octagonal dome-roofed baptistery (10th century): was rebuilt (1863–65); the church of S. Gaudenzio, dedicated to Bishop Gaudentius (d. 417), who is buried under the high altar, rebuilt by Pellegrino Tibaldi about 1570, has a baroque campanile and a dome (1875–78) 396 ft. high. The city also contains handsome market buildings erected in 1817–42, a large hospital dating from the 9th century and a courthouse constructed in 1346. The town has also a museum of Roman antiquities. The principal industry is the carding and spinning ,of silk; there are also ironworks and foundries, cotton mills, rice-husking mills, organ factories, dye works. printing and map-making works.

Novara, the ancient Novaria, lay on the road between Vercellae and Mediolanum. Its rectangular plan probably survives from Roman days. A dukedom of Novara was constituted by the Lombards, a countship by Charlemagne. In the 12th century it accepted the protection of Milan. In 1706 it was occupied by Savoy troops. At the peace of Utrecht it passed to Austria with Milan; but was granted to Charles Emmanuel in 1735. Under the French it was the chief town of the department of Agogna. Restored to Savoy in 1814, it was in 1821 the scene of the defeat of the Piedmontese by the Austrians, and in 1849 of the more disastrous battle which led to the abdication of Charles Albert and an Austrian occupation of the city.

Novara was the scene of a battle on March 23, 1849, between the Austrians, 70,000 strong with 182 guns, under Radetsky and King Charles Albert, who led the Sardinian forces, 65,000 men with 140 guns. Chzarnowski, a Pole, virtually directed the army. Armistice, concluded Aug. 9, 1848. was to terminate March 20. Radetsky retreated from Milan on March 17. feigning to retire to Lodi-Cremona, but on reaching San Angiolo he made for Pavia. crossing the Ticino on March 20. Meanwhile Chzarnowski marched on Magenta without encountering the enemy, but here news reached him that the Austrians were at Pavia; thereupon he halted the army and turned it back to Vigevano. Radetsky had advanced so swiftly that Ramorino's Sardinian division south of the Po was cut off, the bridge at blezzano Corte being destroyed, though it had orders to stand at Cava. threatening the hostile advance. Fighting took place at Mortara on March 21, the Sardinians falling back on Novara, where Chzarnowski decided to await Radetsky. A corps of Austrians approached Novara and engaged the whole Sardinian army on March 23. Seriously outnumbered until reinforcements arrived, the Austrians fought with great tenacity and before the end of the day had driven the Sardinians back in confusion. Charles Albert abdicated that night.

NOVA SCOTIA, a province on the east coast of Canada, composed of the peninsula of Nova Scotia and the adjoining island of Cape Breton. The extreme length from southwest to northeast is 371 mi. (Nova Scotia 266, Cape Breton 105); breadth 59 to 75 mi.; area 21,425 sq.mi. The isthmus of Chignecto. 17 mi. wide. connects it with the province of New Brunswick. The capital of Nova Scotia is Halifax (pop. [1961] 92,511; metropolitan Halifax, 183,946).

PHYSICAL GEOGRAPHY

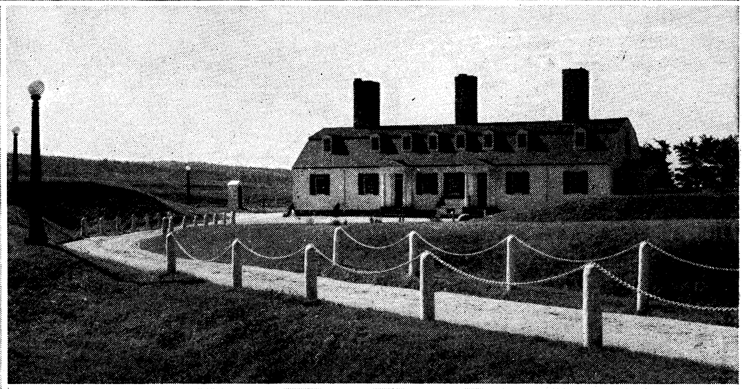
Geology **and** Physiography.— Nova Scotia is composed of five upland and as many lowland areas. The former are underlain by hard crystalline rocks and comprise: (1) the Southern upland, which embraces the southern half of the peninsula and rises gradually from the coast to elevations of 600 ft.; (2) North mountain, a narrow, flat-topped belt (590 ft. high) extending for 120 mi. along the Bay of Fundy shore from Cape Blomidon to Brier Island; (3) the Cobequid mountains (average elevation 840 ft.) stretching for 71 mi. across Cumberland county from the head of the Bay of Fundy almost to Northumberland strait; (4) the highlands of eastern Pictou and Antigonish counties (elevation 800 to 900 ft.); (5) the upland belts and northern tableland (Cape Breton highlands, elevation 1,200 ft.) of Cape Breton Island.

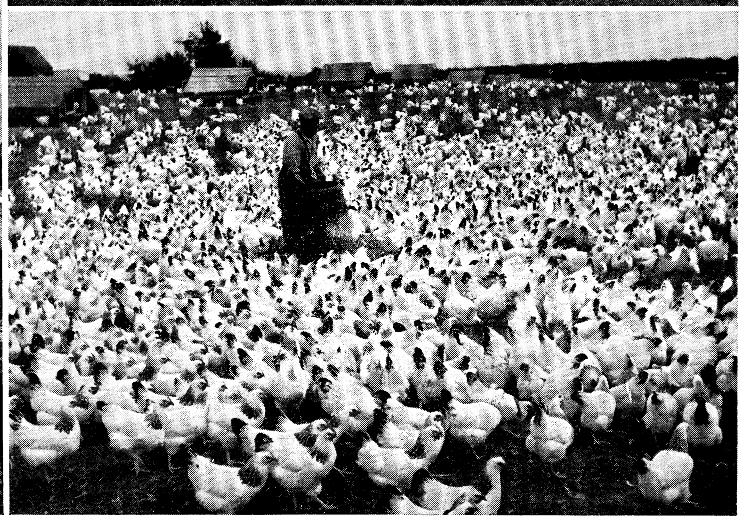
The lowland areas are underlain by softer sedimentary rocks. The three more important are the Annapolis valley, a long troughlike depression lying between the steep walls of North mountain and the Southern upland; the lowlands surrounding Minas basin; and the lowland between the Cobequid mountains and Northumberland strait.

Nova Scotia has a myriad of lakes, short rivers and streams. The salt water Bras d'Or lake (*q.v.*) of Cape Breton Island is particularly large and well known. The Bay of Fundy tides exceed 50 it. in Minas and Cumberland basins, resulting in large areas of tidal marshlands.

Climate.— The climate of Nova Scotia is under both continental and oceanic influences, especially along the southwest coast which is both milder and wetter than other parts of the province. The average annual temperature is 45° F. along this coast, but only 40° in the interior uplands where temperature extremes of 95° in summer and −35° in winter have been recorded. Similarly, the frost-free season varies from 100 days or less in the uplands to 140 days along the south shore, Northumberland strait and in the Annapolis valley. and to 160 days in the Yarmouth area. Rainfall is normally ample and well distributed throughout the year—an annual average of 55 in. on the south coast; 40 in. elsewhere in the province. Less than one-fourth falls as snow; fog occurs on as many as 90 days along the southern shore.

Vegetation.— Slightly more than 15,000 sq mi. (70% of the province) is forested. Softwood stands account for 55% and hardwood stands for 6%, while the remainder is mixed. Balsam fir, spruce (red, white and black), eastern hemlock and white pine are the principal softwood species while yellow birch, sugar maple and red maple are the main hardwood types. With the widespread





BY COURTESY OF (BOTTOM LEFT, BOTTOM RIGHT) NATIONAL FILM BOARD, (CENTRE RIGHT) CANADIAN GOVERNMENT TRAVEL BUREAU; PHOTOGRAPH, (TOP) KOSTI RUOHOMAA FROM BLACK STAR

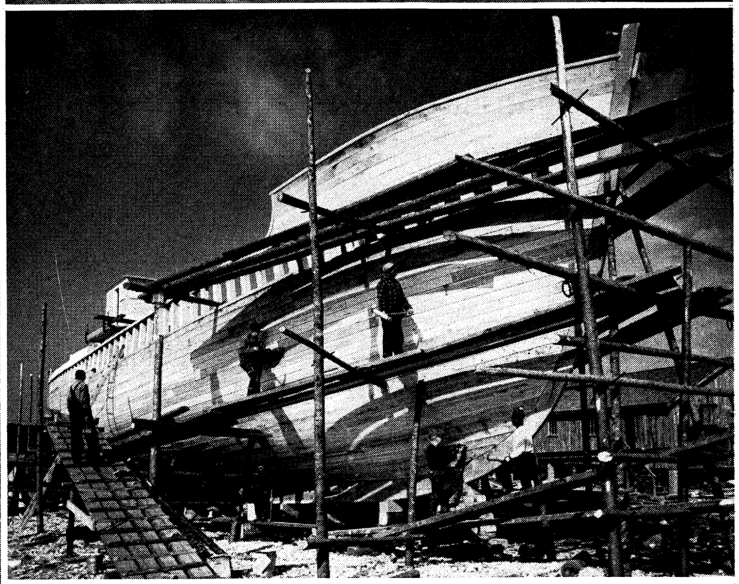
VIEWS OF NOVA SCOTIA

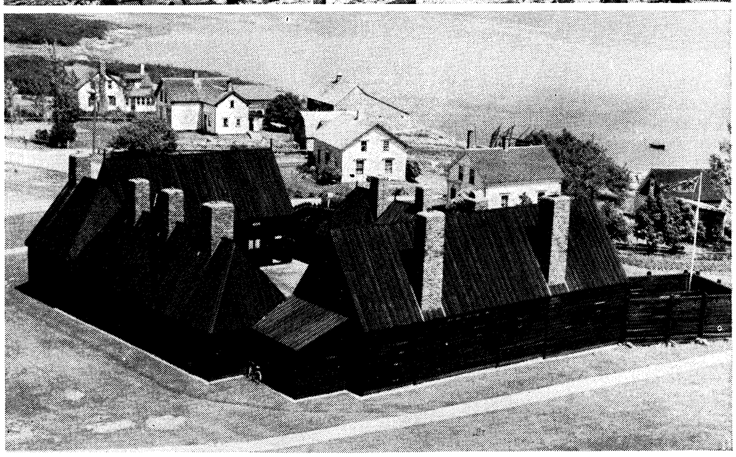
Top: Picking shad from nets in the Bay of Fundy at low tide. The fish are caught when the nets are under water at high tide

Bottom left: Schooners in dock at Lunenburg being made ready for cod fishing off the Grand Banks of Newfoundland

Centre right: Fort Anne historical museum at Annapolis Royal, the site of the oldest fortification in North America

Bottom right: A poultry farm in the Annapolis valley, the principal agricultural area of Nova Scotia





BY COURTESY OF (TOP RIGHT, CENTRE RIGHT, BOTTOM RIGHT) NOVA SCOTIA FILM BUREAU, (BOTTOM LEFT) IMPERIAL OIL LTD.; PHOTOGRAPH, (TOP LEFT) MACKENZIE FROM MILLER SERVICES

SCENES IN NOVA SCOTIA

Top left: The town clock in Halifax, erected in 1803
Top right: Peggy's Cove, a fishing village on the Atlantic coast
Centre right: Building a wooden "dragger" at Shelburne. Shipbuilding is a leading industry in Nova Scotia
Bottom left: Gathering sap for sugar at Mapleton, in northwestern Nova Scotia
Bottom right: The Champlain Habitation at Annapolis Royal, a replica of a building erected on that site by the French in 1605

abandonment of agricultural land from 1900 the forested area has been continually expanding.

Nova Scotia has approximately 50.000 ac. of tidal marshland around Annapolis, Minas and Cumberland basins and along Northumberland strait. Dikes were begun by the Acadians in the early 1700s and the marshes are now largely in agricultural use.

Animal Life.—Nova Scotia has an abundance of wildlife which attracts many sportsmen to the province. Moose and especially deer are common. In addition there are many fur-bearing animals, including the bear. raccoon, beaver, muskrat, woodchuck, rabbit and red squirrel. Of the many species of birds, partridge (grouse) and ducks are most popular as game. Speckled trout and Atlantic salmon are the most valued fresh-water fish.

HISTORY

Nova Scotia may well have been the Markland of early Norse and Icelandic voyages, and Cape Breton was visited by the Cabots in 1497–98, but not until 1605 was any attempt at permanent colonization made by Europeans. In that year, Pierre du Guast, sieur de Monts (1560–*c.* 1630) and Samuel de Champlain (1567–1635) after an unsuccessful attempt on an island in Passamaquoddy bay, founded the first settlement north of Florida on the north shore of Annapolis basin. The habitation was destroyed by English colonists from Virginia in 1613. In 1621 Sir William Alexander obtained a grant to the whole peninsula from James I and named it Nova Scotia (Latin for "New Scotland"), replacing the French name Acadie, a descriptive word of the Micmac Indians. Two settlements were established, but with the restoration of Nova Scotia to the French by the treaty of St. Germain-en-Laye in 1632 most of the Scottish settlers returned home. French and British control of the peninsula alternated until'the treaty of Utrecht (1713) when it passed into the possession of Great Britain. France retained the present areas of Cape Breton, Prince Edward Island and New Brunsmick, and constructed the mighty fortress of Louisburg on Cape Breton Island. In 1749 Halifax was founded as a counterpoise to Louisburg, and more than 4.000 British colonists were sent out. Bloreover, the British attempted to exact allegiance from the French Acadian population. In 1755, fearing that the Acadians could not be neutral in the case of war, Gov. Charles Lawrence decided that they must either take the oath of allegiance or be deported. With their refusal there followed the tragic expulsion (made famous in Longfellow's Evangeline) in which approximately 6,000 Acadians were forced to leave the colony. After France lost its North American colonies in 1763, many returned to Nova Scotia, took the oath of allegiance and obtained new lands. (See ACADIAN.)

Soon after the Acadian expulsion, promises of free lands lured settlers from New England, Yorkshire, Ireland and Scotland. In 1758, in deference to the New Englanders in Halifax, the first popular assembly was elected. Cape Breton and Prince Edward islands became parts of Nova Scotia in 1763, although Prince Edward Island was detached six years later and has remained a separate province ever since.

At the beginning of the American Revolution about one-half of the settlers in Nova Scotia were of New England origin but they did not share all the grievances of the southern colonists. The province strove to retain its neutrality through the struggle, although four delegates from Cumberland went to the Continental congress in Philadelphia. At the close of the war about 35,000 Loyalists flocked to Nova Scotia and, as a result, New Brunswick and Cape Breton became separate colonies in 1784. Cape Breton reunited with Nova Scotia in 1820.

In the first half of the 19th century a substantial increase in population (Scottish, Irish, Negroes) occurred along with new wealth and increased trade. The timber trade and fisheries boomed, and Nova Scotia shipbuilding enormously expanded. The colony had 2,583 vessels in 1846, representing one-third as much tonnage as that of France. However, political life lagged behind because of the peculiar privileges of a small official class. The struggle for responsible government, which marked the 1830s and 1840s, finally met with success in 1848 when Nova Scotia became the first British colony to have the principle of responsible government recognized.

Nova Scotia prospered greatly between 1855 and confederation as a result of improved British trade, the reciprocity treaty (1854) with the United States, and the American Civil War. The province bitterly opposed a union with Upper and Lower Canada, but the dynamic leadership of Charles Tupper (*q.v.*) led the province into confederation in 1867 (with New Brunswick, Ontario and Quebec). The case of the opposition was carried to London by the great orator and journalist, Joseph Howe (*q.v.*), but finally even he accepted a state of federated provinces.

Nova Scotia has had a sense of grievance ever since confederation and one political election (1886) was even won on the platform of secession. Several adverse factors including abrogation of the reciprocity treaty in 1866, the cessation of the American Civil War, the opening of the Canadian west and the changes to steel and steam retarded the economy. Politics in the 20th century have largely turned on the province's economic status in spite of improvements effected by the steel and coal industries, by local manufactures, and by the development of Halifax, along with Saint John. N.B., as Canadian winter ports. In 1926 and 1934 royal commissions investigated the economic problems and reported in favour of better terms for the province. World War I stimulated the provincial economy along many lines but the depression that followed was not checked until the late 1920s. Another boom occurred during and after World War II and in the early 1960s economic progress continued to be favourable, net value of production having doubled since the war.

The province has had several disasters of international concern. Springhill has been the scene of three coal-mine explosions, one occurring in 1958 when 75 men were killed or died as the result of a "bump." The collision of two steamships, one carrying TNT, explosive acid and benzine, in Halifax harbour in 1917 resulted in the death of nearly 2,000 people.

There are six national parks in Nova Scotia, five of which are national historic parks. Cape Breton Highlands Xational park is located in the northern part of the island and has equipped recreational and camping grounds. The Fortress of Louisburg National Historic park is also on the island, located at the site of the ruins of the French fort built between 1717 and 1758. An exact replica of the habitation built by Champlain has been erected at Port Royal. Fort Anne National Historic park commemorates early French settlement and a British fort at the present site of Annapolis Royal. Grand Pré National Historic park is located near Wolfville and preserves a site of early Acadian history made famous by Longfellow's Evangeline. The Citadel at Halifax is also a national historic park. In addition there are numerous historic sites, plaques and cairns in all parts of the province.

POPULATION

The population of Nova Scotia was 737,007 in 1961, with slightly over one-half living in the rural areas. Almost two-fifths of the population was in the urban areas of Halifax and Sydney. More than 75% were of Anglo-Saxon origin while 11% were Acadian French. The latter live mainly in Digby, Yarmouth, Shelburne and Richmond counties.

There are 18 counties in the province. With their areas, population (1961) and county seats they are:

County	Land area (sq.mi.)	Population	County seat
Annapolis	1,285	22,649	Annapolis Royal
Antigonish	541	14,360	Antigonish
Colchester	1,451	34,307	
Cumberland	1,683	37,767	Amherst
Digby	970	20,216	Dugby
Guysborough	1,611	13,274	Guysborough
Halifax	2,063	225,723	Halifax
Hants	1,229	26,444	Windsor
Kings	842	41,747	Kentville
Lunenhurg	1,160	34,098	Lunenburg
Pictou		43,908	Pictou
Queens		13,155	Liverpool
Shelburne		15,208	Shelburne
Yarmouth		23,386	Yarmouth
Cape Breton	972	131,507	Aydney
Inverness	1,409	18,718	Port Hood
Richmond	489	11,374	Arichat
Victoria	1,105	8,266	Baddeck

Note: The last four are on Cape Breton Island.

GOVERNMENT AND PUBLIC FINANCE

The administration of Nova Scotia consists of a lieutenant-governor appointed and paid by the federal government, and by custom a resident of the province; a premier and cabinet representing the party in power; federally appointed judges; and a nonpolitical civil service. The legislative assembly of 37 members meets at Halifax; elections may be called any time within a five-year period. Nova Scotia is represented in the federal government in Ottawa by 10 senators (from 1873). Membership in the house of commons is adjusted after each census; it was 12 after the 1956 census.

There are 2 incorporated cities, Halifax and Sydney (*qq.v*) and 40 incorporated towns. In addition there are 24 municipalities, of which 12 are county municipalities and 12 are district municipalities representing 6 divided counties.

Under the terms of confederation the province is concerned with the protection of persons and property, transportation and communications in local undertakings, natural resources, education, health and welfare, and the incorporation of companies. The sources of revenue collected for provincial purposes are various and are augmented by federal government subsidies and grants as well as various tax-sharing agreements.

EDUCATION

Public education dates from 1811 and is compulsory, free of charge and nondenominational. In the second half of the 20th century there were approximately 2,000 schools, with about 125,-000 attending elementary classes and 20,000 in secondary schools. There were approximately 5,000 attending classes in private schools and another 8,000–9,000 receiving precollege training in various other classes. The major institutions of higher learning are Dalhousie university, Halifax; University of St. Francis Xavier, Antigonish; and Acadia university, Wolfville. Others are College Ste. Anne, Church Point; Convent of the Sacred Heart, Halifax; University of King's college, Halifax; Pine Hill Divinity hall, Halifax; Mount St. Vincent college, Halifax; Nova Scotia Agricultural college, Truro; Nova Scotia Technical college, Halifax; Holy Heart seminary, Halifax; Maritime School of Social Work, Halifax; and St. Mary's university, Halifax. The provincial normal school is located at Truro.

PRODUCTION

Agriculture. — Nova Scotia has very little agricultural land (under 5% of the total area). Aside from the Annapolis valley, the marshlands around Minas and Cumberland basins, and areas along the Korthumberland strait shore, most of the province is too rugged, or has soils which are too thin and infertile to support the industry. Mixed farming (often part-time) is the rule with an emphasis on dairying in proximity to the larger urban centres. Over one-half of the cropland is in hay, with a large additional acreage in pasture. The Annapolis valley is well known as an apple-growing region, although production has declined because of the curtailment of the British market after World War II. Small fruits and vegetables are also grown commercially in that area. There is a livestock specialization in association with the marshlands and an increased egg and poultry production encouraged by the Bermuda market. Blueberry production has also increased greatly after World War II.

Forestry. — Lumbering was long the chief industry of Nova Scotia and, although the timber resources account for little more than 2% of the Canadian total, it is still a major source of provincial income. Most of the forests are privately owned and this, together with the dependence of the industry on a great many small waterways, has resulted in many scattered, small-scale lumber operations. A few large-scale operations, notably the pulp and paper mills at Liverpool (Brooklyn), New Germany, Hantsport and Sheet Harbour, have developed along the larger river systems:

Mining. — Coal is the most important Nova Scotia mineral. The principal mining centres have been Glace bay, New Waterford, Sydney mines, and Inverness on Cape Breton Island; Stellarton and Westville in Pictou county; and until 1958, Springhill in Cumberland county. There are iron ore reserves in the Nictaux-Torbrook area but the ore for the blast furnaces at Sydney is imported from Newfoundland. Gold production reached a peak in 1939 (29,943 oz.), but had declined to negligible amounts by the second half of the 20th century. Large deposits of gypsum occur at Windsor. Milford station. Walton, Little Narrows and Dingwall. The province is the principal Canadian source of barite and a major salt producer.

Fisheries. — Fish has long been one of the important exports of the province. Dried cod, the traditional export item, is still important although fresh frozen fish has increased in value from 1945. Three-fifths of the value is obtained from the deep-sea fisheries, chiefly from cod and haddock; one-quarter from mollusks and crustaceans, particularly lobsters; and the remainder from the surface fisheries and other products. Digby and Wedgeport are noted for scallops and tuna respectively.

Industries.—Nova Scotia is naturally a sea-going province, and ship construction and fish packing and processing have always been major industries. Large supplies of raw materials (coal, limestone, iron from Newfoundland) have favoured Sydney as a primary steel centre. Other steel mills are located at New Glasgow, Trenton and Amherst. Iron and steel products and transportation equipment represent nearly one-third of the selling value of factory shipments, foods and beverages account for about one-fourth and pulp, paper and wood products for one-eighth, with the remainder divided among textiles, clothing, nonmetallic minerals, chemical products, printing and publishing and miscellaneous industries. The principal manufacturing centres are Halifax, Sydney, New Glasgow, Trenton, Pictou, Amherst, Dartmouth, Yarmouth, Truro. Lunenburg, Shelburne, Bridgewater, Louisburg, Windsor, Kentville, Hantsport and Berwick.

COMMUNICATIONS

The major railways of Nova Scotia are the Canadian National and Dominion Atlantic. The Canadian National enters the province near Amherst (from Montreal and Moncton) and has main lines leading to Halifax and Sydney and branch lines to Yarmouth and the Annapolis valley. The Dominion Atlantic, a subsidiary of the Canadian Pacific system, connects with Saint John, N.B., via ferry to Digby and serves Yarmouth. Halifax and Truro. Airports are located at Eastern passage, Kelly lake (both serving Halifax), Yarmouth, Trenton and Sydney. The province has had an impressive highway grading and paving program; out of a total road mileage of about 15,000, more than 2,000 mi. were paved by 1960 A deep causeway (218 ft.) connecting the mainland with Cape Breton Island was opened in 1955.

Ferry service operates between Yarmouth and Bar Harbor, Me.; Digby and Saint John, N.B.; and Caribou and Prince Edward Island.

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NOVATIANUS, Roman presbyter, and one of the earliest antipopes, founder of the sect of the Novatiani or Novatians, was born about the beginning of the 3rd century. On the authority of Philostorgius (H.E., viii, 15) he has been called a native of Phrygia. He was ordained at Rome by Fabian, or perhaps by an earlier bishop; and during the Decian persecution he maintained the view which excluded from ecclesiastical communion all those (*lapsi*) who after baptism had sacrificed to idols—a view which had frequently found expression, and had caused the schism of Hippolytus. Bishop Fabian suffered martyrdom in Jan. 250, and, when Cornelius was elected his successor in March or April 251, Kovatian objected on account of his known laxity on the above-mentioned point of discipline, alloued himself to be consecrated bishop by the minority who shared his views and remained antipope until about 258. He and his followers were excommunicated by the synod held at Rome in October of the same year. He is said by Socrates (H.E., iv, 28) to have suffered martyrdom under Valerian. Novatian has been confused with Novatus, a Carthaginian presbyter, who held similar views.

Novatian was the first Roman Christian who wrote to a considerable extent in Latin Of his numerous writings three are extant (1) a letter written in the name of the Roman clergy to Cyprian in 250; (2) a treatise in 31 chapters, *De trinitate;* (3) a letter written at the request of the Roman laity, *De cibis judaicis* They are well-arranged compositions, written in an elegant and vigorous style The best editions are by Welchman (1724) and by Jackson (1728); they are translated in vol ii of Cyprian's works in the *Ante-Nicene Theol Libr* (1869) The Novatian controversy can be advantageously studied in the *Epistles* of Cyprian.

NOVATION, a legal term derived from the Roman law, in which novatzo was of three kinds-substitution of a new debtor, of a new creditor, or a new contract In English law the term (though it occurs as early as Eracton) is scarcely naturalized; substitution of a new debtor or creditor being generally called an assignment. A new contract either tacitly or expressly operates as a release from the original contract. Where the substituted contract is one of a higher nature, as where a contract under seal supersedes a simple contract, it is called a merger. The extinction of the previous contract is held to be sufficient consideration. The particular points on which novation turns are whether the new firm or company has assumed the liability of the old. and whether the creditor has consented to accept the liability of the new debtors and discharge the old. The question is one of fact in each case. (See especially the Life Assurance Companies' Act, 1872, s. 7, where the word, "novations" occurs in the marginal note to the section, and so has quasi-statutory sanction.) Scots law seems to be more stringent than English law in the application of the doctrine of novation, and to need stronger evidence of the creditor's consent to the transfer of liability In American law, as in English, the term is something of a novelty. In Louisiana, and generally in systems much influenced by Roman law, novation forms a more specific department of the law of contract (*q.v.*).

NOVAYA ZEMLYA. An Arctic land off the coast of European Russia, to which it belongs, consists of two large islands separated by a narrow winding channel 56 mi. long, the Matochkin Shar. It lies between 70° 31′ and 77° N., and between 51° 35′ and 69° 2 E. and forms an elongated crescent, being nearly 621 mi long with a width of 25 to 68 mi. and an area of about 31.382 sq mi. It separates the Barents sea on the west from the Kara sea on the east. With Vaigach island 30 mi. to the south, and the mainland, Novaya Zemlya forms a continuation of the Pal-Khoi hills, a branch of the Ural folds.

The greatest heights occur in the neck of the south islands where near Matochkin Shar are altitudes of about 4000 ft. In the middle part of the south island there are few elevations over 1,400 ft., but in the south the summits rise to over 2,000 ft. The north island seldom rises to greater altitudes than 3.000 ft.

Geology. — A central zone of upper Cambrian and Devonian rocks extends along the islands. These quartzites, conglomerates and dolomites are flanked by carboniferous shales and limestones. The minerals of value are some lignite and a little copper ore.

Climate.—Novaya Zemlya is colder than Spitsbergen (which lies more to the north) as in some degree it shares in the continental conditions of northern Russia and Siberia. The middle and northern parts of the nest coast are not so cold as the east. Temperatures at Karmakul are 2·3° F (Feb.) and 43·2° (July). Snow is universal from October to May.

Flora and Fauna. — vegetation is solely tundra and decreases from south to north. It is most luxuriant in Gooseland on the southwest. There are no trees or bushes. The flowering plants number 187.

In the ice-free areas there are foxes, lemmings, bears. reindeer and an occasional wolf Insects arc numerous near the coast. Countless birds come from the south for the breeding season, and at certain parts of the seacoast the rocks are covered with millions of guillemots, while great flocks of ducks of various sorts, geese and swans snarm every summer on the valleys and lakes of the south. Whales, walruses and various seals are frequently seen. The goltzy occurs in the rivers.

The numbers of sea mammals and birds attracted Russian hunters. and even in the 16th century they had extended their huts (stanovishtcha) to the extreme north of the island. Many of them wintered for years on Novaya Zemlya. Because of the ice in the White sea Russian hunters found Novaya Zemlya less easy of access than did the Norwegians. But about 1877 systematic attempts at settlement were begun by the Russian government, several families of Samoyedes being established at stations on the west coast of the south island, including Karmakul on Moller bay. Pomorskaya bay and Byeloshya bay. There is a Russian observatory on Matochkin Shar.

History.—Novaya Zemlya was probably known to Novgorod hunters in the 11th century and to Norse hunters a century earlier. In 1jj3 Sir Hugh Willoughby may have sighted Gooseland. In 1556 Stephen Borough reached the south extremity of the Novaya Zemlya, being the first western European to do so. R'illem Barents touched the island (1594) at Sukhoi Nos (73° 46') and followed the coast north to the Orange Islands and south to the Kostin Shar. In 1596, after his discovery of Spitsbergen, Barents wintered at Ice haven in 76° 12′ N. (see ARCTIC, THE). Rumours of silver ore led the Russian government to send out expeditions. In 1760 Savva Loshkin cruised along the east coast, spent two winters there, and in the next year returned along the west coast, thus accomplishing the first circumnavigation; but the records of his voyage have been lost. In 1768 Lieut. Rozmyslov explored Matochkin Shar, where he spent the winter. The first scientific information about the island is attributable to the expeditions (1821–24) of Lutke (1797–1882), after whom part of the north island is named Lutkeland. Nearly ail the west coast as far as Cape Nassau, as well as Matochkin Shar, was mapped and valuable scientific information obtained. In 1832 and 183j Lieut. Pakhtusov mapped the east coast as far as 74° 24′. The work of Karl yon Baer in 1837 was untrustworthy. In 1870 the Norwegian Capt. L. E. H. Johannesen accomplished the second circumnavigation of Novaya Zemlya, and in 1871 E. Carlsen found Barents' winter hut. In 1878 M. Grinevetskiy crossed the south island.

Among later expeditions may be mentioned those of C. Nossilov (1887–92), T. N. Chernychev (1895), who made a crossing of the south island, H. J. Pearson (1895 and 1897), A. A. Borisov (1899 and 1900), O. Ekstam (1900 and 1903), W. Russanov (1908), who crossed the south of the island. Pavlov and Weise (1912) of the Sedov expedition. who crossed the north island (see ARCTIC), as did O. Holtedahl (1921). P. V. Vittenburg explored the south island in 1925.

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NOVEL. "A fictitious prose narrative or tale of considerable length (now usually one long enough to fill one or more volumes), in which characters and actions representative of the real life of past or present times are portrayed in a plot of more or less complexity" — so the Oxford English *Dictionary.*

There are obviously many difficulties about this (or any other) definition of the novel, and they have led some critics to deny that there really is such a thing as the novel form! or to assert that it is too vast, various and amorphous to be considered a literary kind or genre. It is certainly true that the novel, beginning much later than the other main literary kinds. never established a definite formal tradition based on its first recognized models of excellence, as the epic, for example. did with Homer's *Iliad.* But we obviously need a term to describe the mode of writing which has been the most characteristic literary phenomenon since the mid-18th century; usage has established the term novel; and a brief consideration of the problems raised by the various items in the definition above may clarify our understanding of the kind of narrative it denotes.

GENERAL DESCRIPTION

First, the problem of "fictitious." The novel is essentially a fictitious literary form; and yet its subjects are often taken from actual events, and its narrative methods typically attempt to create an air of literal truth. This dualism exactly reverses that of the epic, which had a sort of nonfictional, if not wholly historical, status. although its subjects were legendary and its narrative methods laid little emphasis on literal authenticity. The contrast is historically revealing: the novel arose in a much later civilization, and one whose outlook paid great attention to the distinction between fact and fiction. The novelist typically claims for his fictions the authority of fact; and many early novels imitated the letter and the memoir, modes of writing used to relate actual happenings.

The novel's being in prose follows from these considerations. For just as the content of earlier narrative is largely historical or legendary, its mode is usually poetic; similarly the novel's pretense at literal authenticity seems to demand prose, the medium of common speech. This requirement in turn leads to another larger historical contrast: mankind's early modes of literary expression were public, and public recitation or song apparently seemed to require the impressiveness and memorability of formally patterned and ornamented speech; prose literature came later. and the novel is the only major literary form nhich was not shaped under conditions of public and oral delivery.

The "considerable length" of the novel raises difficult problems. Dramatic performance, or indeed any public occasion, tends to set up fairly standard expectations of length. Not so with the novel, nor indeed with any form intended mainly for private reading. The scale of novels varies widely, from the 2,000,000 or so words of Marcel Proust's *À la recherche du temps perdu* to the ajo-page norm common today—roughly E. M. Forster's minimal specification of "over 50,000 words" (Aspects of the Novel, 1927). Below this lower limit, there are two other recognized forms of prose fiction: the short story, for anything up to about 50 pages; and the longer category intermediate between the short story and the novel, for which, English having no better term than the clumsy "long short-story" or the somewhat derogatory-sounding novelette, the French word nouvelle is often used. It must, however, be remembered that the Italian term novella and the German novelle are also applied to what we would call short stories.

The definition's stipulation that the novel portrays "characters and actions representative of the real life of past or present times" brings us to the heart of the problem. People have been quarreling about "reality" ever since the world began; and obviously any definition which arrogates all portrayal of "real life" exclusively to the novel, and which completely denies it to other literary forms, is hopelessly narrow and provincial. The character and actions of Homer's Odysseus have just as much reality in their may as those of Fielding's Tom Jones; the question of the meaning of "real" in such a context obviously needs further definition, to make clear that the novel's defining "reality" is a more mundane and literal one than that of the epic. Characters in a novel, if not statistically average, are at least not normally so far outside the usual dimensions of common life as to be patently of the heroic stuff of history or legend; and their actions are usually both more usual in themselves, and more deeply rooted in common life by a minuter description of the environment than is typical of other kinds of narrative. This steady attention to the surface of things—houses, goods, appearances, daily life, ordinary conversations—is typical of the novel's technique; but one must remember that although it can lead to the supreme truthfulness of a Tolstoy, what may be called the novel's realism of presentation does not ensure realism of assessment; convincing accuracy of surface description can mask an essential lack of understanding or judgment about the actual conditions and values of life.

According to the definition the novel may portray actions and characters "of past or present times." But—in this again unlike earlier kinds of narrative—it is more typically concerned with the contemporary. The word novel itself is ultimately derived from the Latin novus, meaning "new," via the Italian word for a short story, novella, which tended to mean not only "an original as opposed to a traditional" story, but also one that was, pretendedly at least, "of recent occurrence." When the word was adopted in English it kept some of this duality; novel could mean "news" as well as "a short prose fiction" until the 18th century, when its present meaning finally became established. Something of this connotation remains; fiction dealing with times long past, the historical novel, has a special name, and is surely felt to be rather a special case, probably because we cannot be so sure of the reality of things which neither we nor the author have directly experienced.

The last phrase of the Oxford Dictionary's definition, "in a plot of more or less complexity," raises an important though rather intangible problem. and one which helps to distinguish the novel from the prose fiction of other times and places. The word plot itself immediately involves a considerably higher level of narrative organization than normally occurs in a story or a fable. To quote E. M. Forster's formulation, a story is merely "a narrative of events arranged in their time-sequence," whereas a plot organizes the events according to a "sense of causality." This causal linkage of all the actions and characters is obviously very difficult to achieve in a narrative of novel length; it requires, therefore, the unity in variety denoted by the word complex; and historically, the novel developed as soon as causal narrative structures with sufficient scale and complexity were created. Such structures, in turn, depended on a set of basic assumptions which seem to be peculiar to modern western society. Since Aristotle western civilization has been permeated by the idea of causality; and this cause and effect thinking has taken an increasingly secular and individualist direction. It has therefore become natural to envisage a plot in which human life is seen as exclusively determined by the cumulative effects of individual actions. Only with such a plot could one get the kind of novel which led Henry James to ask: "What is character but the determination of incident? What is incident but the illustration of character?" Such plots are not found even in the supreme masterpieces of China and Japan, which went further than any other nonwestern country in the development of large-scale prose fiction. The *Dream* of the Red Chamber (18th century) and The Tale of Genji (11th century), for example, are wholly convincing in background and very sophisticated in psychology, but their plots are not controlled by the sense of the reciprocal causality of character and action on which the coherent unfolding of the masterpieces of the western novel ultimately depends.

CLASSIFICATION OF NOVELS

One possible classification of novels is based on a similarity to some other mode of writing. Beginning with Defoe, who presented his fictions in the guise of historical, travel, religious or criminal memoirs, the novel has taken over the techniques of many other literary kinds. Less specifically, the more defined and stylized ways of looking at life which are the basis of some of the other literary genres find their spiritual, and to some extent their formal, parallels in certain kinds of novel: Jane Austen's novels are very close to the comedy of manners, while Thomas Hardy's The *Return* of the Native has many of the characteristics of tragedy.

Of even greater critical importance is the tendency of novels to group themselves together according to their own intrinsic similarities to each other in manner and matter: a novel's plot, structure and style are inevitably affected by such elements as its setting in place and time, the kind of character it portrays and the role allotted him, and the nature of the author's larger intentions.

Structural Categories.—Percy Lubbock in The Craft of Fiction (1921) and Edwin Muir in *The* Structure of the Novel (1929) suggested certain fairly similar basic structural categories. In the "dramatic" or "scenic" novel such as Henry James's The Ambassadors, the narrative mainly proceeds in a fairly small number of important scenes which are presented rather completely, as in a play; and this concentrated focus necessarily involves a restriction of the time and space dimensions. At the other extreme is the "panoramic" novel, such as Thackeray's Vanity Fair, where the point of view of the novelist ranges over rather wide expanses of time and space; here the narrative is more like a running commentary than a play. Sometimes, as in Tolstoy's War and Peace, the narrative ranges equally widely in space and time, but there is more often a greater emphasis on one or the other. Where the essential emphasis is spatial, we have the adventure novel, such as Stevenson's *Treasure Island,* or the picaresque novel, such as Smollett's *Roderick Random:* we are very conscious in both of the wide variety of places to which the action takes us. In another and more recent kind of novel, we are much more aware of the temporal dimension, of the flow of time; such works as Arnold Bennett's *The Old Wives' Tale* or John Galsworthy's *Forsyte Saga* belong to this category, and may be called chronicle novels.

The time setting in another sense provides the basis for a different kind of classification: the historical or period novel. It has at least three fairly distinct kinds. In one, where actual historical persons and actions are the basis of the novel. the work is really fictionalized history: Robert Graves's brilliant Roman reconstructinns such as *I, Claudius* for example. At the opposite extreme is the historical romance or period novel in which the past is used merely as an exciting and exotic background for adventures — quasi-military in Dumas' *The Three Musketeers,* sentimental in Margaret Mitchell's *Gone With the Wind.* Between the two extremes of antiquarianism and romantic fantasy is the historical novel proper, where there is an authentic historical background but where the chief characters and actions are fictional: Sir Walter Scott's novels are the classic models of the genre, and his example suggests that the success of the historical novel tends to be proportional to its closeness to the author's own time: *Waverley, or 'Tis Sixty Years Since* (1814) dealt with times that were just within living memory.

The particular setting of a novel in place affords an even greater variety of classification according to content. The spatial equivalent of the historical romance is the exotic novel. where the background is treated in a spirit not of topographical accuracy but of romantic escape. The regional novel as a serious genre has been developed in many directions since Maria Edgeworth's studies of Irish provincial life and Balzac's category of "Scenes of Provincial Life" in *La Comédie Humaine.* There are, for example, the American novels of the south, and the many great fictional studies of rural. urban and metropolitan communities — George Eliot's *Middlemarch,* Sinclair Lewis's *Main Street,* and Balzac's *Le Père Goriot,* for example.

Kinds of Characters. — The kind of character in a novel and the role allotted him provides the basis of several important fictional traditions, which may or may not coincide with classifications based on the treatment of time and place. The oldest, and perhaps the commonest, kind of novel is that which bases whatever narrative unity it possesses on the dominance of a single character. Where the character is, in Aristotle's phrase, "less good than ourselves," we have the picaresque novel. The term is often employed as if it were the equivalent of "highly spiced" in cooking, but its derivation — from *pícaro,* Spanish for "a rogue" — indicates that it strictly applies only to novels where the chief character, like Thomas Mann's Felix Krull, is a conspicuous dissenter from established moral and social codes. Where there is one chief character, neither a hero nor a villain but somewhere within the ordinary moral range, we get the ordinary biographical novel which is perhaps the largest of all classes. It, in turn, has many different species. Formally, the main one is probably the autobiographical, where the chief character is the speaker and relates the whole course of his life, as in Defoe's *Robinson Crusoe;* but another important species is the one which covers only that part of the hero's biography which concerns his social and moral initiation into adulthood. Here, Goethe's *Wilhelm Meisters Wanderjahre* is the classical example, and the German term *bildungsroman,* meaning "novel of educational formation," is the most convenient name. It. in turn, has an important subspecies, the *kunstler-roman,* or "novel about the artist's life," of which James Joyce's *Portrait of the Artist as a Young Man* is a supreme example.

All these kinds of biographical novels, except perhaps the last, tend to be panoramic in narrative structure; but as regards characterization, the picaresque novel is like the adventure story in that it mainly employs what Forster has called "flat characters," who are not seen "all round" and who do not develop, whereas the biographical novel proper usually contains at least one fully presented and developing, or "round," character — the hero.

Novels where several characters have equal or at least considerable prominence, as in Jane Austen's, for example, are often dramatic in structure; and their cast is mainly composed of "round" characters. It should. however, be remembered that the majority of minor characters are "flat" in every kind of novel; that the terms themselves are both relative and to some extent subjective; and that. as the example of Mr. Micawber reminds us, "flat characters" may be just as memorable and successful as "round ones" — in characterization much depends on the particular needs and opportunities of the novel's basic structure.

The picaresque novel and the *kunstler-roman* may be regarded as examples of categories based on the class or occupation of the main character; but the same sort of categorizing can be applied to novels which are based on a group of characters rather than on one individual. There is, for example, the political novel, the novel of high life and the novel of peasant life. In some cases this mode of classification determines the essential literary nature of the work: thus the cowboy novel has developed the very strict conventions of plot, character. background and theme which characterize the modern American "western"; but in other cases, the question of the class or occupation of the characters may be quite incidental.

The Author's Intention. — One could, no doubt, establish a large subspecies of novels dealing with marine fishermen; but it would hardly enable us to gut the secrets of Melville's *Moby Dick* or Hemingway's *The Old Man and the Sea.* It is always to the larger emphases that we must attend; and in *Moby Dick,* for example, in spite of the vast amount of information on whales and whaling, the author's main intention is not the study of a particular occupation. Intention is most obvious in the didactic or propagandist novel, of which Harriet Beecher Stowe's *Uncle Tom's Cabin* is the classic example; it has somehow survived, but most didactic or propagandist novels have proved to be as ephemeral as the causes they espoused. Of greater importance in the novel as literature are the intentions which the author may not declare openly. but which may nevertheless be the essence of his novel's meaning. This condition is especially so in many modern novels, where the author rarely confides his views to the audience in the way that Fielding and Trollope did. He may have an attitude to the narrative which is quite different from that of the fictional narrator; an example of this ironic discrepancy between the apparent tenor of the narrative and the very different intention of the author is in Anita Loos's *Gentlemen Prefer Blondes,* where we are not intended to share the narrator's self-complacency but to laugh at it. More generally, there are many novels where there is an ironic interplay between the meanings that the characters themselves see in their situation and the very different implications intended by the author; perhaps the extreme development of this ironic indirection is in the later novels of Henry James, but all novels probably benefit to some extent if we read them not nith an uncritical subjective identification with the characters, but with a degree of dispassionate distance and objectivity.

There are at least two other large categories of fiction which need to be read with an awareness that they are not primarily intended as direct and literal representations of reality: the romance and the fable. Both of them are much older than the novel, but in their modern forms both of them may nevertheless be clothed in sufficient apparent likeness to ordinary life to fall within the category of the novel. In the romance, to which we shall return later, we are given something which may at times look like life in the real world, but which is really idealized in some way; whereas in the fable, it is not so much that the fictional world is an ideal one, but that the essential interest of the narrative lies in some more or less overt general moral lesson which it illustrates, rather than in the narrative for its own sake. Sometimes, as with Christian, the protagonist of Bunyan's *Pilgrim's Progress,* the fact that the characters have allegorical names gives us' a clear guide to the author's special intentions; and sometimes, as in Johnson's *Rasselas* or Voltaire's *Candide,* the author's aim is so obviously the discussion and illustration of general ideas that we feel compelled to nithhold the name of novel; but in the novels of Hawthorne, for example, it is only a certain consistent lack of density in the narrative line, and a pervasive tendency to generality in the psychological presentation, which tells us that we are in a rather special domain where larger metaphysical issues are the main forces in conflict.

Some critics, such as F. R. Leavis and Richard Chase. have used the term "fable" in a rather wider sense, and have applied it, not merely to novels where the writer's gaze is manifestly directed off stage in the direction of cosmic contradictions and eternal verities, but more widely to all novels where, though we read through them with the sense of their presenting complete and real fictional worlds, we later discover that a definitk moral pattern was worked out in the narrative: Jane Austen's novels, for example, can usually be reduced to such an underlying moral fable. This extension of the term has its dangers, but we must recognize that it is impossible to classify and name all the infinite gradations by which different novels range from the total particularity of documentary realism through the various indirections of allegory and fable and symbolism to the supreme generality of myth.

EARLY MODES OF NARRATIVE AND THE NOVEL

Novel and Epic.—Because of the priority of the epic among the established forms of narrative and the enormous prestige given it by the genius of Homer, theorists of the novel have been much concerned about the relation of the new form to the epic. Fielding, for example, claimed as much as he could of its protecting authority for his new kind of prose fiction. in the preface to *Joseph Andrews* (1742), which was, he announced "a comic epic in prose." Many later novelists have been inspired by similar ambitions, but it is probable that the analogy has proved too general and abstract to be very helpful.

Epic belongs, essentially, to a more primitive stage of civilization, where large, but not vast, communities have learned the arts of farming and metalworking but still spend much of their time in fighting and raiding each other. Later stages of civilization, of course, imitated primitive epic, as Virgil and many later writers imitated Homer. But in the 18th century critics became aware that epic poetry belonged to a particular kind of civilization; and they eventually saw that this had implications for the emerging form of the novel. Especially was this true in Germany. C. F. Blankenburg's important *Essay on the Novel* led the way in 1774, and later Goethe and Schiller drew a similar but more comprehensive socio-literary contrast: on the one hand there nas the ideal harmony between man, nature and the gods which had existed in the golden age of Greece and which was reflected in epic poetry; on the other hand there was modern society, with its urban and bourgeois life, and with the influence of Christianity's self-conscious individualism and its pressing sense of the conflict between divine and secular interests: it was obviously impossible for the novel to reflect anything like the coherence and serenity of the Homeric world. Later, Hegel took the contrast a step further: since modern civilization was inexorably "prosaic," the novel's typical theme had to be the division between the poetic and spiritual aspirations of the individual and the prosaic realities of his existence.

The epic and the novel reflect different societies, and therefore present different kinds of people. As Aristotle pointed out, Greek literature had no literary form which represented people who were neither "better than ourselves," like those of epic or tragedy, nor "worse than ourselves," like those of comedy, but merely "like ourselves"—as the characters of novels usually are. Actually, the only items in our opening definition which the novel shares nith the epic are those of size: both are narratives "of considerable length" and both have "plots of more or less complexity"; common usage, indeed, has made "epic" into a mere superlative of scale. As for subject matter, we can only say that the more a novel gives a vast panorama of a whole society, especially one engaged in war, the more it approaches epic. But when we consider how the ultimate power in Conrad's *Nostromo* is capitalism, or how the whole trend of Tolstoy's thought in *War and Peace* is antiheroic, we see how deeply and essentially different the two forms are.

Novel and Romance.—The particular historical and social background of romance tends to confirm the view that the three main forms of narrative correspond to three different phases of civilization. The Greek romances or novels arose long after epic and are associated with the cosmopolitan and commercial cities of the Hellenistic period. Some of the Greek romances related fantastic adventures, like the interplanetary journeys in Lucian's *True History;* but the largest class, of which Heliodorus' *Aethiopica,* in the 3rd century A.D., is the earliest and best surviving example, depicted the endless misadventures of a pair of lovers until they were finally reunited.

The rebirth of literature in medieval Europe exhibited the same sequence: heroic literature was succeeded by romantic. The *chansons de geste* of the 11th and 12th centuries dealt largely with fighting; but the more settled and sophisticated life of the later feudal period, with its development of courtly love, produced the chivalric romance, first in poetry and later in prose.

Medieval romance had two new cultural features which were both essentially Christian: the moral idealism of chivalry, and the erotic idealism of courtly or romantic love. Both of these values, of course, were passed on to the modern world, and they provided an important element in its fiction. The medieval romances were so called because they were narrated, not in Latin, but in the romance vernaculars; and the term has persisted in the French, Italian, German and Russian words for a novel; only English makes a linguistic distinction between the fanciful "romance" and the realistic "novel."

For good and for ill, however, the tendencies cannot be wholly separated. For two reasons. As regards content, the spirit of romance, the aspiration for a world of knightly values and romantic loves, is a genuine part, though perhaps a regrettably small one, of the real world. As regards literary form, many novelists have thought that they could better represent the essential truths of life if they dramatized them even at the cost of complete plausibility, or brought them into higher relief by omitting circumstantial details.

Another combination of the novel and the romance, however, merely exploits the confusion of fiction and reality; for what is often called a romance today is a form of popular fiction which makes a business of purveying romantic wish fulfillments of the most unreal kind through the apparently realistic medium of the novel.

Realistic Traditions of Fiction.—Convincing reference to the details of ordinary life occurs in early literature, but it is usually casual and sporadic. The major exception to this in classical literature is the largest extant portion of the *Satyricon* of Petronius—Trimalchio's feast. Its masterly picture of the vulgar inanity and ostentation of the life of the *nouveaux riches* in the days of Nero gives us our most complete and intimate knowledge of daily life in classical times—its houses and manners and speech and ultimate social values. As a whole, however, the *Satyricon* is not a unified realistic narrative but a curious miscellany of prose essays dealing with social and literary criticism, of picaresque narrative, incidental bawdy stories and interpolated poems. It belongs to the tradition of Menippean satire which has its modern equivalent in that somewhat marginal kind of novel, of which the classic example is Sterne's *Tristram Shandy,* where the narrative is essentially a pretext for incidental and miscellaneous disquisitions.

The two medieval narrative forms closest to the daily life of the people were primarily for the entertainment of the growing urban middle class. The fabliau, a fairly short verse story, usually concerned with amorous adventures in low life, developed in France during the 12th and 13th centuries: the most famous English example is Chaucer's *Miller's Tale.* But it was for the richer and more cultivated merchant society of 14th-century Florence that the first momentous step toward the modern novel was taken. Giovanni Boccaccio's famous collection of *novelle,* the *Decameron,* established the basis of the modern short story; and something of their narrative skill and psychological veracity is also found in Boccaccio's long prose works, the *Ameto,* the *Fiammetta* and the much longer *Filocolo.*

Both the fabliau and the *novella* tended to take a cynical view of life, which was diametrically opposed to the high-strained idealism of the chivalric romances; even closer to the modern novel are some of the 16th-century works in this antiromance tradition which reflect the ending of the heroic chivalric ideals of feudalism. The picaresque novel was initiated by the anonymous *Vida de Lazarillo de Tormes* in 1554, an autobiographical account of a poor boy's attempts to keep alive by tricking his employers; the form typically offers wonderful opportunities for taking the reader into the most varied social environments and for describing the life there with vivid and often seamy detail.

The full development of the novel, however, required a narrative mode that was less episodic and more rooted in character—the *pícaro* himself tends to be merely the sum of his escapades; the novel also had to be able to present the whole of reality, not merely the comic and sordid scenes typical of the picaresque. The first major resolution of these two problems is found in *Don Quixote* (1605, 161j), where Cervantes combined burlesque of the chivalric romances with certain picaresque elements.

In its formal structure *Don Quixote* is almost as episodic a succession of adventures as the romances it parodied, such as *Amadis of Gaul* (1508); and its predominantly comic mode inhibited a fully realistic treatment of the actions of the hero. Yet when Cervantes juxtaposed the romantic idealism of Don Quixote against both the meagre possibilities of realizing them in the world of contemporary actuality, and the earthy empiricism of Sancho Panza, he resoundingly initiated the novel's endless exploration of the conflict between the ideal and the real as it occurs in the individual's dealings with his environment and his fellow human beings. Nor is this all. The characterization of the two protagonists is not only remarkable in itself, but it is the basis of a progressive psychological interaction which is worked out in narrative terms, and thus foreshadotvs what is perhaps the novel's richest and most characteristic resources—basing a unified narrative development on the working out of a personal relationship.

So much for the definition of the novel, its classifications, and its fictional predecessors; we must now turn to a historical survey of the genre as it developed in Great Britain and the United States.

(For its development in other countries, *see* the national literature articles—CANADIAN LITERATURE; FREXCH LITERATURE; GERMAN LITERATURE; etc.)

THE ENGLISH NOVEL TO 1900

That there is a deeply realistic strain in the English national temper is suggested by its early literature. Chaucer's portraits of the pilgrims and their interplay in *The Canterbury Tales* reveal a genius for the vividly concrete; the same tendency is active in the telling detail and mordant observation found in much other medieval poetry; while Sir Thomas Malory's *Le Morte d'Arthur*, printed by Caxton in 1485, gives a compelling sense of physical actuality to the legendary material of the Arthurian romances.

Elizabethan Period.—In the 16th century the greatest achievements of English literature were in poetry and drama, but there was considerable activity in many kinds of prose fiction. John Lyly's *Euphues* (1578) is a romantic intrigue told in elegant letters, which are interspersed with general discussions on such topics as religion, love and epistolary style; Lyly's main interest is not narrative or psychological but educational, as is suggested by his hero's name (Euphues is Greek for "well-cultivated"), and the very considerable influence of *Euphues* was therefore on literary style rather than on the development of fiction. A similarly rhetorical emphasis marks the most widely admired work of Elizabethan fiction, Sir Philip Sidney's *Arcadia* (1590). Combining elements from three kinds of romance—the Greek, the chivalric and the pastoral—Sidney tells a very long and complicated story composed of separated noble lovers. disguises, oracles, love philtres and hairbreadth escapes, which are set in a conventionalized but beautifully described pastoral landscape.

The same emphasis on complicated adventures is found in many of the less aristocratic prose narratives. Chivalric romances, both translated and original, such as Emanuel Forde's *Parismus, the Renowned Prince of Bohemia* (1598–99), were very widely read, and so were the shorter and more stylish pastoral romances of such writers as Thomas Lodge, whose *Rosalynde* (1590) gave Shakespeare the plot of *As You Like It*, and Robert Greene. But if one wants to catch the note of life as it was lived by the Elizabethans, one must turn elsewhere.

To warn people against the methods of real criminals there arose a literature of roguery; and some of this popular journalistic reporting, notably Greene's "cony-catching" pamphlets, vividly describes the life of the London streets. The picaresque tradition also produced one highly original masterpiece, Thomas Nashe's *The Unfortunate Traveller* (1594), in which the often scabrous adventures of Jack Wilton, an unscrupulous page traveling through the continent, are brilliantly and racily described. But it is the silk weaver and popular balladist Thomas Deloney who gives the most detailed pictures of ordinary domestic life in his three narratives about tradesmen, *Jack of Newbury* (1597), *The Gentle Craft* (*i.e.,* shoemaking; 1598), and *Thomas of Reading* (1599). Deloney, however, sets his tale in earlier days; his clothiers and shoemakers, though convincing as characters, are not really developed, and his novels are essentially miscellaneous collections of anecdotes with only a minimal connecting thread. Delony is therefore no exception to the generalization that the Elizabethans, like earlier English writers, were not primarily interested in the kind of faithful representation of ordinary life which is typical of the novel.

The 17th Century.—Under the Stuarts prose fiction continued mainly along the established traditions of the picaresque novel, the romance and the *novella.* The enormously long French heroic romances of the time were much translated and imitated, while Mrs. Aphra Behn wrote some readable "novels"—longish short stories of intrigue, of which the most famous is *Oroonoko* (1688), telling the tragic love of a gallant Negro slave.

Apart from another masterpiece in the same genre, William Congreve's graceful *Incognita* (1692), there is little else in 17th-century prose fiction of note, with the giant exception of John Bunyan. *Grace Abounding to the Chief of Sinners* (1666) is in the established Puritan form of the autobiographical confession, which relates the sinner's life until he finds "the miracle of precious Grace"; the subject of *Pilgrim's Progress* (1678) is similar, but it is cast in the allegorical form of a journey from the City of Destruction to the Gates of Heaven; while *The Life and Death of Mr. Badman* (1680) reveals the ampler opportunities for graphic realism afforded by the exemplarily negative case.

Bunyan's prose style shows the force of popular Puritan preaching combined with the eloquence of the Authorized Version of the Bible; it can accommodate the homely and the sublime, and range a-ith equal conviction from domestic trivialities to the visions of burning faith. Bunyan is thus an excellent example of one of the main arguments of Erich Auerbach's brilliant *Mimesis: The Representation of Reality in Western Literature* (1946; English translation, 1953). Auerbach shows how Christianity's strong egalitarian belief that the souls of all sorts and conditions of men are potentially of equal value produced a narrative tradition quite different from the classical literary theory of the separation of styles, whereby serious treatment was restricted to "noble" subject matter, ahile everyday reality and humble people were considered appropriate only for comic or satiric treatment. Bunyan presents his humble protagonists with utterly serious realism; on the other hand his allegorical method, the narrative equivalent of the traditional Christian way of interpreting realities in other norldly terms, is obviously not typical of the novel, which presents secular life for its own sake.

The 18th Century.—Bunyan was a village tinker, and his works nere a direct expression of the connection between narrative realism and the increasing articulateness of the tradesmen and shopkeepers who had already shown their power in the Great Rebellion. In 1688, the year of Bunyan's death, the Glorious Revolution finally destroyed the feudal pretensions of the Stuarts and inaugurated the political and social dominance of middle-class commercial interests, of which Daniel Defoe was the foremost spokesman. Though born a Puritan like Bunyan, Defoe reflects the strong secularizing tendency of his time; his pretendedly genuine autobiographical memoirs *Robinson Crusoe* (1719), *Moll Flanders* (1722), *The History of Colonel Jack* (1722) and *Roxana* (1724) are vivid and comprehensive expressions of the social and economic individualism of the Protestant ethic. In form they are loosely episodic biographies of heroes or heroines for whom the quest for middle-class security is the most compelling reality, although it is occasionally in uneasy conflict with other values, notably those of religion and of personal feeling. Helped by his journalistic training, Defoe, much more thoroughly than any previous writer, tried to make his fiction literally convincing; and he also introduced into the tradition of the novel one of its most enduring themes—the struggle of the individual both with the external world and with his own conscience.

Another bourgeois Puritan, Samuel Richardson, has often been credited with the novel's paternity—and probably deservedly, if by this is meant that his works are the first which fit completely into the main fictional patterns of the centuries to come. Defoe had no significant successors but Richardson had many, both in England and abroad. His *Pamela: or, Virtue Rewarded* (1740) tells in a series of letters how a virtuous servant girl finally constrains her amorous master to marry her: and it is thus the archetype of the commonest kind of novel, that based on the mating process. Richardson's exhaustive treatment of his heroine's psychological states had led him to construct a unified novel out of what would previously have been material only for a short story: and this great extension in psychological depth, continued in *Clarissa: or, the History of a Young Lady* (1747–48), showed how a single personal relationship could be developed to mobilize a rich complexity of larger ethical and social conflicts: *Clarissa* is the first, and one of the greatest, of tragic novels. Finally, in the *History of Sir Charles Grandison* (1753–54), Richardson used the epistolary method for a less intense kind of social and moral analysis.

Henry Fielding was provoked by the sanctimonious moralism of *Pamela* into writing *Joseph Andrews* (1742), a lively comic story about the travels, misadventures and final marriage of Pamela's virtuous brother. *Tom Jones* (1749) is a panoramic novel in which Fielding exhibited his ethical and social views in a large and complex plot; while *Amelia* (1751) is a more sombre treatment of the consequences of marital infidelity and weakness. Fielding is in many ways the antithesis of Richardson: equally serious as a moral and social thinker, his method was essentially humorous, expansive, eclectic and illustrative; it incorporated many elements from the fable, the comic drama and the essay.

The chief immediate successors of Richardson and Fielding were Tobias Smollett and Laurence Sterne. Smollett in *Roderick Random* (1748), *The Adventures of Peregrine Pickle* (1751) and other novels, of which the best is *Humphry Clinker* (1771), developed the primarily comic and satiric novel along picaresque lines: he is most successful, perhaps in the presentation of eccentrics and grotesques, a characteristic tendency since then in the English novel. Sterne, perhaps the most gifted and certainly the most original of the 18th-century novelists, wrote *The Life and Opinions of Tristram Shandy* (1759–67), a witty, indecent and brilliantly prolonged demonstration of how to entertain the reader without ever giving him the novelistic development he expects.

In the later part of the 18th century the reading public expanded and the number of novels produced increased steadily. Few of them, however, were of much importance apart from Oliver Goldsmith's popular and influential *The Vicar of Wakefield* (1766) and Fanny Burney's *Evelina, or a Young Lady's Entrance Into the World* (1778) and *Cecilia: or, Memoirs of an Heiress* (1782), which showed the natural advantages of feminine novelists for delicate social comedy. The sentimental novels of Henry Mackenzie and the Gothic tales of Horace Walpole, William Beckford, Ann Radcliffe and "Monk" Lewis revealed the growing taste of writers and readers alike for strong appeals to the emotions; while toward the end of the century the novel began to be extensively used by Robert Bage, William Godwin and other radicals for overt social and political propaganda.

The Romantic Period.—English romanticism found its main expression in poetry, but Sir Walter Scott's romantic interest in the past brought about the historical novel which soon became extremely popular all over Europe. The first of the series, *Waverley* (1814), shows the clash of the old feudal order of the Scottish Highlands with the rising bourgeois culture of the Lowlands; and Scottish themes inspired the best of his other novels, *Old Mortality* (1816), *Rob Roy* (1818) and *The Heart of Midlothian* (1818).

Jane Austen described her own times and scenes. *Pride and Prejudice* (1813), *Mansfield Park* (1814), *Emma* (1816) and *Persuasion* (1818) are beautifully poised studies of "three or four families in a country village." Combining Richardson's psychological minuteness with Fielding's broader comic method, and basing her plots on courtship and marriage, she initiated one of the greatest and most characteristic traditions of the English novel, that of familiar domestic comedy used to present larger conflicts of moral and social values: George Meredith and E. M. Forster are perhaps her most illustrious successors.

Two other lesser fictional traditions were developed during the romantic period. Mary Shelley's *Frankenstein* (1818) inaugurates the tradition of science fiction on its horrific side; while Thomas Love Peacock's clever and delightful satires, such as *Headlong Hall* (1815) and *Crotchet Castle* (1831), show the capacity of the novel for miscellaneous topical comment.

The Victorians.—During the reign of Queen Victoria the novel became unquestionably the dominant literary genre. The growth of the reading public and the further consolidation of the political, social and literary power of the middle class enabled the great Victorian novelists to command a public of unprecedented size. Largely because readers had much leisure and because the main outlets for fiction were serial publication or sales to the circulating libraries, the Victorian novel was typically very long; many were published in three volumes, and were called "three-deckers." The novel also became family reading, and this made it rather reticent about many subjects, especially sex; more generally, it tended to a comfortably affirmative tone, which often became mawkish and sentimental about the pieties of family life. Nevertheless, now that the Victorian age is beginning to exchange the ignominy of being out-of-date for the prestige of being antique. we can begin to appreciate more justly how its fiction had a broad humanity which remained faithful to the real proportions of experience; never more so, perhaps, than in the humour which is so characteristic a feature of the fiction of the period.

Nor can the major Victorian novelists be fairly accused of complacency. Charles Dickens, for example, was a reformer in everything he wrote, attacking a multitude of social, political, administration and economic evils. There are many things in his novels which modern criticism finds it difficult to defend: the melodramatic oversimplification of goodness and badness in *Nicholas Nickleby* (1838–39), the sentimentalism of *The Old Curiosity Shop* (1840–41), the insular and unhistorical bias of *A Tale of Two Cities* (1859); the rambling and often overcomplicated plots. Yet the intensity and the variety of Dickens' imagination and his unique rhetorical gifts make light of these defects; *Martin Chuzzlewit* (1843–44), *David Copperfield* (1849–50), *Bleak House* (1852–53) and *Great Expectations* (1860–61) give what only the greatest literature can give, a comprehensive, personal and enduring vision of the world.

If Dickens is the greatest novelist of the age, George Eliot's *Middlemarch* (1871–72) is probably its greatest novel. Her great gifts of heart and head united with her supreme insight into individual moral development to produce a vast panorama of a Midland community in transition under her impact of the political, social and economic changes produced by the Industrial Revolution; while at the individual level we see the tragic attrition which time and circumstance bring to the generous enthusiasms of those who, like Dorothea Brooke and Lydgate, and like so many Victorians in real life, wish to devote their lives to bettering the lot of their fellows.

William Makepeace Thackeray was Dickens' chief rival; although his more polished but less intensely committed novels have not worn so well, *Vanity Fair* (1847–48) remains a great and permanent achievement. Anthony Trollope, on the other hand, turned his very lack of emotional or imaginative intensity into an advantage for performing one of the main functions of the novel: a balanced and detailed chronicling of many areas of social life, most notably in the six *Barchester* novels (18jj–67). Of the four novels of Charlotte Brontë, *Jane Eyre* (1847) maintains its peculiarly powerful spell despite its melodramatic sentimentality; while her sister, Emily Bronte achieved in *Wuthering Heights* (1847) an intensely tragic confrontation of the passions of love, jealousy and hatred.

At a somewhat lower literary level are many other Victorian novelists of real interest and importance. Among the countless novels of social and political enlightenment one should at least mention Disraeli's *Sybil: or The Two Nations* (1845), Charles Kingsley's *Yeast* (1851), Elizabeth Gaskell's *North and South* (18jj), and Charles Reade's *It Is Never Too Late to Mend* (1856). There is even an element of social reform in the novels of Wilkie Collins, whose *The Woman* in *White* (1860) and *The Moonstone* (1868) are outstanding examples of the story of mystery and detection, just as Robert Louis Stevenson's later *Treasure Island* (1883) and *Kidnapped* (1886) are classics of the boy's adventure story.

Later in the century, George Meredith's great reputation was based on wit, intelligence and a marked poetic gift; but although *The Ordeal of Richard Feverel* (1859), *The Egoist* (1879) and *Diana of the Crossways* (1885) reveal considerable psychological acuteness and a brilliantly ironic command of the social scene, they now seem to have an almost disabling affectation of manner. The other great novelist of the later part of the century is Thomas Hardy, also a poet and a master of landscape; intensely direct and honest, his tragic novels *The Return of the Native* (1878), *Tess* of *the D'Urbervilles* (1891) and *Jude the Obscure* (1896), despite the use of somewhat obtrusive coincidences to underline the malignity of fate, give a harrowingly veracious picture of the consequences of sexual frustration and social deprivation.

THE AMERICAN NOVEL TO 1880

General Characteristics. — It was in the novel that American literature first developed its individuality and independence. Lacking intrinsic formal conventions, the novel is immediately and directly responsive to its historical and social environment; and that of the United States until after the Civil War could hardly have been more different from Victorian England. The comparative absence of either a rich cultural heritage, or of complex and long-rooted class distinctions, together with the endless differences of habit, speech and attitude which they entail, meant that the immediate social horizon offered the American novelist less opportunity to develop the kind of realistic notation of the social scene which was the basis of the English (and European) novel of manners.

Americans had no "manners" in this sense of the word; but that is not the only reason they did not produce the kind of novel written by Fanny Burney and Jane Austen, Thackeray and Trollope. For, in the last analysis, the novel of manners assumes that the essential values of life emerge from the processes of society; the American novelist, on the other hand, typically felt himself to be alone and quite unable to share the basic assumptions of the people around him: partly because he had no large and cultivated reading public like that in England; partly because his historical past offered him little besides the intransigent moral individualism of Puritanism.

The isolated artist, then, was left with the need to discover his own new world of moral and social values, and he typically attempted the task with a total abandonment to his own personal insight and a very free handling of the traditions of the novel. In an open and endlessly shifting society, of which the life of the frontier was only an extreme example, the loose framework of the romance could suffice, with its picturesque and uninhibiting settings, simplified characterization and episodic plots. For the more speculative and introverted writer the romance could serve equally well, or melodrama's even more simplified rendering of moral and psychological conflict. In either case the novel was stripped of most of its realistically representational baggage—the lonely explorer travels light.

The Early American Novel. — Despite the Puritan objection to fiction as frivolous and worldly, the 18th-century English novels were imported surprisingly quickly after publication. But it was not until 1789 that the first American novel appeared—William Hill Brown's *The Power of Sympathy*. Its epistolary method and its combination of melodrama and sentimentalism reflect the legacy of Richardson. So do the novels of Susanna Rowson (*c.* 1762–1824) and Hannah Webster Foster (1759–1840); but other influences — Fielding, Smollett and Fanny Burncy — appear in many other early novels, such as Gilbert Imlay's *The Emigrants* (1793), Hugh Henry Brackenridge's *Modern Chivalry* (1792–1815), and Royall Tyler's *The Algerine Captive* (1797).

The first original talent is usually considered to be that of Charles Brockden Brown, who was inspired by William Godwin's *Caleb Williams* to write several sentimental and Gothic novels. The best is *Wieland* (1798), where the hero, a cultivated Rousseauist. lives in happy domestic retirement until he is transformed into the murderer of his family and an eventual suicide under the combined spells of a family doom, religious mania and a fascinating Godminian villain who pursues his fell designs on Wieland's peace of mind (and his sister's honour) by means of his skill as a ventriloquist.

James Fenimore Cooper began with an unsuccessful attempt at the novel of domestic manners, *Precaution* (1820). Later he wrote many historical and political novels in addition to the famous "Leatherstocking Tales." Though neither planned as a unit nor written in chronological order, these romances show a coherent and significant development in their hero's life. *The Deerslayer* (1841) and *The Last of the Mohicans* (1826) show Natty Bumppo learning the arts of the hunter and woodsman, and becoming the companion of Chingachgook and other heroic Indians; older in *The Pathfinder* (1840) and *The Pioneers* (1823), he is forced westward before the advancing frontier, and dies in *The Prairie* (1827): progress, represented by mercenary squatters, has made impossible an independent life in harmony with wild nature and primitive but noble Indians. Despite Cooper's many faults of construction, style and characterization, he created one of the great American myths — Natty Bumppo, lonely seeker of a truer way of life which endlessly eludes him.

During Cooper's long literary career — from 1820 to 1851 — the number of novels written greatly increased. Many regional novelists appeared, especially in New England, Virginia, the Carolinas; the best of them, and the most prolific, was William Gilmore Simms (1806–70), who wrote of the Revolutionary War and the life of the southern frontier settlements,

The Mid-19th Century. — Subject and attitude were original in Cooper. but the essential structure of the novel remained derivative, mainly from Richardson, the Gothic novel and Walter Scott. With Nathaniel Hawthorne came a highly idiosyncratic adaptation of romance to the exploration of timeless moral perplexities. In his greatest work, *The Scarlet Letter* (1850) the early New England background is not presented with profuse historical details; and even the laws for the punishment of adultery, on which the plot is based, are used mainly as symbols of how in the light of eternal standards, the Puritan code, like human lams in general, is a crude form of ethical justice which takes little account of the complex and problematic nature of psychological reality. These complex realities are suggested in many ways. Hester Prynne's later serene dedication to good works seems the result of openly acknowledging her sin, but she remains unrepentantly ready to elope with her seducer: while her vengeful old husband, though legally guiltless, has apparently committed a more deadly spiritual sin which is symbolically punished by the mysterious growth of a perverted attraction toward his wife's lover, Arthur Dimmesdale.

Essentially the same method. sparing of concrete incident and detail but rich in suggestion of larger issues, is found in the satire on Brook Farm idealism in *The Blithedale Romance* (1852) and in the slow Gothic drama of the ancestral Puritan curse in *The House of the Seven Gables* (1851).

Herman Melville began with a series of successful narratives of his early adventures in the Pacific — Typee (1846), *Omoo* (1847), *Redburn* (1849), *White-Jacket* (1850). Melville's subsequent attempt to transcend the phenomenal world — to give "more reality than real life itself can show[H]—was begun in Mardi (1849), and developed more fully in *Moby* Dick (1851) and Pierre (1852). It is only after 1920 that the greatness of Moby Dick has been widely appreciated. Its apparent subject is absorbing enough: the ill-fated hunt of a whaling captain, Ahab, for the white whale which made him lose a leg; but, in addition to this narrative interest, and the extraordinary farrago of miscellaneous information about whales and whaling, we soon become aware that we are on a quest for something even more slippery and deeply submerged than Moby Dick. For what, exactly, has been much debated; Melville was probably attempting to symbolize the impious and fatal attempt of Puritan monomania (Ahab) to extirpate what it sees as evil (the whale) even though it is part of God's creation. D. H. Lawrence in Studies in Classic American *Literature* (1923) defined the essential theme of Melville, and of much other American fiction, as the conflict of passion and morality, and the "evil" whale would stand well enough for the mysterious power and beauty of the instinctive elements in man which are under continual attack from the organized repression of Puritanism.

Melville's later works, such as *The Confidence* Man (1857) and the novelette Billy *Budd* (published posthumously in 1924), suggest a deepening disillusion with American society and a melancholy resignation to the fated victimization of natural innocence (Billy Budd) by senseless evil and corruption (Claggart).

Melville and Hawthorne are the giants of mid-19th-century American fiction; but the most influential novel of the period was undoubtedly *Uncle* Tom's Cabin (1852). Its author, Harriet Beecher Stowe, also wrote pleasing studies of New England life such as *The Minister's Wooing* (1859); and this preoccupation with the local scene, which has remained very strong in the tradition of American fiction, mas continued by such writers as the southerner George Washington Cable (1844–1925) in his portrayal of Creole life in Louisiana.

THE MODERN NOVEL

The modern English and American novel, though still distinct in many ways, have been affected by many of the same historical and social influences, while their literary development has been influenced by the fiction of many other countries, notably of France.

Historical Influences.—Many of the differences between the two societies tended to diminish as industrialism and urbanization coloured the whole of American life and as economic expansion and World Wars I and II increased American contact with the rest of the world. In both countries the exploitation of a vastly enlarged reading public by the mass mediums greatly increased the separation between "highbrow" and "lowbrow." This separation, combined with the increasing political and social dominance of a vulgarly philistine class of financiers and industrialists, widened the gap between writers and society almost as much in England as America. No writer since Dickens has been both the best and the most popular; the greatest modern novelists bear on both sides of the Atlantic the same stigmata of alienation and dissent: Henry James, Joseph Conrad, James Joyce and D. H. Lawrence were alike exiles and expatriates.

Literary Influences: Realism and Naturalism.—The increasing separation of the modern novelist from the values and attitudes of his society is reflected not only in the subjects but in the structures of his fiction and in its modes of representing reality. Scott had given the novelist the dignity of the historian; Stendhal aspired to be the chronicler of his century; Balzac, in his La *Comédie Humaine,* set out to be the scientific naturalist of the human species; but it was not until Gustave Flaubert's Madame *Bovary* in 1857 that the novel was given a pattern of conscious technical expertness. The name of realism was soon, and rather unhelpfully, given to the school of Flaubert; it rejected any idealization of "reality" or any concession, in plot and character, to the romantic wishes of the reader or the writer; instead, the novelist was to be a wholly objective recorder of "reality." Realism was thus the logical systematization of the novel's inherent formal assumption—its pretense at the literal, historical truth of what it presents in terms of positivist science.

With Naturalism the process went further. In his Le roman ex*périmental* (1880) Émile Zola codified the analogy of the novelist and the scientist: neither of them selects or creates; they merely study and report. Actually, however, the biological determinism of the Naturalists led them to cut off their "slices of life" so as to show characters and environments which reduced life to the most elementary struggles to survive in a social environment whose irresistible power condemned man's efforts to an untragic futility.

Impressionism and the Stream of Consciousness.—As regards narrative structure, Naturalism tended toward the sprawling and the diffuse. But another literary tendency, and one in appearance quite opposed to it, soon appeared, which was sometimes described as Impressionist by Ford Madox Ford and others. Impressionism follows from Flaubert's concern with objective methods of narration, but its quasi-scientific and epistemological bias also relates it to Realism and Naturalism, although its relativist, empirical and subjective doctrine was one which had arisen in opposition to Positivism. The doctrine was clearest in the Impressionist painters, who theorized that the "real" pictorial reality was not the object as it was known to be, but the object as it appeared to the observer under special conditions of atmosphere and illumination; similarly the literary Impressionists made "point of view" the basis of a technique whereby their novels might be not only more shapely than those of the Naturalists, but truer to the individual's actual experience of life.

This general viewpoint received classical critical expression in the essays of Henry James, especially in the prefaces which he wrote to the New York edition of his novels (1907–09). According to James. a novel should be a "direct impression of life"; since the author himself must not appear, an adequately sensitive recording intelligence was needed within the novel; the novelist must also organize his narrative so that virtually the whole novel could be rendered "scenically" and made to happen under the reader's eyes. Modern critical theory of the novel as a form with modes of operation as complex and precise as those of any other literary genre was thus established by James, and criticism of the novel is still mainly operating within his concepts; among his 20th-century disciples are Percy Lubbock in England and R. P. Blackmur in the United States.

James's notion of narrative point of view as an optically accurate reflection of how individuals actually receive their impressions of life was capable of much further extension; and Virginia Woolf, both in her later novels and in such critical essays as "Modern Fiction" (1919), took the extreme individualist and relativist direction which is often described as "stream of consciousness" or ' interior monologue." Essentially, this attempts to give the reader a series of verbal stimuli which are literal quotations of the flux of impressions passing through the minds of the protagonists. Like any other representational technique this is, in the last analysis, a mere pretense on the part of the writer; but there is no doubt that in James Joyce, for example, or in William Faulkner it is an innovation which has had many triumphs and has now to some extent been absorbed into the narrative idiom of most modern fiction. (See also CRITICISM.)

ENGLAND AFTER 1900

The Edwardian Period.—The influence of the French and later of the Russian novelists began to be felt in England toward the end of the 19th century. George Moore started in the Naturalist tradition, in his Zolaesque *A Modern* Lover (1883), for example, while George Gissing wrote many sombre studies of the darker side of contemporary life, as in The Nether *World* (1889) and New Grub *Street* (1891). Few of the English novelists were much concerned with the problems of technique. however, and their originality came mainly from their content.

This description is on the whole true of the most successful novelists of the Edwardian period—H. G. Wells, Arnold Bennett and John Galsworthy—although Bennett was at first a conscious adherent of the French Realist tradition. In The Old *Wives'* Tale (1908) and Clayhanger (1910), he showed his great capacities as a shrend observer of social and economic life, capacities which he soon turned to making his own fortune by his pen. H. G. Wells wrote novels of many kinds; but his principal aim, in Tono-Bungay

(1909) for example, was to use fiction as a sounding board for his own radical views of social, political and sexual reform. John Galsworthy began his classic exposure of the Victorian upper middle class in *The Man of Property* (1906), which developed into *The Forsyte Saga* (collected in 1922).

In her essay "Mr. Bennett and Mrs. Brown" (1924) Virginia Woolf suggested that all these Edwardian novelists had been much too busy with the material phenomena of life and their notions about changing the world to concern themselves sufficiently with the truth of individual experience. One of their contemporaries, however, was exempted from this charge — Joseph Conrad, a transitional figure whose deeply personal art combined the old and the new: his plots employed the resources of the adventure story and of melodrama and his essential moral themes were fairly traditional, but in such a novel as *Lord Jim* (1900) the method of indirect narration through Marlow exemplified both the Impressionist technique and the relativist and sceptical attitude to life which it ultimately implies. *Nostromo* (1904), *The Secret Agent* (1907), *Under Western Eyes* (1911) and *Victory* (1915) were his other greatest novels.

E. M. Forster, another transitional figure, wrote all his novels except *Passage to India* (1924) before 1914. He used the comedy of domestic manners as his form, but extended its range and added other more modern devices such as the repeated symbol or leitmotiv, as in *Howard's End* (1910); in the liberal humanist tradition, Forster's novels all explored the possibilities of harmony between countries, classes and persons through intelligence, sensitivity and love.

After World War I.—It would be difficult to exaggerate the extent to which this calamity reshaped the ways in which people looked at life: after 1914 it seemed that brutality and increasing social dissolution were the deepest truths about the world, not peace and progress; as for fiction, history had certainly destroyed the leisure and social stability needed for the kind of large-scale development of family and personal relationships on which the Victorian novel had been based.

The two most revolutionary voices among the novelists were those of James Joyce and D. H. Lawrence. They had little in common except the absolute individualism of their lives and their art, which led them both to unprecedentedly frank explorations of private experience. including the animal functions; this in turn brought them bdth into conflict with the law, and thus converted them into notorious public symbols of literary and moral subversiveness.

D. H. Lawrence began with realistic and fairly traditional novels about the mining towns and countrysides of his native Nottinghamshire, such as *Sons and Lovers* (1913), which recorded with harrowing sincerity the conscious and unconscious results of the hero's emotional attachment to his mother. Later Lawrence became impatient with the careful working out of plot and background in the traditional novel and his fiction became a bolder and freer effort to express the instinctive, inarticulate elements in character and personal relationships; *Women in Love* (1921) and *Lady Chatterley's Lover* (1928) are works of great power, insight and truth.

James Joyce began in the aesthetic tradition, with its cult of the lonely, Godlike creator. *A Portrait of the Artist as a Young Man* (1916) is a brilliantly composed picture of its hero's emergence from the restrictions of family, religion and country into the freedom of the artist. *Ulysses* (1922), probably the most influential and original novel of the period, mainly deals with an advertising-canvasser, Leopold Bloom; there are many intentional parallels with Homer's *Odyssey,* whose main function is as an ironical measure of the degradations of modern life; but what gives *Ulysses* its greatest power is the use of interior monologue to reveal the inmost minds and feelings of the characters as they live, hour by hour, through a Dublin day. Joyce's last work, *Finnegans Wake* (1939), attempts, through a new language and a new mythic mode of narrative, to cover the whole of the recurring cycles of world history in the form of a dream by a Dublin public-house keeper, H. C. Earwicker: Joyce's phenomenal powers as a humorist and a master of language are not in question but the merits of his final effort to revolutionize the novel are.

Virginia Woolf was almost as famous an innovator as Lawrence and Joyce. She developed the consistent stream-of-consciousness method of Dorothy M. Richardson *(Pilgrimage,* 1915–38) in *Mrs. Dalloway* (1925), *To the Lighthouse* (1927) and *The Waves* (1931) in a way which revealed a genius for poetic description of mood and atmosphere. Among the other English writers of the 1920s Aldous Huxley was perhaps the most famous for his intellectual, witty and cynical novels of discussion such as *Crome Yellow* (1921), *Antic Hay* (1923), and his larger scale *Point Counter Point* (1928).

Time will perhaps decide that Ford Madox Ford and Wyndham Lewis were underrated in their day. Certainly Ford's *The Good Soldier* (1915) and his Tietjens series (1924–28) are memorable both for their Impressionist method and for their picture of the decay of the English ruling class during the Edwardian period and World War I; while Wyndham Lewis in *Tarr* (1918), *The Apes of God* (1930), and other fictions remained an uncompromising and powerful critic of the life and literature of his times. On the other hand it may be that the great popular successes of Somerset Maugham blinded the critics to the enduring qualities of his novels Of *Human Bondage* (1915) and *Cakes and Ale* (1930).

After the 1920s.—In the novel, as in poetry, the great innovations of the modern period began just before World War I and came to the forefront very soon after it. The subsequent picture was more confused. and no figure with the authority of Joyce or Lawrence established himself. The fiction of the 1930s was much influenced by the atmosphere of political crisis — unemployment at home, Fascism and the menace of war abroad. Its most permanent additions to the traditions of the novel were probably those of George Orwell (1903–1950) and of the Hungarian-born Arthur Koestler (1905–), whose greatness depended less on their literary qualities than on their political insight.

After World War II the tendency was toward fiction on a smaller scale and in more traditional forms, modified by the technical procedures of such pioneers as James, Conrad and Joyce. Graham Greene (1904–) continued to write melodramas with moral and religious overtones; and Ivy Compton-Burnett (1892–) and Henry Green (pseudonym of Henry Vincent Yorke; 1905–) further developed their sophisticated virtuosity.

THE UNITED STATES AFTER 1880

To World War I.—In the United States the greatest successors of Hawthorne and Melville were the very different figures of Mark Twain and Henry James, who came to maturity after the Civil War.

Mark Twain (Samuel L. Clemens) began by turning toward the idyllic past, to boyhood, to the west and to the vernacular riches of folk culture. All these are combined in *The Adventures of Huckleberry Finn* (1884) where, in the kinship of young Huck and Jim the old Negro slave, two innocents aboard a raft floating down the Mississippi, one may see a parable of the beauty and the unreality of "the American dream": to them codes, cultures, institutions, history, are only interferences with the real things of life; happiness must be sought in the harmony which outcasts can achieve with nature and with themselves, but with nothing else; certainly not with what goes on in the settlements along the river banks. The narrative voice — Huck's vernacular — catches the predestined note of such a theme: its naïve simplicities are equally eloquent in their affirmations of happiness and in their ironic rejections of what man has made of man. This style was to be, as Ernest Hemingway later noted and personally demonstrated, the necessary speech of the naive, the pastoral, the masculine and the primitivist strains in 20th-century American fiction.

Twain later became the obsessed spectator of the gilded age (which he named); and in such works as *A Connecticut Yankee in King Arthur's Court* (1889), *The Man That Corrupted Hadleyburg* (1900) and *The Mysterious Stranger* (published posthumously 1916), he revealed an uncontrolled revulsion from his increasingly commercialized society. Henry James lived most of his life in the genteel and cultivated Europe which Twain had begun his career by mocking in *The Innocents Abroad* (1869); but James's most persistent subject was nevertheless a sophisticated version of Twain's idealization of American innocence in its perilous exposure to the traditional charms and the infinitely varied corruptions of the society of London and Paris and Rome. Such, in essence, is the story of *The American* (1877), and *The Portrait of a Lady* (1881); while in later works, including *The Ambassadors* (1903), *The Wings of the Dove* (1902) and *The Golden Bowl* (1904), the same contrast is part of a much more complicated moral pattern.

But the international theme is not, of course, James's only subject, as *The Awkward Age* (1899), *What Maisie Knew* (1897) and *The Princess Casamassima* (1886) attest. What his works have in common is that in all of them James managed to be, very intensely, both a passionately involved moralist and a meticulously detached artist; and his novels consequently invite a strenuousness of attention to the complexities both of their fictional organization and of their ethical implication, which many readers have found too much to give, and to which others have perhaps given too much.

James's friend William Dean Howells was the chief spokesman of the realistic direction which most U.S. fiction began to take after the Civil War. Having realized itself as a country, the United States had to face its problems; they were not unlike those of any advanced capitalist society, and they had already been described by the French Realists and Naturalists. For example, Howells's *The Rise of Silas Lapham* (1885), a study of the attempt of a self-made paint manufacturer to push his family into the Brahmin society of Boston, could well have been treated by Flaubert or Maupassant.

After Howells, Stephen Crane's short career, produced most notably, *Maggie: A Girl of the Streets* (1893), a Naturalist study of the degradation produced by the tenement environment of New York, his famous masterpiece about the Civil War, *The Red Badge of Courage* (1895), and many short stories, such as the impressionistic "The Open Boat."

The chief tendency of the first decade of the new century was an angry Naturalism. Frank Norris planned a vast Naturalist trilogy to be called "The Epic of the Wheat": *The Octopus: A Story of California* (1901), dealt with production; *The Pit: A Story of Chicago* (published posthumously in 1903), concerned distribution; the third part, to be called "The Wolf: A Story of Europe," would have dealt with consumption. Norris' writing was sometimes banal and forced, but he was a writer of great power, perhaps because his belief in the determining effect of the environment was accompanied by an equally marked romantic identification with the sheer vigour of man's struggles—a dualism which also vitalizes his novel *McTeague* (1899).

Much of Norris' Naturalism and his note of violent social protest was echoed by Jack London; but Norris' most important successor was Theodore Dreiser. The realism of Dreiser's *Sister Carrie* (1900) caused it to be withheld from publication until 1912; *The Financier* (1912). *The Titan* (1914) and *The Genius* (1915) are massive and vigorous studies of a successful tycoon, Frank Cowperwood, and show a progressive identification with the values of wealth and power. Less powerful but more prolific, Upton Sinclair's works included Norrislike studies of particular industries; the Chicago stockyards in *The Jungle* (1906), *King Coal* (1917) and *Oil!* (1927).

After World War I.—Edith Wharton, friend and successor of Henry James, developed the well-made novel of manners. As Howells had already showed, U S. society was now richly provided with differences of class and habit and tradition; Mrs. Wharton took brilliant satirical advantage of this in such novels as *The House of Mirth* (1905) and *The Custom of the Country* (1913). Many other writers who had begun before the war made or increased their reputations afterward, notably Willa Cather, Ellen Glasgow (1874–1945), James Branch Cabell and Booth Tarkington; but the most distinctive note of the postwar years was struck by writers who had just come to manhood; the war and the America of Coolidge turned them away from interest in political and social reform and toward the exploration of themselves, and above all of the small groups of like-minded, world-weary yet very convivial dissenters which are a characteristic feature of the life and the fiction of the 1920s.

F. Scott Fitzgerald is the legendary symbol of what Gertrude Stein dubbed "a lost generation," and the most representative voice of the jazz age, whose fortunes are suggested by the arc of Fitzgerald's own literary development, from *This Side of Paradise* (1920), *The Beautiful and Damned* (1922), to *The Great Gatsby* (1925), *Tender Is the Night* (1934) and the unfinished *The Last Tycoon* (1941). The complex economy of *The Great Gatsby* embodies a great theme of the American novel—the corruption and defeat of a naïvely, romantic mid-western emigrant against a setting of the squalors of society both high and low.

Ernest Hemingway's *The Sun Also Rises* (1926; published as *Fiesta* in England) dealt with the American expatriates of Fitzgerald's generation; but in *A Farewell to Arms* (1929), *For Whom the Bell Tolls* (1940) and many other novels and short stories Hemingway's heroes and their idiom—an artfully laconic understatement—exhibit a brutal and increasing alienation from civilization, and form a connecting link between the earlier American primitivism of Cooper and Twain and the "tough guys" of modern popular fiction.

The chief contemporaries of Fitzgerald and Hemingway were Sinclair Lewis and William Faulkner, both, like Hemingmay, winners of the Nobel prize. Lewis wrote realistic and satiric exposures of mid-western life in *Main Street* (1920) and *Babbitt* (1922), of medicine in *Arrowsmith* (1925), and of religion in *Elmer Gantry* (1927). William Faulkner, on the other hand, was a much more original and powerful writer: especially in *Sartoris* (1929), *The Sound and the Fury* (1929), *As I Lay Dying* (1930), *Sanctuary* (1931), *Light in August* (1932) and *Absalom, Absalom!* (1936). Many of his later works, such as the trilogy on the rise of the Snopeses—The *Hamlet* (1940), *The Town* (1957) and *The Mansion* (1959)—continued his study of Yoknapatawpha county, while *A Fable* (1954) is a parable of Christ's Passion.

The depression of the 1930s reinforced the radical and naturalist traditions. John Dos Passos produced a vigorous and original panorama of American life through the first three decades of the century in *U.S.A.* (1938). James Farrell wrote the *Studs Lonigan* trilogy (1932–35), an impressive study of the impact of the Chicago environment on a young man. John Steinbeck's *The Grapes of Wrath* (1939) is a memorable picture of the struggles of emigrant farm workers in California.

Among the other important writers of the 1930s, Thomas Wolfe, with his sprawling autobiographical narratives, demands notice; while it is ironical to observe that the tendency toward the radical proletarian novel had some influence on Erskine Caldwell, whose *Tobacco Road* (1932) and *God's Little Acre* (1933) were to become the world's all-time best-sellers among works of fiction.

After World War II the general level of technical narrative skill was remarkably high, and Thornton Wilder (1897–), James Gould Cozzens (1903–), Robert Penn Warren (1905–), and Walter Van Tilburg Clark (1909–) added to their considerable reputations. *See* also ROMANCE; AMERICAN LITERATURE; ENGLISH LITERATURE; the articles on national literature—FRENCH LITERATURE; GERMAN LITERATURE, etc.; and the biographies of the various authors.

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NOVELLO, the name of a family of English musicians. VINCENT NOVELLO (1781–1861) was born in London on Sept. 6, 1781. From 1796 to 1822 he was successively organist at the Sardinian, Spanish and Portuguese chapels, and from 1840 to 1843 at St. Mary's chapel, Moorfields. He was an original member of the London Philharmonic society, which he sometimes conducted. In 1849 he went to live at Nice, where he died on Aug. 9, 1861. He composed a great quantity of sacred music; but his finest work lay in the introduction to England of unknown compositions by the great masters. The masses of Haydn and Mozart were unknown in England until he edited them, as were also the works of Palestrina and the treasures of Italian music in the Fitzwilliam museum, Cambridge. The first work Novello published, *Novello's Sacred Music, as Performed at the Royal Portuguese Chapel,* in 1811 marks the founding of the publishing house of Novello.

JOSEPH ALFRED NOVELLO (1810–1896), eldest son of the above, was born in London on Aug. 12, 1810, and died at Genoa on July 16,1896. He had a career as a bass singer and in 1829 became a regular music publisher. He really created the house of Novello. He first introduced cheap editions to England and departed from the method of publishing by subscription. His assistant Henry Littleton became a partner in 1861 and, when J. A. Novello retired in 1867, sole proprietor. The firm of Ewer and Co. was acquired in 1867 and with it all the copyrights of Mendelssohn's works then existing. On Littleton's death (1888) his two sons carried on the business. His grandsons also eventually became directors. Novello's grew, and became the sole British agent for many continental music publishers.

CLARA ANASTASIA NOVELLO (1818–1908), daughter of Vincent Novello, was one of the most famous sopranos of her time. She was born in London on June 10, 1818. She won continental as well as English renown after she sang at Mendelssohn's invitation at the Gewandhaus concerts in Leipzig in 1837. She died in Rome on March 12, 1908.

NOVEMBER, the 11th month of the modern calendar, with 30 days. It was the ninth month (Lat. *novem* "nine") in the early Roman calendar, which began with March. The attempt of the Roman senate to rename it in honour of Tiberius provoked his reply, "And what will you do if you have thirteen Caesars?" In the churches of western Christendom Nov. 1 and 2 are celebrated as All Saints' and All Souls' day, respectively, perhaps replacing an old Celtic feast of the dead. *(See* HALLOWEEN.) The end of World War I is commemorated on Nov. 11. In the United States the fourth Thursday of the month is a national holiday, Thanksgiving day (*q.v.*). (F. R. WN.)

NOVERRE, JEAN GEORGES (1727–1810), was a distinguished French choreographer, whose revolutionary *Lettres sur la danse et sur les ballets* (1760) crystallized 18th-century ideas on the need for important reforms in ballet production. Noverre stressed the importance of dramatic motivation, and decried overemphasis on technical virtuosity. Born in Paris, April 29, 1727, Noverre studied under Louis Dupré, made his debut at Fontainebleau in 1743 and danced in Berlin and Lyon. His first notable choreographic success was *Fêtes Chinoises* (Paris, 1754). This production attracted the attention of David Garrick, who presented it at Drury Lane, London, in 1755.

Noverre was court ballet master at Stuttgart from 1760 to 1767, producing such masterpieces as *Medée et Jason* and *Psychk et l'Amour.* He was summoned next to Vienna, where his powerful dramatic ballets *Adele de Ponthieu, Les Horaces* and *Apelles et Campaspe* effectively incorporated his theories. In 1776, on the recommendation of Marie Antoinette, his former pupil, he was appointed ballet master at the Paris Opéra, fulfilling a life-long ambition. He died at St. Germain, Oct. 19, 1810.

Noverre's *Lettres* have been translated into many languages, including English, German, Czech and Korean. His ideas are still valid and constitute an eloquent plea for dramatic expressiveness in the dance.

See Derek Lynham, *The Chevalier Noverre, the Father of Modern Ballet* (1950). (LN. ME.)

NOVGOROD (formerly known as *Velikiy-Novgorod,* Great Novgorod), a town of the R.S.F.S.R., U.S.S.R., in the Leningrad region, in 58° 33' N., 31° 20' E., on the navigable Volkhov, 2 mi. below the point where it issues from Lake Ilmen. Pop. (1959) 61,000. The town has sawmills and manufactures boots and shoes, candles, bricks and tiles and has a brewery and a distillery.

The date at which the Slavs first erected forts in the marshy region of the Volkhov near Lake Ilmen is unknown. That situated on a low terrace close by Lake Ilmen was soon abandoned, and Novgorod or "New-town" (in contradistinction to the Scandinavian Aldegjeborg or Ladoga) was founded by Scandinavian sea-rovers as Holmgård on another terrace which extended a mile lower on both banks of the river. The older fort (Gorodishche) existed in the 13th century. Even in the 9th century the new city on the Volkhov exercised a kind of supremacy over the other towns of the lake region, when its inhabitants in 862 invited the Varangians, under the leadership of Rurik, to the defense of the Russian towns of the north. Down to the end of the 10th century Novgorod to a certain extent depended on Kiev; yet in 997 its inhabitants obtained from their prince Yaroslav a charter which granted them self-government. For five centuries this charter was the bulwark of the independence of Novgorod. From the end of the 10th century the princes of Novgorod, chosen either from the sons of the great princes of Kiev (until 1136) or from some other branch of the family of Rurik, were always elected by the *vyeche;* but they were only its military defenders, and their delegates were merely assessors in the courts which levied taxes for the military force raised by the prince. The *vyeche* invariably expelled the princes as soon as they provoked discontent. Their election was often a subject of dispute between the wealthy and the poorer classes; and Novgorod, which was dependent for its corn supply upon the land of Suzdal, was sometimes compelled to accept a prince from the Suzdal branch instead of from that of Kiev. After 1270 the city often refused to have princes at all, and the elected mayor was the representative of the executive. Novgorod in its transactions with other cities took the name of "Sovereign Great Novgorod" (*Gospodin Velikiy Novgorod*). The supreme power was vested in the *vyeche.* The city, with a population of more than 80,000, was divided into wards, each ward constituting a distinct commune. The wards were subdivided into streets, which corresponded to the occupations of their inhabitants, each being quite independent with regard to its own affairs.

Trade was carried on by corporations. By the Volkhov and the Neva, Novgorod — then known also as Naugart and Novwerden — had direct communication with the Hanseatic and Scandinavian cities, especially with Visby or Wisby on the island of Gotland. The Dnieper brought it into connection with the Bosporus, and it was an intermediary in the trade of Constantinople with northern Europe. The Novgorod traders penetrated to the White sea shores, hunted on Novaya Zemlya in the 11th century, colonized the basins of the northern Dvina, descended the Volga, and as early as the 14th century extended their trading expeditions beyond the Urals into Siberia. Two great colonies, Vyatka and Vologda, organized on the same republican principles as the metropolis, favoured the further colonization of northeast Russia.

It is said that the population of Novgorod in the 14th century reached 400.000, but the pestilences of 1467, 1508 and 1533 carried off no fewer than 134,000 persons. These figures seem to relate rather to the whole Ilmen region.

Invasions of Novgorod.—Novgorod's struggle against the Suzdal region (now the government of Vladimir) began in the

12th century. In the following century it had to contend with the Swedes and the Germans, who were animated not only by the desire of territorial acquisition, but also by the spirit of religious proselytism. Their advances were checked by battles at Ladoga and Pskov in 1240 and 1242 respectively. Protected by its marshes, Novgorod escaped the Mongol invasion of 1240–42, and repelled the attacks of the princes of Moscow by whom the Mongols were supported. It also resisted the attacks of Tver.

The first serious invasion, in 1332, was rolled back with the aid of the Lithuanians. But in 1456 the great prince of Moscow imposed a heavy tribute. Ivan III of Moscow took possession of the colonies in the northern Dvina and the Perm regions, and began two bloody wars, during which Novgorod fought for its liberty under the leadership of Martha Boretskaya, the mayor. In 1475–78 Ivan III entered Novgorod, abolished its charters, and carried away 1,000 of the wealthier families, substituting for them families from Moscow; the old free city then recognized his sovereignty. A century later Ivan IV (the Terrible) abolished the last vestiges of the independence of the city. Having learned that a party favourable to Lithuania had been organized in Novgorod, he took the field in 1570, and entered the city (much weakened by the recent pestilences) without opposition. His follo ers killed the heads of the monasteries, the wealthier of the merchants and clergy, and burned and pillaged the city and villages. No fewer than 15,000 were massacred at Novgorod alone (60,000 according to some authorities). A famine ensued, and the district of Novgorod fell into utter desolation. Thousands of families were transported to Moscow, Nijni-Novgorod, and other towns of the principality of Moscow.

In the beginning of the 17th century Novgorod was taken and held for seven years by the Swedes; and in the 18th century the founding of St. Petersburg (now Leningrad) finally destroyed its trade. Its position on the water highway from the Volga to St. Petersburg and on the trunk road from Moscow to the capital, still gave it some commercial importance; but even this was destroyed by the opening of the Vishera canal, connecting the Msta with the Volkhov below the city, and by the construction of the railway from St. Petersburg to Moscow, which did not reach Novgorod. Later a branch loop linked the town with the main line and its position improved.

Antiquities. — The town consists of a Kremlin (old fortress), and of the city, which stands on both banks of the river, connected by a handsome stone bridge. The Kremlin was much enlarged in 1044, and again in 1116. Its stone walls, originally pzlisades, were begun in 1302, and much extended in 1490. Its historical monuments include the cathedral of St. Sophia, built in 1045–52 by architects from Constantinople to take the place of the original wooden structure (989), destroyed by fire in that year. Apart from minor changes the building remained unaltered until its restoration in 1893–1900. It contains highly-prized relics, including 12th century bronze doors, one brought reputedly from Sigtuna, the ancient capital of Sweden. Another ancient building in the Kremlin is the Yaroslav tower. Other remarkable monuments are the church of St. Nicholas (1135), the Znamenski cathedral (14th century), and churches of the 14th and 15th centuries. Within the town itself there are four monasteries and convents, two of them dating from the 11th century and two from the 12th century; and the large number in the immediate neighbourhood shows the great extent which the city formerly had. A monument to commemorate the 1,000th anniversary of the foundation of Russia (the calling in of the Varangians by Novgorod in 862) was erected in 1862. Another monument commemorates the repulse of the Napoleonic invasion of 1812.

NOVI PAZAR, a town of Deževski, Yugos., at the head of the fertile valley of the upper Rashka, on the site of the ancient Serbian city of Rashka. Pop. (1961) 20,712, comprising Serbs, Albanians and some Greeks. Agriculture is the only industry. There are Roman baths in the vicinity, and in the old church of St. Peter and St. Paul, the metropolitan church of the bishopric of Rashka, Stephen Nemanya founder of the Serbian empire, passed from the Roman to the Greek church in 1143. The town was taken by the Serbs and Montenegrins in the Balkan Wars (1912–13), and assigned to Serbia by the Treaty of Bucharest (1913).

The town was occupied by German troops in 1941.

NOVI SAD (German NEUSATZ), a town of the Vojvodina, Yugos. Pop. (1961) 102.385. It is the seat of a Greek Orthodox bishop, and is a prosperous town with wide, well-paved streets, public gardens, a cathedral, a hospital, schools, theatres and barracks. There is a daily market for household commodities, and for the artistic pottery and cotton goods manufactured in the town. Before the union of the province with Yugoslavia at the close of World War I Novi Sad was the literary and religious centre of the Serbians in Hungary, especially after the foundation in 1864 of the Matica Srbska, or Serbian Literary society. The town was founded in the middle of the 18th century, and was almost totally destroyed during the revolution of 1848–49. During World War II the town was occupied by Hungarian troops.

NOVOCAINE is a proprietary name for procaine, a synthetically prepared local anesthetic, introduced by Alfred Einhorn in 1905 as a substitute for cocaine. It is probably the safest local anesthetic agent for injection anesthesia (infiltration, nerve block and spinal anesthesia). Its penetrating properties are poor. however, and when applied to mucous surfaces it is effective only in dangerously high concentrations. Unlike cocaine, procaine is not a habit-forming drug. (F. O. K.)

NOVOCHERKASSK, a town in Rostov *oblast* of the Russian Soviet Federated Socialist Republic, U S S R., in the North Caucasian region, at the confluence of the Don and Aksai rivers. in 47° 28' N , 40° 5' E. Pop. (1959) 94.000 It manufactures cloth and machinery and is a collecting centre for corn, wine and timber exports Novocherkassk was founded in 1805, when the inhabitants of old Cherkassk were compelled to leave the site because of the frequent inundations of the Don.

NOVOKUZNETSK (formerly STALINSK), a town in Kemerovo *oblast* of the Russian Soviet Federated Socialist Republic. U.S.S.R.. stands on both banks of the Tom river, just below its confluence with the Kondoma, in the Kuznetsk basin (*q.v*) industrial area. Pop. (1959) 377.000 Originally the small village of Ruznetsk. founded in 1617, stood on the right bank. with about 4.000 inhabitants in 1926. In 1929, under the first five-year plan, an iron and steel works was founded on the opposite bank Round the works a new town, Novo (New)-Kuznetsk grew up, which was renamed Stalinsk in 1932. Development was extremely rapid and the fully integrated plant became one of the largest in the U.S.S R The town is now the largest in the Kuznetsk basin; in 1961 its name reverted to Novokuznetsk. As well as iron and steel it produces aluminum. using bauxite from the nearby Salair deposit. Large-scale coal mining is carried on round the town and supplies coking coal for the blast furnaces. There is a chemical industry using by-products, while slag is used in making cement The main heavy-engineering manufactures are mining machinery and bridge girders. Novokuznetsk has metallurgical and pedagogic institutes. (R. A. F.)

NOVOMOSKOVSK (formerly STALINOGORSK), a town of Tula *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R.. lies 40 km. (25 mi.) S.E of Tula. on the shores of (Lake) Ivan-Ozero on the upper Don Pop. (1959) 107.000. Originally the small settlement of Bobriki. the town was founded in 1930 and developed rapidly as a major centre of the chemical industry. In 1934 it was renamed Stalinogorsk In 1961 the name was changed again to Novomoskovsk. It lies in the Podmoskovny coal basin, and lignite is mined there, which is used in a large thermal power station Natural gas. brought by pipeline from the north Caucasus mountains is used in the chemical industry which produces particularly fertilizers. There is a mining machinery factory. (R A F.)

NOVOMOSKOVSK, a town in Dnepropetrovsk *oblast* of the Ukrainian Soviet Socialist Republic, U.S S.R., 16 mi. N.E. of Dnepropetrovsk (Ekaterinoslav), in 48° 38' N., 35° 16' E. Pop. (1956 est) 32,000. It extends some distance along the right bank of the Samara river, a tributary of the Dnieper; its main industry is brickmaking. The Zaporogian Cossacks occupied the site in the 17th century, when it was known as Samarchik. In 1687 Prince

Golitsuin founded the Ust-Samara fort there, destroyed after the Treaty of Pruth (1711), but rebuilt in 1736. Near it is the Samarsko-Nikolayevskiy monastery.

NOVOROSSISK, a town in Krasnodar *krai* of the Russian Soviet Federated Socialist Republic, U.S.S.R., a port on N.E. coast of the Black'sea in 44" 42' N., 37° 45' E.. in the North Caucasian area. Pop. (1959) 93.000. It has connections with the net of Russian railways, with Baku. and with Rostov-on-Don. It has large cement works, and its exports are mainly cement, naphtha, potash: leaf tobacco and champagne, its imports being machinery, coke and coal. The bay, nearly 3 mi. wide at its entrance and 5 mi. deep from east to west, is exposed to the violent northeast wind (bora), sweeping down from the Caucasus.

The town became Russian in 1829.

NOVOSIBIRSK (formerly NOVO-NIKOLAYEVSK), a city and administrative centre, Novosibirsk *oblast,* Russian Soviet Federated Socialist Republic. U.S.S.R., in latitude 55° 6' N.. longitude 83° 6' E., situated on the navigable Ob river, where the Trans-Siberian railway crosses it on a 9 span bridge 30 ft. above high water level. The town was founded in 1896. but in 1959 had a population of 887.000. In 1915 a branch line was opened from Novosibirsk going through Barnaul. with a branch to Bisk. and on to Semipalatinsk, and a link with the railways of the central Asiatic Russian republics was completed in 1930. There is telegraphic communication with Mongolia. The town is a centre for distributing agricultural machinery. There are also grain elevators, one with a capacity of 16,070 tons, and several well set up flour mills. Butter trains, with ice trucks, start daily for the west, and frozen meat is also exported to Leningrad and Moscow.

There are three electric sawmills in Novosibirsk dealing with the timber from this region. The town also exports the woodcock, hazelhen and quails. Other industries are brickmaking, ironsmelting. oil pressing, distilling, brewing and leather preparation.

NOWELL, ALEXANDER (1507?–1602), dean of St. Paul's, London, son of John Nowell of Read hall. Whalley, Lancashire, was educated at Brasenose college. Oxiord, where he is said to have shared rooms with John Foxe. He was elected fellow of Brasenose in 1526. He became master of Westminster school (1543) and prebendary of Westminster (1551). In Mary's reign he was deprived of his prebend. probably as being a married man, before May 1554, and sought refuge at Strasbourg and Frankfort, where he developed puritan and almost presbyterian views. He submitted. however. to the Elizabethan settlement of religion and was rewarded with the archdeaconry of Middlesex. a canonry at Canterbury nnd in 1560 with the deanery of St. Paul's. His sermons occasionally created some stir and on one occasion Elizabeth 1 interrupted his sermon. telling him to stick to his text and cease slighting the crucifix. He held the deanery of St. Paul's for 42 years, surviving until Feb. 13. 1602. Nowell is believed to have composed the Catechism inserted before the Order of Confirmation in the Prayer Book of 1549, which was supplemented in 1603 and is still in use. Early in Elizabeth's reign he wrote a larger catechism, to serve as a statement of Protestant principles; it was printed in 1570, and in the same year appeared his "middle" catechism. designed for the instruction of "simple curates."

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NOWGONG, a town and district in Assam, India. The town (pop., 1951. 28,257) is situated on the Kalang river. 56 mi. E. of Gauhati. It has a college attached to Gauhati university.

NOWGONG DISTRICT has an area of 2,167 sq.mi.; pop. (1961) 1,205,340. It consists of a wide plain overgrown with jungle and canebrakes. intersected by numerous tributaries of the Brahmaputra and dotted with shallow marshes. Elephants are common, but the rhinoceros is becoming scarce; reserved forests cover 530 sq.mi. The Kamakhya hills near the bank of the Brahmaputra are about 1.500 ft. high. On the highest peak is a temple of Kamakhya, a local form of the consort or "energy" oi Siva. where three annual festivals are held. The staple crop is rice. Tea cultivation and manufacture are also carried on. (S. GL.)

NOWY SACZ (NEU SANDEC), town, Poland, in the *wojewodztwo* of Cracow. Pop. (1960) 34,000. It grew to importance through the oriental trade in the 14th century and owed much to the patronage of Casimir the Great. It is near the Carpathians in the valley of the Dunajec, in the country of the Gorale. or Polish Highlanders. It has a church founded by the Franciscans in the 14th century. Germany took the town in 1939. It was returned to Poland in 1945.

NOYES, ALFRED (1880–1958), English poet, was born in Staffordshire on Sept. 16, 1880, and educated at Exeter college, Oxford. The *Loom of Years,* his first volume of poems, appeared in 1902. and his *Collected Poems* in 1910, 1920, 1927 and 1950. His *Forty Singing Seamen* (1907) and *Drake* (1908) struck the patriotic note of a poet of the sea. A volume of lectures given in America. *The Sea in English Poetry,* was published in 1913 and in 1914 he was elected to a proiessorship of modern English literature at Princeton university, Princeton, N.J., which he resigned in 1923. His other publications include: *The Wine Press* (1913); *The Watchers of the Sky* (1912); *Aspects of Modern Poetry,* essays (1924); *The Torch-bearers* (3 vol., 1922, 1925 and 1930; 1 vol., 1937); *Ballads and Poems* (1928); *The Return of the Scarecrow,* novel (1929); *The Opalescent Parrot,* essays (1929); *Voltaire* (1936); *Orchard's Bay* (1939); *The Edge of the Abyss* (1944); *The Accusing Ghost; or Justice for Casement* (1957). He died at Ryde, Isle of Wight, June 28, 1958.

NOYON, a city of northern France, in the *département* of Oise. 67 mi. N.N.E. of Paris by the railway to Brussels. Pop. (1954) 7,030. Noyon is built at the foot and on the slopes of a hill.

Noyon, the ancient Noviomagus Veromanduorum, was Christianized by St. Quentin at the end of the 3rd century; and about 530 St. Medard, bishop of the district of Vermandois, transferred his see there from St. Quentin. St. Eligius was bishop in the 7th century. Charlemagne was crowned there in 768 and Hugh Capet elected in 987. Until the French Revolution the bishopric was one of the ecclesiastical peerages of the kingdom.

At the beginning of the 12th century Noyon obtained a communal charter through the favour of its bishops. Toward the middle of the 12th century the diocese of Tournai was split off. Noyon was ravaged. by the English and the Burgundians during the Hundred Years' War. The city was captured by the Spaniards in 1552. and by the Leaguers who were expelled in 1594 by Henry IV. John Calvin was born there in 1509.

Noyon was bombarded and reduced to ruins, 1917–18. Its transitional Romanesque Gothic cathedral was burned. but a good deal oi its stone work survived the fire and was later restored. The town has trade in livestock and grain and contains chemical works and iron foundries.

NSAW, a West African people known also as Banso, numbering about 52,000, are the largest of the Tikar groups in Bamenda province of British Cameroons. Their kingdom. with its capital at Kimbaw (or Kumbo), is ruled by the *Fon* ("king." pl. *Afon*), whose position is hereditary within one of their exogamous patrilineal lineages. The queen mother (*Ya*, pl. *Aya*) assists in the government and in the hearing of court cases.

The Nsaw practise sedentary farming with fallowing. Maize is the principal crop, supplemented by taro, yams, a white carrot *(Coleus)*, white and sweet potatoes, cassava. guinea corn *(Sorghum)*, finger millet (*Eleusine*), plantains, beans, peas and other fruits and vegetables. Farming is done largely by women, with a short-handled hoe as the main tool. Men clear the high bush, help in harvesting grain crops, hunt, gather honey, raise plantains, tobacco, chickens and goats, provide fire wood and are responsible for house building and thatching. Women trade in local produce, and men make long trading journeys. Some men do wood carving, make baskets or raffia hats, tap palm wine and engage in new crafts such as carpentry, tailoring and brickmaking. Pottery and iron tools are obtained in trade from neighbouring peoples. and cotton cloth from the Hausa of northern Nigeria. European clothing has been adopted by a few, but men generally wear loincloths woven by the Hausa, and women wear string fringes. Islam has been introduced through the Hausa and Fulani (*qq.v.*), but it is estimated that over 80% of the Nsaw follow their traditional religion. They believe in a supreme god who created human beings and is associated with the earth and its fertility. Ancestors are worshiped as intermediaries between god and the living. Diviners consult the black spider (ngam), as among the Bamum.

See P. M Kaberry, *Women of the Grassfields (1952).* (Wi. B.)

NUBA, THE. The Nuba may be regarded as the Negro or negroid aborigines of Kordofan, although at mid-20th century the northern half of the area was inhabited by Arabic-speaking tribes professing Islam, so that Dar Nuba, the country of the Nuba, occupies only the southern half of the administrative province, extending over $2\frac{1}{2}°$ to 10° N. One of the most remarkable features of Dar Nuba is the multiplicity of languages spoken within its bounds. The inhabitants of hills only a few miles apart may speak languages mutually unintelligible, and even on the same *massif* there may be two or three communities speaking different languages and coming little in contact with one another, though their customs and beliefs are fundamentally the same.

The inhabitants of the hills of southern Kordofan situated but little north of the Bahr-el-Ghazal have a series of languages with grammatical structure and vocabularies differing substantially from the Berberine dialects. The resemblances noted between the latter and those of Kordofan apply only to those spoken by a limited number of northern communities which have been subjected to foreign (*i.e.,* Berberine) influence for a considerable period. Moreover, as Meinhof points out, such "Nubian" or "Hamitoid" languages extend scarcely a hundred miles south of El Obeid. Farther south in the territory recognized by the Arabs as the true home of the Nuba (Dar Nuba corresponding on the administrative side roughly to the Jebel subprovince) two groups of languages must be recognized. One includes a number of "Sudan" languages, the other a series of tongues, called by Meinhof "pre-Hamitic," which, in some respects, resemble Bantu and Fulani and which Struck now terms "Bantoid."

Mode of Life.—The Nuba are for the most part agriculturists, the regulation of public life in each community being ultimately in the hands of the rainmaker. There is no clan organization among the southern Nuba and no restrictions upon marriage other than those imposed by blood relationship. No bride-price is paid, and either party can break the marriage at pleasure; property passes in the female line. This applies especially to the southern communities speaking Bantoid languages; farther north, where a bride-price is paid, matters are less simple.

Neither circumcision nor infibulation is practised, but the women of Jebel Talodi and the hills round it perforate the lower lip, in which they wear a quartz ornament. On many hills, especially where the lip ornament is worn, the lower incisors are removed in both sexes.

Darfur.—The non-Arab races of Darfur belong ethnically to, or originated from (many are now mixed) the hill stock, spoken of in Kordofan as Nuba (*supra*). In the north are the Bedayat, a nomad people related to Zaghawa; to the north of these are the Kura'an, who have been identified with the ancient Garamantes. The Zaghawa to the south are mentioned by Mas'udi, while Ibn Khaldun speaks of them as living farther east, and at the present day there is a colony of them at Jebel Kagmar in Kordofan. These folk, although Muslims, have not yet given themselves Arab pedigrees; they retain their belief in rainmakers and are noted as potters. The people of Jebel Midob about 400 mi. west of Khartoum, described by MacMichael, differ but little from the Nuba of Kordofan; they are perhaps the least unknown of the pagan tribes of Darfur. The Tungur and Dargu are other ancient peoples of Darfur, the latter living by cultivation and breeding cattle in the fertile areas to the west of Dara. None of these peoples are as important as the Fur, from whom the country takes its name. Their stronghold is or was the considerable range known as Jebel Marra, whence they descended probably in the 17th century. Now nominally Muslims they still worship stones or trees to the extent that certain spots associated with rocks or trees are regarded as holy and are the scenes of sacrifice.

(C. G. S.)

NUBAR PASHA (1825–1899), Egyptian statesman, was born at Smyrna in Jan. 1825. In 1845 he became first secretary to Ibrahim Pasha, the heir apparent, and accompanied him on a special mission to Europe. Abbas Pasha, who succeeded Ibrahim in 1848, maintained Nubar in the same capacity and sent him in 1850 to London as his representative to resist the pretensions of the sultan, who was seeking to evade the conditions of the treaty under which Egypt mas secured to the family of Mohammed Ali. There he was so completely successful that he was made a bey. In 1853 he was sent on a similar mission to Vienna, where he remained until the death of Abbas in July 1854. The new viceroy, Said, at once dismissed him from office, but two years afterward appointed him his chief secretary and later gave him charge of the important transport service through Egypt to India. Nubar was then mainly instrumental in the completion of railway communication between Cairo and Suez. After falling a second time a victim to Said's caprice and being dismissed, he was again sent to Vienna, but returned as principal secretary to Said, a position he held until Said's death in Jan. 1863.

On the accession of Ismail (see Ismail Pasha), Nubar Bey was charged with a mission to Constantinople to smooth the way for various projects, notably the completion of the Suez canal. The sultan, believing as little as everyone else that the canal was anything more than a dream, gave his consent at a moderate price. The gratified Ismail created Nubar a pasha, and the sultan himself, persuaded to visit Cairo, confirmed the title so rarely accorded to a Christian. Nubar was sent to Paris to complete the arrangements and to settle the differences between Egypt and the canal company.

On his return Nubar created the department of public works; but in 1866 he was made minister of foreign affairs and at once went on a special mission to Constantinople, where he obtained the sultan's consent to the adoption by Ismail of the title of khedive and the change in the law of succession. Nubar now had a harder task to undertake than ever before. The antiquated system of "capitulations" which had existed in the Ottoman empire from the 15th century had grown in Egypt until there were practically 17 *imperia* in *imperio.* That in spite of the jealousies of all the powers, in spite of the opposition of the Porte, he should have succeeded in replacing the 17 consular courts by mixed international courts with a uniform code puts Nubar in the first rank of statesmen of his period.

The extravagant administration of Ismail, for which perhaps Nubar can hardly be held wholly responsible, had brought Egypt to the verge of bankruptcy, and Ismail's disregard of the judgments of the court at last compelled Great Britain and France to interfere. Under pressure, Ismail assented to a mixed ministry under Nubar, with Charles Rivers Wilson as minister of finance and De Blignières as minister of public works. Nubar tried to reduce Ismail to the position of a constitutional monarch, but he lost the support of Great Britain and France and was dismissed. (See Ismail Pasha.) He remained out of office until 1884, when he was induced to become premier as the instrument of British policy, but he soon found himself in disagreement with Lord Cromer and was dismissed by the khedive Tewfik in 1888. Riaz Pasha, who succeeded him, was, with one interval of eight months, prime minister until April 1894, when Nubar returned to office. Lord Cromer was the real ruler of Egypt, and the death of Tewfik in 1890 had necessitated a more open exercise of British authority. In 1895 Nubar completed his 50 years of service and retired. He died in Paris in Jan. 1899.

NUBIA, a region of northeastern Africa, between upper Egypt, the Red sea and the Libyan desert and extending south indefinitely to about Khartoum. It includes the Nile valley from Aswan near the First Cataract to the confluence of the White and Blue Niles, stretching for about 560 mi. between latitudes 16° and 24° N. Nubia, however, has no strictly defined limits and is little more than a geographical expression. Its name is derived from nob (slave) in the Mahas dialect of the language known as Nubian. of which four different dialects are spoken between Aswan and Dongola.

The first historical mention of the Nuba is in Strabo, Geography, book 17, ch. 1 and 2, where they are described as "a large tribe, who beginning at Meroe, extend as far as the bends of the river and are not subject to the Ethiopians but are divided into several separate kingdoms."

The country consists mainly of sandy desert and rugged and arid steppes and plateaus through which flows the Nile. In this section of the river there occurs a continuous series of slight falls and rapids, and between Khartoum and Philae it makes a great S-shaped bend, the region west of the Nile within the lower bend being the Bayuda desert and that east of the Nile 'the Nubian desert, which districts roughly correspond to the conventional divisions of upper and lower Nubia respectively. Most of Nubia is within the almost rainless zone. An auriferous district lies between the Nile and the Red sea, in 22° N. Politically Nubia is now divided between Egypt and the Anglo-Egyptian Sudan and has no administrative existence.

The life and agriculture of Egypt and the Sudan depend upon the Nile (*q.v.*), which, for a great part of its course, flows through Nubia. The railway from Alexandria and Cairo terminates at El-Shellal and is joined by a steamer service with Wadi Halfa. The Sudan railway system connects Wadi Halfa, Atbara, Port Sudan, Kassala, Gedaref, Sennar, Kosti and El Obeid. Kosti is connected by river steamer and road with east Africa. (D. M. H. E.)

ARCHAEOLOGY

In Nubia the early Stone Age ran its usual course. Pre-Chellean tools occur at Wadi Halfa and at Nuri below the Fourth Cataract. Chellean tools are found at Wadi Halfa, between the Second and Third Cataracts at Sai Island and Wawa, in Wadi Hudi near the mouth of the Atbara river and near Omdurman. Acheulean tools occur near Wadi Halfa, at Lagiya in the Wadi el-Gaab and at Omdurman. Early Levallois occurs near Tangāsi between the Third and Fourth Cataracts; and Acheulean-Levallois hybrid cultures near Wadi Halfa, at Selima oasis, north of Abri and, in the Tumbian form, at Omdurman.

The Levalloisian technique lasted long. It is seen in the Sebilian culture from Kom Ombo and in surface finds all over Nubia; and it still affected cultures at the beginning of the historic period.

Fossils have been found associated with the Sebilian at Wadi Halfa. In the Upper Sebilian, microliths become dominant, suggesting the Capsian culture from North Africa with its backed-blade technique. Similar microliths are widely found on the surface; and at Khartoum a culture with Capsian connections and indistinguishable from the Wilton of South Africa occurs with bone spears with four or more barbs, barbed bone arrowheads and red-ware pottery bowls decorated with wavy-line impressions made by a catfish spine. The makers were Negroes who lived by hunting and fishing. They had no domestic cattle and did not cultivate. This culture has been found as far north as the Fourth Cataract and between Wadi Howar in the west and Kassala in the east.

It mas followed between Jebel Aulia and the Second Cataract by one in which gouges, celts and amazon stone beads, all typical of the Fayum Neolithic, occur with pottery. most of which is burnished and the most typical of which is a hard red ware decorated with triangular impressions in a pattern imitating basketwork. This pattern developed out of the wavy-line pottery of Early Khartoum. Early forms of black and black-topped red ware occur; and shards burnished after combing or incision show how easily rippled ware could have developed. With this Khartoum Neolithic culture occur zeolite lip plugs, notched fishhooks of shell and bone harpoons, most of which have four or more barbs and a perforated butt and resemble examples from Taferjit and Tamaya Mellet in French West Africa. The next culture so far known is one nith pottery sometimes decorated with ripples made by pebble burnishing over combing. One such pot found at Omdurman is identical in all but size with one from the A-group cemetery at Faras near Wadi Halfa. which has been dated to the reigns of Zer and Zet (about 3000 B.C.) by pottery and copper tools imported from Egypt. At Omdurman about 18 pots were buried in each grave. Gourd shapes were common and small deep bowls. Large deep bonls of coarse red ware decorated with squares alternately plain or hatched by impressions made by catfish spines show connections with both Early Khartoum and the Gerzean of Egypt.

Rock pictures are frequent along the Nile between the First and Third Cataracts, and while no doubt a few representing wild animals date from the prehistoric period, all historic periods are represented. Sites of the earlier Egyptian predynastic have not been found south of Dakka. There is on a rock near the Second Cataract an apparent reference to the conquest of lower Nubia by Zer, third king of the 1st dynasty, and Egyptian imports dating from his and the succeeding reign were found in the neighbouring A-group cemetery of Faras. Lack of sites in Nubia associated with the Old Kingdom may be because of the activities of those Pharaohs: the earliest historic reference to Nubia is to a raid by Seneferu (c. 2750 B.C.) who built ships and "hacked up" the land of the Nehesi (*cf.* modern Mahas) and brought back many prisoners and cattle; it is probable that such raids devastated a land in which civilization had flourished during the Neolithic and predynastic periods. Under the 5th and 6th dynasties (2500–2300 B.C.) Egypt's contact with the south became rather more peaceful. Although under Pepi I military expeditions had been led by Uni to the Nehesi lands of Irthet, Medju (cf. modern Beja), Yam. Wawat, Kau and the land of Temeh, nevertheless Herkhuf of Elephantine made four trading expeditions during the reigns of Merenre and Pepi II, as far as Yam (Darfur ?), returning with donkeys laden with incense, ebony, leopard skins and ivory.

After the fall of the Old Kingdom a cattle-owning people (the C-group) came into the area between the First and Second Cataracts and survived until the beginning of the 18th dynasty. They lived on the river bank in settlements of round huts of wood and grass and buried their dead beneath mounds of earth protected by circular walls of dry stone. They wore leather clothing; and bowls of black or brown ware, decorated with elaborate incised patterns often filled with white and later with coloured pigments, are characteristic of their pottery. Under the 11th dynasty Egypt turned its attention to the south again. An inscription near Aswan records the dispatch of ships to Wawat.

The first Pharaohs of the 12th dynasty, Amenemhet I and Senusret I, occupied Nubia as far as Semna, about 50 mi. S. of the Second Cataract. Communications with Egypt were protected by massive mud-brick forts. A trading post was built probably in the reign of Amenemhet II (1938–04 B.C.) at Kerma at the downstream end of the Dongola reach and 150 mi. S. of Semna. Kerma was probably the home of the chief of Cush. In graves excavated locally the principal occupant was laid in native fashion on a bed in a large low tumulus, while women and retainers, sometimes numbering hundreds, were buried alive with him. It is in any case most unlikely that G. A. Reisner was correct in thinking that it was the headquarters of successive Egyptian governors. The Egyptian statues found in these graves were presumably traded to the princes of Cush by Egyptian merchants during the Second Intermediate period (c. 1700 B.c.). At Kerma Egyptian craftsmen developed local industries. They made exquisitely fine burnished black-topped red pottery never again equalled, objects in faience and quartz decorated with blue glaze and short copper swords with ivory hilts.

The southern group of Egyptian forts (Mirgissa, Shelfak. Uronarti and Semna) were probably built by Senusret III (c. 1887–50 B.c.) after a local rising. Until the 13th dynasty the level of the Nile flood was recorded at the forts at Semna. These levels show that the Nile was 26 ft. higher in flood then than it is today, and the rainfall must have been greater than now to provide grazing for the C-group cattle and to allow tribes to live on the west bank in what is now desert.

At some period subsequent to this, and probably connected with the expulsion of the Hyksos from Egypt, these forts nere all destroyed by fire. Shards of C-group and Pan-grave pottery and stone axes copying bronze axes typical of the 17th dynasty have been found as far east as Agordat in Eritrea.

Ahmose I, the founder of the 18th dynasty, began the reoccupation of Nubia and built a temple at Buhen (Wadi Halfa); and his successor Tuthmosis I occupied the whole of Cush at least as far as 50 mi. S. of Abu Hamed. where he set up a boundary inscription. Cush was now incorporated in Egypt under a viceroy, whose first duty was to dispatch the tribute of Nubia to

Egypt. Informative representations of the arrival of this tribute in Egypt may be seen in tomb and temple at Luxor. Almost every Pharaoh founded a town or built one or more temples in Nubia from the local sandstone. The most splendid was that at Sulb dedicated to Amon and himself by Amenhotep III, who also built a smaller one at Seddenga for the worship of his queen Tiy. Other temples include those built by Hatshepsut at Buhen, Tuthmosis IV at Barkal, Amenhotep IV at Sesibi and Tutenkhamon at Faras and Kawa.

The construction of temples was continued under the 19th dynasty. Rameses II built two great rock-hewn temples to himself and his queen at Abu Simbel, and also temples or shrines at Gerf Hussein, Beit el-Wali. Wadi Sabu'a, Dirr, Ibrim, Faras and Aksha in lower Nubia; and his name occurs at Amara West. Sai, Kawa and Jebel Barkal in upper Nubia. In places, as at Kawa, he was not above erasing the name of the original builder and substituting his own. Seti I built the town wall at Amara West and probably built the original temple, to which various kings up to Rameses IX made additions. The known antiquities of Nubia under the New Kingdom are entirely Egyptian. They include at Aniba tombs built with pyramidal roofs like those at Deir el-Medina; and farther south inscriptions at Tangur, Dosha, Nauri, Tumbus and Kurgus.

From the period between 1100 and 750 B.C. nothing is known. Napata seems to have been still Egyptianized when in 750 B.C. Kashta set himself up there as king of Cush and conquered upper Egypt, founding the 25th dynasty. Reisner on slight evidence concluded that this dynasty was Libyan. Piankhi (*c.* 725 B.C.) included the rest of Egypt in his empire, and Shabaka his successor transferred the capital to Thebes and was known as king of Cush and Egypt. Piankhi built the great temple of Amon at Napata. The only monuments of Shabaka and Shebitku (Shabataka) in Nubia were their pyramids at Kurru. All the pyramids in this cemetery are now ruined, but the painted chambers of Tanutamon and his sister Kalhata are preserved. The burial chamber was excavated in rock below ground level, approached from the east by a stairway cut in the rock. The pyramid was built on ground level above the chamber and had a small mortuary chapel on its eastern face. (These chapels have all disappeared at Kurru and Nuri, but some of those at Meroe remain, and the designs with which they are decorated are of considerable interest and importance.) Taharka built more than one temple at Napata, carved four colossal figures out of the face of Jebel Barkal and built the largest pyramid of a new cemetery at Nuri. A disastrous clash with the Assyrians, who were armed with iron weapons and had recently included Palestine in their empire, led to the evacuation of Egypt by Taharka. His successor Tanutamon temporarily reoccupied upper Egypt, but was soon forced to abandon it (661 B.C.). The dynasty, ho ever, continued to reign, first at Kapata (with a palace at Meroe) and subsequently at Meroe, for about 1,000 years. The immediate successors of Tanutamon (Atlanersa, Senkamanseken, Anlaman, Aspalta, Amtalka and Malenakan, *c.* 653–538 B.C.) were able to construct pyramids and temples in the pure Egyptian style. A temple at Jebel Barkal was begun by Atlanersa and finished by Senkamanseken. The sun temple at Meroe (mentioned by Herodotus) was built by Aspalta; and the temple of Amon at Meroe was apparently built by Aspalta, Amtalka and Malenakan.

It is not unlikely that Meroe became the political capital soon after the loss of Egypt. although the kings were buried at the old religious capital of Napata up to Nastasen (c. 308 B.C.). The kingdom no doubt stretched as far as Sennar, where a scarab of Shabaka has been found, and Jebel Moya, where objects dating from Taharka to Aspalta and later were discovered: and it is reasonable to suppose that from Sennar it extended to the gold country of Beni Shangul, and from Jebel Moya to the Shilluk country on the upper White Nile.

In lower Nubia, there are the graffiti of Greek and Syrian mercenaries of Psammetichus II (594–589 B.C.) at Abu Simbel and Buhen in the reign of Aspalta. The Persians are said to have invaded Nubia under Cambyses in 522 B C. but of this there is no evidence, although Nubians with carnelian-tipped arrows served in the army of Xerxes.

From his study of the royal cemeteries of Napata and Meroe, Reisner constructed a king list covering this period. Twenty kings and some of their queens were buried at Nuri, and all their names have been recovered. Forty-one rulers, who succeeded them, of whom 23 have been identified and 4 or 5 were queens, were buried from 300 B.C. in pyramids at Meroe. Reisner thought that during this later period there were two occasions when Napata was for a time independent of Meroe and its rulers buried in the earlier of the two groups of pyramids at Jebel Barkal. But there is some doubt about this, although the names of four kings did turn up at Kawa that were not found at Meroe. Ergamenes (225–200 B.C.) built the temple of Dakka and imported an Egyptian scribe to decorate his tomb chapel. He and his successors (who built six large pyramids) represent the most prosperous period of Meroe, when relations with Ptolemaic Egypt were friendly. But, cut off from Egypt, the Egyptian culture of the kingdom naturally degenerated. The Meroitic cursive script was invented before 200 B.C. When it was in general use, the knowledge of Egyptian and Egyptian scripts was quickly lost. Soon after 150 B.C. the Meroitic hieroglyphic script was invented for decorative inscriptions. The traditional offering scenes, which occur on the older pyramids, were now varied, giving them a distinctive Meroitic tinge. Degeneration was continuous until 45 B.C., when Queen Amanishakhete came to the throne. In 23 B.C. Gaius Petronius had invaded Napata with a Roman army as a result of frontier trouble in lower Nubia, when the statue of Augustus had been looted from Syene (modern Aswan). He destroyed Napata and, retiring, left a garrison at Ibrim. Queen Amanishakhete is buried in the second largest pyramid, in which Giuseppe Ferlini found a hoard of treasure. Her successors, King Natakamani and Queen Amanitere (15 B.C.–A.D. 15), repaired the temple of Amon at Meroe, built two temples at Naga, a temple at Wad Ban Naga and one at Amara East—the last two disappeared during the 19th century—and restored the great temple of Amon at Napata. The colossal royal statues on the temple site on Argo Island probably belong to this period. From this date degeneration was unchecked. The pyramids get gradually smaller, red brick eventually replacing stone in their construction. Red brick was much used for building in the latter centuries at Meroe, and in the last palace it was used in a crude imitation of a Roman bath.

Nubia entered the Iron Age during the Meroitic period. A few manufactured iron objects were imported in the 6th century B.C., but by 480 B.C. Nubia was still practically without iron. Pyramid foundation deposits first include iron about 360 B.C., when it probably began to be smelted at Meroe, although remaining a royal monopoly for several centuries. Meroitic pottery at Faras was predominantly wheel-made with some elaborate painted designs in the 2nd century A.D. To the same date belong fine ware, with repeated impressions of small stamps with designs such as the ankh. and imported barbotine cups. Handmade pottery including black ware with impressed designs filled with red or yellow pigment also occurred and was probably more frequent in the south. Artificial reservoirs in the island of Meroe. some of them associated with small temples (as at El-Musawwarat, Naga, Hardan, Awateib, Basa, Duanib and Umm Usuda) and in the Gezira were a feature of the Meroitic period and suggest decreasing rainfall.

The last record of the kings of Meroe is a demotic inscription from Philae recording an embassy of King Tekerideamani in A.D. 253. The knowledge of writing died out. There are no inscriptions on the walled group of temples at El-Musawwarat. The Blemmyes of the eastern desert (Beja) destroyed the Meroitic culture in lower Nubia; and Meroe itself was destroyed c. AD. 350 by an expedition dispatched by Aeizanes, king of Axum, to crush a trade rival.

The Meroitic culture is followed in Nubia by one attributed by Reisner to the X-group. These may have been the Nobatae, a name possibly derived from confusion betneen Nuba and Napata (the "Red Nuba' of Aeizanes). They replace the northern kingdom of Napata, which had twice made itself independent of Meroe. The X-group tumulus is a direct descendant of the Meroitic pyramid, and X-group pottery is in the Meroitic tradition. X-group cemeteries occur at Napata (Zuma and Tangāsi) and at Wawa, Sai Island. Firka. Atiri, Gemai, Adindan, Ballana, Kustul. Ibrim and Kalabsha. The royal cemeteries at Ballana and Kustul covered two centuries. The kings were buried with Meroitic insignia, and human beings and animals were sacrificed to accompany them. Grave goods included imported Byzantine objects; but no evidence of a written language was found. In the Meroe area graves contemporary with the X-group contain many large handmade mat-impressed pots and smaller bowls burnished and decorated with incisions near the rim. Large mound graves of this period are common as far south as Khartoum. The X-group have also been identified with the Blemmyes, who from the 3rd century had continually troubled Egypt and by the jth century were established at Talmis, combining with the Nobatae to raid upper Egypt. They were compelled by Florus in A.D. 452 to keep the peace but were allowed to visit the temple of Philae and to borrow the statue of Isis.

About A.D. 540 the Nobatae were converted to Christianity, and shortly after that. at Kalabsha, their king Silko, now a Christian, records his defeat of the Blemmyes and of the upper Nobatae (of Napata?). After this the capital of the Nobatae seems to have been at Pachoras (Faras), until they were amalgamated with Makuria in the single Christian kingdom of Dongola. South of that was the kingdom of Alwa with its capital at Soba near Khartoum. Alwa had become Christian in A.D. 580.

In A.D. 652 a Moslem army from Egypt captured Dongola and compelled the kingdom to pay tribute to Egypt. Arabic historians often mention relations between Egypt and Nubia; but the kingdom of Dongola remained Christian until the 14th century, when it was overrun by Mameluke armies from Egypt. The stone castles of Nubia (Sai, Khandag, Bakhit, etc.). which show crusader influence, date from the unsettled period beiore the final fall of Dongola. Soba survived for another two centuries, and then gave place to the Moslem Fung kingdom of Sennar.

The churches of Nubia were small, when not adaptations of heathen temples. Some were built of stone masonry, but brickwork was commoner. In the north there were two principal types, basilican and domed, and mud brick was usual: whereas in Dongola a typical church had red brick walls with a roof supported by four granite monolith columns with separate granite capitals. Mural paintings covered the walls. Little now remains of any of these churches except one or two small mud-brick buildings in out-of-the-my places (*e.g.*, the church of Abdelgadir near Wadi Halfa), and the ugly atypical fortified church at Old Dongola, which owes its preservation to its conversion to a mosque in the 14th century. In Dongola in the Christian period graves frequently had a rectangular stone superstructure with tombstones inscribed with Greek letters and either Greek or Coptic inscriptions; and circular stone cairn graves of the same period also occur as far south as Khartoum and west across northern Kordofan. Rare inscriptions of Old Nubian in Greek characters have also been found. Pottery in the Meroitic tradition continued in the Christian period, the best being a thin ware coated with a white slip and decorated with designs in sepia.

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NUBIAN LANGUAGE AND WRITING. Nubian is the name given to the language of the Barabra or Nubians in the Nile valley, between Merawi, a few miles below the ancient Napata, and the First Cataract at Aswan. It has there two principal dialects: the Mahass-Fadija being spoken in the central portion, from a little south of the Third Cataract, and the Dongola-Kenuzi at both ends of the region.

Languages related rather closely to Nubian of the Nile valley are spoken in the hills of Kordofan and as far westward as eastern Darfur. This entire area is considerably south and west of the portion of the Nile valley in which Nubian is spoken and probably represents the point of origin of Nile Nubian. The entire Nubian group belongs to the large Macro-Sudanic family of languages spoken in East and Central Africa. (See AFRICAN LANGUAGES.)

The speakers of Nile Nubian are at present Moslems and their language is penetrated with Arabic borrowings. During the medieval period, however, they were Christians and the Nubian Church was affiliated with the Coptic Church of Egypt with its patriarch in Alexandria. These Nubians adapted the alphabet of the Egyptian Copts, in turn derived from the Greek alphabet, to their own language. The documents which are generally of a religious character and translated from the Greek are of great linguistic interest as representing the only language at present spoken by Negroes from which indigenous records antedating the modern period are to be found. The language appears to be directly ancestral to the modern dialect of Mahass-Fadija. The writings date from the end of the 8th century to the beginning of the 14th century.

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NUBIANS: see BARABRA.

ÑUBLE, a province of central Chile, includes segments of coastal range, central valley and cordillera. Area 5,487 sq.mi., pop. (1952) 251,342. Ruble, formed in 1848, was altered significantly in area in 1927 when Itata department was transferred from Maule province (*q.v.*). Chillán, founded in 1580, is the provincial capital; pop (1952) 48,543. Together with San Carlos (11,094), Bulnes (5,147), Yungay (2,575) and Quirihue (2,930), it is a departmental seat.

The provincial economy is stimulated by the Chillán plan, a comprehensive rural improvement program operated by Chilean and U.S. agronomists. The vine, wheat. edible legumes, fruit and livestock are important. Industry, chiefly in Chillán, is concerned with food processing, milling (grain and lumber), tanning and shoe manufacturing. The city's recovery from the catastrophic 1939 earthquake is advanced; new public buildings and the cathedral are striking. Chillin's open-air market is perhaps the most colourful in Chile. The state railway, which traverses the centre of the province, has branches that lead to Tomé and Concepción and into the cordillera. Minor beach resorts, the cordilleran spa of Termas de Chillbn and ski lodges near Chillán volcano are recreation areas. Chillbn Viejo (4,033) is the birthplace of Bernard O'Higgins and Ninhue is the birthplace of Arturo Prat, Chile's most celebrated naval hero. (J. T.)

NUCERIA, an ancient city, Magna Graecia, on the west coast of Italy near the modern Nocera Tirinese. It was a small city in an important strategic position between two rivers, the valley of one of which afforded a route to the valley of the Crathis, but had no harbour.

NUCLEAR ENGINEERING is concerned primarily with the design, construction and operation of nuclear reactors. It became clear during the 1950s that substantial numbers of specially trained engineers are needed for the development of nuclear power and its associated industries. The working methods of nuclear engineering are derived from physics and the older engineering fields, but special techniques have had to be developed to solve the unique problems encountered in dealing with nuclear fission, and many of these are surveyed in this article. The physical principles of nuclear fission are discussed in the articles ATOM; ATOMIC ENERGY and NUCLEUS. This article consists of the following sections:

I. INTRODUCTION

Nuclear reactors are devices which yield large amounts of heat and radiation and nhose existence depends upon the availability in nature of one particular isotope of uranium known as U^{235}. This is a rare isotope, since in natural uranium it is outnumbered approximately 140 to 1 by another isotope, U^{238}.

Uranium containing higher proportions of U^{235} is artificially produced in large gaseous diffusion plants. A gaseous compound of uranium is pumped through barriers containing very small openings, and since the lighter atoms of U^{235} have. on the average, slightly higher velocities than those of U^{238}, they slip through the barrier a bit more easily, thus increasing their concentration. Repeated often enough, the process yields uranium with almost any desired degree of enrichment in U^{235}.

The special property of U^{235} is that it easily undergoes nuclear fission. When a single slow-moving neutron collides nith an atom of U^{235}, it becomes suddenly so unstable that it splits violently into two major fragments accompanied on the average by two or three extra neutrons. There is a large release of energy, contained mostly in the kinetic energy of the fragments, nhich is quickly dissipated as heat. The energy release is so large by ordinary standards that the heat from the fissioning of all of the atoms of 1 lb. of U^{235} is as much as from burning 1,500 tons of coal.

Since neutrons are expelled in the fissioning process, it is possible for one fission to initiate another, and this another, and so on, thus creating a chain reaction. Basically, therefore, a nuclear reactor is designed to permit a self-sustaining and controlled nuclear chain reaction and to remove safely the heat which is generated.

Of the tno to three neutrons that are released in each fission, at least one must be successful in producing another fission if the chain reaction is to persist There are two main reasons why this is difficult to accomplish with natural or with only slightly enriched uranium. Instead of colliding with another of the widely-spaced U^{235} atoms, the neutrons may escape from the uranium altogether, or they may strike and be absorbed by one of the U^{238} atoms. Although a fast neutron will occasionally cause fission of U^{238}, a chain reaction in natural uranium is impossible. It is found. however, that if the neutrons are slowed to a tiny fraction of their initial speed, they are much more likely to cause fissions of U^{235}, and it is then possible to sustain a chain reaction in natural uranium. The device for slowing the neutrons is called a moderator.

The moderator is either mixed with the uranium or, if the uranium is in the form of a latticework of solid fuel elements, the moderator occupies most of the intervening space. It must meet two primary requirements: first, it must be a very poor absorber of neutrons so that, when neutrons collide with its atoms, they are not lost; second. its atoms must be as small as possible—in other words. as near to the weight of the neutron as possible—so that the rapidly-moving neutrons, through a series of "billiard ball" collisions, will lose almost all of their speed. The neutrons are then moving with small energies nearly in equilibrium with the average kinetic energy of the molecules of the moderator, and they are referred to as thermal neutrons.

A chain reaction, therefore, occurs if the neutrons released from any single fission bounce around often enough among the moderator atoms, without escaping or without being absorbed, and are slowed enough so that eventually at least one collides with another atom of U^{235} and causes it to undergo fission. When the number of neutrons moving in this manner in the reactor remains constant from one generation of fissions to the next, the reactor is said to be "critical." If, on the average, neutrons are being lost, the system is "subcritical," and the chain reaction will not sustain itself. If the density of neutrons is increasing. the system is "supercritical," and the rate of energy release will increase. Control of the reactor is accomplished by introducing materials which readily absorb neutrons, such as cadmium or boron. These may be in the form of control rods which can be withdrawn sufficiently for the reactor to become "critical"

The fission products (the fragments which result from fission) in a reactor are a nuisance. There are about 40 different ways in ahich U235 may split, so that as the chain reaction proceeds, a variety of elements accumulate in the remaining uranium, most of them intensely radioactive—many of them strong absorbers of neutrons. To protect against the radiation, the reactor has to be surrounded by thick, heavy shields. The gradual increase within the reactor in the amount of this neutron-absorbing material must be taken into account in the design of the control system

Although U^{235} is the only easily fissionable material found in nature, it is fortunately possible to produce others. If nuclear energy depended solely on U^{235} fissions, it would be far less interesting as a new source of fuel for power generation. The more abundant atoms of U^{238} may become easily fissionable by converting them to isotopes of plutonium, Pu^{239}. This conversion may take place over a period of several days through a series of nuclear transformations when U^{238} absorbs a neutron. A nuclear reactor in which a chain reaction is being sustained may, therefore, at the same time be producing new fissionable material. In fact, when it is possible for a second neutron from each fission to find its way into an atom of U^{238} and convert it to plutonium, thus renening the supply of fissionable material at the same rate that it is being consumed, the energy available from natural uranium is multiplied theoretically by a factor of approximately 140. A reactor which accomplishes this is called a breeder; the U^{238} in this instance is referred to as fertile material.

The production of plutonium, without attempting to utilize the energy release, mas the specific purpose of the first big reactors ever built, located at Hanford, Wash. When these reactors were first put into operation their success seemed doubtful because the chain reaction tended to cease nhen the power level was increased. This was determined to result from the build up of one particular fission product, an isotope of xenon, having an affinity for neutrons. The solution to this problem and the subsequent successful operation of the reactors nas one of the exciting accomplishments of World War II.

Th^{232}, the predominant isotope of thorium found in nature, is also a fertile material, since a neutron absorbed in Th^{232} gives rise to a conversion to still another isotope of uranium. U^{233}, also easily fissionable. Thus, a reactor containing enough U^{235} to support a chain reaction and Th^{232} as a fertile material may also become a breeder.

In summary, therefore, a reactor will ordinarily consist of fissionable material, a moderator, control rods, shielding and fertile material. In addition, there must be structural materials and mechanisms for removing the heat which is produced.

II. NUCLEAR REACTOR PRINCIPLES

1. Multiplication Factor.—The "effective" multiplication factor is a useful concept for studying reactor behaviour. It is sometimes called the criticality factor and may be defined as the ratio of the number of neutrons present following any one generation of fissions to the number present following the immediately preceding generation. If the effective multiplication factor, represented by k_{eff}, is unity, the reactor is critical, and the chain reaction is self-sustaining. If k_{eff} is greater than 1, the neutron density will increase; and if k_{eff} is less than 1, the neutron density will decrease.

Since neutrons are always lost at the boundaries of a reactor, it is convenient to study first a reactor of infinite dimensions, thus making it possible to ignore temporarily the leakages of neutrons through the boundaries. In this case the multiplication factor is called **k,,** and the determination of its value is a major part of nuclear reactor design.

As shown by the equation **k,** $= \eta\epsilon p f$, its value may be expressed as the product of four factors: η is the number of neutrons produced per thermal neutron absorption in fuel, *i.e.,* in the fissionable atoms (this number is smaller than the neutrons released per fission because some of the neutrons are absorbed in fuel without causing fission; ϵ is the fast fission factor, defined as the ratio of the total number of neutrons produced, including the additional production of neutrons by a small number of U^{238} fissions caused by fast neutrons, to the number caused by thermal neutrons alone; p is the resonance escape probability, the fraction of neutrons that are not absorbed while being slowed; and f is the thermal utilization, the fraction of thermal neutrons that are absorbed in fuel.

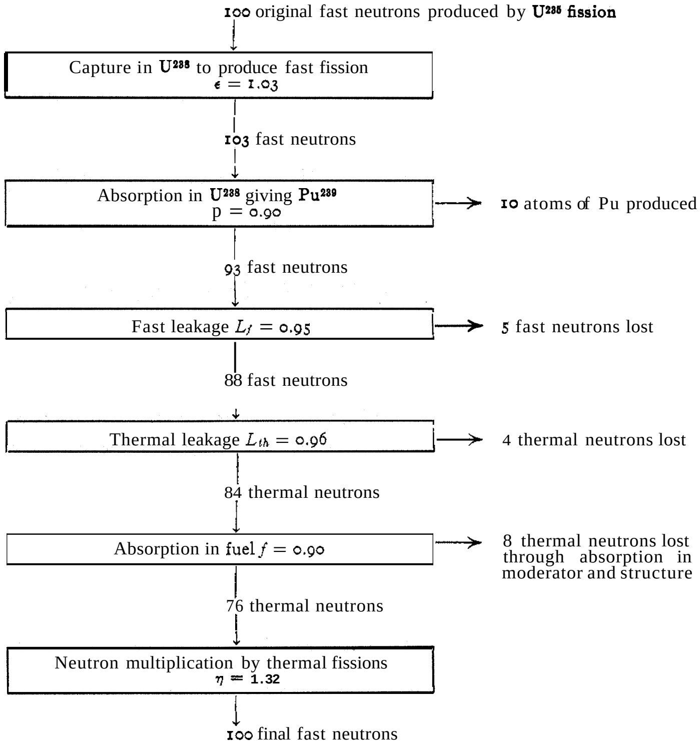
The factor k, depends only upon the material in the reactor and must be corrected for leakage in any actual reactor design. Neutrons which make collisions near the edges of a reactor have large probabilities of escaping. It is convenient to separate the leakage factor which applies while the neutrons are slowing down from that which applies while the neutrons are thermal. The "effective" multiplication factor for a finite reactor is then written as $k_{eff} = k_\infty L_f L_{th}$ where L_f is the fraction of fast neutrons that do not escape before becoming thermal and L_{th} is the fraction of thermal neutrons that do not escape before being absorbed. The combination of effects in the formula for k_∞ and due to the leakages are shown for a'typical case in the accompanying diagram. The chain is applied to 100 neutrons to make the calculation come out in whole numbers.

2. Slowing of Neutrons.— In the slowing or moderation process, neutrons generally lose energy at each collision. Since the neutrons slow down in a discontinuous manner, considerable effort has been devoted to finding some smooth mathematical step functions which will describe their over-all behaviour accurately. One such method is the "continuous-slowing-down model" which assumes that the neutrons slow down continuously until they reach thermal energy, at which time they diffuse until they are absorbed or leak from the reactor. This model gives good calculated results for'a large range of reactors.

3. Neutron Spatial Distribution.— The neutron density (the number of neutrons found in a unit volume) and the neutron flux (ϕ, the number passing across a unit area per unit time) are not uniform throughout a reactor because of the leakage losses through the outermost surface and because of nonuniformities in fuel arrangement and in neutron-absorbing materials.

The fundamental equation which describes the energy, spatial and time dependence of the neutrons in a reactor is so complicated for most practical applications that approximations must be made. The most elementary approximation is to assume that all neutrons have the same energy and that their spatial distribution may be described by the same rules as those applying to diffusion of gases, or to the diffusion of heat in a conducting material. This one

Typical Nuclear Chain Reaction



velocity (or energy) model is reasonably accurate for large thermal reactors in which almost all fissions occur at thermal energies.

For reactors with fissions occurring at energies above thermal this simple model is not accurate enough. The usual method used is to break the full neutron energy range into discrete blocks and assume that the neutrons have "group average" characteristics while in this energy range. The diffusion equations relating to each separate group are solved simultaneously to give the neutron flux as a function of energy and space. One major limitation to this method is the difficulty of obtaining for high energies the necessary "group constants" with which to solve the equations. This leads to the paradox that the simpler one- or two-group method with empirical constants may give more accurate results than the theoretically more elegant multigroup methods.

For simple geometries, the diffusion equations may be solved analytically, but in practice the reactor design is so complicated that high-speed electronic computing machines are needed to obtain approximate solutions. The digital computer is utilized by all reactor designers as a useful tool by means of which designs can be tried without the expense of building critical experiments.

4. Reactor Transient **Behaviour.**—Care must be taken during the operation of a reactor that k_{eff} never be allowed to deviate much from the critical value of unity. If k_{eff} is the number of neutrons left after one neutron has completed its cycle, then $k_{eff} - 1$ or Δk is the number of extra neutrons per cycle per starting neutron. Thus the gain each cycle for n neutrons is $n\Delta k$, and if the cycle time is l seconds, the gain in neutrons each second is $n\Delta k/l$. This relationship is usually expressed in the form of $n/n_o = \mathrm{e}\left(\frac{\Delta k t}{l}\right)$, where n_o is the original neutron density; n is the time-dependent neutron density; t is the time after Δk appears; and l is the neutron generation time, or lifetime, which is on the order of 10^{-5} to 10^{-2} sec. Thus, if ***hk*** is large and l is small, the neutron density (and consequently, the power level) can rise exponentially at a very rapid rate. This is to be avoided since uncontrolled power increases can damage the reactor and perhaps create a serious hazard.

If ***hk*** remains smaller than about 0.75% of the neutrons produced per cycle per starting neutron. the reactor may be safely controlled. This is due to the fortunate fact that some of the neutrons released as a result of fission are delayed. Instead of being emitted immediately as a part of the fission process, they are emitted a short time later from some of the fission products. The fraction of these delayed neutrons is about 0.75% of the total, resulting in an average neutron lifetime for all the neutrons of about 0.1 sec. after the fission occurs. It is this margin of time which allows control mechanisms to operate to change the value of k_{eff} one way or the other. If Δk should become larger than this delayed neutron fraction, the chain reaction is then no longer dependent upon the delayed neutrons, and it becomes "prompt critical," a dangerous situation since the rate of power level increase can become extremely fast.

5. Reactor Control and Instrumentation.— The primary control of the reactor is through measurements of the neutron flux. This is not only because the neutron flux increases in proportion to the power level, but also because neutron-sensitive instruments inherently have very quick responses. The wide range of neutron flux, varying by factors of as much as 10^{10} from start-up to full-power operation, requires the use of a variety of instruments with overlapping ranges since no single instrument could cover this whole range. These instruments are used to activate the control system. consisting of the addition or removal of neutron-absorbing material. A large number of auxiliary control and alarm devices may be used in addition to the nuclear instrumentation for adequate understanding and control of operating conditions at all times.

The control system must be devised so as to provide for immediate shutdown in the event of any emergency. In addition it must take account of changes in k_{eff} which occur during routine operation. For example, k_{eff} may have a "temperature coefficient"; *i.e.*, its value may be affected by the temperature of the fuel or moderator. If the coefficient is negative, it tends to be self-correcting from a safety standpoint because an increase in temperature reduces the reactivity. With a positive temperature coefficient a much greater burden is placed on the control system.

The control system must also offset the changes in time due to the "burn up" of the fuel and due to the accumulation of fission products. The latter is referred to as fission-product poisoning because of the strong tendency of some of the products to absorb neutrons.

To offset all of these changes, the control system must contain large amounts of excess k_{eff} to be used only as needed. To avoid premature use of this excess reactivity is one of the prime safety problems in the design of a reactor. (See also NUCLEAR INSTRUMENTS.)

6. Heat Production.— A characteristic feature of a nuclear reactor is that heat can be produced at almost any desired rate. The upper limit on the rate at which the fissions may be allowed to occur depends not upon the fission process or upon the chain reaction, but simply upon ability to safely remove the heat which is generated. The fission energy appears almost immediately as heat, and if it is not removed fast enough, the temperature of the reactor will rise until the materials of construction begin to melt or are damaged in some other manner.

A major problem of reactor design is, therefore, to devise schemes for transferring large amounts of heat quickly. Power densities of the order of several thousand kilowatts per liter of core volume may be considered, and it is necessary to use materials of construction and coolants which not only have good heat transfer characteristics but which can withstand very high temperatures.

III. REACTOR MATERIALS AND CONSTRUCTION

Materials which may serve as moderators include ordinary water, heavy water, beryllium and graphite. Each of these meets the requirement of containing elements of low atomic weight which are poor neutron absorbers.

Ordinary water has the advantage of containing hydrogen atoms, which are small, but an important disadvantage is that these hydrogen nuclei occasionally absorb neutrons. The oxygen atoms contained in the water are poor absorbers but they are fairly heavy, thus contributing little to the slowing down process.

Heavy water has the advantage of containing atoms of deuterium which, although not quite as small as the hydrogen atoms, are much less likely to absorb neutrons. Heavy water is expensive, however. and both light and heavy water have the disadvantage of requiring high pressure for containment at high temperature.

Beryllium is an excellent moderator from the standpoints of the size of its atoms, of its neutron-absorption power and of its ability to withstand high temperature, but again it is expensive and it is difficult to machine and fabricate.

Finally, graphite has been used extensively. Its atoms are not ideally small, but they are also poor neutron absorbers, and the temperature properties of graphite are excellent. However, it has the disadvantage of being adversely affected by continued exposure to neutron and gamma irradiation.

When used to surround the entire core of the fuel-bearing region of the reactor to retard the escape of fast neutrons, the moderating material is called a reflector. By conserving neutrons, a good reflector always reduces the fuel requirement for a reactor.

The coolant for a reactor is usually a fluid, either gaseous or liquid. Desirable coolants have good heat transfer properties, the ability to withstand high temperatures, low neutron-absorbing properties and. of course. low cost. Both light and heavy water have been used, as well as liquid organic materials. fused salts, liquid metals such as sodium, and air and carbon dioxide. Helium and nitrogen are also possibilities.

As a coolant, water again has the disadvantage of having to be pressurized at higher temperatures, whereas both the liquid organic materials and liquid sodium may go to much higher temperatures without pressurizing equipment. It is found, however, that the organic materials tend to deteriorate chemically under radiation exposure, and liquid sodium is difficult to handle because of its chemical properties and because of the intense radioactivity which it develops under neutron bombardment. Air and carbon dioxide have desirable temperature and heat transfer properties, but both absorb neutrons and acquire undesirable radioactivity. Helium has excellent heat transfer characteristics and it does not become radioactive, but it is extremely difficult to contain, thereby giving rise to special pumping problems.

Structural materials are required to hold the reactor together, to channel the coolant, to form control rods and to clad and protect the fuel. These materials must perform satisfactorily under prolonged and intensive neutron and gamma irradiation. Also. they must be poor neutron absorbers.

The gross physical properties of most materials will eventually change under intense irradiation. Coolant molecules are broken up into smaller molecules or into their constituent atoms. Crystalline lattices, characteristic of metals and ceramics. are distorted or strained through a shifting or removal of constituent atoms. Furthermore, the atoms may be transmuted into different elements altogether.

Radiation damage may also be due to the thermal "spike" caused when the kinetic energy from a single fast neutron, for example, is absorbed in a very small region. The highly localized peak temperatures, perhaps exceeding 10000 C., may cause alterations in the properties of the material. From a macroscopic point of view these effects are manifested as hardening and embrittlement in metals, discoloration and hardening or softening in plastics, and decomposition in water and in organic materials.

In addition to radiation damage, corrosion problems tend to be accentuated within a reactor because of high temperature and, more uniquely, because of the particle bombardment which is believed to remove the protective film from materials normally resistant to corrosion.

Induced radioactivity due to neutron exposure is another complication. Aluminum, for example, becomes radioactive with a half life of 2.3 min. In other words, the activity decreases to half of its value during this short period. Iron, on the other hand. contains a particular isotope which becomes radioactive with a half life of three years. If it is necessary to remove the material from the reactor for any reason, the aluminum obviously is preferable from the standpoint of dangers in handling.

Materials which have been widely used in structural elements within the reactor include stainless steel, aluminum and zirconium. The chief disadvantage of stainless steel is high neutron absorption by iron; the melting point of aluminum is low; and zirconium is expensive and difficult to fabricate.

Consideration must be given to the internal heat generation which takes place due to the absorption and scattering of radiation. As a result, excessive internal stresses may develop in materials within and adjacent to an operating reactor unless adequate heat removal methods are provided.

The different combinations and arrangements of materials for coolant, moderator and structure provide a large variety of reactor concepts for consideration. *See* also METALLURGY: *Metallurgy in Nuclear Engineering.*

IV. RADIATION HAZARDS AND SHIELDING

Although it is occasionally necessary to shield certain reactor system components from the radiation in order to minimize radiation damage, the protection of operators and other personnel in the vicinity is the major purpose of reactor shielding. For example, for a high-power reactor without any shielding personnel would have to remain at a distance of at least five miles in order not to be harmed by the radiation.

The unit of radiation dosage applied to humans is called the rern (the rern is that dosage of radiation having the same biological effect as 1 rad of X-radiation; the rad, in turn, is defined for any radiation as the amount that releases an energy of 100 ergs per gram of matter). A person being X-rayed for some diagnostic purpose may receive a dosage of about 1 rem. A dose of 25 rern is commonly applied for the removal of local growths. Dosages of 450 rern or above are likely to be lethal. The recommendation of the U.S. National Committee on Radiation Protection is that no individual should receive more than 0.3 rern per week, with a maximum daily exposure of not more than 0.1 rem. The dosages to which human beings are continuously exposed from cosmic rays and from radioactive materials in the earth and atmosphere are much smaller than this amount.

In the vicinity of a typical power reactor core the radiation intensity must be reduced by a factor of 10^{10} to 10^{12} if human beings are to enter the area. Since the gamma rays and neutrons are highly penetrating, large masses of material are required to reduce the intensity of these radiations to tolerance level.

The mechanism for absorbing fast neutrons is somewhat different from that for gamma rays. They must be slowed down and then captured. The shielding material, therefore, should contain a combination of light atoms and atoms, such as cadmium, boron and hafnium, with high absorbing power for slow neutrons.

The attenuation of gamma rays, on the other hand, depends upon the density of the material. The heavier the atoms, the smaller the thickness required. In practice, therefore, to shield for both neutrons and gamma rays a combination of the two types of material is used.

Because of its high hydrogen content and its availability, water is the most commonly used neutron shield. In applications where there is no premium on keeping the shield small, water may also be used effectively as a shield for gamma rays.

For stationary power reactors a homogeneous mixture, such as concrete is normally used. This has the advantage of being relatively inexpensive, of containing water molecules to aid in slowing down and capturing neutrons and of having a relatively high density to promote absorption of gamma radiation.

For mobile reactors, such as those for nuclear propulsion of an aircraft, the weight of the shield is of overriding importance, and its cost is secondary. In this instance laminated layers are almost alnays used because of their reduced weight. One of the laminations will consist of materials of low mass number for the neutron attenuation, and the other lamination will consist of a high mass number to attenuate the gamma rays. Also, for this particular application full advantage is taken of the attenuating effect of distance and of shadow shielding; *i.e.*, the shielding of a small area such as the crew compartment is accomplished by interposing a small shield between the compartment and the reactor instead of completely around the reactor.

V. RADIOACTIVE WASTES AND DISPOSAL PROBLEMS

The accumulation of radioactive waste materials is one of the major problems confronting nuclear engineers. With the ever-increasing amounts of material which give off alpha, beta and gamma radiation, it becomes more and more difficult to make certain that human beings are never exposed to anything more than very tiny radiation levels.

The alpha and beta rays have very low penetrating power and are usually not harmful unless the waste material emitting these radiations is taken internally. In this case there may be direct exposure, perhaps over extended periods of time, of vital parts of the human body. Therefore it is necessary to make certain that contamination of water and air by such materials is kept below tolerable limits.

Radioactive wastes may exist as liquids, solids or gases, and they are usually classified, by the intensity of the emitted radiations, as either high-level or low-level wastes. When the emitted radiation intensity is sufficient to reduce the time a human being can remain near the material, it is considered high-level. On the other hand, if the waste material can be handled directly without undue consideration being given to the time of contact (radiation intensities up to 0 05 rern per hour), it is considered low-level.

The major source of radioactive waste materials is from the fission process itself. Almost all of the fragments are intensely radioactive, with half lifes varying from a few seconds up to thousands of years. In time the radiation level of these materials always decreases, but on the average this radioactive decay is so slow that it alleviates the waste disposal problem only slightly.

Radioactive materials are also induced by radiation within a nuclear reactor. Certain radioisotopes are deliberately manufactured in this manner and others are necessarily produced in connection with operation of the reactor. For example, if air is used as a coolant, radioactive isotopes of oxygen, nitrogen and argon will be produced as well as radioactive materials from particles of dust and other impurities found in the air.

One method of reducing the radiation level of radioactive waste materials to tolerable levels is simply by dilution and dispersion. The aim is generally to reduce the concentration of the offending isotope to less than -& of the limits considered tolerable. Care must be taken, however, to make sure that there is no reverse process which mill reconcentrate these materials; for example, involvement in the life cycle of some organism found in the sea where the waste material may be dumped.

Gases and most low level aqueous wastes are disposed of by dilution and dispersion. The gases—for example, those used for reactor cooling—are usually diluted with large volumes of air and discharged to the atmosphere through high stacks. If the gas contains particular matter, it is passed through filters and electrostatic precipitators before being discharged.

Dilution is also used extensively in disposal of reactor cooling water and relatively low-level aqueous wastes. But most such wastes are stored for a short period prior to release to allow short half life isotopes to decay. After dilution and dispersion in a river, lake or the sea, the concentration of the active isotopes must be low enough to be below drinking water tolerances—approximately 10^{-11} curies per liter. The total volume of low-level liquid wastes disposed of in the United States by this technique in 1956, for example, was nearly 9,000,000,000 gal.; the cost of disposal was more than $1,500,000; both figures increased in succeeding years.

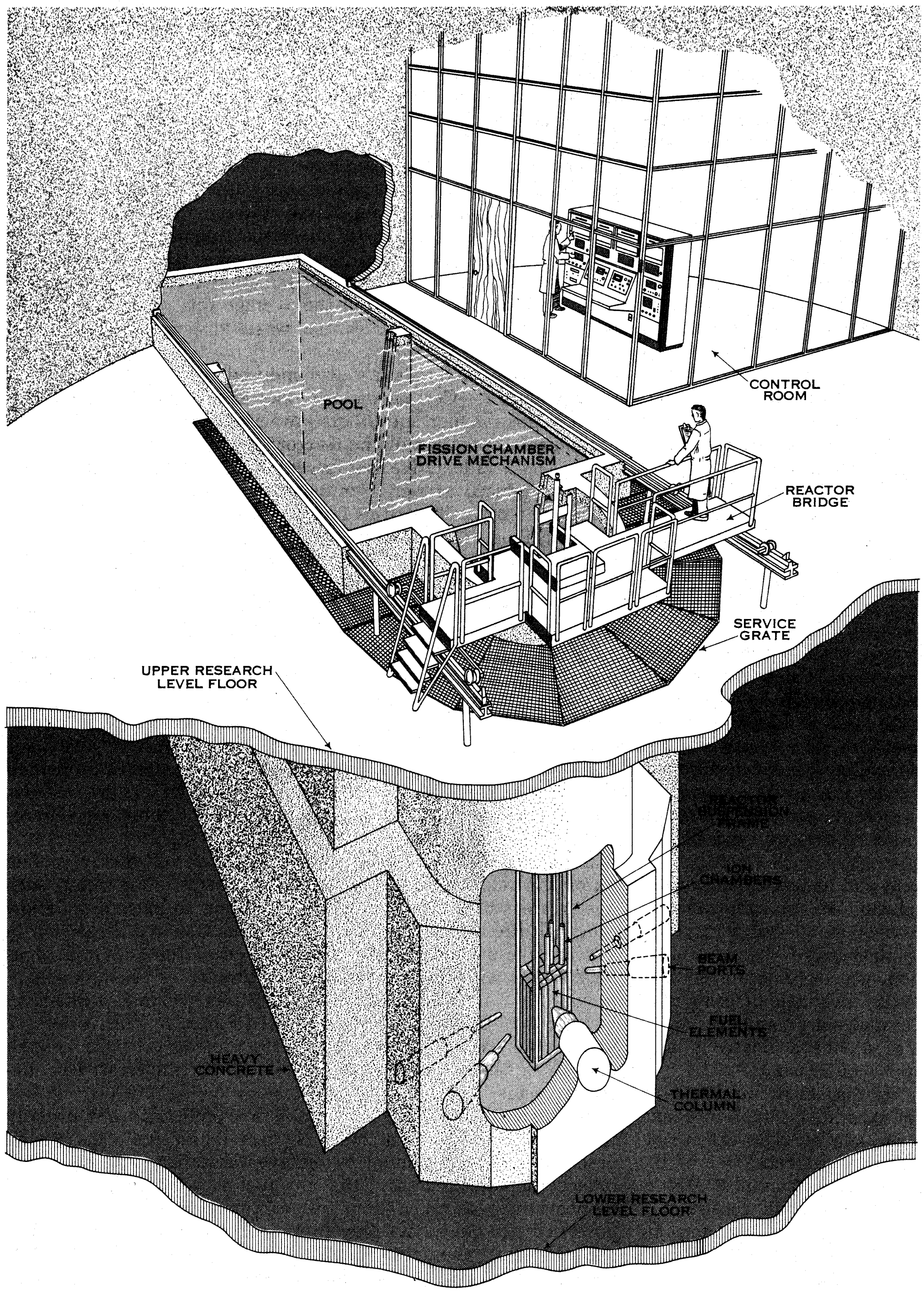
The highest-level wastes are the fission products taken directly from nuclear fuel. For reactors with liquid fuel, the fission products may be continuously removed as a part of the process of operating the reactor. But for fuel in solid form. the fuel elements must be taken from the reactor from time to time and processed separately, not only to remove the fission products but also to separate the unused fuel to make it available for manufacture of new fuel elements. In either event, high-level radioactive wastes accumulate in abundance, and their level is far too high to consider dilution and dispersion. The only other method of waste disposal is to concentrate and store the material. Its bulk may be reduced by evaporation, and the condensate then can be treated, if possible, as low-level waste. Large amounts of the high-level concentrate have been stored in underground tanks. Another method of storage is to fix the fission products into an inert solid carrier, such as blocks of concrete, so that they cannot escape. These blocks are then buried or stored indefinitely in a remote area.

Still another procedure is to remove those particular isotopes which have long half-life periods and high radio toxicity, such as strontium-89 and cesium-137. This reduces substantially the radioactivity level of the remaining material and facilitates its disposal. It is also possible to store high-level wastes in underground geologic formations, such as salt beds, salt domes and deep basins with no connection to potable waters or other natural resources.

VI. NUCLEAR REACTOR TYPES

Nuclear reactors may be classified according to design in several different ways depending on the types of fuel, moderator and coolant used, on the arrangement of these compounds and on the velocity of the neutrons sustaining the chain reaction.

In addition, reactors may be classified according to their purpose. Research and test reactors are built primarily to supply neutrons for physical and biological research, for testing of materials and for manufacture of radioisotopes. Production reactors are built to manufacture fissionable materials by converting fertile materials. Reactors capable of producing heat in sufficient quantity and at temperatures high enough to have practical use are known as power reactors. Sometimes more than one of these purposes are served simultaneously by a single reactor.



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PHANTOM DRAWING OF "SWIMMING POOL" RESEARCH REACTOR AT THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

To classify reactor types solely on the basis of design, or solely on the basis of purpose, fails to emphasize those types which are of greatest interest because of past experience or because of their promise for advancement of the technology. Instead it is customary to group reactors primarily on the basis of their chronological development.

1. Heterogeneous **Natural-Uranium Reactors.**— The world's first self-sustaining nuclear chain reaction was achieved in an experiment at The University of Chicago on Dec. 2, 1942. Natural uranium metal rods were placed between alternate blocks of graphite, which served as moderator. In such a design, where the fuel is distributed in a fairly definite geometrical pattern or lattice within the mass of the moderator, the reactor is referred to as heterogeneous.

The large plutonium production reactors built originally at Hanford are of the heterogeneous type. using natural uranium and graphite. and cooled by ordinary water. The research reactor at the Oak Ridge (Tenn.) National laboratory, commonly referred to as X-10, is also graphite-moderated and uses natural uranium. The graphite cube in this reactor measures about 25 ft. along each edge and is traversed by several hundred equally spaced, cylindrical channels. These channels are loaded nith 1.1 in. diameter aluminum-clad cylinders of metallic uranium ; the aluminum is to keep the fission products nithin the fuel. Cooling is achieved by air flow through these channels.

Another example of a heterogeneous natural uranium reactor was the "Calder Hall" type built in Great Britain, the first reactor to produce electric power on a commercial scale. The moderator is graphite, and the heat is removed from finned fuel elements by carbon dioxide, which is pumped through the fuel element channels under pressure.

Heavy water can also be used as a moderator with natural uranium. The NRX, completed in Aug. 1947 at Chalk River, Ont., is an early example. Aluminum is used to clad the fuel elements, and ordinary water is pumped through the fuel element channels as a cooling fluid.

Heavy water also shows promise for use in large power reactors fueled with natural or perhaps slightly enriched uranium.

2. Heterogeneous Enriched-Uranium Reactors.—With the use of enriched uranium, the size of the core required to sustain the chain reaction may be greatly reduced. For example, the material testing reactor. located at Arco, Ida., has a core with over-all dimensions of about $9 \times 27 \times 24$ in. The uranium is enriched to more than 90%, then alloyed and clad with aluminum in the form of curved plates. The reactor is water cooled and operates at a relatively high power level (40 megawatts) to produce high neutron fluxes for research and test purposes.

The pressurized water reactor at Shippingport, Pa., was the first in the United States to produce substantial amounts of electric power for commercial use. In it, the water serves both as moderator and coolant. The fuel elements are of two types: most of them are tubes of zircaloy (an alloy of zirconium) containing natural uranium oxide pellets; to permit attaining the critical state, the core is "seeded" with a smaller number of plate-type fuel elements, also clad with zircaloy but containing uranium enriched to 93% and alloyed with zirconium.

Heterogeneous reactors containing organic materials as coolants also showed promise because of the lower operating pressures which are possible. Slight enrichment is necessary for reactors of this type, except perhaps when heavy water is used as a moderator.

3. Boiling Water Reactors.—There are some advantages to generating steam within the reactor core. It has been found that a water-moderated reactor can be made to operate stably while the water is boiling in the core. The steam produced may be used directly to drive a turbine or passed through an intermediate heat exchanger to generate steam in a secondary turbine loop.

The experimental boiling water reactor at Argonne National laboratory, Chicago, Ill., has a cylindrical core, approximately four feet in each dimension, containing interchangeable natural and enriched uranium plate-type fuel elements. Either natural or forced circulation of the water is possible. The reactor is constructed to permit operation with heavy water as the reactor coolant and moderator.

4. Fast Breeder Reactor.—The fissions in this type of reactor occur at high neutron energies since no moderator is provided to slow the neutrons. Attainment of the critical level necessitates relatively high enrichment and large fuel mass. The Enrico Fermi reactor, Detroit, Mich., consists of zirconium-clad fuel pins enriched to 27% in U^{235} and cooled by liquid sodium. Surrounding the core is a "blanket" of uranium, consisting primarily of U^{238}. Conversion to plutonium occurs more easily with the faster neutrons, and it was anticipated that plutonium would be produced in this blanket at a rate equal to or exceeding that at which the U^{235} was consumed.

5. Homogeneous Reactors.——A reactor in which the fuel material is more or less evenly dispersed throughout the moderator is known as a homogeneous reactor. One type utilizes a uranium salt, such as uranyl sulphate, which is dissolved in ordinary or heavy water and is contained in a corrosion-resistant metal vessel. As energy from the chain reaction heats this fluid, power may be obtained by circulating it to an external heat exchanger. An advantage of this reactor is that it permits continuous removal of fission fragments and continuous refueling. The problem of reactor "poisoning" is therefore minimized, and the costly fabrication and processing of fuel elements necessary with heterogeneous reactors is eliminated.

The homogeneous reactor test facility at Oak Ridge, Tenn., had a 32-in. diameter zirconium alloy core tank which contained a uranyl sulfate-heavy water solution having a concentration of approximately 10 g. of U^{225} per liter. Plutonium could be produced either from U^{238} in the solution or in a blanket. One of the major problems connected with this type of reactor has been the highly corrosive character of the solution.

6. Research, Test and Training Reactors.—The earlier research reactors used natural uranium, but with the availability of enriched uranium for fuel it has been possible to effect substantial reductions in cost for reactors of more recent design.

One of the more popular types, providing moderate neutron fluxes (10^{12} to 10^{13} neutrons per square centimetre per second) is called the "swimming pool" reactor. This has a reactor core suspended in an open pool of water. The water serves as coolant, moderator, radiation shield and neutron reflector. Plate-type fuel elements, highly enriched in U^{235}, are ordinarily used.

For higher neutron fluxes (10^{13} to 10^{14}) a better cooling system is needed if ordinary uater is retained as the moderator; therefore a closed cooling system with a tank reactor is generally used. In a tank reactor the core is located within a closely fitting tank through which water is pumped to carry away the heat. This type lacks the simplicity of the swimming pool reactor, and the core is not so easily accessible for research purposes. Even though the core is small in order to obtain a high power density, the tank is designed in such a way that materials to be irradiated for research and test purposes may be inserted directly into the core. In addition there are a variety of openings for test purposes, also yielding high fluxes, in the blanket of these reactors.

The first research reactors using enriched uranium were of the homogeneous type, commonly called "water boilers," even though boiling was not permitted. The core consisted of a stainless steel spherical shell, about one foot in diameter, which contained the aqueous fuel solution. The heat was removed by a cooling coil wound through the inside of the sphere. This design, which is characterized by low fuel inventory and a relatively high neutron flux in relation to its low power level, has a high degree of inherent safety.

A heavy water research reactor has a lower mass of fissionable material and a higher thermal neutron flux than a comparable light water reactor designed for the same power. The thermal neutron flux distribution across the core is relatively flat, and consequently this reactor type provides a large experimental volume at a comparatively high flux level.

VII. FUELS AND FUEL RECOVERY

Three nuclides, U^{235}, U^{233} and Pu^{239}, undergo fission with thermal neutrons and therefore have received major consideration as nuclear fuels for industrial purposes. Relatively large quantities of Pu^{239} have been produced, but this nuclide has found its major use in weapons production. U^{233} has also been produced, but in considerably smaller quantities, and it has been used principally for experimental purposes. U^{235} remains, therefore, of primary interest for industrial applications.

Since nuclear reactors are inherently incapable of consuming all the fuel they contain, the fuel elements taken from heterogeneous reactors will always contain substantial amounts of fuel. The recovery of this unused fuel from solid fuel elements so that it may be reused generally reduces the total fuel cost.

There are many different kinds of solid fuel elements. The major considerations involved in their design include not only nuclear characteristics but also heat transfer and coolant flow, radiation damage, corrosion, mechanical strength and the containment of fission products.

In order to minimize the cost of reprocessing the fuel and of refabricating the new fuel elements, it is desirable to leave the fuel in the reactor as long as possible. Pure uranium metal makes a poor fuel element because it is susceptible to radiation damage, it is very reactive chemically. and it undergoes three solid phase transitions below its melting point. Thermal cycling causes severe and permanent distortion in shape and volume. Substantial improvements are made by alloying the metal with appropriate diluent metals and by use of chemical compounds of uranium, such as uranium oxide and uranium carbide.

The basic materials for most reactor fuel elements are of three types: metallic fuels contain uranium metal or uranium metal alloys; ceramic fuels are sintered compacts of uranium compounds; and cermets are dispersions of uranium compounds in a metal matrix.

These materials are ordinarily formed into flat or curved plates, rods or hollow tubes, and then are clad completely with a thin metal sheath that protects the fuel material from corrosive attack by the coolant and prevents fission products from contaminating the coolant. Geometric arrays or clusters of the individual plates, rods or tubes of the clad fuel material form the active portion of a fuel element. End boxes of inert materials are often attached to both ends of the active portion to hold the fuel element in place in the reactor core and frequently to direct the flow of coolant through a particular section of the core. Thus, the finished fuel element generally contains a rather high ratio of inert to active material.

Fuel recovery is the technology of separating fission products and diluent materials from irradiated fuels and converting the purified fuel to a reusable form. Chemical processing of used fuel has been the only method utilized on an industrial scale.

Basically, chemical processing consists of two steps: .fuel dissolution and solvent extraction. However, several ancillary steps are required in a complete fuel processing plant.

Used fuel elements are first stored temporarily, then transferred to a fuel stripping facility where all easily separated inert material, such as end boxes, side plates or cladding, are stripped from the basic fuel material by chemical or mechanical processes, or both. The stripped fuel is dissolved in a suitable acid solution, which is then adjusted with reagents to produce an appropriate feed solution for the solvent extraction step.

Solvent extraction is the heart of the process, because it accomplishes the separation of fuel from the fission products (decontamination) and from all other diluents not previously removed. This is accomplished by intimately mixing the feed solution with an organic solvent that selectively entraps the uranium or plutonium in the feed. The organic solvent, being less dense than and immiscible with the feed solution, is easily separated from it, and the fuel-depleted aqueous feed solution becomes the highly radioactive aqueous raffinate (waste). The fuel-rich organic solvent is then contacted with a stripping solution having a different acid concentration than the feed solution, and the fuel is transferred from the organic solvent to the aqueous strip solution. The fuel-depleted organic solvent now becomes organic raffinate and must be purified in a solvent recovery step before it is reused. If sufficient decontamination has occurred in the first cycle of solvent extraction, the fuel-rich strip solution is concentrated and becomes the product of the chemical processing plant, an aqueous solution of uranyl or plutonium nitrate. If not, the fuel-rich solution may be processed through a second and perhaps a third cycle of solvent extraction to achieve the desired degree of decontamination.

If the feed to the solvent extraction cycle contains a mixture of uranium and plutonium, a partitioning cycle, wherein the plutonium is separated from the uranium, is generally interposed between the first and second extraction cycles. Partitioning is accomplished by adding to the first cycle strip solution a reagent that will readily reduce the plutonium from the +VI valence state to the +IV valence state but will not alter the valence of uranium. When this solution is contacted with organic solvent, the uranium is readily extracted while the reduced plutonium remains in the aqueous phase. Thereafter the uranium and plutonium streams are treated separately if further decontamination is required.

Radioactive aqueous raffinates from the solvent extraction, solvent recovery and fuel stripping processes are treated in a liquid waste treatment step to reduce the volume of radioactive wastes that must be stored permanently. The storage of the radioactive wastes is one of the major cost factors in the chemical recovery of used fuel.

The fuel stripping, dissolution, feed treatment and waste treatment steps of chemical processing may be either batch or continuous processes, but the solvent extraction and solvent recovery steps are inherently continuous processes. Continuous processing methods throughout a plant are more economical than a combination of batch and continuous methods; however, the wide variety of fuel enrichments, compositions and geometries encountered are not readily adaptable to continuous processing methods.

Highly enriched fuel must be processed in "critically safe" equipment or be "batch controlled" in order to prevent the inadvertent assembly of a critical mass. The geometry of critically safe equipment is such that it is impossible to achieve a critical state. Batch control limits to less than a critical amount the quantity of fuel that may be admitted to any given vessel.

The kind and quantity of diluent in the fuel mixture has its greatest effect on the dissolution step. Highly corrosion-resistant diluents require chemically sophisticated acids for their dissolution and even more specialized materials of construction in the dissolver. Fuel materials having high diluent-to-fuel ratios result in inefficient dissolver and solvent extraction operation and large waste volumes per unit of fuel processed.

VIII. ECONOMICS OF NUCLEAR POWER PRODUCTION

From an economic standpoint the great potential of nuclear energy for producing electrical energy or motive power lies in the enormous amount of energy released from a relatively small amount of fissionable material. In spite of this, however, the cost of producing power with nuclear fuels has remained high in comparison to the cost with conventional fuels.

The capital costs of a nuclear power reactor tend to be high because of the complexity of the plant and the large inventory of nuclear fuel. Surrounded by thick concrete shielding, power reactors may be of the order of 30–60 ft. in diameter, and some require 1,500–3,000 tons of high-purity graphite or 50–100 tons of costly heavy water. While the size of the reactor can be reduced by enriching the fuel, the reduction in capital cost tends to be offset by higher fuel cycle costs. In addition, elaborate and complex mechanisms are required for control. Large storage facilities for coal and oil are not needed, but instead rather elaborate facilities are required for transferring and storing the highly radioactive fuel discharged from the reactor.

The operating costs, in particular the cost of the fuel cycle, remain higher than the conventional counterpart, but with the advance of reactor technology substantial reduction in these costs can be expected. The cost items for uranium fuel include its mining, refinement from ores, enrichment and conversion to a form suitable for use in the reactor. If in solid form, it must further be clad in a protective jacket to prevent the escape of the fission products.

When the highly radioactive fuel elements are discharged from the reactor, they must be stored in shielded pits until the activity has decayed to a sufficiently low level to permit their transportation to chemical processing plants. Even after a period of 100 days or more, the fuel is still radioactive enough to require heavy lead shielding during transportation. Thus, every ton of fuel shipped to the reactor plant must be accompanied by 20–30 tons of shielding when reshipped to the fuel reprocessing plant. The recovered fuel is recycled back into new fuel elements with additional makeup material to account for the fuel burned. Since the enrichment of the fuel is reduced by fissioning of the U^{235}, the recovered fuel may have to be recycled through a gaseous diffusion plant or blended with a higher enrichment uranium in order to achieve the required enrichment.

Because of the great expense of fuel processing and fabrication, it is clear that substantial savings in the cost of fuel can be achieved by increasing the fuel burn up—in other words, by reducing the frequency with which the reactor has to be recharged with new fuel elements. The obstacles to high burn up are primarily, (1) the accumulation of fission products which "poison" the reactor by absorbing neutrons; (2) the damage to the fuel elements resulting from the effects of radiation; (3) the build up of contained fission products in gaseous form; and (4) thermal cycling. To offset the poisoning, increased enrichment can be used, but this in turn adds expense because of the cost of compensating for the excess reactivity during the early life of the fuel element when the increased enrichment is not needed, and because of the extra cost of the fuel itself.

An extensive development effort is directed toward means of increasing the burn up of reactor fuel before replacement is necessary. Besides improvements in the physical soundness of the fuel elements. there are under development schemes which involve intentional poisoning of the fresh fuel elements, use of two or more fuel regions of different enrichment and other plans to prolong reactor core life.

Homogeneous reactors also show promise for reduction in fuel costs, With fuel in a fluid form, the expensive and complicated fabrication step is eliminated and continuous chemical processing of the fuel becomes an integral part of the reactor operation. Fission products are continuously removed, providing more efficient utilization of the fuel. and the other obstacles to high burn up found in solid fuel elements are nonexistent.

A reactor which breeds new fissionable material has the important economic advantage of accumulating nen- fuel at least as fast as it is burned. but the large inventories of fuel and fertile material which are required at the outset is a strong offsetting cost factor.

IX. OTHER INDUSTRIAL APPLICATIONS

Experience with several experimental vessels clearly demonstrated the technical feasibility of nuclear energy for ship propulsion. The cost remains high in comparison with conventional fuels. but nuclear propulsion has certain inherent advantages which tend to offset these high costs. These include increased cruising range. elimination of the need for carrying liquid fuel except for emergency purposes and for the generation of electricity while in port. and elimination of the need for an air supply or an exhaust system for the power unit. Exploitation of these advantages suggests that ships may be designed for greater earning capacity even if propulsion costs remain about the same.

In general, the types of reactors which appear to be suitable for central station generation of electricity may also be considered for ship propulsion. Greater emphasis in marine service is placed, however, on compactness, reduced weight and operation at the higher temperatures which permit higher thermal efficiency.

The process heat requirements of industry are large in comparison with their requirements for electric power. In certain types of industry where large amounts of heat are needed on a relatively continuous basis, nuclear fuel may prove interesting as a source of energy. The industries having such heat requirements include certain types of food processing, pulp and paper and chemicals.

Neutrons from nuclear reactors have been used extensively to manufacture radioisotopes with wide industrial and research applications. Large gamma-ray sources may be used for the preservation and perhaps sterilization of certain types of food. In the chemical industry the effects of radiation on materials may in some cases be turned to an advantage through promoting or initiating certain desirable chemical changes. See also ATOMIC ENERGY: *Peacetime* Applications.

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NUCLEAR INSTRUMENTS. Radiations from the nucleus, rather than the nucleus itself, are the usual object of measurement in nuclear instruments. This article therefore deals with devices for measuring numbers and energies of a-rays, β-rays, y-rays and neutrons. Basic scientific concepts are presented elsewhere. (See ATOM; ELECTRON; ISOTOPE; NEUTRON; NUCLEUS; RADIOACTIVITY, ARTIFICIAL; RADIOACTIVITY, NATURAL.)

Because y-rays and X-rays are so nearly identical, much of y-ray instrumentation is applicable also to X-rays. (See X-RAYS.) Radioactivity and X-rays have similar applications to medical diagnosis and therapy. (See RADIOLOGY.) Detection of protons, deuterons, tritons and heavier ions is similar to a-ray measurement.

CLASSIFICATION AND DESCRIPTION

Physical Basis of Measurement.— All nuclear instruments depend on an interaction of the measured radiation with some matter, contained in the instrument, which may be called the reacting medium. Since each kind of radiation may have a variety of interactions nith each form of matter. there is no simple way of summarizing the myriad possibilities. In the table an attempt is made to organize the art according to six main groups of basic effects. This classification emphasizes the nay in which the information about the radiation originates; the way in which it is organized and presented in the instrument reading is treated below, under *Information* Obtazned.

Of the classes of instruments represented in this tabulation, the

Classification of Nuclear Instruments

Physical basis	Same of instrument or method	Reacting medium
Production of heat	radiation calorimeter. bolometer	solid
Production of light	scintillation counter, Cerenkov* counter	solid or liquid
Change of electrical property	electrometer, ionization chamber, proportional counter, Geiger counter, spark† counter	gas
	crystal counter‡	solid crystal
	electron multiplier	solid metal surface
Change of chemical property	photographic method	photographic emulsion
	chemical dosimeters	solid or liquid
Change of physical state (phase)	cloud chamber¶	supersaturated vapour
	bubble chamber?	superheated liquid
Nuclear reaction	fission chamber, neutron counter	solid or liquid

*J. V. Jelley, "Cerenkov Radiation," *Progress in Nuclear Physics*, vol. 3, pp. 84–130 (London, 1953; New York, 1954). †S. C. Curran and J. D. Craggs, *Counting Tubes*, pp. 183–185 (New York, 1939; London, 1950). ‡F C Champion, "Solid Conduction Counters." *Progress in Suclear Physics*, vol. 3, pp. 159–176. §F. S. Dainton, "Radiation Chemistry," *Annual Reviews of Nuclear Science*, vol. 5, pp. 213–240 (Stanford, Calif., 1955). M. Snomden, "The Diffusion Cloud Chamber,": *Progress in Nuclear Physics*, vol. 3, pp. 1–17. ♀C. Dodd, "The Bubble Chamber, *Nature* 176:142–143 (London, July 23, 1955). ¶*See* CLOUD CHAMBERS.

four of greatest general interest (gas-filled instruments, scintillators, photographic methods and neutron counters) are discussed in some detail in the following sections. References on others are given in footnotes to the table.

Gas-Filled Instruments.— When radiation particles (except neutrons) or photons pass through a gas, interaction occurs with the electrons of the gas molecules. Probability of interaction is high for doubly charged a-particles, less for β-rays and very small for y-ray photons. If the interaction is such that an electron is completely removed from the molecule, an ion pair is formed (the negative electron and the positive molecular ion). This is the simplest and, for nuclear instruments. the most important ionizing process; there are other possibilities. such as attachment of electrons to molecules to form negative ions and dissociation of polyatomic molecules.

Electrical charges available in the gas must be separated, positive from negative, and made to give some visible indication. The simplest means of accomplishing this is by the use of electroscopes and electrometers. These are devices which give a visible deflection proportional to the charge stored on their electrodes. When the gas between two oppositely charged electrodes is ionized by radiation, electric current flows through the gas to reduce the stored charge and the deflection. The chamber containing the gas to be ionized (the ionization chamber) may be more or less integral with the device (electrometer) for measuring the ionization current but functionally, at least, one can always think of them as separate.

In applying electron tube amplification to ionization chambers, the ionization current is made to flow through a large resistance (hundreds or thousands of megohmsj and the voltage across this resistance, when ionization current flows, activates the control grid of the amplifier (fig. 1). Special requirements on this first amplifier tube (electrometer tube) are low grid currents and high insulation of the control grid.

The ionization chamber may be used either to indicate average ionization current (current type) or to indicate individual ionizing events (pulse type). In the current type sufficient capacitance C must be parallel with R of fig. 1 to provide a time constant RC large compared with the average interval between ionizing events, whereas in the pulse type this time constant must be small.

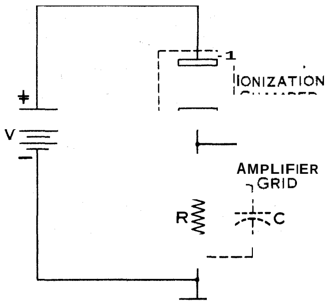

FIG. I.— IONIZATION CHAMBER CIRCUIT

The amount of battery voltage V supplied to the chamber and the nature of the gas with which the chamber is filled are factors of importance. In principle, neither the battery nor the gas is necessary for charged-particle radiation such as a- and β-rays. In fact, strong a- and 0-sources can be measured in a vacuum simply by exposing the source to an electrode which intercepts a small fraction of the emitted particles, giving rise to a current in the circuit of fig. 1, even though V is zero. Thus it is clear that the battery voltage and ionizing gas provide a kind of charge amplification, whereby, instead of only one or two electronic charges being collected per incident particle or photon, a large number of ion pairs (hundreds or thousands per centimetre of path) may be formed and collected. (A different avenue of amplification is exploited in the electron multipliers, where the surface on which the primary particle impinges releases several secondary electrons. *See* ELECTRON TUBE: *Photoelectric Devices.)*

An electron released in a primary ionizing event will be accelerated along the voltage gradient existing in the chamber volume. Depending on the nature of the gas, the gas pressure, the distance to the electrode and the voltage gradient, the electron may (1) reach the anode and make its contribution to the ionization current; (2) become attached to a neutral molecule to form a negative ion, which will move much more slowly toward the anode; (3) recombine with a positive ion and be totally lost; or (4). and this is the most interesting possibility, have one or more collisions with neutral gas molecules as a result of which new ion pairs are formed. This secondary increase in number of ion pairs, called gas amplification. is defined in terms of the average number of ion pairs formed by an electron per centimetre of its path along the voltage gradient; it is unity for an ionization chamber (which by definition is understood to be an instrument operated with voltages small enough for this statement to be essentially true).

The voltage on an ionization chamber should be large enough, however. to ensure that substantially all primary ion pairs escape recombination and are collected. Once this "saturation" voltage is reached, a somewhat higher voltage is equally satisfactory. so that a closely regulated voltage is not required. If the voltage is raised to the point where gas amplification becomes noticeably greater than one, there will then be a range of voltage such that at any point in this range the magnitude of current pulse furnished by a given type of particle will be proportional to the particle's energy. An instrument operated in this range is called a proportional counter. The distinction between a proportional counter and a pulse-type ionization chamber is rather subtle since both instruments can be made to furnish output pulses proportional to the ionizing particle's energy. In the ionization chamber the voltage is low (typically, a few hundred volts) and the exact value is not at all critical; there is no gas amplification, so the primary ions must be sufficient in number to drive the electronic amplifier, and therefore only heavily ionizing radiation such as a-rays can be measured. In proportional counters. the voltage is higher (perhaps 1,000 v.) and there is gas amplification possibly as large as 10,000; so, although the output pulse magnitude is proportional to particle energy, the exact value of the large proportionality factor is markedly dependent on voltage. Thus, the ability of the proportional counter to measure energy of weaker radiation, such as β-rays, necessitates a well-regulated voltage supply.

Gas amplification is naturally limited by the fact that the individual multiplying processes, or "avalanches," will, as they become larger, eventually interfere with each other. As voltage is raised above the proportional range, therefore, one finds this interference developing and causing transition to a new mode of counter operation. In this voltage range (typically centred at about 1,400 v.) the instrument is known as a Geiger or Geiger-Miiller counter. These G-M tubes give pulses of a size not depending on the energy of the ionizing particle, which simply serves to trigger the discharge in go or no-go fashion. Thus the G-M counter serves only for counting but is nevertheless extremely useful, since it may respond to a single primary ion pair. The Geiger discharge is characterized by its rapid spread along the full length of the anode. Once a given discharge pulse is initiated, the entire counter volume becomes insensitive and remains so until the pulse of positive ions is cleared. (The more mobile electrons are very rapidly collected on the anode.) For this reason Geiger counters cannot be made to operate as fast as proportional counters, in which the pulse of positive ions moving toward the cathode is more localized.

The size of pulse from a Geiger counter is more or less proportional to the voltage, and quantitative use of these counters therefore requires a well regulated high-voltage supply. The voltage must be kept below the point at which the electrical discharge becomes continuous. Even below this limit, the G-M counter will give a continuous succession of discharges unless provision is made for quenching. The necessity for quenching follows principally from the emission of secondary electrons at the cathode upon arrival there of the positive ions released in the first discharge. Occurrence of single discharges may be ensured by admixture to the main filling gas of a quenching gas, which suppresses the secondary electron emission.

The choice of gas with which to fill the ionizing volume is important, particularly for proportional and Geiger counters. Current-type ionization chambers are commonly filled with air or with noble (inert) gases. In high-quality pulse-type ion chambers and proportional counters it is important to avoid all possible traces of electronegative gases, such as oxygen. Argon is extensively used for all three groups of gas-filled counters, with the addition of one part in ten of ethyl alcohol for quenching in Geiger tubes. Endless varieties of pure and mixed gases have been tried, most with some degree of success. Behaviour of a supposedly pure gas may be radically modified by a trace of another.

Range of gas pressures is also quite wide—from many atmospheres in high-efficiency ionization chambers to small fractions (*e.g.*, one-tenth) of an atmosphere in Geiger counters. Construction is rather standardized for proportional and Geiger counters, viz., a cylindrical cathode, of diameter one inch or less, with a fine-wire anode, a few thousandths of an inch in diameter. mounted along the axis of the cylinder. The large voltage gradient near the fine wire is an essential feature of these instruments. Ionization chamber design is more flexible. Choice of electrode material is important, particularly for γ-ray Geiger counters, which are activated by electrons ejected from the cathode rather than by ionization of the filling gas.

Gas-filled nuclear instruments are an application of one of the most complicated branches of physics. *(See* ELECTRICITY, CONDUCTION OF: *Conduction in Gases.)* Crudely contrived devices may work after a fashion, but a precisely quantitative instrument involves careful combination of design factors.

Scintillation Counters.—Visible light plays a minor role in gas-filled instruments, except Geiger counters, where photons are an important ingredient of the discharge mechanism. There are solid materials, such as zinc sulphide. which as early as 1908 were observed under a-particle bombardment to emit tiny flashes of light, visible through a microscope to the dark-adapted eye. By counting the number of flashes, or scintillations, seen on a zinc-sulphide screen a direct measure of the number of incident a-particles is obtained. The only comparably direct observation of nuclear particles is to see their tracks in a cloud chamber or bubble chamber.

The important role of visual scintillation counting in the first quarter of the 20th century was ended by developments in gas-filled tubes and associated electronics, Nevertheless, it was an electronic development which, after World War II, revived interest in scintillators. This was the electron multiplier, mentioned above. If the cathode of such a tube is designed to eject electrons in response to incidence of visible light, the tube is called a photomultiplier. It is an extremely sensitive means for detecting photons. By using a photomultiplier in place of visual observation, scintillation counting becomes competitive with and in some respects superior to gas-tube techniques.

The scintillation counter consists of three essential parts: scintillating phosphor, photomultiplier tube and any optical coupling required between these two. The ability of such an instrument to measure incident radiation properly depends on (1) whether some of the energy of the incident particle or photon is absorbed by the phosphor; (2) whether any of the absorbed energy appears as emitted visible photons; (3) whether any of the emitted photons reach the photocathode; (4) whether the photons cause emission of photoelectrons; and (5) whether the electron multiplication proceeds properly. Each of the three structural elements must be evaluated against these five points.

There are three main classes of phosphor (see LUMINESCENCE). inorganic crystals, organic crystals and organic plastics and solutions. In general, fluorescence occurs more rapidly than phosphorescence, so that fluorescence is preferred for fast counters. There is one principal difference between organic and inorganic scintillators. The luminescence process is characteristic of the organic molecules themselves and can occur whether the phosphor molecules make up pure crystals or are dispersed in plastic or liquid solutions. By contrast, the luminescence of inorganic phosphors is essentially related to the crystalline structure, either by way of lattice defects in a pure crystal or, more commonly: by way of impurities deliberately introduced to "activate" the crystal.

Important inorganic phosphors are sulphides of zinc and cadmium. activated with copper or silver; alkali halides (notably sodium iodide), activated with thallium; and tungstates of calcium and cadmium. The first-used organic crystal, naphthalene ($C_{10}H_8$), has been largely superseded by the more efficient anthracene ($C_{14}H_{10}$). Other organic crystalline phosphors include stilbene, terphenyl, diphenylacetylene and quaterphenyl. Plastic phosphors are solid solutions of an organic phosphor in a transparent plastic—for example, 2% of anthracene in polystyrene. An efficient liquid scintillator (about half as good as solid anthracene) is a solution of 0.5% *p*-terphenyl in xylene; numerous other organic solvents and solutes also give good results. The total domain of all phosphor types is seen to be very complex and rich in possibilities.

For the second element of the scintillation counter. the photomultiplier tube, there are available ever-increasing numbers of specially developed types. The spectral response of the photocathode must match to a reasonable extent the colour of light in the scintillations. High luminous sensitivity, large current gain and low "dark current" (noise due to thermionic emission, leakage current, etc.) combine to give a good signal-to-noise ratio. For fast coincidence counting it is important that there be small spread in transit time (the interval between appearance of light pulse at cathode and appearance of current pulse at anode). Transit time and spread in transit time have both been reduced to the order of a millimicrosecond (one-billionth of a second).

The nature of the optical coupling of phosphor to photomultiplier depends on the situation. If the efficiency of light collection is unimportant, the phosphor may be at some distance from the phototube. with air intervening. This is wasteful of light for two reasons: the photocathode subtends only a small fraction of the total solid angle into which light is radiated; and no attempt is made to eliminate reflection from the glass surface of the phototube. The first wastage may be minimized by "persuading" the light to leave the phosphor principally in the direction of the tube by giving attention to such optical details as geometrical shape and surface finish. The second wastage is reduced by providing a complete optical path with no large discontinuities in refractive index. By "light piping" through plastic rods, this can be done even over long distances and over curved paths.

Photographic Methods.—Nuclear science and technology have from their beginning made use of photographic materials, for a photographic plate was the means whereby radioactivity was discovered. In addition to the general practices of picture taking (*e.g.*, photographing particle tracks in a cloud chamber) and radiography (*e.g.*, using y-radiation. like X-rays, to reveal flaws in an iron casting), there are three specifically nuclear applications of photographic emulsions: exposure measurement. autoradiography and high-energy particle studies. In all of these the emulsion is treated in the usual sequence of exposure, development, fixing and washing. (See PHOTOGRAPHY.)

Photographic emulsions are dispersions of fine grains of silver bromide (sometimes with a bit of silver iodide for greater sensitivity) in gelatin. Exposure to light or to particle radiation causes some grains of the bromide (those constituting the latent image) to become "developable." This means that in the development process spots on these particular grains are first and most rapidly reduced to pure silver. (In "physical development," the sensitive specks receive deposits of silver from the developer.) As the silver particles are opaque, the most exposed portions of emulsion are darkest.

Presumably this basic process is essentially the same in all photographic and nuclear emulsions. The primary mechanism. by which some grains become developable, is not fully understood either for light or for nuclear radiations.

Measurement of exposure to radiation usually depends on degree of blackening of a piece of film, although in special cases particle tracks in the film may be counted. This general blackening is similar to radiographic applications, except that here no picture is involved and hence contrast and resolution are unimportant. Various film types have been developed. differing chiefly in the variety of radiation to which they are sensitive and in the total exposure for which they are suitable. Energy dependence of a film can be modified by covering all or part of the film sample with an absorbing coating or shield.

Autoradiography (or radioautography) is a peculiarly nuclear method of studying material structure. A small number of radioactive atoms are introduced into the chemical build-up of the structure. Under the assumption that the radioactive isotope (the tracer) behaves chemically just as would its nonradioactive twin—an assumption which is not always justified, particularly with light elements—one obtains the desired structure, normal except for the fact that some of the atoms eventually betray their locations by radioactivity. A photographic emulsion placed near these atoms will record their positions.

Close proximity of a thin layer of emulsion to the specimen under study is desirable for greatest accuracy, resolution and sensitivity. Special ways of getting emulsion as close as possible include emulsion stripped from its main supporting base, liquid emulsion painted on the specimen, the wet-process method of forming a single-grain layer of crystals directly on the specimen and floating the emulsion on water as a means of applying it directly to the specimen. Resolution down to the region of one micron has been obtained, which is about the limit with visible light. Techniques include both optical density measurement of the developed image and study of individual particle tracks. For the latter purpose special emulsions have been developed.

Nuclear track emulsions are used a great deal also in high-energy physics to record the passage or transformation of nuclear and cosmic ray radiations. In ordinary optical emulsions the proportions by weight of halide grain and gelatin are about equal; in nuclear track emulsions, the grain proportion is about six times as large. Nuclear track preparations are also characterized by narrow grain size distribution and by large thickness of emulsion.

Neutron Counters.—Measurement of neutrons is distinguished from other radiation measurement by the negligible interaction of neutrons with electrons. Hence the process of ionization. so important in most nuclear instruments, is not directly useful for neutron detection. Neutrons do, however. react with atomic nuclei. (See NEUTRON: Detection *of Neutrons.*)

Seutron-nucleus interactions are more complex than the relatively simple ionizing action of other varieties of radiation. The complexity is threefold: (1) the large number of nuclear species; (2) the different reactions that may occur between a neutron and any given nucleus; and (3) the strong dependence of cross section (probability) for any one reaction on the energy of the neutron. Besides making neutron instrumentation rich in possibilities. this complexity has the more sinister effect of leading to unexpected troubles caused by interaction of neutrons with the materials of which the instrument is constructed This is especially important in high-flux measurements, such as are made on nuclear reactors.

Boron is perhaps the most-used material: in ion chambers and proportional counters filled with BF_3 gas or with boron coatings or foils; as a loading for photographic emulsion; and in the boron thermopile, which indicates by thermocouple the heat derived from large neutron flux. Scintillators are being used with increasing success. For example, an anthracene crystal scintillator will detect neutrons quite well via the recoil of its own hydrogen nuclei. Lithium iodide crystal phosphors have proved quite effective because of the large probability of thermal neutron interaction with the lithium-6 nucleus. Scintillators also are used to respond to the y-radiation emitted when neutrons are captured in cadmium or boron. Since neutrons are often accompanied by y-rays. which most scintillators detect efficiently, the problem of discriminating between neutrons and γ-rays is important. There is also continued development of fission chambers. The isotopes uranium-238, neptunium-237 and plutonium-239 have fission cross sections that make them especially useful, in the range from 10 kev to 2.5 Mev, for measurement of neutron energy spectra. **A** combination of three fission chambers, each utilizing one of these isotopes, permits good coverage of the range mentioned. The slow neutrons, for which the plutonium has a large fission cross section, must be screened from the plutonium counter by shields of boron. The 2.5-Mev threshold of the reaction of neutrons on sulphur-32 is also useful.

EVALUATION AND USE

Nuclear instruments are used in a wide variety of situations to obtain many different kinds of information. It is therefore important to evaluate these instruments as to information obtained, as to factors affecting accuracy and as to the best choice of instrument for a particular purpose.

Information **Obtained.**—Nuclear instruments furnish answers to two kinds of questions: quantitative (how much radiation?) and qualitative (what kind of radiation?).

Taking first the quantitative approach. it is convenient to distinguish information about the source of radiation from information about the radiation traversing space. In either case one may also distinguish the measurement of a total, integrated number of radiation events from measurement of the rate at which events are occurring. This leads to a fourfold classification depicted in fig. 2. In each of the four squares a single word is chosen to characterize the quantity measured. Irradiation instruments give a quantitative indication of how much total radiation has entered a certain space over a certain interval of time. Intensity meters indicate the rate at which radiation is entering a certain space. Activity instruments show the rate at which radiation is leaving a certain source. Depletion instruments show how much radiation has left a certain source over a certain interval of time. For charged-particle radiation, depletion may be measured by the charge built up on the source. Source depletion may also be inferred from other observations, but it is seldom directly measured.

	integrated action	rate of action
space effect	irradiation	intensity
source strength	depletion	activity

FIG. 2.—QUANTITATIVE CLASSIFICATION OF INSTRUMENT INDICATION

So the important categories are irradiation, intensity and activity.

The question "how much;" may be taken to mean "how many;" This is pure counting: irradiation is measured in counts by a counter; and intensity in counts per time unit by a counting rate meter or rate meter. Counter scales usually consist of a combination of high-speed electronic registers (many operate with small neon bulbs) and a lower-speed mechanical register. Typical rate meters indicate by a pointer on a scale marked in counts per minute. Source activity is rated in curies (1 curie $= 3.700 \times 10^{10}$ disintegrations per second', or in rutherfords (1 rutherford $=$ 10^6 disintegrations per second). Choice of a good unit for activity involves an awkward dilemma Disintegration rate is not a straightforward measure of activity. for it does not specify number and kind of radiations per disintegration—a given source may, for example, simultaneously emit β- and y-rays. Nevertheless, this choice is doubtless better than trying to specify the total radiation, which could hardly be measured by a single instrument in the mixed cases.

For many applications, especially those of a biological nature, an answer to the question "how many?" is not enough What is needed is an indication of the effect the radiation might have on matter occupying the space in question. **A** highly available form of matter air, is made the basis of such a unit. The roentgen (abbreviated r; mr for milliroentgen) is the quantity of X- or y-radiation such that the associated corpuscular emission (electrons released from air molecules by the photons) in 0.001293 g. of air produces, in air, ions carrying one electrostatic unit of electricity of either sign. The mass is that of 1 c.c. of dry air at 0° C. and 760 mm. pressure. Assuming an average of 32.5 ev of energy required to form an ion pair in air, 1 r corresponds to the expenditure of about 83 ergs in each gram of air. This number may need revision, as more recent measurements suggest that 32.j ev is about 10% too small. Irradiation instruments calibrated in roentgens are commonly called dosage meters or dosimeters. Intensity meters are called dosage-rate meters and are generally calibrated in r/hr or mr/hr. Source activity can be similarly expressed in a unit abbreviated rhm, which stands for roentgen per hour at one meter.

For nonphoton radiation. such as α-rays, β-rays and neutrons, the roentgen is not available. A similar unit, the rad, is defined for any radiation as that amount which releases energy of 100 ergs per gram of matter. But the biological effects of radiation are not solely dependent on the amount of energy released: it is also a question of how highly localized the energy is. Such considerations have led to another unit. the rem. supposed to be that dose of radiation which has the same biological effect as 1 rad of X-radiation. These rad and rem units, though poorly defined, help to emphasize the variation of biological effectiveness and to ensure careful setting of proper exposure tolerances.

Calibration requires the availability of standards against which the instrument response may be checked. For calibration of the counting mechanism of counters and rate meters there are available electronic pulse generators of various kinds. But for over-all calibration of counters a standard source of radiation must be used. The preparation and use of standard α-, β- and y-sources is a complicated and difficult art. involving all the considerations discussed below under accuracy. Carefully prepared sources are available commercially.

The situation is simpler for instruments calibrated in roentgens. It is relatively easy to build a standard instrument measuring ionization of air. But when biological effectiveness is brought in, as in rem units. the requirement of "standard biological tissue" is clearly impossible of fulfilment in any absolute sense.

Turning from the quantitative "how much?" to the qualitative "what kind?" the first question concerns the variety of radiation —whether it is α, β, γ or neutron. Of these four varieties. a-rays are least able to penetrate matter, γ-rays and neutrons are the most capable and @-rays are intermediate. One way, therefore, of distinguishing varieties of radiation is to introduce more or less absorbing material in front of the counter. In standard air, for example, a-rays are unable to travel more than a few inches, whereas y-rays and neutrons can penetrate 100 ft. or more. This range of penetration, however, of any given variety of radiation is also a function of the radiation's energy. So the use of absorbers does not always unambiguously identify variety. Some instruments by their very nature will respond only to one variety. This is essentially true of the fission counter for neutrons, because only the neutron has an appreciable chance of causing fission. But instrument response, like absorption, is in general energy dependent as well as variety dependent.

A measurement which helps in identifying variety and is also interesting in itself is the determination of half life (more generally, of time dependence) of radiation intensity. Radiation of a given variety, originating in a given mass of a single species of radioactive nucleus. decays exponentially with a characteristic time constant. Thus the half life, the time for the observed intensity to decrease to half its original (first-observed') value. is characteristic of the nuclear species. These three factors — nuclear species, half life and variety of radiation — are connected; and in cases where the connections are known from previous work, knowledge of any two determines the third.

Energy dependence of absorption and of instrument response has been mentioned above. These two techniques, therefore, give a start on the measurement of radiation energy. Actually. the study of energy distribution, often called spectroscopy in analogy with the similar study of light. is a large and important part of nuclear science. Highly precise instruments have been developed. For charged particles, they may sort out different energies by means of electric and magnetic fields. Crystal diffraction methods are useful for γ-rays and neutrons.

With proper care, the size of pulse obtained from a pulse-type ion chamber, a proportional counter or a scintillation counter will be a measure of the particle or photon energy. These instruments are particularly effective when used with electronic devices, called multichannel differential pulse-height analyzers. which automatically sort out pulses according to size and display the distribution. Nuclear reactions having a well-defined energy threshold are useful. as mentioned above in connection with neutron counters!

An important class of measurement, somewhat related to energy measurement, is coincidence counting, recording the counts from two (or more) counters only when they occur simultaneously. The definition of simultaneity is limited by the counters, especially by the deviations in their time lags. Examples of coincidence counting would be detection of annihilation radiation — a pair of y-rays formed when a positron and a negative electron meet and annihilate each other; or detection of β- and y-rays emitted simultaneously by some radioactive nuclei. The term anticoincidence counting is applied to those cases in which all counts from the two channels are recorded except those occurring simultaneously.

A typical nuclear physics problem is to determine the distintegration scheme of a particular nucleus. Boron-10, for example, has been found to decay after neutron bombardment to lithium-? by two processes. In about 7% of the disintegrations, an a-particle is emitted with the full 2.79 Mev of energy; in the other 93%, the a-particle carries only 2.31 Mev and the remaining 0.48 Mev appears in a promptly emitted y-ray. Elucidation of such a disintegration scheme requires measurement of variety of radiation, of energy (of each particle or photon) and of activity or intensity (number of particles and photons).

The information obtained from nuclear instruments is usually presented visually by pointer-scale combinations, oscilloscope traces or patterns of lights; qualitative applications of counters make good use of headphones or loud-speakers, in which the rate of clicking is an indication of intensity.

Nuclear instruments are applied to many industrial measurements, yielding information on pressure, liquid level, thickness of strips and coatings, wear, fluid flow, etc. But these devices, as well as the numerous uses of tracer isotopes, are beyond the scope of this article.

Factors Affecting Accuracy. — Information from nuclear instruments is limited in accuracy by the fact that radiation and radioactivity are universal. Cosmic rays and radioactivity of the earth and air provide a background count which sets a lower limit to the useful range of instrument indication. To these outside sources of background may of course be added spurious counts from the instrument itself; leakage of charge across insulators and radioactive impurities in materials of construction are sources of this trouble. Fission counters are least subject to background error, since for some fissionable elements so-called spontaneous fission occurs only at the rate of once in several hours. Alpha-counting may be pushed down to about 1 count per minute, but unshielded proportional and G-M counters have a background rate of about 30 counts per minute, which with an inch or so of lead shielding may be reduced below 15 counts per minute. In scintillation counters background is about 1 count per minute per cubic centimetre of crystal. Similar limitations apply to photogiaphic methods, under the general label of fog. In autoradiography the word "artifact" is sometimes used to denote spurious evidence of radiation. If N radiation counts are recorded in time t, the standard deviation or error, neglecting background, is $\sqrt{N}$ in the count and $\sqrt{n/t}$ in the counting rate, $n = N/t$. If the background alone is counted for time t_b to establish a background rate b, and then in the presence of this background a source is observed for time t_2 to give a total counting rate n_2, the net rate of the source is $n_1 = n_2 - b$, and the standard deviation in n_1 is $\sqrt{\frac{n_2}{t_2} + \frac{b}{t_b}}$.

Sometimes a radiation variety giving strong counter pulses is to be measured against a high background of a weaker pulse variety. Examples are fissions against a-particles and a-particles against β-particles. The numerous weaker variety pulses may accidentally bunch together closely enough at some instant to build up in the amplifier what looks like a strong pulse. Much the same problem occurs in counting weak radiation pulses over crests in grid current noise of the first amplifier tube.

Accuracy in measuring a single variety requires discrimination against other varieties which may also be present. In current-type chambers this may be achieved by subtracting currents; thus the y-compensated neutron chamber has a three-electrode system, one pair of electrodes collecting current from a volume affected both by neutrons on boron coatings and by y's, the other pair collecting from a volume in which only y's are effective. The difference of the currents is a good measure of neutrons, provided equal y-efficiencies are obtained in the two regions between the electrode pairs, as by adjustment of volumes.

Another limitation on counters, especially serious for the full-volume breakdown of G-M tubes, is imposed by dead time, the period during which, aiter one count has been initiated, the instrument is incapable of detecting another event. Furthermore, even if the counter can generate a very rapid succession of pulses, the electronic indicating system may be unable to resolve them. Electronic pulse shaping, emphasizing the rapidly changing portions of the pulse wave form, can bring great improvement in resolution.

Efficiency of counting means the ratio of counts observed to the total one would like to observe or could observe from the given sources. This involves first the question whether a given particle or photon ever enters the counter; and then the question whether, if it does enter, it will be counted. In the first place, the counter must have some or all of its walls thin enough for the radiation to penetrate; for the soft β-radiation measured in carbon-14 dating, for instance, thin-window counters must be used, or else the sample must be inside the counter. Other considerations are geometrical — for example, a point source of radiation in iree space could register on a counter no more than the fraction F of its emission, where F is the ratio of the effective solid angle, subtended by the counter relative to the point source, to the maximum possible solid angle, 4π steradians. If the counter can be made to surround the source completely, as u-hen a small source is embedded within a scintillator, total (or 4π) counting becomes possible. Shape and dimensions of the source have an effect, not only on counting geometry, but also on scattering and absorption. Scattering is pronounced for electrons, and the backscattering from a reflector may be used to increase by 50% the count from a β-source. Absolute counting refers to the effort to assign an accurate value, based on the observed count, to the total number of radioactive atoms in the sample being counted. Scattering, absorption and efficiency are all of great significance to absolute counting.

Evaluation for Various Applications. — In addition to basic technical factors discussed above, there are practical matters such as cost, size, reliability and portability to be considered in making the best choice of instrument for a particular application. Simple, open-to-the-atmosphere, air ionization chambers are admirably suited to moderate-accuracy rate-meter applications at medium to high levels, as for military and civil defense needs. In dosimetry the fountain-pen size condenser r-meter and the film badge are most useful for monitoring personnel. The condenser r-meter is a roentgen-meter, or dosimeter, consisting of an electrometer chamber given an initial electric charge, worn by the user and then measured ior charge lost, which indicates the total ionizing radiation received. Chemical dosimeters have the advantage over film badges of being easily and quickly read.

Geiger counters combine sensitivity at low counting rates with relative simplicity. An example of an inexpensive assembly would be a Victoreen type 1B86 counter tube, a 1-megohm resistor, a miniature 300-v. battery, a pair of high-impedance magnetic headphones and an on-off switch — all connected in series. G-M counters are sensitive, reliable and portable enough to be very useful in prospecting for radioactive ores. For this purpose the more sensitive but more expensive scintillation counters are also in wide use. For prospecting, an upper limit on scale range of 5 to zo mr/hr suffices, as background at earth's surface averages 0.02 to 0.05 mr/hr, and a count of several times background is encouraging (but not conclusive !) evidence of mineral radioactivity. The scintillator method is extremely flexible as to counter volume. For a medical dosimeter probe a tiny crystal may be used on the end of a light-piping plastic rod; at the other extreme, large volumes oi liquid scintillator surround a counting chamber large enough to receive a human body. Liquid scintillators oi large volume also played a key role in detection of the neutrino, most elusive of iundamental particles.

Accurate nuclear measurement can be achieved only if a good instrument is used with good auxiliary equipment. For example, medical dosimetry of y-emitters such as radioiodine may be wrong by a factor of two because of scattered radiation, but this error may be largely eliminated by using with the counter a collimator that will accept only rays coming from a highly limited direction, and by feeding the counter output to a pulse analyzer which permits counting only peak, unscattered pulses. Other auxiliary items useful on occasion include automatic counting timers and sample changers; flow controls for liquid or gaseous samples; shielding and absorbing materials; and devices for remote handling of dangerously strong sources.

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(J. D. T.)

NUCLEAR MAGNETIC RESONANCE, a technique for observing the magnetic character of atomic nuclei through a resonant response to a high frequency magnetic field when the nucleus is placed in a static magnetic field.

Approximately two-thirds of the stable and almost all of the unstable atomic nuclear species possess angular momentum. called nuclear spin. 4s required by quantum mechanics, the magnitude of the angular momentum is a half-integral multiple of $h/2\pi$ where h is Planck's constant. 6.625×10^{-27} erg-seconds. Accompanying the spin is a magnetic dipole moment, as if electric charge mere circulating around the axis of the spin (*see* NUCLEUS: *Further Properties of Nuclei*). The convenient unit for the specification of the magnitude of nuclear magnetic moments is the nuclear magneton.

A particle with the charge and mass of a proton, the simplest nucleus and a constituent of all others. would have a magnetic moment of one nuclear magneton, if it rotated as a rigid body with one unit $h/2\pi$ of angular momentum. The proton actually has a spin of one-half $h/2\pi$ and a magnetic moment of 2.7896 nuclear magnetons.

In a static magnetic field, the torque acting on a nucleus through its magnetic moment gives rise to a characteristic frequency of precession about the direction of the field, resembling the precession of a spinning top. A relatively weak oscillating or rotating magnetic field lying in the plane perpendicular to the static field can, when in synchronism with the precession, radically change the nuclear orientation; this phenomenon is called nuclear magnetic resonance. Such a technique was applied by I. I. Rabi and collaborators to molecular and atomic beams to improve their precision for measuring nuclear magnetic moments and spins. Magnetic resonance can be detected purely electromagnetically, provided the nuclear spins and moments are in some degree,preferentially oriented, as they are in normal matter in thermal equilibrium in a static field. As an example one may consider the radio-frequency impedance of a coil of wire wound around a small bottle of ordinary water. If a suitably weak radio-frequency current at 20 megacycles per second is used to measure the impedance. while a strong uniform magnetic field of about 5,000 gauss in the direction perpendicular to the axis of the coil is slowly varied. a measurable increase in resistance will be observed as the field moves through the region of 4,673 gauss. This increase in circuit loss is the result of the magnetic resonance of the hydrogen nuclei in the water. Such effects were first observed by E. M. Purcell and collaborators and, independently, by F. Bloch and collaborators. In this way it has been found possible to study the paramagnetism due to the nuclear moments in matter, a phenomenon that is very difficult to detect statically. Nuclear magnetic resonance has other uses than the precise measurement of the magnetic moments of nuclei. Properties of solids and liquids can be studied because the shapes, widths. splitting and transient responses of the resonances depend upon such properties. Data relating to crystalline structure, thermally induced internal motions, electronic band structures, antiferromagnetism, diamagnetism, electronic paramagnetism, ferroelectricity. self-diffusion in solids and liquids, viscosity in liquids and chemical exchange rates are among the subjects included in the results of experiments on nuclear magnetic resonance. Chemists find the study of the resonance of hydrogen in liquids especially useful because of the presence of small shifts and splittings originating in molecular structure. Nuclei having more than one-half unit of angular moment have magnetic resonances that are profoundly influenced in some materials through torques originating in the electric fields of the atoms and molecules which couple with the nonspherical distribution of electric charge in the nuclei, as characterized by its electric quadrupole moment. It is, for example, possible to have magnetic resonance of such nuclei in some solids at very high frequencies even without a static magnetic field. Studies of such resonances provide further information about electrostatic aspects of solid and nuclear structures. See also ATOMIC AND MOLECULAR BEAMS; ELECTRON PARAMAGNETIC RESONANCE.

See E R Andrew, *Nuclear Magnetic Resonance* (1955); N F Ramsey, *Nuclear Moments* (1953).

(R. V. P.)

NUCLEIC ACIDS or POLYNUCLEOTIDES, a group of naturally occurring complex phosphorus compounds, acidic in character, which on hydrolysis yield orthophosphoric acid, a pentose or deoxypentose sugar and a mixture of purine and pyrimidine bases.

In 1868 Friedrich Miescher succeeded in obtaining from pus cells a material which he believed to be the essential chemical substance of the nucleus. This substance, which Miescher called nuclein and which would in modern terminology be referred to as a nucleoprotein, proved to contain phosphorus and to be soluble in dilute alkali but insoluble in water, dilute acid or organic solvents It gave the usual tests for protein. Similar material was shortly afterward obtained by various workers from avian and reptilian erythrocytes, from yeast and from salmon sperm. On further investigation it became apparent that nucleins could be dissociated into two components, a basic protein and a protein-free polybasic phosphorus-containing acid. The latter was termed a nucleic acid. It was subsequently established that nucleic acids could be distinguished from other protein-bound phosphorus compounds by the fact that on hydrolysis they yielded the purine bases adenine and guanine.

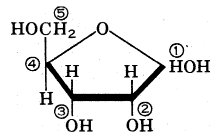


FIG 1—D-RIBOSE (FURANOSE FORM)

Structure.— Investigation by the classical methods of organic chemistry has since shown that nucleic acids fall into two classes:

1. Ribonucleic acids or pentose nucleic acids (commonly abbreviated to RNA or PNA), which on hydrolysis yield phosphoric acid, the purine bases adenine and guanine, the pyrimidine bases cytosine and uracil and a pentose sugar.

2. Deoxyribonucleic acids or deoxypentosenucleic acids (commonly abbreviated to DNA), which on hydrolysis yield phosphoric acid, the purines adenine and guanine, the pyrimidines cytosine or, in rare cases, 5-hydroxymethylcytosine), thymine and, in some cases, j-methylcytosine, and a deoxypentose sugar. In all cases in which the question was investigated it was found that the pentose of RNA is D-ribose and the deoxypentose of DNA is D-2-deoxyribose (*see* figs. 1 and 2).

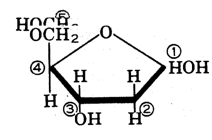


FIG 2 — D-2-DEOXYRIBOSE (FURANOSE FORM)

Within the nucleic acid molecule each purine or pyrimidine base is glycosidically linked to a pentose or deoxypentose residue to form a nucleoside; this linkage involves the nitrogen atom at position 9 in the case of purines and position 3 in the case of pyrimidines. The ribonucleosides of adenine, guanine, cytosine and uracil are named adenosine, guanosine, cytidine and uridine, respectively (*see* fig. 3). The deoxyribonucleoside of thymine is named thymidine; other deoxyribonucleosides are named by adding the prefix "deoxy-" to the names of the corresponding ribonucleosides (*see* fig. 4). In both RNA and DNA the sugar residue is in the furanose form (*see* fig. 1 and 2), and in the case of RNA the linkage to the base is known to have the β configuration.

In nucleic acids the nucleosides are in the form of their phosphoric esters or nucleotides. These are named after the corresponding nucleosides: adenylic acid, guanylic acid, cytidylic acid, uridylic acid and thymidylic acid. Alternatively they may be regarded as nucleoside phosphates and named accordingly; *e.g.*, adenosine-3'-phosphate: thymidine-5'-phosphate (see fig. j and 6). In ribonucleotides the phosphate residue may be attached at positions 2, 3 or 5 of the pentose; in deoxyribonucleotides it can be attached only at positions 2 or 5, since 2-deoxypentoses have no hydroxyl group at position 3.

Within the limits of the analytical techniques at present available it appears that nucleic acids-are built up entirely from such nucleotide units. The manner in which they are linked together was first indicated by electrometric titration data, which suggested that the linkages were of the phosphodiester rather than the pyrophosphate or ether type. Enzymic hydrolysis of RNA (using either snake venom diesterase or ribonuclease followed by intestinal phosphatase) yields the nucleoside-5'-phosphates of the constituent bases; alkaline hydrolysis, on the other hand, yields a mixture of the nucleoside-2'- and -3'-phosphates by a series of reactions involving the formation of the corresponding cyclic nucleoside-2', 3'-phosphates! in which the phosphate residue is attached to positions 2 and 3 of the pentose.

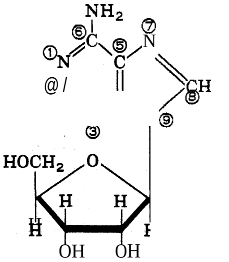


FIG. 3.— ADENOSINE

Apparently, therefore, in the intact molecule each nucleoside is linked to a phosphate residue at the 5' position and also at the 2' or 3' position. The internucleotide linkage, that is to say, is from $C_{5'}$ of one nucleoside through a phosphate residue to $C_{2'}$ or $C_{3'}$ of the next. While it is theoretically possible that both $C_{5'}$-O-P-O-$C_{3'}$ and' $C_{5'}$-O-P-O-$C_{2'}$ linkages might occur in RNA, the balance of evidence favours the view that the RNA molecule is a straight chain of nucleotides in which all the internucleotide linkages are of the $C_{5'}$-O-P-O-$C_{3'}$ type. The possibility that other linkages might be formed through the amino groups of the bases is excluded by the fact that intact RNA can be deaminated by nitrous acid. The hydroxyl groups of the bases may also be excluded from consideration in this connection, since electrometric titration indicates that they are unsubstituted.

The length of this postulated unbranched RNA chain can at present be estimated only on the basis of molecular weight determinations. Unfortunately since RNA exists in the cell in combination with protein, from which it can be separated only at the expense of some degradation. the validity of physical measurements of molecular size and shape is very dubious. The available results indicate a molecular weight in the range 10,000 to 250,000; that is, a molecule containing between 30 and 750 nucleotides. The RNA of tobacco mosaic virus, which can be isolated in an apparently undegraded form. has a molecular weight of about 300,000 when freshly prepared.

Due to recent advances in quantitative chromatographic analysis it has been possible to obtain fairly reliable estimates of the relative properties of the different nucleotides within a specimen of nucleic acid. By this means it has been shown that RNA's from difierent sources vary quite widely in their nucleotide composition. It has. however. been pointed out that in general the number of nucleotides carrying an amino group in the 6-position (viz., in adenine and cytosine) is equal to the number having a 6-keto group (viz.. in guanine and uracil). The order in which the different nucleotides are arranged along the RNA molecule cannot yet be determined, although it has proved possible by enzymic methods to identify the nucleotides at the 'end of each chain.

In DNA the problem of establishing the structure of the molecule is somewhat simplified by the fact that the only possible phosphodiester linkage is C_3-O-P-O-C_5. If this is, in fact, the only type of internucleotide bond, the DNA molecule must be a long unbranched polynucleotide chain. A short section of such a chain is shown in fig. 7. Quantitative chromatographic analysis has shown that there are great differences in nucleotide composition between DNA's from different plant and animal species, although DNA's from different organs of the same species are in this respect indistinguishable. As in RNA, it has been observed that, in spite of wide variations in the relative proportions of the different nucleotides, the number carrying 6-amino groups (in adenine and cytosine) is equal to the number carrying 6-keto groups (in guanine, thymine and 5-methylcytosine). Two further regularities have also been observed in DNA: (1) in any specimen the ratios of adenine/thymine and guanine/cytosine + 5-methylcytosine are approximately unity; and (2) the total number of purine nucleotides is equal to the total number of pyrimidine nucleotides. On the basis of their nucleotide compositions most DNA's appear to fall into two main groups: an AT type, in which the content of adenine and thymine is considerably greater than that of guanine and cytosine, and a GC type, so far found only in bacteria, in which this relationship is reversed.

The manner in which DNA is bound to protein in the cell permits its isolation in a fairly pure state with less danger of disruption than in the case of RNA. The molecular weight of such isolated DNA has been estimated by a number of methods, most of which have given figures of the order of a few million. Measurements of viscosity, flow birefringence and light scattering have combined to suggest that in solution the DNA molecule behaves as a long and rather rigid rod. Some indications of its internal structure have been obtained from X-ray diffraction measurements. On the basis of such studies it has been suggested by J. D. Watson and F. H. C. Crick that the DNA molecule consists of two polynucleotide chains in the form of a double helix, the strands of the helix consisting of two deoxypentose phosphate chains winding round the same axis and held together by hydrogen bonding between their bases.

Nucleic acids seem to occur naturally only in association with protein in the form of so-called nucleoproteins. Relatively little is known of the protein moiety of these complexes and of the manner in which they are linked to the nucleic acids. In general, DNA seems to be bound by a saltlike linkage to a protein of the protamine or histone class, from which it can be fairly easily dissociated.

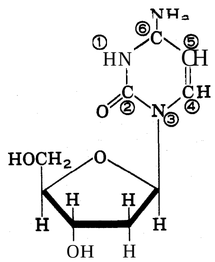


FIG. 4.—DEOXYCYTOSINE

RNA, on the other hand, is usually found in combination with a more complex and nonbasic type of protein; and, except in the special case of the viruses, the two cannot be dissociated without damage to both.

Occurrence.— plant and animal cells and all microorganisms other than viruses appear to contain both RNA and DSX. All plant viruses appear to contain RNA; and all animal viruses. either DNA or RSA.

The position of nucleic acids in individual cells can be determined by making use of the fact that, because of their content of purines and pyrimidines, they show a very intense absorption of ultraviolet light at a wave length of about 260 mμ. Consequently if a tissue section is photographed in ultraviolet light of this wave length, the parts of the section which have a high concentration of nucleic acids can be identified as dark areas in the photograph. This method does not. of course. distinguish between RNA and DNA, but a distinction can be made by the use of specific histochemical reactions. The oldest and most widely used of these, the Feulgen nucleal reaction, is based on the fact that after mild acid hydrolysis, DNA. but not RNA, gives a red colour with basic fuchsin which has been decolorized with sulfurous acid. If a histological tissue section is subjected to this procedure it is assumed that those areas of the section which show a similar red stain originally contained DNA. This assumption rests on a somewhat insecure theoretical basis, and its correctness has from time to time been questioned; in practice, however, it appears to be justified. Unfortunately there is no equally simple and specific histochemical test for RNA. This deficiency has to some extent been remedied by use of the ribonuclease test, which depends on the fact that RNA can be specifically removed from a histological tissue section by treatment with the enzyme ribonuclease, which breaks down RNA. In practice the section is treated with ribonuclease and then stained with a basic dye, such as toluidine blue. Comparison with a similar section which has been stained without enzyme treatment reveals those areas of the cell from which the enzyme has removed stainable material; *i.e.,* those which originally contained RNX.

The results obtained by such methods may be summarized as follows: All cell nuclei contain DNA, which is apparently located on the chromosomes, and except in a few special cases DNA is not found outside the nucleus. During cell division DNA is found only in the chromosomes. Most of the RNA of the cell is found in the cytoplasm, but a small proportion can be demonstrated in the nucleus, especially in the nucleolus.

In recent years histochemical studies have been supplemented by experiments in which nuclei and other cell components have been isolated from a variety of animal tissues in sufficiently large amounts to be submitted to chemical analysis. In such experiments the tissue is first disintegrated in an aqueous or organic solvent, and the resulting suspension of cell debris is allowed to sediment in the centrifuge in gravitational fields of varying strength for varying times. By this means it is possible not only to isolate the cell nuclei in bulk but also to separate the cytoplasmic material into several fractions. Analysis of these fractions confirms that DNA occurs only in the nuclei, which also contain a small amount of RNA. A relatively large proportion of the total RNA of the tissue is found in the microsome or small granule fraction and a lesser amount in the nonparticulate or cell sap fraction. The RNA content of the mitochondria1 fraction is relatively small. Determinations of nucleic acid content of a variety of animal tissues have, in general, shown that those in which the cell nuclei are densely packed, such as spleen, thymus and bone marrow, have a higher concentration of DNA per unit weight of tissue than tissues such as liver and kidney in which the ratio of nuciei to cytoplasm is lower. The concentration of RNA per unit weight of tissue is generally high in tissues in which the cytoplasm is intensely basophilic, such as liver. The total amount of DNA in any of the organs of an adult animal appears to be relatively little affected by starvation or malnutrition; the total content of RNA, on the other hand, is frequently depressed under such conditions.

Biological Function of DNA.—The universal distribution of the nucleic acids suggests that they must play some essential role in biochemistry. Their biological activities are. however, still under investigation.

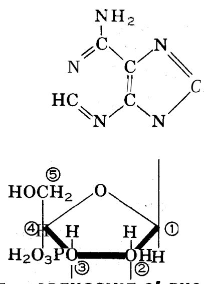


FIG. 5.—ADENOSINE-3′-PHOSPHATE

The fact that DNA is an invariable constituent of the chromosomes and that it is so seldom detected anywhere else in the cell suggests that it may be involved in the mechanism of inheritance. More direct evidence on this question has been obtained from studies on bacteria. It has been known for many years that the pneumococci may be classified into a number of strains or types, each characterized by the production of a serologically and chemically specific capsular polysaccharide. The type to which an individual cell belongs appears to be determined by its genetic constitution; it does not change spontaneously during the life of the cell and at cell division is passed on to the daughter cells. If, however, a culture of, say, type II pneumococci is treated under suitable conditions with an aqueous extract prepared from pneumococci of, say, type III, some of the cells will lose their capacity to synthesize type II polysaccharide, and acquire instead the capacity to synthesize type III polysaccharide. By this means pneumococci of one type may be transformed to another type by treatment with an aqueous extract of cells of the second type. Such transformed cells show no tendency to revert spontaneously to their original type. nor do their descendants. It appears, therefore, that transformation involves a change in the genotype of the cells. For this reason transformation has been termed a directed mutation. The active principle of the aqueous extracts which bring about such transformations in pneumococci has been shown to be DNA of high molecular weight.

Similar transformations have been demonstrated in a variety of bacterial species, notably *Haemophilus influenzae* and *Escherichia coli.* These have not been limited to changes in cell type or serological character but have included changes in resistance to drugs and capacity to synthesize enzymes. In each case the new characteristic acquired by the transformed cell is induced by DNA obtained from a strain of cells of the same species which already possess that characteristic. It would appear, therefore, that the hereditary chemical characteristics of one bacterial cell can be transferred to a second cell of the same species in the form of DNA. This generalization has led to the hypothesis that the hereditary characteristics not only of bacterial cells but of cells in general may be determined by the DNA which they contain; in other words, DNA may be the biologically active material of the gene. If this hypothesis is correct it would seem to follow that in any given species each set of chromosomes, since it contains the same complement of genes, must contain the same amount of DNA, In any given species, therefore, all diploid nuclei would contain the same amount of DNA, and tetraploid and octoploid nuclei would contain, respectively, twice and four times this amount. Gamete nuclei, being haploid, would contain half as much DNA as diploid nuclei. This question has been investigated by two methods. The average DNA content per nucleus has been determined for a variety of tissues, and for the same tissue under a variety of conditions, by isolating the nuclei in bulk and submitting them to gross chemical analysis; and the relative DNA contents of individual nuclei in different tissues have been estimated by photometric measurements on histological preparations. The balance of the evidence obtained by these methods suggests that, except in certain special cases, the DNA content per set of chromosomes is, in fact, approximately constant for any given species, and thus affords some support for the view that DNA is the active material of the gene.

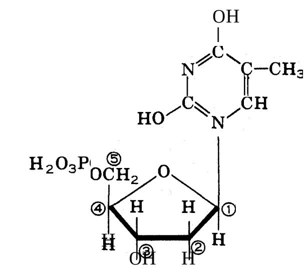


FIG. 6 —THYMIDINE-5′-PHOSPHATE (THYMIDYLIC ACID)

The metabolic activity of DNA may also have some bearing on the question of its function in the life of the cell. From experiments in which nucleic acids have been labeled with isotopic tracers it appears that, whereas RNA, like most other constituents of the cell, is continuously being synthesized and broken down, DNA may be synthesized only in preparation for cell division and may be stable throughout the life of the cell. Such stability might well be postulated for the active material of the genes.

Evidence that DNA can profoundly influence the activities of the cell in a specific direction has also been obtained from the study of the DNA-containing viruses; in particular, the bacteriophage T2, which infects E. *coli.* Each particle of this virus appears to consist of a DNA core completely surrounded by protein. In the process of infection the particle adheres by means of its protein to the surface of the bacterial cell. The phage DNA then enters the cell, in which it initiates the synthesis of new phage particles. This synthesis is accompanied by rapid and extensive changes in the metabolism of the host cell. The normal synthesis of respiratory and adaptive enzymes, and of RNA, ceases. DNA synthesis continues, but the DNA formed is typical not of the host but of the infecting phage and is characterized by its content of hydroxymethylcytosine, a pyrimidine never found in the DNA of normal E. *coli.* An even more remarkable phenomenon is that a strain of E. *coli* normally incapable of thymine synthesis will begin to produce this pyrimidine as soon as it is infected with phage. All these changes appear to be brought about only by the DXA of the phage. The phage protein appears to take no part in them and remains throughout attached to the exterior of the host cell. If it is removed from the cell wall after the entrance of the DNA into the cell, the production of new phage particles and the concomitant changes in the metabolism of the host continue unaffected.

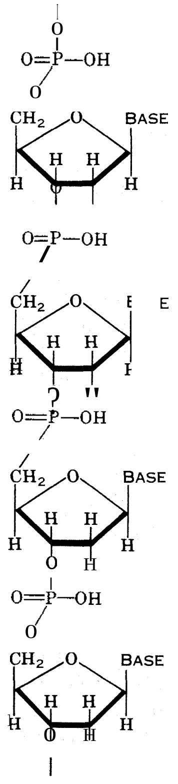


FIG. 7.— STRUCTURE OF THE POLY-NUCLEOTIDE CHAIN IN DNA

The consensus is that the DNA structure functions as a "coded" record of the amino acid sequence of each protein made by the cell.

Biological Function of RNA.—It is generally accepted that RNA is in some way involved in the biosynthesis of protein. This view was originally based on numerous observations that RNA is particularly abundant in cells which are actively synthesizing protein either for growth (*e.g.,* in embryonic tissues) or for secretion (*e.g.,* in the cells of the pancreas which produce digestive enzymes or in the cells of the silk gland of the silkworm). In bacteria, also, rate of growth is approximately proportional to RNA content per cell. A connection between protein synthesis and RNA is also suggested by the evidence that in animal cells the microsomes, which, as stated above, have a high content of RNA, may be the major site of protein synthesis. Nevertheless it does not appear that protein synthesis and RNA synthesis necessarily proceed simultaneously. Thus in cells growing in tissue culture, RNA synthesis precedes protein synthesis; in bacteria, protein synthesis can be inhibited chemically without affecting RNA synthesis; and if pancreas tissue is stimulated to synthesize protein, there is no concomitant synthesis of RNA.

More direct evidence on the relationship between RNA and protein synthesis has been obtained from the study of bacteria. Thus it has been shown that so-called protoplasts prepared from B. *megaterium* by treatment with the enzyme lysozyme under appropriate conditions are capable of synthesizing the enzyme β-galactosidase, provided they are supplied with an energy source and a mixture of the necessary amino acids. If such protoplasts are prepared in presence of the enzyme deoxyribonuclease, up to 99% of their content of DNA may be lost in the process of preparation; but their capacity to synthesize β-galactosidase is unimpaired. If, on the other hand. they are prepared in presence of the enzyme ribonuclease their content of RNA is similarly reduced in the preparation process. If this reduction exceeds 35% of the total the ability of the protoplasts to synthesize β-galactosidase is markedly depressed.

These results would appear to suggest that RNA is required for protein synthesis, but DNA is not. There is, however, evidence to indicate that the situation may, in fact, be more complex than this. If staphylococci are disrupted by supersonic vibration they retain the capacity to synthesize the enzymes catalase and β-galactosidase, if provided with a source of energy and a mixture of the necessary amino acids. This enzyme-synthesizing capacity is greatly diminished if the cells are depleted of nucleic acid. If only part of the nucleic acid is removed formation of both enzymes can be restored by addition of a mixture of purines and pyrimidines. Formation of catalase can also be restored by addition of RNA. If the cells are depleted of nucleic acid to a greater extent, the effect of RNX or a purine-pyrimidine mixture is less marked, but addition of DNA restores the capacity to synthesize both enzymes. The experiments cited indicate that RNA is concerned in protein biosynthesis, but they do not show that RNA is capable of producing a specific effect on the metabolism of the cell in a manner analogous to that of the DSA in bacteriophage or the transforming factors. Evidence of such an effect has, however, been obtained from the study of tobacco mosaic virus (TMV). The TMV particle appears to consist of a thick-walled cylinder of protein surrounding a rodlike core of RSA. Both constituents may be obtained free and undegraded, the protein by removing the RNA with alkali, the RNA by removing the protein with sodium dodecyl sulfate. Such free RNA and protein may then be made to combine stoichiometrically and the reconstituted nucleoprotein so produced possesses virus activity. Bforeover, it has been found possible to recombine RNA from the rib-grass strain of TMV with protein from the ordinary strain. The resultant hybrid virus produces the disease in tobacco plants characteristic of the rib-grass strain. and the virus protein recovered from such infected plants has the characteristics of the rib-grass strain protein. Apparently, therefore, the RNA of the virus determines the nature of the pathological changes produced in the host and the nature of the virus protein synthesized in the course of the infection. As in the case of bacteriophage, the protein of the virus seems to serve mainly as a vehicle and protective coating for the nucleic acid.

All of these observations are consistent with the hypothesis that the function of RNA in the cell is to serve as an intermediary that "translates" the code of the DNA structure into protein structure.

Formation of nucleic acids in living organisms is generally presumed to occur by the combination of preformed purine and pyrimidine nucleotides (or related compounds) to form polynucleotides. The existence of enzymes catalyzing this process has been demonstrated in the cells of various organisms. The purine nucleotides required for this process are believed to be synthesized by combination of phosphoribosylamine and glycine to give glycinamide ribotide, which by addition of a one-carbon unit and reaction with glutamine yields aminoiminazole ribotide. Reaction with aspartic acid and addition of a second one-carbon unit results in formation of formyl-4-amino-5-iminazole carboxamide ribotide. This compound undergoes ring closure to give inosinic acid from which adenylic and guanylic acids are derived. The pyrimidine nucleotides are thought to be formed by combination between aspartic acid and carbamyl phosphate to give ureidosuccinic acid. which undergoes ring closure and dehydrogenation to give orotic acid. This compound on combination with phosphoribosyl pyrophosphate followed by decarboxylation yields uridylic acid, from which cytidylic and thymidylic acids are thought to be derived.

Since nucleic acids are present in all plant and animal tissues, they constitute a significant element in the diet. In the digestive tract dietary RNA and DSX are thought to be liberated by the action of proteolytic enzymes from the proteins with which they are associated and, under the influence of the enzymes ribonuclease and deoxyribonuclease, respectively, are broken down to a mixture of mono- and oligonucleotides. These are in turn converted by the action of phosphatases into a mixture of nucleotides and then nucleosides, and the latter are further broken down by nucleosidases into the corresponding free sugars and free bases.

While some of the purines and pyrimidines absorbed from the gut may be incorporated into the nucleic acids of the tissues. the greater part is broken down and excreted. Guanine and adenine are enzymically deaminated to hypoxanthine and xanthine, respectively, and both of these are oxidized to uric acid under the action of xanthine oxidase in the liver. In man and other primates uric acid is excreted as such; in other species it is converted to allantoin, allantoic acid. urea or ammonia before excretion. Pyrimidines are thought to be broken down mainly to urea and ammonia.

See E. Chargaff and J. N. Davidson (eds.), *The Nucleic Acids: Chemistry and Biology* (1955); J. N. Davidson, *The Biochemistry of the Nucleic Acids,* 3rd ed. (1957). (J. N. D.; R. Y. T.)

NUCLEUS. In animals and higher plants a nucleus is that portion of the cell containing the hereditary materials (chromosomes, genes) and a nucleolus. It is discussed in the article CYTOLOGY. This article deals with the nucleus of the atom, a particle of very small radius and exceedingly great density located at the centre of the atom. All but a negligible fraction of the atomic mass is concentrated in the nucleus. At the same time the size of the nucleus is more than 100,000 times smaller than the size of the atom. The approximate size of the atom, in turn, is a few billionths of an inch (*i.e.,* one. two or three times 10^{-8} cm.). The nucleus carries a positive electric charge which is an integral multiple of the elementary charge (whose magnitude is 4.8×10^{-10} electrostatic units).

DESCRIPTION AND HISTORY

The first clear evidence about the internal structure of the atom was obtained by E. Rutherford in 1911. He was led by his experiments to assume that atoms consist of a nucleus, as described above, and a number of electrons. These electrons carry a negative elementary charge (of magnitude 4.8×10^{-10} electrostatic units) and they have a mass which is a small fraction of the atomic mass. (The fraction representing the total weight of the electrons in the atom to the atomic weight is $\frac{1}{1,840}$ in the case of hydrogen, the lightest element, or $\frac{1}{4\,760}$ for uranium, a typical heavy element.) The number of electrons in the atom is equal to the number of positive charges the nucleus carries so that the atom as a whole is neutral. The atomic number and the designation Z are used for either of these quantities. All chemical and most physical properties of atoms are determined, apart from exceedingly small variations, by the atomic number. Z. Atoms having a given Z value form an atomic species. For example, if the nucleus has one unit of charge and one electron is present, we have a hydrogen atom. As further examples, nuclei with 2, 6, 26. 79 and 92 charges may be mentioned; the corresponding atoms have 2, 6, 26, 79 and 92 electrons and the atomic species are helium, carbon, iron, gold and uranium. respectively. The chemical transformations, the appearance and common behaviour of materials built from the atoms depend only on the configuration of the electrons. This is influenced, in turn, only by the nuclear charge and is practically independent of other properties of the nucleus. The atomic properties are discussed in detail in ATOM. In the following the interest is in the central particle; *i.e.,* the nucleus.

Formerly it was believed that atoms were immutable entities. This statement did not imply that the configuration of the electrons in the atoms could not change. It was. indeed. soon recognized that chemical changes are caused by the rearrangement of the electrons. As long as the charge of the nucleus has remained the same, however, the atom is considered unchanged. No matter what deformation occurs in the electron arrangement, it will always return to the normal configuration as soon as the disturbing force is removed.

In 1896 A. H. Becquerel noticed that uranium emits unusual radiations, designated as radioactivity. In the next few years the work of Marie and Pierre Curie, E. Rutherford, F. Soddy and others led to the recognition that the phenomenon had to be explained by a spontaneous, permanent and intrinsic change of the atomic species (see RADIOACTIVITY, NATURAL). In uranium this is brought about by the emission of a particle from the nucleus which carries away two units of positive charge and which is called an a-particle (alpha particle). Thus the uranium nucleus, originally containing 92 units of charge, disintegrates into a nucleus containing 90 units of charge. This nuclear charge characterizes a different atomic species, thorium. These phenomena will be discussed later in the section on a-decay. The emitted particle has a very high velocity, as much as the 20th part of the greatest possible velocity, that of light. Thus a much larger kinetic energy is concentrated on the a-particle than was ever before found on a body of comparable mass. Actually the α-particle is the nucleus of the helium atom.

In the hands of Rutherford these a-particles became powerful tools in exploring the interior of the atoms. In experiments published in 1911 Rutherford showed that the majority of particles pass through thin (of the order of $\frac{1}{10,000}$ in.) but solid foils without being deflected. A few a-particles were scattered through quite large angles. These observations could be explained by assuming that the a-particles had collided with heavy, charged particles, the atomic nuclei. The greater number of small deviations were the result of "distant" collisions; *i.e.,* of forces acting between two particles nhich did not approach closely. The large deflections were caused by the larger force of two charged particles more nearly in contact. In order to account for the large number of undeviated particles, the nucleus had to be given a radius small compared with that of the atom. Rutherford assumed that the charge of the nucleus is positive and that the remainder of the atom consists of the light negatively charged electrons.

Collisions between the a-particles and the electrons are much more frequent than the noticeable collisions betneen a-particles and nuclei, but because of the small mass of the electron these collisions do not result in an observable deflection of the α-particles. Rather they cause a gradual loss of energy of the a-particles. The distance through which the particle travels before it loses all of its available energy is called the range of the particle. The range depends, in general, on the initial energy of the particle, on its charge, its mass and on the density of the electrons with which it can collide. The hypotheses nhich Rutherford made to explain his experiments have been fully verified by the great body of experimental and theoretical studies of atomic and nuclear physics.

In 1919 Rutherford observed that nitrogen bombarded by a-particles emitted a new product. This turned out to be a nucleus of the hydrogen atom. which is called a proton, carries a single unit of positive charge and is the simplest of all atomic nuclei. The reaction was produced by a close collision of the a-particle and the nucleus of the nitrogen atom, which carries seven positive charge units. The a-particle attached itself to the nitrogen nucleus, producing a so-called compound nucleus of high internal energy. From this structure the fast proton is subsequently emitted. The actual time for the emission is an exceedingly small fraction of a second.

The result of this nuclear reaction is that the nitrogen nucleus, having absorbed the α-particle with two positive charges and having emitted a proton carrying only one positive charge, has now turned into an oxygen nucleus. In this way Rutherford's experiments accomplished the transmutation of nitrogen atoms into oxygen atoms. At the same time the bombarding helium nuclei were transformed into hydrogen nuclei. In the process the kinetic energy of the system had also changed. The final particles contained less energy than the original helium nuclei.

Rutherford's experiments also explained why the transmutation of elements could not be accomplished by the previously used methods of chemistry and physics. Artificial change of nuclear charge requires a nuclear reaction induced by the close contact of two atomic nuclei. Because of the strong electrostatic repulsion of the positively charged nuclei. sufficiently close contacts can occur only if the nuclei approach each other with a high initial velocity. The required high velocities do not occur in chemical processes and thus the endeavour of the alchemists to transmute elements by chemical means was doomed to failure. As soon as methods and techniques specialized in the production and observation of high-velocity particles were developed, transmutation of atoms could be observed.

The study of atomic nuclei remained a field sharply separated from the investigation of atoms and from other branches of chemistry and physics. The reason for this is twofold. First, the details of nuclear structure influence the properties of the atom as a whole and the properties of matter in bulk to an exceedingly small extent.

Thus the study of the structure of matter could proceed without detailed knowledge of the atomic nucleus. Second, the internal behaviour of nuclei can be influenced only when energy is present in very high concentrations. The required high energies are carried by a-particles such as were used in Rutherford's experiments. In chemical and most physical processes, however, the concentration of energy is not high enough to influence the behaviour of nuclei to a noticeable extent. Thus, nuclear processes occur, so to speak, in a world of their own and unusual special methods must be devised to penetrate into this world.

For several years following the publication of these first experiments on nuclear transmutations, radioactive materials occurring in nature remained the only source of high-energy particles. The study of nuclear processes was handicapped by the relatively small number of particles these sources made available to the experimenter. Observations had to be made over quite long periods of time and results had to be based on the observations of relatively few processes. Nuclear scientists therefore made every effort to produce similarly fast particles by artificial means. The first machine to do this was the "cascade transformer" of C. C. Lauritsen, H. Crane and others which was completed in 1928. This was followed by the machine of J. D. Cockcroft and E. T. S. Walton in 1929 and the "electrostatic generator" of R. J. Van de Graaff in 1931. These machines are called "linear accelerators," a term derived from their common fundamental principle. The charged particles, such as protons or a-particles, are introduced at one end of a cylinder containing a very strong and extended electric field. As the particles move through the field they are continuously accelerated. In order that no energy should be lost by collisions with atoms, the cylinder is evacuated. The fundamental principle of these machines is the method by which the necessary electric fields are obtained.

Another principle was used in the cyclotron (E. O. Lawrence, 1932, see ACCELERATORS [PARTICLE]). In this machine particles are confined by a magnetic field to a spiral-shaped orbit and accelerating electric fields are repeatedly applied while the particles are moving along this orbit.

The betatron (D. W. Kerst, 1940) is similar to the cyclotron in that the particles are confined by a variable magnetic field. The acceleration, however, is accomplished by the principle of induction. According to this principle, increase of current in one coil induces an opposite current in a coaxial coil. In the betatron a change of current in a coil causes an acceleration of electrons which do not move in a second coil but rather in free space. An important practical difference between the cyclotron and the betatron is that the former is used to accelerate atomic nuclei while the latter accelerates electrons.

After 1945 improvements in all these machines became possible through closer control of the electromagnetic fields which are used to confine and accelerate the particles. In some of these, electrons or nuclei are accelerated in straight lines (L. Alvarez, acceleration of protons, 1946; H. H. Hansen, acceleration of electrons, 1948). Acceleration is achieved by the continuous action of an accelerating field which moves along with the accelerated particle. A machine of the cyclotron type is the synchrotron (E. M. McMillan, 1945) for the acceleration of electrons. In this machine electrons are kept in a circular orbit by a changing magnetic field and the acceleration is accomplished by repeated application of an electric field near a certain point in the orbit of the electrons. By a close correlation betneen the changing magnetic field and the period in which repeated accelerations are applied (synchrocyclotron), it became possible to accelerate nuclei to very high energies; the highest energy reached in mid-1950s was in the bevatron at the University of California. Berkeley. The energy obtained was approximately 1,500 times higher than the energy of the a-particles of uranium.

These high-voltage machines were capable of producing a considerable number of nuclear reactions which were, in principle, analogous to the reaction studied by Rutherford in 1919. In some of these reactions energy was released, in others energy was absorbed. but in all cases the energy changes were great compared with the energy changes involved in chemical reactions.

In 1932 Irène Curie and F. Joliot discovered that by nuclear reactions radioactive nuclei can be produced. In their experiments they used, like Rutherford, a-particles. With these they bombarded boron atoms, whose nuclei carry five elementary charges. The resultant nucleus contained two more charges and was therefore a sevenfold charged nucleus, or a nitrogen nucleus. This nitrogen nucleus differed from all nitrogen nuclei found in nature in that it emitted a particle called the positron. This particle is similar in all respects to the electron discussed above except that it carries a positive rather than a negative charge. In the following years a great number of radioactive nuclei were produced. Many of these emit positive electrons like the nitrogen nucleus just described, others emit the more common negative electrons. Radioactivities of this type are called @-activities,and the positive or negative particles emitted by the nuclei are called β-rays. (See RADIOACTIVITY, ARTIFICIAL.) Actually β-radioactivity was discovered practically simultaneously with a-activity, but up to 1932 only a few naturally occurring β-activities were known. All elements can be obtained in a radioactive form.

Considering the great energy release which was frequently encountered in nuclear reactions, the question arose whether it would be possible to utilize this energy. This was not possible for the following reason: in order to release nuclear energy one had to start with highly energetic particles. Most of these particles, if they impinge on a piece of matter, will not get close to nuclei and will not produce reactions but will instead squander their energy by making collisions with light electrons. In this way the originally concentrated energy of the particles will ultimately be transformed into heat. Only a small fraction, less than $\frac{1}{100}$ of 1%, of the originally fast particles get close enough to an atomic nucleus to produce a nuclear reaction. In these rare instances the nuclear energy may be greater, sometimes even 10 or 100 times greater, than the energy of the impinging particle but since these processes occur only rarely, the net gain in energy is small. The bombardment of a piece of material by a stream of energetic, charged particles will thus produce a heating of the bombarded sample which is only slightly increased by the reactions occurring in the sample. Considering the exceedingly high cost of the original source of energy, the actual slight energy production could not be considered as a practical source of power.

A great number of additional nuclear transformations became possible in 1932 when J. Chadwick discovered the neutron (*q.v.*). This particle has a mass which is very slightly in excess of the mass of the hydrogen nucleus, or proton. In contrast to the proton, however, it carries no charge and is the only known nuclear particle that is neutral. Consequently the neutron does not attract any electrons and does not have the property of other nuclei of surrounding itself with an extended electron configuration. Thus one of the striking properties of the neutron is that it may penetrate practically freely through several inches of solid materials, being influenced in its path only whenever it touches an atomic nucleus.

The fact that neutrons are not charged gives rise to a second important consequence. This is that neutrons can approach any nucleus without being repelled by the charge on the nucleus. Therefore a neutron need not have a high velocity, or a high energy, in order to cause a nuclear reaction. Unlike the charged particles the neutrons can approach with equal ease nuclei of small charge like nitrogen nuclei or nuclei of big charge like gold or uranium. This fact was utilized by many investigators following 1932 to explore a great number of nuclear reactions. E. Fermi and his collaborators in Rome, It., were by far the most active and successful workers in the field.

The fact that a neutron need not possess energy in order to approach a nucleus reopens the question whether nuclear reactions can be used to produce useful power. Unfortunately neutrons could be produced only in reactions in which fast particles were involved. A typical example is the reaction described above in which a fast a-particle impinges on a boron nucleus and forms a radioactive nitrogen nucleus. In this reaction a neutron is also ejected. In the final analysis this neutron represents as costly an investment of energy as the fast particle itself and practical power production seems to remain unattainable.

Actual utilization of nuclear energy on a big scale became .a concrete possibility at the end of 1938 when O. Hahn and F. Strassmann in Berlin, Ger., discovered uranium fission. These investigators made a careful study of the artificial radioactive substances which were obtained when neutrons impinged on the uranium nucleus. Fermi and his collaborators had noticed several years previously that when a uranium nucleus is hit by a neutron, a variety of radioactive substances are produced. At that time the reaction was not understood. Hahn and Strassmann specifically identified barium in the bombarded uranium target they were studying. To explain the presence of this much lighter element a very violent reaction must have occurred in the uranium nucleus. It was concluded that the nucleus of uranium, because of its large size and the repulsion of its many positive charges, is on the verge of disintegration. The additional energy brought into the nucleus by the neutron is sufficient to make the nucleus break apart. The process is called the fission of the nucleus. The electrostatic repulsion of the product nuclei at the instant of fission makes them fly apart with great velocity and an amount of energy, unusually large even in the scale of nuclear energies. This splitting of the uranium nucleus can occur in a number of ways, giving a variety of pairs of disintegration products. These nuclei, which are unstable and disintegrate by β-particle emission, add to the energy liberated by the reaction. The above conclusion was reached and verified experimentally by several scientists. The first of these were O. Frisch and L. Meitner in Copenhagen, Den.

It was further guessed that neutrons are liberated in fission making possible a chain reaction. If, for instance, 2 neutrons were emitted, these could react with uranium nuclei producing 4 neutrons. These would multiply to 8, then to 16 and so on. In a feu' steps the number of neutrons will become extremely large, the reaction is accelerated and energy is liberated at an ultimately explosive rate. Later in 1939 L. Szilard, F. Joliot and others experimentally verified the liberation of a sufficient number of neutrons. This was the necessary proof of the feasibility of a chain reaction and work was begun on producing such a reaction. To control the chain reaction means, first, to allow neutrons to multiply and, subsequently, to strike a balance of neutron production and neutron absorption so that the number of neutrons just maintains itself and does not grow to explosive proportions. This was first achieved under the guidance of E. Fermi on Dec. 2, 1942, at The University of Chicago. Subsequently, many additional nuclear reactors were built, all based on the principle explained above. Some of these reactors liberate considerable amounts of energy and progress has been made toward transforming this energy into useful power.

In 1942 the development of the explosive aspects of the nuclear chain reaction was undertaken by a group headed by J. R. Oppenheimer. On July 16, 1945, the first so-called "atomic" bomb was exploded in the desert near hlamogordo, N.M. Afterward, two atomic bombs were exploded over Japan. In the following years numerous tests of atomic bombs were carried out by U.S. scientists in the Pacific and Nevada; by Russian workers; and by a British group in Australia. In later tests (in particular the U.S S R test of 1953 and the U S. tests of 1951 and 1952), the explosion was based in part on the building up of light nuclei. The nuclear reaction involved in that case is the fusion of small nuclei into larger units rather than the fission of the heaviest nuclei into two parts. The fusion reaction is most easy if hydrogen nuclei are involved which carry only a single unit of charge and if the temperature in the reaction is extremely high so that charged particles can approach each other. The designations "hydrogen bomb" and "thermonuclear bomb" refer to the facts just mentioned.

DETECTION OF NUCLEAR PROCESSES

When a nuclear reactor produces energy, and particularly when an atomic bomb explodes, the effects of nuclear processes are very noticeable, even without elaborate detecting devices. The energy released appears in the form of heat or, in the case of the atomic bomb, partly in the form of motion of air masses, light and other radiations. Some of these radiations are capable of ionizing and rearranging individual molecules. If that happens extensively in living tissue, radioactive burns result and the tissue may suffer serious damage.

In the development of nuclear science, both past and future, observations of an individual process are more important than the observation of the impressive phenomena that accompany the large-scale release of nuclear energy. Individual nuclear processes are observable, in fact, for two reasons. One is that particles participating in nuclear reactions as a rule have exceptionally high energy and are, for that reason alone, noticeable among the myriads of atoms of comparable size but much lower energy through which these nuclear fragments move. Another reason is that the effects of these fast particles can be amplified. Thus, while the effects are usually too small for direct observation, they can easily be detected by the use of suitable apparatus.

Any of the charged particles or electromagnetic radiations connected with nuclear reactions can produce an effect in a photographic plate similar to that of light. This effect essentially consists of producing disturbed grains in the photographic plate. These disturbed grains then are developed in subsequent chemical processes so that a deposition of metal big enough to be visible to the naked eye or under the microscope is formed at the position of the disturbed grain. The process of developing plays in this special instance the role of amplifying the original effect of the nuclear radiation. The characteristic property of nuclear fragments is their high energy by which they can activate a number of grains lying along a straight line. Use of photographic plates of various sensitivities and detailed study of the density of the excited grain and of the length of the track make it possible to recognize the kind and energy of the particles that cause the track. It is interesting to note that the blackening of a photographic plate by the faintly radioactive pitchblende started H. A. Becquerel in 1896 on the first investigation of a nuclear process. Half a century later the finer methods of observation described above made photographic plates most valuable tools of research in nuclear physics.

The Wilson cloud chamber, devised by C. T. R. Wilson in 1912, is a piece of apparatus especially designed for the detection of charged nuclear fragments. (See **CLOUD** CHAMBERS.) In its general principle of action it is similar to the photographic plate. In the latter nuclear radiations give rise to disturbed centres in the photographic emulsion. In the cloud chamber, a-rays or other fast charged particles form ions, *i.e.*, charged atoms or molecules, along their paths. The process of developing is replaced in the cloud chamber by a process of condensation. The cloud chamber contains a vapour, usually water vapour, which is maintained at a temperature just above the condensation temperature. Following the passage of nuclear particles, the cloud chamber is expanded and by this process the vapour contained in it is cooled so that condensation sets in. The water molecules are attracted to the ions which mark the trail of the fast particle. Thus a set of droplets is formed making the path of the particle visible. The process of amplification in this case is the growth of the droplets around the ions.

There is one method of observing nuclear particles without the use of an amplifying mechanism. This is the method of observing fluorescence or scintillations. Along the path of the fast particles atoms and molecules are not only ionized but also disturbed to various degrees. These atoms and molecules return to their normal states and in doing so emit light. The light effects produced in a suitable fluorescing material by a single a-particle are actually visible to the naked eye. These individual processes are called "scintillations." It is remarkable that in a scintillation the effects of a single nuclear process can be seen directly without the use of intervening equipment. This is possible because of the great amount of energy of the a-particle and the extremely great sensitivity of the human eye. As a practical means of studying nuclear reactions the observations of scintillations were of great importance around 1920. The scintillation method, combined with sensitive apparatus for the detection and amplification of light, again proved of great usefulness.

Purely electric apparatus may be used to detect nuclear particles. In these detecting devices the ions produced by the nuclear particles are set in motion by electric fields. This can be done in a variety of ways. The field may be chosen relatively small and its effect may be merely to collect the ions on an electrode. In this case the resulting current is always so small that in order to observe it one has to amplify the current. This is done by equipment similar to the common radio receiving sets. If stronger fields are used to move the original ions, these ions may acquire enough energy to knock electrons out of other atoms or molecules, thereby producing more ions. In this way some amplification takes place immediately. This initial amplification might become so considerable as to develop into an actual discharge, as happens in the Geiger-Müller counter.

Electric detecting devices are particularly useful because of their great flexibility. They can be set in a way to become selectively sensitive to a specific particle. When arranged and coupled in an appropriate manner these electric devices can count particles of a specified energy. They can be used to study the coincidence in time of two processes. Therefore they are capable of furnishing the important information whether two nuclear particles have been released in the same process. Finally, by purely automatic methods one can keep records of the number of various kinds of particles that have passed through a counter.

While electric fields are most frequently used in collecting the ionized atoms along the path of a nuclear fragment, magnetic fields are frequently used to determine the exact speed and energy of the fragments. Simultaneous use of electric and magnetic fields gives a further piece of important information, namely the mass of the particle with which we are dealing. This latter piece of equipment, the mass spectrograph, is not, properly speaking, an instrument of detection, but a precision instrument, designed to measure one of the basic properties of nuclei.

Among the nuclear fragments there is one which cannot be observed directly by any of the methods described above. This particle is the neutron. The detection of neutrons proceeds as a rule in an indirect way. The collisions of the neutron with atomic nuclei of various kinds produce fast. charged particles or electromagnetic radiation and either of these may be detected by one of the many methods which have been described.

CONSTITUENTS OF THE NUCLEUS

According to ideas in the 1950s the nuclei are built from two simpler particles, the neutrons and the protons. These two particles, which are considered the building blocks of nuclei, are also called nucleons. As has been mentioned above the protons carry the elementary charge (4.8×10^{-10} electrostatic units), whereas the neutrons do not carry a charge. The masses of the proton and neutron are 1.6730×10^{-24} and 1.6752×10^{-24} g., respectively. In nuclear physics it is customary to introduce a special unit of mass. 1.6604×10^{-24} g. This mass is actually $\frac{1}{16}$ of the mass of the most abundant stable variety of the oxygen nucleus.

In general a nucleus contains Z protons and N neutrons. where Z and N are integer numbers. The charge of the nucleus is Z times the elementary charge. It was pointed out in the first section that the atomic species is determined by Z alone. Nuclei of the same atomic species may, however, contain various numbers of neutrons. It is found, for instance, that hydrogen with Z equal to one may have N equal to zero. one or two. Such members of the same atomic species with different N values are called isotopes. It is customary to differentiate isotopes by a superscript equal to $Z+N$ following the chemical symbol of an atomic species. Thus the isotopes of hydrogen are H^1, H^2 and H^3. Frequently the Z value is indicated by a leading subscript, *i.e.*, ${}_1H^2$, but this subscript may be omitted since the chemical symbol also indicates the Z value. As further examples, the isotopes of oxygen may be mentioned, where Z equals 8 and N may be 6, 7, 8, 9, 10 or 11, and isotopes of uranium, in which Z is equal to 92 and N may have any value from 135 to 148. Further isotopes are being discovered.

Because isotopes have the same Z value and hence the same chemical behaviour, it is extremely difficult to separate them. Methods depending on the difference in mass: or N value, have been developed (see ISOTOPE) but these are much more expensive and less efficient than chemical processes.

The total number, $Z+N$, of particles in the nucleus is called the mass number and is designated by A. The actual mass of a nucleus differs by a small amount from the sum of the masses of its protons and neutrons. It should be noticed that while the charge of the nucleus is exactly Z times the elementary charge, the mass of the nucleus is not obtainable in a similarly simple manner. A more detailed discussion of this remarkable fact will be given in the next section.

Among nuclei which contain few particles it is often found that the values of Z and N are nearly the same. Some of the most abundant isotopes found in nature such as ${}_2He^4$, ${}_6C^{12}$, ${}_7N^{14}$ and ${}_8O^{16}$ exhibit this phenomenon. As one goes to heavier nuclei the number of neutrons increases faster than the number of protons in the nucleus. In uranium, for instance, the most abundant isotope has 54 more neutrons than protons.

There is no consistent theory as to the forces which hold neutrons and protons together in the nucleus. In order to assure stability it must be assumed that these forces are in the main attractive. In the following there will be occasion to discuss some properties of these forces. Here it is sufficient to mention that these forces have extremely short range. The forces between neutrons and protons become negligible if the distance exceeds the order of magnitude of the nuclear diameter.

In addition to nucleons, that is, protons or neutrons, other particles are known to be emitted in nuclear transformations. Among these the a-particles and β-particles should be mentioned. These occur in the great majority of spontaneous puclear disintegrations (spontaneous radioactivity) and historically they were the first to be observed. Nevertheless they are not considered to be primary constituents. In fact the a-particle may be considered to consist in turn of two protons and two neutrons, having a charge of two and a mass of approximately four units. The fact that a-particles so often occur as the product of nuclear disintegrations is caused by the extraordinary stability of this particular arrangement of protons and neutrons.

The reason β-particles, which are either negative or positive electrons. are not considered regular constituents of the nucleus is more involved. According to the basic theory of atomic physics one cannot confine a particle of small mass, such as the electron, in a region as small as the nuclear radius without giving it an energy greater than the nuclear energy. In other words, the paradox occurs that the electron, if thus confined, must have an energy great enough to permit the particle to escape.

Nuclear theory describes the emission of negative or positive electrons as a process in which the negative or positive electron is created at the moment of emission. This concept becomes plausible when it is added that both the creation and annihilation of pairs of positive and negative electrons have been observed outside of nuclei. Thus these electrons cannot be considered immutable. Any attempt to assume the presence of these electron pairs in the nucleus leads to a complicated picture where any number of positive and negative pairs may be assumed to be present. In the accepted theory and for the following discussion, the presence of positive and negative electrons is ignored. Attention is confined to a model composed of neutrons and protons.

NUCLEAR ENERGY

Observations of natural and artificial nuclear transmutations prove that the energies involved in nuclear reactions are of great magnitude. In fact. these energies are larger by a factor of 1,000,000 than the energies involved in chemical reactions. The neutrons and protons are bound together in nuclei about 1,000,000 times more strongly than atoms are bound together in chemical compounds or in the most stable crystals known. This great energy is closely associated with a general law of atomic physics according to which the binding or localization of a particle in a smaller region necessarily requires a greater binding energy.

The most direct way to obtain nuclear binding energies is the study of nuclear reactions. Thus if one nucleus of the lithium isotope Li^6 is bombarded by a deuteron, the nucleus of heavy hydrogen, H^2, two nuclei of helium are obtained. The reaction may be written similarly to an equation in chemistry:

$$Li^6+H^2\rightarrow 2He^4.$$

In order to produce the reaction the bombarding deuterons must contain enough kinetic energy to approach the lithium nucleus in spite of the electrostatic or coulomb repulsion of the two particles. The required energy is a few hundred thousand electron volts. (The electron volt, abbreviated ev, is the usual unit of energy in atomic and nuclear physics. It is the energy an elementary charge gains when it falls through a potential of one volt. One electron volt equals 1.6×10^{-12} ergs or approximately 1.5×10^{-18} of the work done in lifting a pound weight to a height of one inch.) The energy contained in the two resulting a-particles is equal to the energy of the deuteron plus an additional 22.17 million electron volts (Mev). This difference in energy arises from the stronger binding of the neutrons and protons when combined in two helium nuclei, rather than in a lithium nucleus and a deuteron. The total binding energy of the helium nucleus compared with four free particles is 28 Mev or 7 Mev per particle. This is close to the largest binding energy per particle in any nucleus. The binding energy is a negative energy in the sense that one has to add energy to decompose a helium nucleus into neutrons and protons.

A determination of nuclear binding energies is often complicated because of the fact that the reaction products have an excess internal energy, or excitation. The energy of excitation is retained by the nucleus for a very short time and then is emitted as y-rays. These y-rays are electromagnetic waves and are similar to light. There are, however, significant differences: y-rays are emitted by nuclei, light is emitted by atoms; y-rays carry away in a single process about 1,000,000 times more energy than light does; considered as a wave process, y-rays have approximately 1,000,000 times shorter wave length than light. The most striking difference is that y-rays are invisible though they cause physiological changes which are not specifically localized in the eye.

These y-rays can enter actively into nuclear reactions. The absorption of y-rays may excite a nucleus and furnish enough energy to cause the nucleus to disintegrate. The most common result of such a disintegration is the splitting off of a neutron. If a nucleus of deuterium is bombarded by y-rays containing an energy of 2.2 Mev or more, the nucleus may disintegrate into a neutron and a proton, $H^2+\gamma\rightarrow n^1+H^1$. Since the energy of the y-rays can be measured independently, this type of reaction furnishes an additional method of obtaining binding energies. The reaction just described indicates a binding energy of 2.2 Mev for the deuteron.

The great amount of energy liberated in nuclear reactions makes it possible to use a method of energy measurement for nuclei which in other cases is impractical. The method of energy determination is based on a law obtained from theoretical arguments by Albert Einstein in 1905: whenever the energy of a system is changed, the mass is changed by a corresponding amount.

Energy changes in familiar objects are accompanied by exceedingly small changes in mass and, thus, the mass change postulated by Einstein was beyond the powers of observation. As an example consider a large spring weighing, say, j lb. and suppose a force of 3,000 lb. compresses the spring 6 in. The change of mass is $10^{-12}\%$ of the mass of the spring. In chemical reactions the change in mass is a few orders of magnitude larger, but still too small for observation. Let us suppose a gram molecular weight of pyrite (FeS) (87.9 g.) is formed from iron and sulphur. The change in mass, calculated from the heat energy released in the reaction. is 10.7×10^{-10} g. This corresponds to one billionth of 1% change in mass.

If now a neutron and a proton are considered as combining to form a deuteron, the energy liberated is 2.18 Mev per deuteron. This represents a difference in mass between the two particles when free and when combined in a deuteron of about a tenth of 1%. This difference is large enough to be measured accurately. Therefore, by reversing this procedure and measuring the difference in mass of separated and combined particles, the binding energy of the particles can be calculated. Thus the statement of the previous section, that the mass of a nucleus is not equal to the mass of the constituent particles. is explained by the mass change accompanying the energy change.

The relationship between mass and energy changes stated by Einstein may be uritten:

$$\Delta E=\Delta m\, c^2$$

where *AE* is the energy change expressed in ergs, Am is the accompanying change of mass given in grams and c is light velocity, equal to 3×10^{10} cm. per second. If the energy is measured in million electron volts (Mev) and the mass is measured in the usual nuclear mass units ($\frac{1}{16}$ of the mass of the oxygen atom) then the above relation gives a change of 1/931 nuclear mass units for every Mev change in energy.

As an example. we consider the mass of deuterium or heavy hydrogen, H^2, which is composed of a proton, H^1, and a neutron, n. The masses in nuclear mass units are:

$$\text{Mass of } H^2 = 2.01412,$$
$$\text{Mass of } H^1 = 1.00754,$$
$$\text{Mass of } n = 1.00894.$$

$\Delta m=$ mass of H^1+ mass of n $-$ mass of $H^2 = 0.00236$. To convert this mass difference into a binding energy, we multiply by 931 and obtain 2.2 &lev.

The choice of the unit of mass as $\frac{1}{16}$ of O^{16} can now be clarified. On this basis, the masses of other atoms are nearly integer numbers because in O^{16} the binding energy of the nucleons is similar to the binding energy in most other nuclei. Thus the mass of the nucleons in O^{16} is similar to the mass of the nucleons in other nuclei and if the total mass of O^{16} is set equal to the total number of nucleons contained in that nucleus, that is to 16, masses of other nuclei will be close to integer numbers.

FURTHER PROPERTIES OF NUCLEI

The particles that compose the nuclei. *i.e.,* the protons and neutrons, have a property which in a subtle way influences nuclear structure. These particles behave as though they were rotating around their own axes. There is no reason to believe that the statement just made can be taken in a literal sense. A picture as detailed as a definite axis localized in the particle is misleading. Kevertheless, neutrons and protons behave in many respects like rotating tops. The protons and neutrons carry an angular momentum which is half the unit of angular momentum in atomic physics. (The magnitude of unit angular momentum is 1.0544×10^{-27} erg-seconds and is usually called $\hbar$. This quantity is $\frac{1}{2\text{x}}$ times h, the quantum of action. *See* QUANTUM MECHANICS.) The angular momentum or spin of neutrons and protons behaves according to a certain set of rules. If the spinning motion around a given direction in space is investigated, it will always be found that the magnitude of the proton and neutron spin is one half of a spin unit, but that the sign of the spinning motion may have one of two opposite values. In other words the rotation may be clockwise or counterclockwise. The spin of nuclei may be considered as composed of the spins of the neutrons and protons in the nucleus. In the deuteron, which consists of a neutron and a proton, the spins of the neutron and proton seem simply to add, giving a total spin of one unit of angular momentum. The spin of the a-particle, which contains two protons and two neutrons, is equal to zero. In this case the spins of the constituent particles may be considered as partly clockwise and partly counterclockwise, so that the effects of the individual spins cancel. Indeed the spin was found equal to zero in all nuclei containing an even number of neutrons and an even number of protons.

To the angular momentum caused by the spins of neutrons and protons there must be added the effect of the motion of these particles along their orbits within the nucleus. Consider the nucleus of the lead isotope containing 208 particles. The spin of this lead isotope has been found equal to zero. Now if a proton, which carries one half unit of spin. is added to the nucleus, the result is a nucleus of bismuth (Bi^{209}) and it might be expected that this nucleus had a spin of one half (zero, caused by Pb^{208} plus one half, caused by the proton). Actually the nuclear spin of Bi^{209} is nine halves. Therefore an additional spin or angular momentum is present which is caused by the motion of the proton in its orbit.

Spin values of nuclei show a few simple regularities. If the system contains an even number of particles of spin one half, the total spin is zero or an integral multiple of the atomic unit of angular momentum. If the system contains an odd number of particles of spin one half, then the system has a spin which is $n+\frac{1}{2}$ atomic units. where n is any positive integer or zero. This rule follows from the basic facts of atomic physics and from this rule was derived a strong argument against the presence of electrons in nuclei. According to earlier ideas the deuteron was considered as composed of two protons and an electron. Now the electron, like the proton, possesses a spin which is one half unit of angular momentum. This would give the deuteron an odd number of particles, each with one half unit of spin and according to the statement made above, the deuteron would be expected to have $n+\frac{1}{2}$ spin units. Actually it has a spin of one unit. If, on the other hand, the deuteron is assumed to consist of a proton and a neutron, the observed spin value agrees with the rule given above.

The spin of neutrons and protons suggests the idea of an internal rotation. Whenever a charged particle like the proton rotates, one expects to find that the particle behaves like a magnet. Furthermore, from the charge and the spin may be predicted the strength of the magnet associated with the proton. The proton, indeed, behaves like a magnet, but the strength of the magnet is 2.79 times the predicted value. This has been considered as an indication that the proton is not quite a simple particle but can undergo some internal change.

According to the simplest ideas the neutron, not carrying a charge, should have no magnetic effects. This again turns out to be incorrect. The neutron carries a magnetic moment whose strength is 1.935 times the predicted strength for the proton and whose sign is opposite to that of the proton. This means that the magnetic properties of the neutron are those of a rotating negative charge. The discrepancies just mentioned do not contradict any rigorous predictions of atomic theory but only those conclusions based on the idea that neutrons and protons are particles of a very simple kind.

The magnetic moment of the deuteron is almost but not quite the sum of the magnetic moments of the proton and neutron. The fact that there is a slight deviation does not constitute a real difficulty if one considers the effect of the orbits of these two particles within the deuteron. In general all nuclei which have a spin have a magnetic moment. Detailed predictions are not possible because knowledge of the internal structure of nuclei is meagre.

Neutrons and protons have a further peculiarity in that two particles of the same kind are never found to occupy the same state. This rule bears the name of the "Pauli exclusion principle." Within a nucleus orbits may be assigned to the nucleons (neutrons or protons). This assignment has to be made in such a manner that no more than two neutrons (or protons) shall be found in one orbit. Further, if there are two neutrons (or protons) in one orbit then these two particles must differ in spin; *i.e.,* one spin must be clockwise and one must be counterclockwise. It is possible for these two particles to be in the same orbit only because they differ in another one of their properties. The rule that two particles cannot be in the same state is thus satisfied. We see that the spin is significant for the details of nuclear structure. The possibility of two spin orientations allows the presence of two neutrons (or protons) in the same orbit of the nucleus.

The configuration of two neutrons or two protons in the same orbit seems to be stable so that, in general, a somewhat greater binding energy is found if the number of neutrons and the number of protons in the nucleus are both even; less if one or the other number is odd. The smallest binding energies are found for odd numbers of both neutrons and protons. In fact, only four stable isotopes are known with odd Z values and odd N values: H^2, Li^6, B^{10} and N^{14}. All others in this category are radioactive, indicating that the nucleus possesses sufficient energy to cause a transformation. Atomic species with even mass numbers are more abundant in the earth's crust and atmosphere than atomic species with odd mass numbers. The most abundant elements, Fe^{56}, Si^{28} and O^{16}, for instance, have even charges as well as even mass numbers. This is further evidence for the stability of the nuclei in question.

The simplest example of a very stable nucleus is helium, He^4. As many particles as possible are put into the lowest orbit which can hold two protons and two neutrons. As mentioned before, the packing fraction of helium is large. Any additional particles, either protons or neutrons, must go into new orbits in which the binding energy per particle is less.

Atomic nuclei behave differently according to whether A is even or odd. If the mass number is odd, then two identical nuclei cannot occupy the same state. If the mass number is even, two identical nuclei can be placed in the same state. In the former case we say that the nuclei obey Fermi-Dirac statistics; in the latter case we say that Einstein-Bose statistics apply. The two kinds of behaviour may be more exactly described by a statement concerning a function, the wave function (see QUANTUM MECHANICS), which describes the behaviour of particles, in particular the behaviour of pairs of identical particles. In the case of Einstein-Bose statistics this wave function remains unchanged if the positions of the identical particles are interchanged. In the case of Fermi-Dirac statistics a similar change leads to a change in sign of the function. Which of the two rules applies can be found experimentally by studying the rotation of a diatomic molecule containing the two identical nuclei. In this case the rotation actually brings about the interchange of the nuclei.

The application of these rules gives further proof that neutrons and protons, rather than protons and electrons, are the proper constituents of nuclei. For example, take a nucleus of nitrogen, ${}_7N^{14}$, which experimentally has been shown to obey Bose statistics. Assuming electrons and protons in the nucleus there would be present a total of 14 protons and 7 electrons. According to knowledge concerning protons and electrons, the interchange of two electrons or of two protons changes the sign of the function characteristic of the system. Thus the interchange of 14 protons and 7 electrons will invert the sign 21 times which amounts to a simple reversal of sign. This contradicts Einstein-Bose statistics which imply that interchange does not change the wave function. If on the other hand, ${}_7N^{14}$ is considered an assembly of 7 protons and 7 neutrons the interchange of the nuclei inverts the sign 14 times, which is equivalent to saying that the interchange leaves the sign unchanged.

It is seen, therefore, that a detailed consideration of finer nuclear properties like spins and wave functions gives the same final results as were obtained by more crude arguments: nuclei are built from neutrons and protons. To assume electrons in the interior of the nuclei would lead to a whole series of difficulties.

β-DECAY

A great number of nuclei are known to emit β-particles; *i.e.,* electrons or positrons. The emission of such a particle is accompanied by the transmutation of the nucleus. The resultant nucleus has the same mass number as the original one. If an electron has been emitted the nucleus in the final state will have one more positive charge than the original nucleus. If a positron is emitted the nuclear charge decreases by one unit. C^{11} is an example of a positron emitter, transforming into B^{11}, a boron isotope. C^{14}, another isotope of carbon, emits an electron and decays into nitrogen, N^{14}. An isotope of potassium, K^{40}, is capable of emitting either an electron or a positron and of transforming into calcium or argon, respectively.

The radioactive decay may be considered as a single act which takes an exceedingly short time, about 10^{-22} seconds. This is not, however, the time in which radioactive substances disappear. These elements have "lifetimes" which have been observed to vary from less than one-tenth of a second to more than 1,000,000,000 years. If there is an assembly of radioactive nuclei of a certain kind, then one half of these nuclei will have undergone radioactive decay in this "lifetime," which is more specifically called the half life.

Each radioactive nucleus has a probability of undergoing the radioactive process per unit time and this probability is independent of the previous history. In particular, this probability does not depend on the length of time the radioactive nucleus has existed. Thus is obtained the law for a radioactive population according to which the radioactive population is halved in each lifetime.

One may assume that each β-decay is caused by one of two basic processes. These are the transformation of a neutron into a proton accompanied by the emission of an electron and the transformation of a proton into a neutron with the simultaneous emission of a positron. These processes are intrinsically slow but the reasons causing the transition or determining its rate are not yet known.

The transition of a free proton into a neutron cannot be observed. This transformation could be written:

$$H^1 \rightarrow n + e^+$$

where n stands for a neutron and e^+ is the symbol of a positron. The neutron is known to be heavier than the proton by 0.00136 mass units and the total reaction products are heavier than the proton by 0.0019 mass units. The mass difference corresponds to an increase of energy during the reaction amounting to 1.77 Mev. If the neutron and positron gained kinetic energy during the reaction, the energy needed would be greater still. Thus at least 1.77 Mev must be supplied if the proton is to disintegrate into a neutron and a positron. Thus the reaction does not occur and the free proton is stable.

On the other hand a neutron can decay giving rise to a proton and an electron,

$$n \rightarrow H^1 + e^-.$$

The proton and electron together are 0.00081 mass units lighter than the neutron. According to the equivalence of mass change and energy change 0.754 Mev of energy are set free. The reaction described here is the simplest of all possible β-decays. It has been actually observed and its lifetime is approximately a quarter of an hour. Neutrons usually disappear much more quickly by reacting with other nuclei.

A β-decay process in a complex nucleus is described by one of the neutrons in the nucleus turning into a proton or one of the protons changing into a neutron, emitting an electron or positron, respectively. This picture correctly describes the fact that the mass number of the nucleus remains unchanged while the charge of the nucleus changes by plus or minus one in the two cases mentioned. In complex nuclei it often does pay to convert a proton into a neutron plus a positron. One may consider, for instance, the decay

$$C^{11} \rightarrow B^{11} + e^+.$$

While the sum of the masses of the neutron and positron is greater than the mass of the proton, the sum of the masses of B^{11} and e^+ is actually less than C^{11}. In the

$$C^{11} \rightarrow B^{11} + e^+$$

process a proton is turned into a neutron and a positron. The necessary energy is supplied by the greater binding energy of the resultant neutron. Thus the question whether or not a nucleus can emit an electron or a positron depends on whether or not the transformation of a proton into a neutron or the transformation of a neutron into a proton can lower the energy of the system. In the energy balance must be included: the mass difference between the neutron and proton, the binding energy of these particles in the nucleus and the mass of the positron or electron which is to be ejected.

It may occur that there is not enough energy available to transform a proton within a nucleus into a neutron and to eject a positron at the same time. A nuclear transformation may nevertheless proceed. Instead of the emission of a positron the nucleus may absorb one of the electrons which are always to be found in the vicinity of the nucleus. In this way instead of having to supply an energy equal to the mass of the positron, one gains the energy corresponding to the similar mass of the electron. For instance, the isotope of manganese containing 54 mass units in its nucleus decays by capturing an electron and one obtains an isotope of chromium.

Consider two nuclei: one shall contain N neutrons and Z protons, the other $N-1$ neutrons and $Z+1$ protons. Add to the latter an electron. Of the two systems now considered, one or the other will have a higher energy and whichever one this is will not be stable but will transform into the other system. Nuclei of the same mass number are called isobars. Two isobars, differing by one charge unit, are called neighbouring isobars. The argument shows that of neighbouring pairs of isobars, one must be unstable.

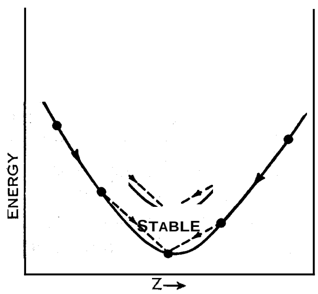
There are a few known cases of neighbouring isobars where both nuclei seem to be stable. The reason for this apparent stability is the small energy difference between the isobars. It will be seen later that β-transformations in which little energy is released may have long lifetimes. In these cases @-processes may be so rare as to escape observation.

Now consider two isobars which differ by two charge units. There are many examples of such isobars. If all other isobars have higher energies than these two, then both of these isobars may be stable. In fact, a single transition will lead to a system of higher energy. A lowering of the energy could occur only if two β-transitions, *i.e.,* the ejection of two electrons or two positrons, occurred simultaneously. It has been mentioned above that the lifetime of radioactive nuclei is very long compared with the time an electron needs to cross the nucleus. This fact can be expressed by saying that the β-process is an improbable one. A process in which two electrons or two positrons undergo this improbable transition simultaneously is unlikely, and no direct measurement had detected it by the mid-1950s.

In the previous section it was stated that nuclei containing an even number of neutrons or an even number of protons have lower energies and are more stable than nuclei containing an odd number of neutrons or an odd number of protons. If a nucleus contains an odd number of neutrons and an odd number of protons then one may suspect that it can assume a more stable configuration in two ways: by emitting an electron and transforming a neutron into a proton or else by emitting a positron and transforming a proton into a neutron. In either case an even number of protons and neutrons will be obtained. It is frequently observed that a nucleus of even mass number and odd Z value emits both electrons and positrons. One example is K^{40} mentioned above.

In a stable nucleus a certain balance exists between the number of neutrons and the number of protons. For a given number of protons the neutron number may vary between narrow limits. If an excess of neutrons is present an electron will be emitted and one of the neutrons turns into a proton. The product will be a stable nucleus or at least one which has a smaller neutron excess. In a like manner, if the nucleus has a proton excess. the nucleus will emit a positron, transforming a proton into a neutron.

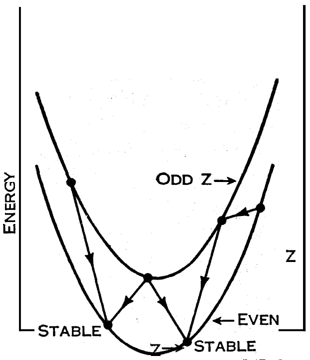
These facts can best be summarized in two curves, as shonn in figs. 1 and 2. For isobaric nuclei with odd mass number it does not make much difference whether Z is even or odd. In the first case we have an even number of protons but an odd number of neutrons. In the latter case the number of neutrons is even, that of the protons is odd. The result is a smooth dependence of the energy on Z as shown in fig. 1. The arrows indicate possible transitions. For isobaric nuclei with even mass number nuclei with even Z values have a lower energy than nuclei with odd Z values. The former contain an even number of protons and an even number of neutrons, the latter an odd number of protons and an odd number of neutrons. The resulting energies are shown by the curves in fig. 2. The transitions are again indicated by arrows. The figures illustrate that for even mass number one may expect more than one stable isobar, while for odd mass number only one isobar is likely to be stable.



ADAPTED FROM A FIGURE BY H BETHE IN REVIEWS OF MODERN PHYSICS," APRIL 1936, V 8, NO 2

FIG. 1.— SCHEMATIC REPRESENTATION OF THE ENERGY OF ISOBARS AS A FUNCTION OF ATOMIC NUMBER: ODD MASS NUMBER

It would be expected that when a 0-ray is emitted from a nucleus it should carry away with itself in the form of kinetic energy the difference in energy between the original and the resulting nuclei. This is not so. The p-particles emitted from one definite nuclear species have various energies: some carry very little energy, most of them about one-half or one-third of the expected energy and a few nearly all of that energy. None are found to carry an energy in excess of the expected amount. In fig. 3 it is shown how in two definite examples the frequency of occurrence of β-rays depends on the energy of the β-rays. The frequency of occurrence for β-rays carrying various amounts of energy is plotted on the abscissa. The maximum energy indicated (in the figure the energy corresponding to six electron masses or 6 mc^2 is used; this corresponds to about 3 Mev) is the expected amount. It is seen that the frequency of occurrence goes to zero as the maximum energy is approached. The curves might be expected to go to zero for zero energy also. The coulomb force of the charged nucleus, however, influences the distribution curves for the low-energy electrons and positrons. The nucleus attracts electrons, decreasing their energy and increasing the occurrence of zero-energy electrons. Conversely, the repulsion of the positrons by the nucleus increases their energy. None is emitted with zero energy and few with very low energies.



ADAPTED FROM A FIGURE BY H BETHE IN "REVIEWS OF MODERN PHYSICS," APRIL 1936, V. 8, NO. 2

FIG. 2.— SCHEMATIC REPRESENTATION OF THE ENERGY OF ISOBARS AS A FUNCTION OF ATOMIC NUMBER: EVEN MASS NUMBER

The fact that 0-rays of a definite decay process have varying energies is surprising. It has not been possible to explain the varying energies of β-rays by the assumption that β-rays come from nuclei differing to a certain extent in their properties. Neither did it prove possible to assume that β-rays of varying energy leave the nucleus with correspondingly varying residual energy. On the other hand. the law of conservation of energy requires that the energy difference between the expected and the actual amount should appear in some other form.

The simplest explanation of the facts described above is the following: in the decay process not one but two particles are emitted from the nucleus. One of them, the β-ray, is an electron carrying a positive or negative charge. The other one is called the neutrino. It carries no charge and has no intrinsic mass, but it carries away the missing amount of energy from the nucleus in the form of kinetic energy.

The assumption that a neutrino is emitted together with the β-ray has helped to explain a number of peculiarities of the β-process. First, the neutrino hypothesis does not merely explain that β-rays from the same decay process have various energies, but it is also capable of accounting for the frequencies with which various β-energies occur. Fig. 3 gives the energy distribution for the simplest kind. This type of distribution has been predicted by theory and has been verified experimentally in many cases. Other types of frequency distributions have been observed.

On the basis of the neutrino theory it was also possible to predict that the probability of p-decay increases with the fifth power of the energy released in the decay. In other words, the lifetime of the radioactive nucleus is inversely proportional to the fifth power of the maximum energy of the β-particle. This law is an approximate one and holds only for the simplest type of β-decay, for sufficiently high energies. More complex β-disintegrations seem to have a decay probability which differs from the probability predicted by the simple theory. These anomalous β-decay processes have smaller decay probabilities and considerably longer half lives than the normal processes.

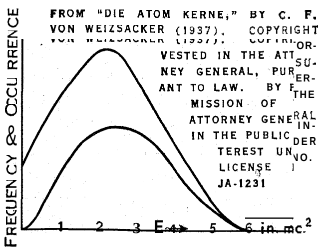


FIG. 3.— THEORETICAL β-RAY SPECTRUM FOR Z=82. UPPER CURVE IS FOR ELECTRON EMISSION: LOWER CURVE. FOR POSITRON EMISSION

There is a further group of phenomena which can be explained with the help of the neutrino hypothesis. These are the changes of nuclear spin and nuclear statistics during a β-decay. It has been stated previously that a nucleus or, more generally, an association of particles will have a spin which is an even or odd multiple of one-half the elementary unit of spin according to whether the system contains an even or odd number of particles, each carrying one-half unit of spin. Now a β-ray carries one-half of a spin unit and so do the neutrons and protons of which the nucleus is built. If it is assumed that in a 0-process the β-ray is emitted by itself, then the number of particles carrying one-half unit of spin would have increased by one during the process. It would be necessary to assume that the total spin of the system changes. It is, however, a very general rule that the spin of a system left to itself, like a nucleus undergoing a β-decay, must not change. The rule of conservation of spin is indeed almost as strongly supported by experience as the rule of conservation of energy. The emission of a single electron would violate spin conservation as well as energy conservation. If it is assumed that together with the electron a second particle. the neutrino, is emitted and, if it is also assumed that the neutrino carries a half unit of spin, the difficulty disappears.

An analogous argument can be put forward for nuclear statistics. It has been mentioned that a nucleus or system of particles has Einstein-Bose statistics or Fermi-Dirac statistics, respectively, if it contains an even or odd number of particles which themselves obey Fermi-Dirac statistics. Protons, neutrons and electrons do behave according to Fermi-Dirac statistics. If the β-process consisted of the emission of an electron only, the total number of particles would change by one and during the process the system would change from Einstein-Bose statistics to Fermi-Dirac statistics or vice versa.

Such a change in statistics is completely alien to our notions about the composition of matter. For instance, two systems obeying Fermi-Dirac statistics cannot be in the same state, but two systems obeying Einstein-Bose statistics prefer to be in the same state. The transformation of a system from one statistics to another would imply a changed behaviour of similar systems. This change would be so peculiar that we find ourselves unable to incorporate it in the mathematical laws which describe physics in the atom. If it is assumed, however, that together with an electron a neutrino is emitted and that the neutrino obeys Fermi-Dirac statistics, the difficulty is resolved. Two particles obeying Fermi-Dirac statistics are emitted in the process and therefore a change in statistics is not expected.

In addition to carrying energy a neutrino also carries away a momentum which can be calculated from the energy which it possesses. If a nucleus which was originally at rest suffers a β-decay, the momenta carried by the decay products must add up to zero. Since the neutrino is invisible, the momenta of the observable particles do not cancel. By measuring these momenta, one can obtain the momentum which the neutrino must have carried. This difficult experiment has been performed and indicates that the neutrino carries the expected momentum.

Finally, since neutrinos are emitted in β-decays, one can show that they in turn stimulate β-disintegration when they impinge on otherwise stable nuclei. Since the β-disintegration is an exceedingly improbable process, this stimulating effect of the neutrinos is very weak. By using the large neutrino fluxes which are emitted by big nuclear reactors, it has been possible to obtain some indication of this stimulating influence of the neutrino. The evidence for the existence of neutrinos is thus partly indirect and partly based on extraordinarily difficult experiments. Nevertheless, the existence of neutrinos can hardly be questioned.

a-DECAY AND SPONTANEOUS FISSION

In the β-decay a nucleus emits particles which, according to our model, the nucleus does not actually contain. The electron and neutrino emitted in the process may be considered as born at the moment of emission. In other radioactive processes. which are discussed now, particles are ejected from the nucleus which were present in a different configuration before the decay took place.

In another respect all radioactivities are similar: the half life of a radioactive nucleus is always exceedingly long as compared with times in which nuclear rearrangements could be expected to take place. The ratio of these times is in most cases larger than 10^{20} and sometimes even much greater than that. The reason for such long lifetimes is unknown in the case of β-processes. The reason must, it is thought, lie in the nature of the birth process of electron-neutrino pairs. In the case of other radioactive processes, such as a-decays and spontaneous fission, G. Gamow, E. U. Condon and R. Gurney have satisfactorily explained the long lifetimes.

In an a-disintegration a nucleus emits an a-particle, which is itself a very stable nucleus containing two neutrons and two protons. a-active nuclei are encountered among the nuclei which carry the highest charges. In these nuclei the repulsion between the a-particle and the rest of the nucleus results in an energy release which is not only sufficient to overcome the short-range attraction between the a-particle and the rest of the nucleus, but also gives the a-particle a kinetic energy of a few million electron volts.

The spontaneous fission process is also observed in the most heavily charged nuclei. In this process a nucleus divides into two approximately equal fragments which under their mutual coulomb repulsion, fly apart with a kinetic energy close to 200 Mev.

Both in the a-decay process and in the spontaneous fission process there is an important obstacle to the disintegration. The initial part of the disintegration, instead of releasing energy, actually would require some added energy which is not available in the cases considered. Thus an a-particle at a large distance from the nucleus has a lower potential energy than when it is inside the nucleus. However, an a-particle outside the nucleus but close to it, *i.e.,* when it is in an intermediate state of the disintegration process, has a higher potential energy than when either in the initial state inside the nucleus or in the final state when it is far away. This is, indeed, not surprising. In order to bring the a-particle from the initial state to the intermediate state it is necessary to do work against the short-range forces holding the a-particle in the nucleus. Again, if it is desired to bring the nucleus from the final state into the intermediate state it is necessary to do work against the coulomb repulsion. It is seen that the a-particle has to overcome a potential barrier in order to get from the initial state to the final state. Since there is not enough energy available to do this the process should be impossible from the point of view of classical mechanics. In the mechanics which is valid for particles of atomic and subatomic size it is not possible to localize sharply any particle without giving it a high amount of energy at the same time. Applying this kind of mechanics to the motion of the a-particle it is found that the α-particle, instead of staying in the nucleus, will leak through the potential barrier. While this statement is in conflict with our intuition concerning the behaviour of particles, it must be accepted on the basis of extensive experience of atomic and subatomic physics. The penetration of the potential barrier by these particles is closely related to the fact that these small particles, as long as they have a well-defined energy, cannot be sharply located on one side of the barrier.

The necessity of penetrating a potential barrier in the process of disintegration explains the long life and small disintegration probability of the a-active substances. This surprising penetration of a potential barrier becomes extremely improbable as the height or the breadth of the barrier or else the mass of the particle in question becomes bigger. The result is that an a-particle may approach the surface of the nucleus 10^{20} times or more often before it actually succeeds in leaving the nucleus. A further consequence is that relatively small differences between a-active substances cause great changes in the decay probability. The most important factor influencing the decay probability is the energy released in the a-process. If the decay energy is high, that energy will approach more closely the top of the barrier, The result is a greatly increased penetration probability and a greatly increased rate of decay. In fig. 4 the half lives of the a-active nuclei are plotted against the energy released in the or-decay. While the range of energies for which observations exist extends only from 3.5 to g Mev, the corresponding lifetimes are of quite different orders of magnitude. They range from 10^{-7} seconds to 10^{10} years, a time longer than the age of the earth. In order to plot all of these different times in a single graph a logarithmic scale is used. This means that each unit on the vertical scale stands for a factor ten in the lifetime. Next to the ordinate the half-life values are entered in units of seconds and also in units of years. The dots in the figure represent observations for various a-active nuclei. The curve was obtained by applying the theory of barrier penetration to the a-decay process. While this theory disregards all finer details of nuclear structure it is still in excellent agreement with the general trend of the observed points.

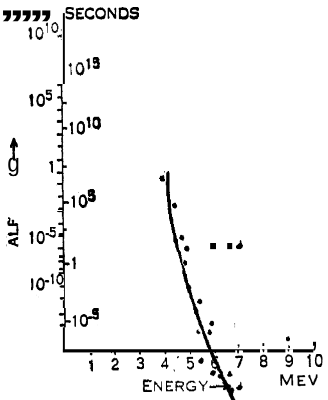


FIG. 4.—HALF LIFE FOR α-DECAY AS A FUNCTION OF α-RAY ENERGY.
THEORETICAL)

An entirely similar situation is encountered in the theory of spontaneous fission. Here the nuclear division must be considered as the end result of a process in which an originally spherical nucleus first takes on the form of an ellipsoid, then that of a dumbbell, then that of two smaller and nearly spherical pieces close to each other which finally fly apart to form the fission fragments. The initial distortion in this process requires an energy which, as in the case of a-decay, is actually not available. A potential barrier must be overcome if the fission is to proceed. This potential barrier is probably less high than the one encountered in a-decay. The particles to be moved through this barrier, however, are the fission fragments, containing about 100 neutrons and protons instead of the 4 nuclear units contained in an a-particle. The fact that a much bigger mass must be moved through a potential barrier decreases the disintegration probability. The uranium isotope U^{238} is among the a-active nuclei of longest life with a half life of 4.5×10^9 years. Yet this nucleus will have more than 1,000,000 times greater probability to decay by an a-process than to undergo spontaneous fission.

METASTABLE NUCLEI

If a nucleus is not in its lowest state of energy, it is said to be in an excited state. Lifetimes of such excited states, as a rule, are short and the nucleus falls into the lowest energy state, emitting the excess energy as radiation. The time required for this process in many cases is of the order of 10^{-14} seconds. The energy emitted leaves the nucleus in the form of γ-radiation.

If the excitation energy is relatively small, *i.e.,* of the order of 100,000 v., the lifetime of the excited state is relatively longer, in some cases exceptionally long. These transitions are similar to the anomalous β-decay processes which, as has been pointed out, have longer half lives than the normal β-decay processes. The exceptional nuclei are called metastable. Their lifetimes are often of the order of a few seconds, some much longer. An isotope of krypton, Kr^{83}, for instance, has a lifetime of 113 minutes. Two y-ray energies have been observed: 0.029 Mev and 0.046 Mev. A long lifetime, 13.8 hours, is also shown for Zn^{69}. The y-ray energy for this metastable state is 0.45 Mev.

Often such nuclei apparently emit electrons rather than y-rays. The reason for this behaviour is that the electromagnetic radiation transmits its energy to an electron before the radiation leaves the immediate vicinity of the nucleus. While this electron originally has been a part of the same atom to which the nucleus belongs, it should be emphasized that the electron never was a part of the nucleus. That is, the electron is not actually emitted by the nucleus.

The electromagnetic energy has been converted to kinetic energy of an electron which was formerly bound to the atom. These electrons are called conversion electrons. These conversion electrons can easily be distinguished from β-rays because their energy is well defined, while the electrons emitted from nuclei always have a continuous range of energies. Conversion electrons very frequently accompany y-rays, but they are found with particularly high probability in the y-processes of long lifetime which were described above.

NUCLEAR REACTIONS

Up to now, this discussion has considered in some detail processes in which a nucleus 'undergoes a spontaneous transition. There exists a much more varied class of nuclear transformations, namely the transformations which occur when a nucleus collides with another nucleus or some other particle. Every nucleus is, of course, in practically continuous contact with the electrons which together with the nucleus make up an atom. Stable nuclei are not capable of reacting with these electrons. β-active nuclei may absorb an external electron, as described above. This process is closely related to ordinary β-activity and it has been treated under the heading *β-Decay*. This section will consider the collisions of a nucleus with a fast electron, with a y-ray, with another nuclear particle, such as a neutron, proton, deuteron, a heavier nucleus or with one of the unstable particles called mesons, which themselves are generated in nuclear collisions.

Bombardment of nuclei by fast electrons throws the nuclei into excited states whose characteristic y-radiations have been studied. The collision of a nucleus with a y-ray may also result in the excitation of that nucleus. If the energy of the y-ray is sufficiently high, absorption of the y-ray will be followed by a nuclear disintegration, most frequently the emission of one or more neutrons. It has been observed that y-rays of a characteristic resonance energy are particularly readily absorbed by nuclei. This resonance energy is in the neighbourhood of 20 Mev. It is somewhat higher for light nuclei and somewhat lower for heavy nuclei.

If a reaction between two charged nuclei is to be studied at least one of these particles must have considerable kinetic energy. Otherwise the electric repulsion prevents the nuclei from approaching to a sufficient extent. According to classical mechanics one would expect that the approaching particles must possess a minimum kinetic energy if they are to get in contact with each other and if they are to react. Actually this simple argument is incorrect. The approach of two charged particles is more involved and is similar to the process of a-decay in which two charged particles are moving apart. Even if sufficient energy is not available for the two particles to come into contact according to the classical picture there remains a small probability for the collision partners to penetrate through the barrier separating them. This probability rapidly becomes smaller as the energy of approaching particles decreases. At small energies the resulting nuclear reactions occur so rarely that they become practically unobservable.

It follows that reactions between nuclei are more easily observed when the nuclei contain relatively low charge. The reactions which can be studied at lowest energies are those between two singly charged deuterium nuclei: $H^2+H^2 \rightarrow H^1+H^3$ and $H^2+H^2+He^3+n$. These reactions have actually been followed down to 10,000 ev bombarding energy; *i.e.,* to the energy of a "soft" X-ray tube.

Reactions between light nuclei and protons are of particular interest because according to present ideas such reactions are responsible for energy production in the sun. In some of these reactions the proton attaches itself to a nucleus and an a-particle is emitted. An example of such a reaction is $Li^7+H^1 \rightarrow He^4+He^4$. A second example is $N^{15}+H^1 \rightarrow C^{12}+He^4$. When more heavily charged nuclei are bombarded by protons, the emission of a-particles becomes less likely. The reason for this is similar to the reason for the long life of a-emitters. The a-particle to be emitted must surmount a high barrier. This process, therefore, becomes improbable and the nuclear reaction is likely to take another course.

One of these other possibilities is that the proton attaches itself to the nucleus and a neutron is emitted instead. This has been observed in collisions between lithium and protons. The reaction proceeds according to the relation: $Li^7+H^1 \rightarrow Be^7+n$. One notices that the colliding partners are the same as those which lead to two a-particles according to: $Li^7+H^1 \rightarrow He^4+He^4$. It actually is frequently true that a collision between two nuclei gives rise to several competing processes. Depending on the energy of the colliding particles one or the other of these reactions will occur either preferentially or exclusively. For instance, if the energy of the bombarding proton is less than 1.6 Mev, neutron emission does not occur because the sum of energies of Be^7 and a neutron is higher than the energy of the Li^7 and H^1 by just 1.6 Mev. On the other hand, the formation of two a-particles releases energy and can, therefore, proceed at any energy of the bombarding protons providing the proton gets close enough to the lithium to react with it. Since the neutrons are unaffected by electrostatic repulsion the ejection of a neutron by a proton may proceed without difficulty in more heavily charged nuclei. An example is:

$$Sb^{121}+H^1 \rightarrow Te^{121}+n.$$

A proton may also simply attach itself to the nucleus with which it collides. This happens in the reaction

$$C^{12}+H^1 \rightarrow N^{13}+\gamma.$$

In reactions of this type the binding energy of the proton in the nucleus is released in the form of y-rays. This energy release is a relatively slow process. It takes, as a rule, only 10^{-14} seconds, but the time in which a neutron or an a-particle could be released by the reacting partners is very much shorter still, namely 10^{-20} seconds or less. Thus, the reaction between N^{15} and protons could, in principle, lead to the formation of O^{16} according to the scheme $N^{15}+H^1 \rightarrow O^{16}+\gamma$. The reaction mentioned above $N^{15}+H^1 \rightarrow C^{12}+He^4$ seems, however, to occur almost exclusively because this type of rearrangement between the reaction partners happens to take a much shorter time. On the other hand, $C^{12}+H^1 \rightarrow N^{13}+\gamma$ can occur more readily because in this case no competing process exists as long as the proton does not have too high an energy. Actually both the ejection of an a-particle or a neutron from the carbon nucleus would require a very high proton energy.

When a nucleus is bombarded by a deuteron, reactions similar to those discussed above occur. In particular, neutrons and α-particles are found among the reaction products. The reaction to which deuteron bombardment most often leads is the ejection of a proton. This reaction occurs with relative ease even if the bombarded nucleus has a high charge. The deuteron does not need actually to penetrate to the surface of its target. When the coulomb repulsion becomes too strong the deuteron decomposes into a neutron and a proton. The neutron suffers no repulsion and reaches the surface of the nucleus while the energy of the reaction is carried away by the proton.

Among reactions with heavier nuclei mention shall be made only of the reactions with a-particles. Because of the availability of natural α-rays these were the first to be observed; they were of further historical importance in that they led to the discovery of the neutron. One of the easiest and earliest methods of producing neutrons is by the reaction $Be^9+\alpha \rightarrow C^{12}+n$. In reactions with more heavily charged nuclei a-particles can participate only if they carry a rather high kinetic energy. Even more kinetic energy would be required if the bombarding nucleus had more than two charge units.

When a nucleus is bombarded with neutrons whose energy is in excess of 1 Mev, the result is not very different from the reactions that occur when fast deuterons or protons are the bombarding particles. Of course the neutrons, not being repelled by the nuclear charge, can penetrate into heavy and light nuclei with equal ease. The result again may be the attachment of a neutron to the nucleus accompanied by the emission of a y-ray. An example is $Au^{197}+n \rightarrow Au^{198}$. The resulting isotope of gold is unstable and decays to mercury. The fact that the resulting gold isotope is radioactive makes it easy to establish that the reaction has actually occurred in a bombarded gold sample.

A second type of reaction with neutrons is the re-emission of the original neutron plus the emission of another neutron. The first neutron serves to knock the second neutron out of the bombarded nucleus. Since the second neutron is strongly bound only bombarding neutrons carrying high energy produce this reaction.

The result of this reaction is an isotope of the original bombarded nucleus having a mass number diminished by one. The reaction

$$O^{16}+n\rightarrow O^{15}+n+n$$

may serve as an example.

In another type of reaction the neutron attaches itself to the nucleus and a proton is emitted instead. This is illustrated in the reaction

$$Zn^{66}+n\rightarrow Cu^{66}+p.$$

While in this reaction the neutron is free to penetrate into the nucleus, the proton encounters a potential barrier on its way out. This barrier again results from coulomb repulsion and is higher for more heavily charged nuclei. Thus this reaction will occur with considerable probability only in light nuclei or else in those cases where the outgoing proton receives a rather high energy, sufficient to overcome the potential barrier just mentioned.

The same situation is encountered if an α-particle is emitted after the neutron has attached itself to the bombarded nucleus. As an example we may mention the reaction:

$$N^{14}+n\rightarrow C^{11}+\alpha.$$

The reaction products have, in this case, a greater total mass than the original neutron and nitrogen. The mass difference corresponds to 2.25 Mev and therefore only neutrons having an energy greater than 2.25 Mev will be able to produce this reaction. It might be noted that in this case neutron bombardment also gives rise to the reaction:

$$N^{14}+n\rightarrow C^{14}+p.$$

This reaction releases energy, and therefore proceeds at low as well as high neutron energies. The two reactions just discussed are competing processes. This situation is quite typical. If the bombarding particle does not have much energy few types of reactions can take place. At higher bombarding energies more reactions become possible.

Among the nuclear reactions induced by neutron bombardment the fission of uranium and thorium are of greatest practical importance. As stated above, uranium may disintegrate into two roughly equal fragments even of its own accord. The rearrangement of nuclear matter, however, which leads to this fission process requires an initial investment of energy. Thus the spontaneous fission can take place only if the resultant particles penetrate a potential barrier: which is an exceedingly improbable process. If a uranium or thorium nucleus is hit by a neutron, the neutron attaches itself to the nucleus and delivers to the nucleus the binding energy of the neutron, amounting to several Mev. This energy sets the particles of which the nucleus is composed into motion. This motion may lead to the rearrangement necessary to initiate the fission process. It is interesting to note that the common isotopes of thorium and uranium, Th^{232} and U^{238}, require neutrons of relatively high initial energy if fission is to be produced. The reason is that fission is a quite improbable process unless the neutron furnishes enough energy to deform the nuclear matter to a point from where the further process is a "downhill" motion; *i.e.*, a motion which is connected with a diminution of potential energy. If a neutron fails to deliver sufficient energy to lift the nucleus to the top of the potential barrier, the fission process becomes quite improbable. In this case it is more likely that the excited nucleus will get rid of its energy either by re-emission of the original neutron or by the emission of a y-ray. In the former case the neutron reverts to the original bombarded nucleus; in the second case. the reaction product is an isotope of the bombarded nucleus which contains an additional neutron. There is no reason why nuclear fission could not be produced by proton and deuteron bombardment as well as neutron bombardment. The protons and deuterons are, however, strongly repelled by the electrostatic field of the heavily charged uranium nucleus. Thus only highly energetic protons and deuterons are capable of producing fission.

Neutrons with an energy of 20 Mev or more are capable of producing fission in bismuth. lead and even lighter nuclei. In these cases fission probably results after a few preliminary processes have occurred. First the neutron communicates to the nucleus a high excitation energy. Thereafter the nucleus emits several particles, mostly neutrons. This process is called spallation. Neutrons escape preferentially because they need not overcome any potential barrier. Thus the nucleus is left with an unusually great excess of protons. The charge of these protons facilitates fission and a certain fraction of the bombarded nuclei actually divide into two similar particles.

The neutron reactions discussed thus far are usually referred to as "fast" neutron reactions. In contrast to these, "slow" neutron reactions signify events in which nuclei are hit by neutrons carrying a fraction of an electron volt. The neutrons in a typical slow neutron reaction possess about 100,000,000 times less energy than the neutrons in a fast neutron reaction. These slow neutron reactions are in many respects quite different from reactions in which only fast particles participate. These will be discussed in some detail since they play an important part in the release of atomic energy for useful purposes.

All the neutrons observed are products of nuclear reactions. Originally these neutrons are fast. Slow neutrons are obtained by allowing the fast ones to make a considerable number of collisions with other nuclei. There are many nuclei with which neutrons can collide repeatedly without causing nuclear reactions and without being captured by these nuclei. Frequently the only possible process is an elastic collision in which the neutron gives some of its energy to the collision partner. If, for instance, a neutron collides with a proton it loses roughly one-half of its energy in each collision. In collisions with carbon nuclei the neutron is apt to lose one-sixth of its energy. As a result 20 collisions with protons will suffice to deprive a neutron of all but one-millionth of its original energy and roughly 100 collisions with carbon nuclei produce the same result.

The energy loss, however, will not proceed indefinitely. All nuclei of the atoms in and around us participate in a disorderly motion which is caused by the heat energy shared by all bodies. The average energy of the particles at room temperature is about $\frac{1}{40}$ ev. When the neutrons are slowed down to this energy they will cease. on the average, to lose energy in collisions. They will rather participate from then on in the general thermal agitation of all particles. Neutrons of about $\frac{1}{40}$-ev energy are therefore often called thermal neutrons. The term "slow" neutrons is not restricted to the thermal neutrons but includes those of somewhat higher and lower energies. Thermal neutrons, however, are typical representatives of the class of slow neutrons. It is of interest to note that thermal neutrons move with an average velocity of 1.3 mi. per second. It seems peculiar to call such neutrons slow but they are slow compared with neutrons of 1 Mev energy whose velocity is little less thap 10,000 mi. per second.

Reactions of slow neutrons differ from other nuclear reactions in several important respects. Slow neutrons may be absorbed very effectively by certain appropriate materials. Thus $\frac{1}{100}$ in. of cadmium is sufficient to absorb most of a beam of slow neutrons. A beam of fast neutrons, on the other hand. penetrates approximately two inches of any condensed material before the beam is strongly absorbed or otherwise altered in its properties. Slow neutrons are not absorbed so strongly by all kinds of nuclei. In collisions with nuclei such as carbon or lead, for instance, slow neutrons are hardly ever absorbed. Furthermore a reaction between a slow neutron and a nucleus depends on the energy of the neutron in a very sensitive manner. The reaction of neutrons with indium nuclei are very characteristic in this respect. A thermal neutron beam is effectively absorbed by an indium foil, while neutrons of one volt energy are considerably less affected. Neutrons of a sharply defined energy of 1.44 ev are more strongly absorbed in indium foils than neutrons of any other energy.

The peculiar behaviour of neutrons described above is the result of two facts. One is that slow neutrons spend a longer time in the neighbourhood of each nucleus and are more likely to be captured in a single collision. The second fact is the existence of compound nuclei which are formed by the initial fusion of the reaction partners and which possess well-defined energy levels. As an example let us continue to consider the reaction of indium with slow neutrons. If a neutron is bound to an indium nucleus an energy of approximately 8 Mev is released. At the time that a slow neutron enters the binding energy appears as agitation of the compound nucleus. The designation of compound nucleus refers to this original agitated nucleus which is formed as a first step in the nuclear reaction.

The energy of agitation is not arbitrary but can be one of a certain number of rather sharply defined values. If the small kinetic energy of the incident neutron added to its big binding energy is just sufficient to form a compound nucleus in one of these sharply defined energy states then the neutron will enter the nucleus with a high probability. The energy at which the neutron enters with the greatest probability is called the resonance energy. The more the energy of the neutron differs from this resonance energy, the smaller will be its chance to enter the nucleus. A change in neutron energy of only one-tenth of an electron volt is sufficient to alter considerably the chance of the neutron to participate in the reaction.

These sharply defined levels of compound nuclei do not occur in the case of light atomic nuclei. This fact has been explained by a typical law of atomic physics according to which sharply defined energy levels occur only if these energy states have comparatively long lifetimes. If a state has a lifetime of 10^{-21} seconds (which is a typical period for nuclear rearrangements) then the energy levels cannot be defined better than to 1,000,000 v. The sharply defined energy of the compound nuclei indicates a lifetime more than 1,000,000 times longer than the time for a simple rearrangement. Why such long lives should occur when a slow neutron enters a nucleus of high weight, such as indium. may be understood in the following manner. When a neutron of small energy enters a nucleus its considerable binding energy is promptly shared as energy of agitation by the many particles of the nucleus. If the original neutron is to leave the nucleus again all of this energy must once more be concentrated on a single neutron. This process is unlikely and. on the average, takes a long time. If the nucleus consists of few particles then it will be more easily possible to concentrate the energy on a single one of these particles. On the other hand, if we have started with a fast neutron, then it will not be necessary to return to this neutron all of its energy to enable the original neutron to escape again.

Once a slow neutron has entered a nucleus and has found a compound state several reactions are still possible. The most probable of these is the emission of the binding energy of the added neutron in the form of y-radiation. In this way an isotope of the original bombarded nucleus is formed. Thus we have the reactions:

$$H^1+n\rightarrow H^2+\text{y}.$$

$$U^{238}+n\rightarrow U^{239}+\text{y}.$$

The last reaction will be referred to again in the utilization of nuclear energy.

Among the lightest and the heaviest nuclei there are a few more important reactions following neutron capture.

Protons are emitted in the reaction of slow neutrons and nitrogen:

$$N^{14}+n\rightarrow C^{14}+p.$$

The resulting β-active isotope of carbon is most useful in the study of reactions in organic chemistry and biochemistry. This isotope of carbon is formed in small amounts by cosmic rays and occurs, therefore, as a "natural" activity. Its half life is 5,568 years. By measuring the carbon activity in an archaeological sample one may determine the age of that sample.

In reactions with Li^6 and B^{10} the absorption of a slow neutron results in the emission of an a-particle. according to

$$Li^6+n+H^3+He^4$$

and

$$B^{10}+n\rightarrow Li^7+He^4.$$

These reactions are important because these nuclei, especially B^{10}, are very strong neutron absorbers. In contrast to indium, which preferentially absorbs neutrons of 1.44 ev energy. all neutrons are absorbed by Li^6 and B^{10}, but slow neutrons, which spend more time in the neighbourhood, are absorbed with greater probability.

The fact that slow neutrons are strongly absorbed by particular materials permits the regulation of the number of slow neutrons and allows or denies them access to certain parts of materials. The control of the energy release in chain reacting materials is based on this property of slow neutrons.

The energy released by slow neutron capture is insufficient to cause fission in any isotope which occurs with great abundance in a natural substance. In some materials, particularly in U^{235} and Pu^{239}, slow neutrons do give rise to fission. The consequence of this fact will be discussed later.

New high-energy accelerators have produced protons carrying several hundred Mev. Bombardment of nuclei by such protons often gives rise to disintegration into several fragments. It is remarkable, however. that more gentle interactions are not unusual. Thus a proton may collide with a nucleus without changing its energy or momentum to a great extent. In the collision, however, the proton turns into a neutron, leaving its charge behind in the nucleus with which it collided. It also happens quite often that the impinging proton picks up a neutron during its contact with a nucleus. The bombarding particle changes, therefore, into a deuteron but continues on its path without any great deflection or loss of energy.

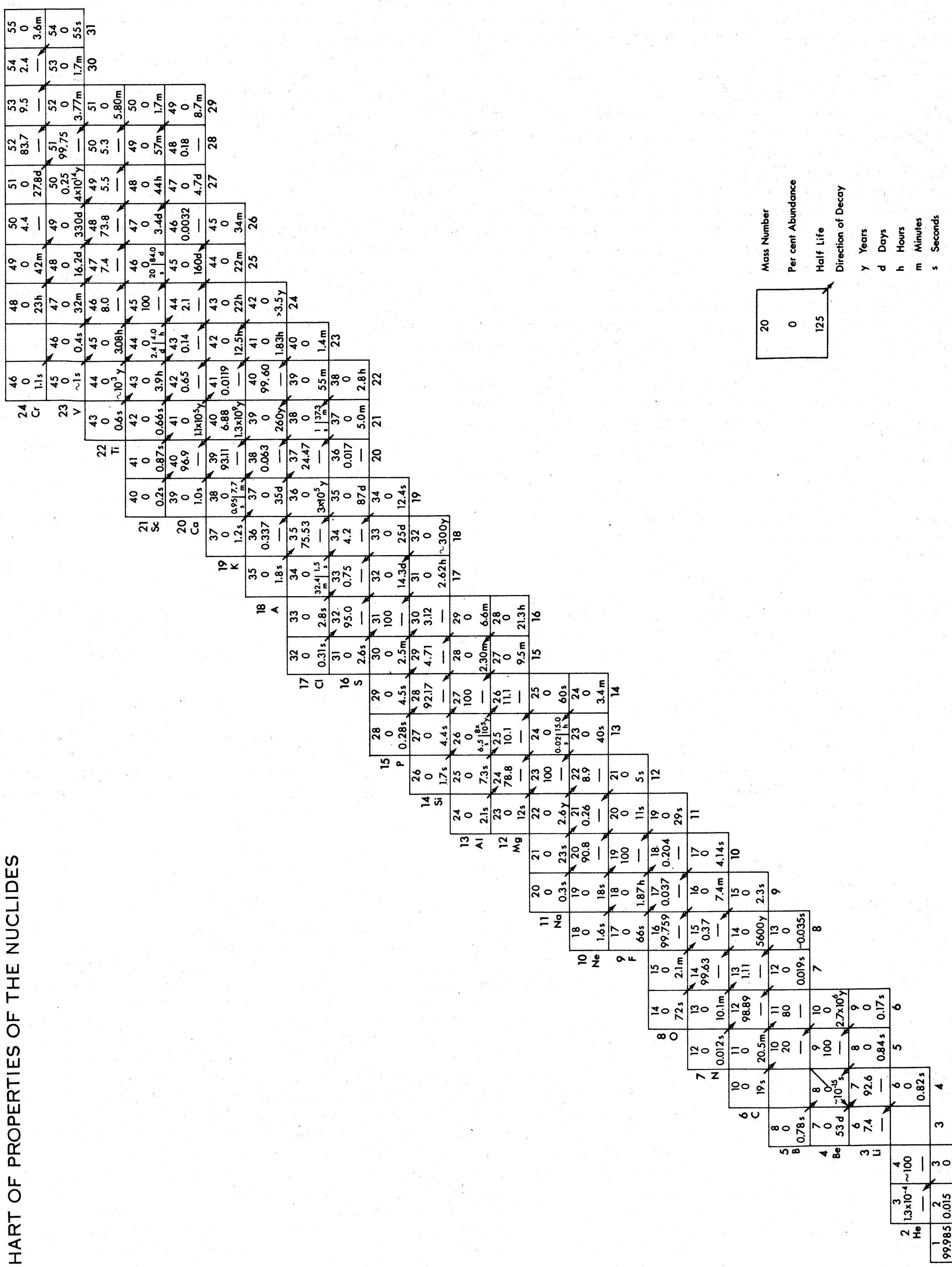
The most important result of experiments in the several-hundred-Mev range has been the production of mesons. These are unstable particles, some of which are neutral while some carry a unit of positive or negative charge. A considerable variety of these particles has been discovered. They differ not only in their charge but also in their masses, spins, lifetimes and modes of decay. At least one class of these mesons, the a-mesons (pi mesons) is closely connected with the forces that bind the nucleons into stable nuclei. This connection will be discussed below.

It has become customary to designate mesons as well as nucleons, electrons and neutrinos as "elementary particles." With the increase in the number of these particles it becomes likely that at least some of them are no more elementary than atoms are indivisible. It is expected that some simple and general laws of physics will eventually explain the properties of all these particles.

SUMMARY OF NUCLEAR PROPERTIES

The nuclear reactions described in the last section led to the discovery of a very great number of previously unknown radioactive nuclei. These, together with the nuclei which occur in nature, are collected in the accompanying chart. In this chart each nucleus is represented by a square. For instance, in the second row from the bottom the isotopes of hydrogen appear. The charge number, one, and the atomic symbol, H (for hydrogen) appear at the left of the row. The first square corresponds to a proton. In the square is found the mass number for the proton, which is one, and below it the abundance of protons in ordinary hydrogen is indicated. The figure 99.985 means 99.985% of ordinary hydrogen consists of light hydrogen or protons. The square to the right of the proton corresponds to heavy hydrogen or deuterium with a mass number two. Its abundance in ordinary hydrogen is 0.015%, which is also entered. The third square in the row corresponds to tritium, the radioactive isotope of hydrogen. This isotope does not occur in nature and so the second line in the square contains a zero. Instead the half life, 12.26 years, has been entered in the third line. The arrow attached to this isotope shows that the nucleus decays to He^3. the light isotope of helium, occurring in the next row. At the bottom of each column is the number of neutrons in the nuclei. Therefore, below the proton is found zero. indicating that this lightest isotope contains no neutrons. Below deuterium and tritium, the figures 1 and 2 indicate that these isotopes contain one and two neutrons. respectively. The next row represents the helium nuclei, of which again two stable and one radioactive nuclei are known. It is significant that the square corresponding to He^5 is empty. The reason for this will be discussed in the next section. The following rows correspond to lithium. beryllium, boron and heavier nuclei. The table is presented in five sections. Throughout the table the three numbers occurring in the squares correspond to the atomic number. the abundance and the lifetime. In the second line zero appears for all nuclei which are not found in the elements as they

CHART OF PROPERTIES OF THE NUCLIDES



BASED ON DATA COMPILED BY J. STEHN AND E. CLANCY

35 Br	74 0 37m	75 0 1.6h	76 0 17h	77 0 57h	78 0 6.4m / <6m	79 50.6 —	80 0 4.4h / 17.6m	81 49.4 —	82 0 35.9h	83 0 2.3h	84 0 6m / 32m	85 0 3.0m		87 0 56s	88 0 15.5s	89 0 4.5s	
34 Se	70 0 44m	71 0 5m	72 0 8.6d	73 0 7h / 44m	74 0.93 —	75 0 120d	76 9.1 —	77 0 17s / 7.5 —	78 23.6 —	79 0 3.9m / 7×10^4y	80 49.9 —	81 0 57m / 18m	82 9.0 —	83 0 69s / 25m	84 0 3.3m	85 0 39s	86 0 17s
33 As	68 0 ~7m	69 0 15m	70 0 50m	71 0 62h	72 0 26h	73 0 76d	74 0 18d	75 0 0.02s / 100 —	76 0 26.4h	77 0 39h	78 0 90m	79 0 9m	80 0 ~36s				
32 Ge	66 0 2.5h	67 0 19m	68 0 275d	69 0 40h	70 20.5 —	71 0 11d	72 27.4 —	73 0 0.53s / 7.8 —	74 36.5 —	75 0 49s / 82m	76 7.8 —	77 0 52s / 12h	78 0 86m				
31 Ga	64 0 2.5m	65 0 15.2m	66 0 9.4h	67 0 78h	68 0 68m	69 60.1 —	70 0 21m	71 39.9 —	72 0 14.1h	73 0 5h	74 0 ~8m						
30 Zn	60 0 2.1m	61 0 1.5m	62 0 9h	63 0 38m	64 48.9 —	65 0 245d	66 27.8 —	67 4.1 —	68 18.6 —	69 0 14h / 58m	70 0.63 —	71 0 3h / 2.2m	72 0 49h				
29 Cu	58 0 9.5m / 3s	59 0 81s	60 0 24m	61 0 3.33h	62 0 9.8m	63 69.0 —	64 0 12.8h	65 31.0 —	66 0 5.1m	67 0 61h	68 0 32s						
28 Ni	56 0 6.4d	57 0 36h	58 68.0 —	59 0 8×10^4y	60 26.2 —	61 1.1 —	62 3.7 —	63 0 120y	64 1.0 —	65 0 2.56h	66 0 55h						
27 Co	54 0 0.18s	55 0 18h	56 0 77d	57 0 267d	58 0 9h / 71d	59 100 —	60 0 10.5m / 5.2y	61 0 1.65h	62 0 1.6m / 14m								
26 Fe	52 0 8h	53 0 9m	54 5.9 —	55 0 2.6y	56 91.6 —	57 2.20 —	58 0.33 —	59 0 45d	60 0 ~3×10^5y	61 0 5.5m							
25 Mn	50 0 0.28s	51 0 45m	52 0 21m / 5.7d	53 0 ~10^6y	54 0 280d	55 100 —	56 0 2.58h	57 0 1.7m									
24 Cr	46 0 1.1s		48 0 23h	49 0 42m	50 4.4 —	51 0 27.8d	52 83.7 —	53 9.5 —	54 2.4 —	55 0 3.6m							
23 V	45 0 ~1s	46 0 0.4s	47 0 32m	48 0 16.2d	49 0 330d	50 0.25 4×10^{14}y	51 99.75 —	52 0 3.77m	53 0 1.7m	54 0 55s							

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54

45 Rh	97 0 35m	98 0 8.7m	99 0 15d / 4.7h	100 0 21h	101 0 5y / 4.5d	102 0 220d	103 57m / 100 —	104 0 4.4m / 42s	105 0 45s / 36h	106 0 2h / 30s	107 0 23m	108 0 18s	109 0 <1h					
44 Ru	≤93 0 0.9m	94 0 1h	95 0 99m	96 5.6 —	97 0 2.8d	98 1.9 —	99 12.7 —	100 12.7 —	101 17.0 —	102 31.5 —	103 0 39.7d	104 18.6 —	105 0 4.5h	106 0 1.00y	107 0 4.5m	108 0 ~4m		
43 Tc	92 0 4.3m	93 0 44m / 2.7h	94 0 53m	95 0 60d / 20h	96 0 52m / 4.3d	97 0 91d / 10^5y	98 0 1×10^6y	99 0 6.0h / 2.1×10^5y	100 0 16s	101 0 14.0m	102 0 5s / 4.5m	103 0 1.2m	104 0 18m	105 0 10m				
42 Mo	90 0 5.7h	91 0 66s / 15.6m	92 15.7 —	93 0 6.9h / >2y	94 9.3 —	95 15.7 —	96 16.5 —	97 9.5 —	98 23.8 —	99 0 67.0h	100 9.5 —	101 0 14.6m	102 0 11m			105 0 <2m		
41 Nb	89 0 ~2h / 1.9h	90 0 24s / 14.6h	91 0 62d / LONG	92 0 13h / 10h	93 0 3.7y / 100 —	94 0 6.6m / 2×10^4y	95 0 90h / 35d	96 0 23h	97 0 1m / 72m	98 0 30m	99 0 2.5m							
40 Zr	86 0 ~17h	87 0 1.6h	88 0 85d	89 0 4.4m / 79h	90 0 0.8s / 51.5 —	91 11.2 —	92 17.1 —	93 0 9×10^5y	94 17.4 —	95 0 65d	96 2.8 —	97 0 17h						
39 Y	82 0 70m	83 0 3.5h	84 0 3.7h	85 0 5h	86 0 15h	87 0 14h / 80h	88 0 105d	89 0 16s / 100 —	90 0 64.2h	91 0 50m / 58d	92 0 3.5h	93 0 11h	94 0 17m	95 0 10m		97 0 SHORT		
38 Sr	81 0 29m	82 0 26d	83 0 33h	84 0.56 —	85 0 70m / 64d	86 9.9 —	87 0 2.8d / 7.0 —	88 82.5 —	89 0 51d	90 0 28y	91 0 9.7h	92 0 2.6h	93 0 7m	94 0 ~2m	95 0 SHORT		97 0 SHORT	
37 Rb	79 0 24m	≤80 0 8d	81 0 31m / 4.7h	82 0 6.3h / 75s	83 0 83d	84 0 21m / 33d	85 72.2 —	86 0 1.0m / 18.7d	87 27.8 5×10^{10}y	88 0 18m	89 0 15m	90 0 2.7m	91 0 1.7m / 14m	92 0 ~80s	93 0 SHORT	94 0 SHORT	95 0 SHORT		97 0 SHORT
36 Kr	76 0 10h	77 0 1.15h	78 0.35 —	79 0 55s / 34h	80 2.27 —	81 0 13s / 2×10^5y	82 11.6 —	83 0 1.86h / 11.5 —	84 57.0 —	85 0 4.4h / 10.4y	86 17.3 —	87 0 78m	88 0 2.8h	89 0 3.2m	90 0 33s	91 0 10s	92 0 3s	93 0 2s	94 0 1s
36 Kr (cont.)	95 0 SHORT		97 0 ~1s															
35 Br	74 0 37m	75 0 1.6h	76 0 17h	77 0 57h	78 0 6.4m / <6m	79 50.6 —	80 0 4.4h / 17.6m	81 49.4 —	82 0 35.9h	83 0 2.3h	84 0 6m / 32m	85 0 3.0m		87 0 56s	88 0 15.5s	89 0 4.5s		
34 Se	70 0 44m	71 0 5m	72 0 8.6d	73 0 7h / 44m	74 0.93 —	75 0 120d	76 9.1 —	77 0 17s / 7.5 —	78 23.6 —	79 0 3.9m / 7×10^4y	80 49.9 —	81 0 57m / 18m	82 9.0 —	83 0 69s / 25m	84 0 3.3m	85 0 39s	86 0 17s	

36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

CHART OF PROPERTIES OF THE NUCLIDES—Continued

50 Sn

Mass number	Abundance	Half-life
108	0	9 m
109	0	18 m
110	0	4.0 h
111	0	35 m
112	1.02	—
113	0	120 d
114	0.69	—
115	0.38	—
116	14.3	—
117	0	14 d; 7.6 –
118	24.1	—
119		270 d; 8.5 –
120	32.5	—
121	0	>1 y; 27 h
122	4.8	—
123	0	130 d; 40 m
124	6.1	—
125	0	9.5 m; 10 d
126	0	50 m
127	0	2.0 h
128	0	57 m
130	0	2.6 m
131	0	3.4 m
132	0	2.2 m

49 In

Mass number	Abundance	Half-life
107	0	30 m
108	0	40 m; 55 m
109	0	<2 m; 4.3 h
110	0	5.0 h; 66 m
111	0	2.8 d
112	0	21 m; 14 m
113	0	1.73 h; 4.2 –
114	0	50 d; 72 s
115	0	4.5 h; 95.8, 6×10^{14} y
116	0	54.0 m; 13 s
117	0	1.9 h; 1.1 h
118	0	4.5 m; <1 m
119	0	18 m

48 Cd

Mass number	Abundance	Half-life
104	0	59 m
105	0	55 m
106	1.22	—
107	0	6.7 h
108	0.88	—
109	0	1.3 y
110	12.4	—
111	0	49 m; 12.8 –
112	24.0	—
113	0	5 y; 12.3 –
114	28.8	—
115	0	43 d; 54 h
116	7.6	—
117	0	3.0 h; 50 m
118	0	~30 m
119	0	10 m

47 Ag

Mass number	Abundance	Half-life
102	0	16 m
103	0	1.1 h
104	0	27 m
105	0	40 d
106	0	24 m; 8.3 d
107	0	44 s; 51.4 –
108	0	2.3 m
109	0	40 s; 48.6 –
110	0	253 d; 24 s
111	0	74 s; 7.5 d
112	0	3.12 h
113	0	1.2 h; 5.3 h
114	0	5 s; 2 m
115	0	~20 s; 21 m
116	0	2.5 m
117	0	1.1 m

46 Pd

Mass number	Abundance	Half-life
98	0	17 m
99	0	22 m
100	0	4.0 d
101	0	8.5 h
102	1.0	—
103	0	17 d
104	11.0	—
105	0	23 s; 22.2 –
106	27.3	—
107	0	7×10^{6} y
108	26.7	—
109	0	4.8 m; 13.6 h
110	11.8	—
111	0	5.5 h; 22 m
112	0	21.0 h
113	0	1.4 m
114	0	2.4 m
115	0	45 s

45 Rh

Mass number	Abundance	Half-life
97	0	35 m
98	0	8.7 m
99	0	15 d; 4.7 h
100	0	21 h
101	0	5 y; 4.5 d
102	0	220 d
103		57 m; 100 –
104	0	4.4 m; 42 s
105	0	45 s; 36 h
106	0	2 h; 30 s
107	0	23 m
108	0	18 s
109	0	<1 h

44 Ru

Mass number	Abundance	Half-life
≤93	0	0.9 m
94	0	1 h
95	0	99 m
96	5.6	—
97	0	2.8 d
98	1.9	—
99	12.7	—
100	12.7	—
101	17.0	—
102	31.5	—
103	0	39.7 d
104	18.6	—
105	0	4.5 h
106	0	1.00 y
107	0	4.5 m
108	0	~4 m

Neutron numbers: 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 / 65 66 67 68 69 / 70 / 71 / 72 73 74 75 76 77 78 79 80 81 82

61 Pm

Mass number	Abundance	Half-life
141	0	20 m
143	0	~300 d
144	0	~300 d
145	0	25 y
146	0	~2 y
147	0	2.65 y
148	0	5.3 d; 42 d
149	0	50 h
150	0	2.7 h
151	0	27 h

60 Nd

Mass number	Abundance	Half-life
138	0	22 m
139	0	5.5 h
140	0	3.3 d
141	0	2.4 h
142	27.1	—
143	12.2	—
144	23.9	2×10^{15} y
145	8.3	—
146	17.2	—
147	0	11.1 d
148	5.7	—
149	0	1.8 h
150	5.6	—
151	0	15 m

59 Pr

Mass number	Abundance	Half-life
135	0	22 m
136	0	70 m
138	0	2.0 h
139	0	4.5 h
140	0	3.4 m
141	100	—
142	0	19.2 h
143	0	13.8 d
144	0	17 m
145	0	5.9 h
146	0	24 m

58 Ce

Mass number	Abundance	Half-life
133	0	6.3 h
134	0	72 h
135	0	22 h
136	0.19	—
137	0	35 h; 9 h
138	0.26	—
139	0	55 s; 140 d
140	88.47	—
141	0	32 d
142	11.08	—
143	0	33 h
144	0	285 d
145	0	3.0 m
146	0	14 m

57 La

Mass number	Abundance	Half-life
131	0	58 m
132	0	4.5 h
133	0	4 h
134	0	6.5 m
135	0	19 h
136	0	9 m
137	0	6×10^{4} y
138	0.089	1.1×10^{11} y
139	99.911	—
140	0	40.2 h
141	0	3.8 h
142	0	77 m
143	0	~19 m
144	0	SHORT

56 Ba

Mass number	Abundance	Half-life
126	0	97 m
127	0	~12 m
128	0	2.4 d
129	0	1.9 h
130	0.11	—
131	0	11.6 d
132	0.13	—
133	0	39 h; 8 y
134	2.5	—
135	0	29 h; 6.6 –
136	7.9	—
137	0	2.6 m; 11.4 –
138	71.4	—
139	0	85 m
140	0	12.8 d
141	0	18 m
142	0	6 m
143	0	<0.5 m
144	0	SHORT

55 Cs

Mass number	Abundance	Half-life
123	0	6 m
125	0	45 m
126	0	1.6 m
127	0	6.2 h
128	0	3.8 m
129	0	31 h
130	0	30 m
131	0	9.7 d
132	0	6.2 d
133	100	—
134	0	3.1 h; 2.1 y
135	0	2.0×10^{6} y
136	0	13 d
137	0	30 y
138	0	32.2 m
139	0	9.5 m
140	0	66 s
141	0	SHORT
142	0	~1 m
143	0	SHORT
144	0	SHORT

54 Xe

Mass number	Abundance	Half-life
121	0	40 m
122	0	19 h
123	0	1.8 h
124	0.094	—
125	0	55 s; 18 h
126	0.092	—
127	0	75 s; 36.4 d
128	1.92	—
129	0	8 d; 26.4 –
130	4.1	—
131	0	12 d; 21.2 –
132	26.9	—
133	0	2.3 d; 5.27 d
134	10.4	—
135	0	15 m; 9.2 h
136	8.9	—
137	0	3.8 m
138	0	17 m
139	0	41 s
140	0	16 s
141	0	2 s
143	0	1 s
144	0	~1 s

53 I

Mass number	Abundance	Half-life
119	0	18 m
120	0	>1.3 h; 30 m
121	0	1.4 h
122	0	3.5 m
123	0	13 h
124	0	4.5 d
125	0	60 d
126	0	13.3 d
127	100	—
128	0	25.0 m
129	0	1.7×10^{7} y
130	0	12.6 h
131	0	8.05 d
132	0	2.3 h
133	0	21 h
134	0	52 m
135	0	6.7 h
136	0	86 s
137	0	22 s
138	0	6 s
139	0	2.7 s

52 Te

Mass number	Abundance	Half-life
116	0	~3 h
117	0	2.5 h
118	0	6.0 d
119	0	16 h; 4.5 d
120	0.091	—
121	0	150 d; 17 d
122	2.5	—
123	0	104 d; 0.88 –
124	4.6	—
125	0	58 d; 7.0 –
126	18.7	—
127	0	110 d; 9.3 h
128	31.8	—
129	0	35 d; 72 m
130	34.4	—
131	0	30 h; 25 m
132	0	77 h
133	0	63 m; 2 m
134	0	44 m

51 Sb

Mass number	Abundance	Half-life
116	0	15 m; 60 m
117	0	2.8 h
118	0	3.5 m; 5.1 h
119	0	38 h
120	0	5.8 d; 16.4 m
121	57	—
122	0	3.5 m; 2.8 d
123	43	—
124	0	21 m; 1.3 m; 60 d
125	0	2.0 y
126	0	19 m; 9 h; 28 d
127	0	88 h
128	0	10 m; 9.6 h
129	0	4.6 h
130	0	10 m; 40 m
131	0	22 m
132	0	2 m
133	0	4.1 m
134	0	0.8 m

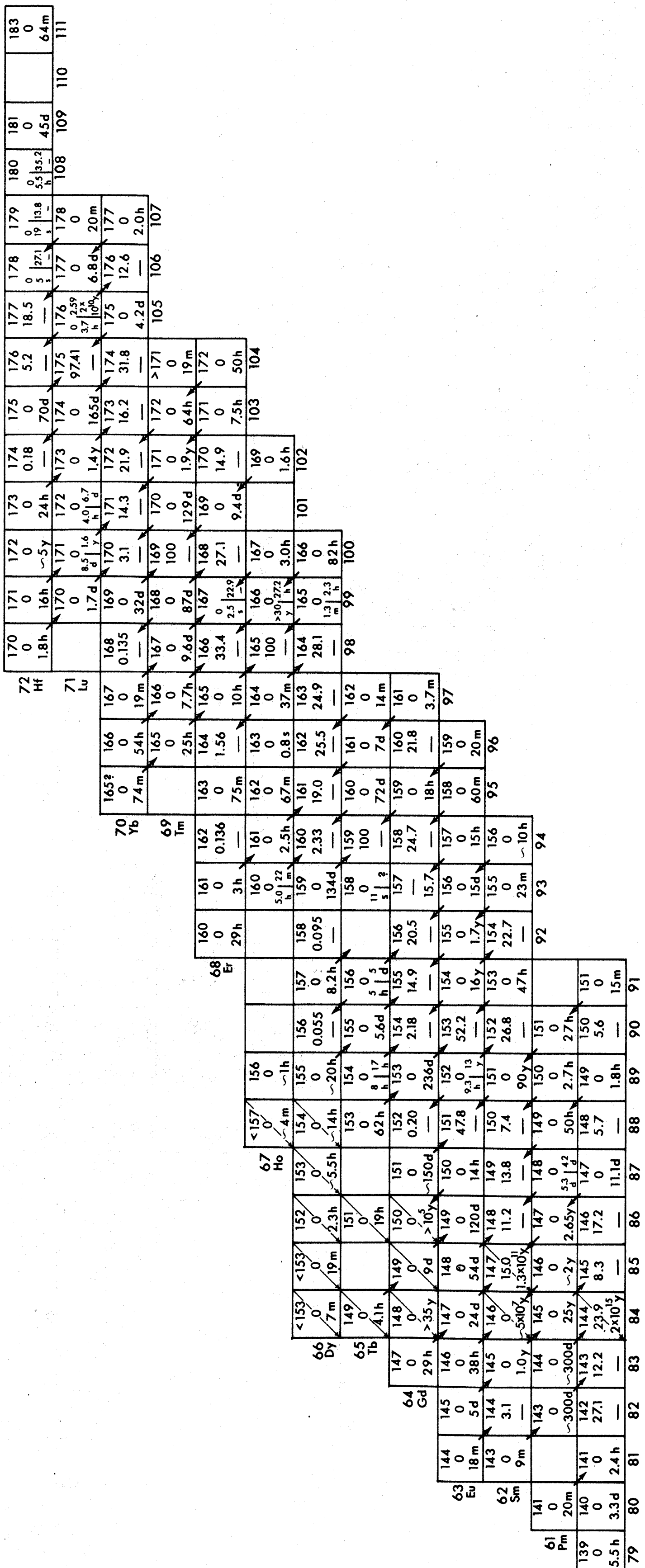
50 Sn

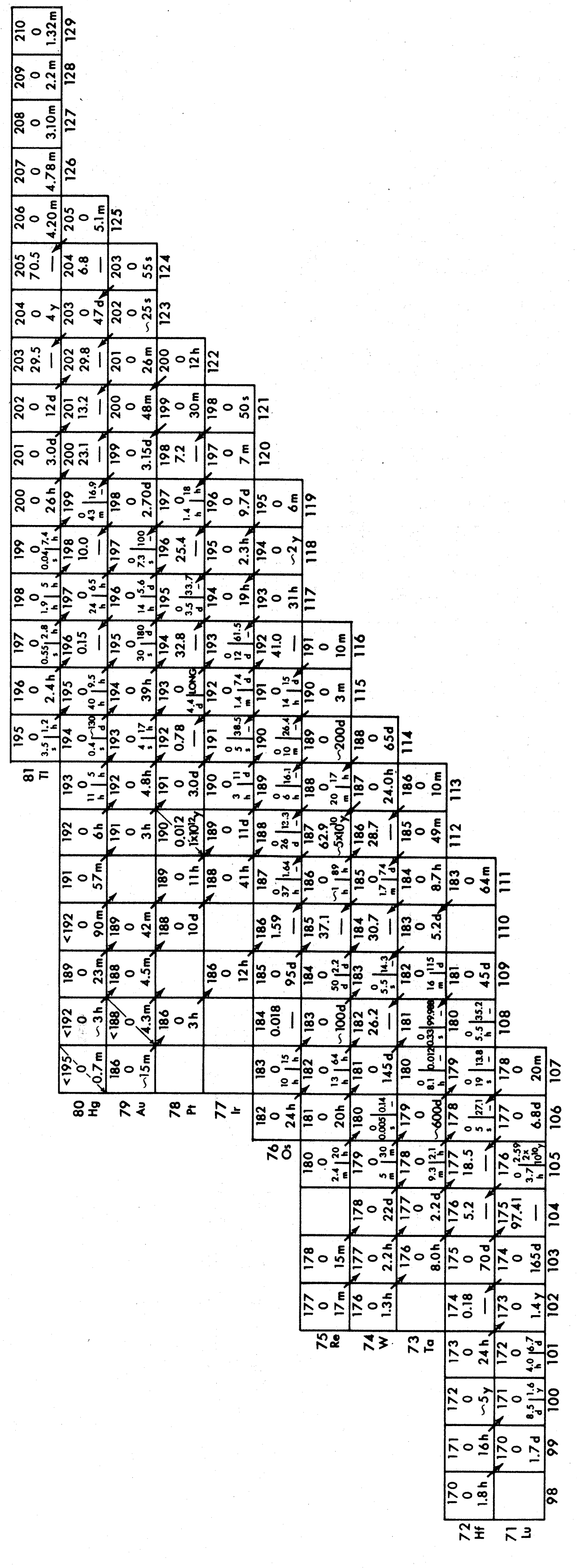
Mass number	Abundance	Half-life
108	0	9 m
109	0	18 m
110	0	4.0 h
111	0	35 m
112	1.02	—
113	0	120 d
114	0.69	—
115	0.38	—
116	14.3	—
117	0	14 d; 7.6 –
118	24.1	—
119		270 d; 8.5 –
120	32.5	—
121	0	>1 y; 27 h
122	4.8	—
123	0	130 d; 40 m
124	6.1	—
125	0	9.5 m; 10 d
126	0	50 m
127	0	2.0 h
128	0	57 m
130	0	2.6 m
131	0	3.4 m
132	0	2.2 m

49 In

Mass number	Abundance	Half-life
107	0	30 m
108	0	40 m; 55 m
109	0	<2 m; 4.3 h
110	0	5.0 h; 66 m
111	0	2.8 d
112	0	21 m; 14 m
113	0	1.73 h; 4.2 –
114	0	50 d; 72 s
115	0	4.5 h; 95.8, 6×10^{14} y
116	0	54.0 m; 13 s
117	0	1.9 h; 1.1 h
118	0	4.5 m; <1 m
119	0	18 m

Neutron numbers: 58 59 60 61 62 63 64 65 66 67 68 69 70 / 71 72 73 74 75 76 77 78 79 80 81 82 / 83 / 84 85 86 / 87 88 89 90 / 91





Z	Element	A	Abundance	Half-life
86	Rn	204	0	3m
86	Rn	206	0	6.5 m
86	Rn	207	0	11m
86	Rn	208	0	22m
86	Rn	209	0	30 m
86	Rn	210	0	2.7h
86	Rn	211	0	16h
86	Rn	212	0	23m
86	Rn	215	0	<1 m
86	Rn	216	0	<9m
86	Rn	217	0	~0.001s
86	Rn	218	0	0.019s
86	Rn	219	0	3.92s
86	Rn	220	0	52s
86	Rn	221	0	25m
86	Rn	222	0	3.825d
85	At	<202	0	43s
85	At	<203	0	1.7m
85	At	203	0	7m
85	At	204	0	~25m
85	At	205	0	25 m
85	At	206	0	2.9h
85	At	207	0	1.7 h
85	At	208	0	1.6 h | 6 h
85	At	209	0	5.5 h
85	At	210	0	8.3 h
85	At	211	0	7.2h
85	At	212	0	0.22s
85	At	213	0	<2 s
85	At	214	0	<5 s
85	At	215	0	~10^{-4}s
85	At	216	0	~3×10^{-4}s
85	At	217	0	0.018s
85	At	218	0	1.3 s
85	At	219	0	0.9m
84	Po	196	0	1.9 m
84	Po	197	0	~4 m
84	Po	198	0	~6 m
84	Po	199	0	~11 m
84	Po	200	0	~8 m
84	Po	201	0	18 m
84	Po	202	0	53m
84	Po	203	0	42 m
84	Po	204	0	3.8 h
84	Po	205	0	1.8 h
84	Po	206	0	9d
84	Po	207	0	6h
84	Po	208	0	2.9y
84	Po	209	0	100 y
84	Po	210	0	138.40d
84	Po	211	0	25 s | 0.52 s
84	Po	212	0	3×10^{-7}s
84	Po	213	0	4×10^{-6}s
84	Po	214	0	1.6×10^{-4}s
84	Po	215	0	0.0018s
84	Po	216	0	0.16 s
84	Po	217	0	<10 m
84	Po	218	0	3.05m
83	Bi	≤198	0	1.7 m
83	Bi	198	0	7 m
83	Bi	199	0	~25m
83	Bi	200	0	35 m
83	Bi	201	0	6.2 m | 1.9 h
83	Bi	202	0	1.6 h
83	Bi	203	0	12h
83	Bi	204	0	12h
83	Bi	205	0	15 d
83	Bi	206	0	6.4d
83	Bi	207	0	~10y
83	Bi	208	0	.003 s | 3×10^{4}y
83	Bi	209	100	—
83	Bi	210	0	5.0 d | 2.6×10^{6}y
83	Bi	211	0	2.15m
83	Bi	212	0	60.5m
83	Bi	213	0	47m
83	Bi	214	0	19.7m
83	Bi	215	0	8 m
82	Pb	195	0	17 m
82	Pb	196	0	37 m
82	Pb	197	0	42m
82	Pb	198	0	25 m | 2.3 h
82	Pb	199	0	12 m | 1.5 h
82	Pb	200	0	21 h
82	Pb	201	0	61 s | 9 h
82	Pb	202	0	3.6 h | ~10^{5} y
82	Pb	203	0	6 s | 52 h
82	Pb	204	0 | 1.3	68 m | —
82	Pb	205	0	~5×10^{7}y
82	Pb	206	26	—
82	Pb	207	0 | 21	0.8 s | —
82	Pb	208	52	—
82	Pb	209	0	3.3h
82	Pb	210	0	20 y
82	Pb	211	0	36.1 m
82	Pb	212	0	10.64 h
82	Pb	214	0	26.8m
81	Tl	195	0	3.5 s | 1.2 h
81	Tl	196	0	2.4 h
81	Tl	197	0	0.55 s | 2.8 h
81	Tl	198	0	1.9 h | 5 h
81	Tl	199	0	0.04 s | 7.4 h
81	Tl	200	0	26h
81	Tl	201	0	3.0d
81	Tl	202	0	12d
81	Tl	203	29.5	—
81	Tl	204	0	4 y
81	Tl	205	70.5	—
81	Tl	206	0	4.20m
81	Tl	207	0	4.78m
81	Tl	208	0	3.10m
81	Tl	209	0	2.2 m
81	Tl	210	0	1.32 m
80	Hg	<195	0	0.7 m
80	Hg	<192	0	~3 h
80	Hg	189	0	23m
80	Hg	<192	0	90m
80	Hg	191	0	57 m
80	Hg	192	0	6h
80	Hg	193	0	11 h | 5 h
80	Hg	194	0	0.4 s | ~130 d
80	Hg	195	0	40 h | 9.5 h
80	Hg	196	0.15	—
80	Hg	197	0	24 h | 65 h
80	Hg	198	10.0	—
80	Hg	199	0 | 16.9	43 m | —
80	Hg	200	23.1	—
80	Hg	201	13.2	—
80	Hg	202	29.8	—
80	Hg	203	0	47d
80	Hg	204	6.8	—
80	Hg	205	0	5.1m

Neutron numbers: 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136

Z	Element	A	Abundance	Half-life
103	Lw	257	0	8s
102	No	253	0	~10m
102	No	254	0	~3s
102	No	255	0	~15s
101	Md	255	0	30m
101	Md	256	0	1.5h
100	Fm	249	0	30 m
100	Fm	250	0	30 m
100	Fm	251	0	7h
100	Fm	252	0	23h
100	Fm	253	0	4d
100	Fm	254	0	3.24h
100	Fm	255	0	21.5h
100	Fm	256	0	~3h
99	Es	246	0	SHORT
99	Es	247	0	7m
99	Es	248	0	25m
99	Es	249	0	2h
99	Es	250	0	8h
99	Es	251	0	1.5d
99	Es	252	0	~140d
99	Es	253	0	20.0d
99	Es	254	0	320 d | 38 h
99	Es	255	0	24d
99	Es	256	0	SHORT
98	Cf	244	0	25m
98	Cf	245	0	44m
98	Cf	246	0	36h
98	Cf	247	0	2.5h
98	Cf	248	0	225d
98	Cf	249	0	500y
98	Cf	250	0	9y
98	Cf	251	0	~700y
98	Cf	252	0	2.2y
98	Cf	253	0	18d
98	Cf	254	0	55d
97	Bk	243	0	4.5h
97	Bk	244	0	4.4h
97	Bk	245	0	5.0d
97	Bk	246	0	1.8d
97	Bk	247	0	~10^{4}y
97	Bk	248	0	16h
97	Bk	249	0	290d
97	Bk	250	0	3.1h
96	Cm	238	0	2.3h
96	Cm	239	0	~3h
96	Cm	240	0	27d
96	Cm	241	0	35d
96	Cm	242	0	163d
96	Cm	243	0	35y
96	Cm	244	0	18y
96	Cm	245	0	1.2×10^{4}y
96	Cm	246	0	6000y
96	Cm	247	0	>4×10^{7}y
96	Cm	248	0	4×10^{5}y
96	Cm	249	0	5m
96	Cm	250	0	~10^{4}y
95	Am	237	0	~1h
95	Am	238	0	1.9h
95	Am	239	0	12h
95	Am	240	0	50h
95	Am	241	0	458y
95	Am	242	0	16.0 h | ~100 y
95	Am	243	0	7600y
95	Am	244	0	26m
95	Am	245	0	2.0h
95	Am	246	0	25m
94	Pu	232	0	36m
94	Pu	233	0	20m
94	Pu	234	0	9h
94	Pu	235	0	26m
94	Pu	236	0	2.85y
94	Pu	237	0	45.6d
94	Pu	238	0	90y
94	Pu	239	0	24,300y
94	Pu	240	0	6600y
94	Pu	241	0	13.1y
94	Pu	242	0	3.8×10^{5}y
94	Pu	243	0	5.0h
94	Pu	244	0	8×10^{7}y
94	Pu	245	0	11h
94	Pu	246	0	10.9d
93	Np	231	0	50m
93	Np	232	0	~13m
93	Np	233	0	35m
93	Np	234	0	4.4d
93	Np	235	0	1.1y
93	Np	236	0	22 h | >5×10^{3}y
93	Np	237	0	2.2×10^{6}y
93	Np	238	0	2.10d
93	Np	239	0	2.34d
93	Np	240	0	7.3 m | 60 m
92	U	227	0	1.3m
92	U	228	0	9.3m
92	U	229	0	58m
92	U	230	0	21d
92	U	231	0	4.3d
92	U	232	0	74d
92	U	233	0	1.62×10^{5}y
92	U	234	0.0055	2.5×10^{5}y
92	U	235	0 | 0.72	27 m | 7.1×10^{8}y
92	U	236	0	2.39×10^{7}y
92	U	237	0	6.75d
92	U	238	99.27	4.51×10^{9}y
92	U	239	0	23.5m
92	U	240	0	14h
91	Pa	225	0	2.0s
91	Pa	226	0	1.8m
91	Pa	227	0	38m
91	Pa	228	0	22h
91	Pa	229	0	1.5d
91	Pa	230	0	17d
91	Pa	231	0	34,000y
91	Pa	232	0	1.31d
91	Pa	233	0	27.0d
91	Pa	234	0	1.18 m | 6.66 h
91	Pa	235	0	24m
91	Pa	237	0	10m
90	Th	223	0	<1m
90	Th	224	0	<9m
90	Th	225	0	8m
90	Th	226	0	31m
90	Th	227	0	18.2d
90	Th	228	0	1.91y
90	Th	229	0	7300y
90	Th	230	0	8×10^{4}y
90	Th	231	0	25.6h
90	Th	232	100	1.39×10^{10}y
90	Th	233	0	23m
90	Th	234	0	24.10d
90	Th	235	0	<5m
89	Ac	221	0	<2s
89	Ac	222	0	5.5s
89	Ac	223	0	2.2m
89	Ac	224	0	2.9h
89	Ac	225	0	10.0d
89	Ac	226	0	29h
89	Ac	227	0	22y
89	Ac	228	0	6.13h
89	Ac	229	0	66m
89	Ac	230	0	<1m
88	Ra	213	0	2.7m
88	Ra	219	0	<1m
88	Ra	220	0	<9m
88	Ra	221	0	30s
88	Ra	222	0	37s
88	Ra	223	0	11.6d
88	Ra	224	0	3.64d
88	Ra	225	0	14.8d
88	Ra	226	0	1620y
88	Ra	227	0	41m
88	Ra	228	0	6.7y
88	Ra	229	0	<5m
88	Ra	230	0	1h
87	Fr	212	0	19m
87	Fr	217	0	<2s
87	Fr	218	0	<5s
87	Fr	219	0	0.02s
87	Fr	220	0	28s
87	Fr	221	0	4.8m
87	Fr	222	0	15m
87	Fr	223	0	22m

Neutron numbers: 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 occur in nature. In all but a few of the heaviest elements natural terrestrial sources always have the same isotopic abundances. This abundance is indicated by the figure in the second line. It should not be taken for granted that the isotopic abundance outside the earth is the same as on the earth. This. however, seems to be the general rule.

The figures on abundance are omitted in some of the heavy nuclei in which all isotopes are radioactive and in which the isotopic abundances are dependent upon the method by which the element is obtained.

The radioactive nuclei are distinguished in the chart, not only by the fact that in their squares a lifetime appears, but also by the arrows which indicate their process of decay. p-active nuclei are distinguished by arrows which point toward the upper left if negative electrons are emitted or by arrows in the opposite direction if positive electrons are emitted. Nuclei which do not have enough energy to emit an electron but capture an atomic electron are indicated in the same way as an ordinary positive electron emitter. Some nuclei may decay both by positive and negative electron emission. This is indicated by two arrows attached to the squares. Alpha-activity of the nuclei is shown by an arrow in the loner left-hand direction and extending to the second diagonal neighbour. Thus in every case the arrow ends on the product of the radioactive decay.

The chart shows several interesting facts. Among the light nuclei only those with approximately equal numbers of neutrons and protons are stable. Those nuclei which have a great neutron excess are p-active and emit negative electrons, thus transforming a supernumerary neutron into a proton. Nuclei having too many protons emit a positive electron and transform a proton into a neutron. The fact that among light nuclei an equal number of neutrons and protons seems to give greatest stability to the nucleus is the result of the exclusion principle. The first neutrons and protons that build up a nucleus will occupy the lowest energy states. Each additional neutron and proton will be forced into an orbit of higher energy. If the number of neutrons greatly exceeds the number of protons. the last neutron will find itself in a state of rather high energy, while states of lower energy are still available for protons. Thus energy may be released by the transformation of a neutron into a proton. A similar argument holds for an excess of protons.

As the number of protons and neutrons becomes greater the stable nuclei tend to have a greater number of neutrons than protons. The reason for this is the electrostatic repulsion between protons. Because of this repulsion the presence of many protons in the nucleus causes an increase of the energy of the nucleus and transforming a proton into a neutron will correspondingly lower the energy. Too great a neutron excess will be prevented for the reasons discussed in the preceding paragraph.

It has been mentioned that the electrostatic repulsion in heavily charged nuclei gives rise to a-activity. The frequent occurrence of a-activity in the last elements of the table can be readily observed. Instability of nuclei caused by the excess charge is probably the reason why fewer isotopes of heavy nuclei are known and why nuclei having more than 92 charge units do not occur in nature.

While two neutrons and two protons can never occupy exactly the same state within a nucleus, a pair of such particles may be found in the same orbit. These two particles must differ in the orientation of their spins. It seems that two particles in the same orbit possess similar energies. The result is that two successive particles can be bound in a low-energy state, while the addition of a third particle will release considerably less binding energy. This circumstance is illustrated by two facts in the table of nuclei. First, few stable nuclei exist in which both the number of neutrons and the number of protons is odd. Such nuclei are usually radioactive, emitting a positive electron, a negative electron or both. The decay product is a nucleus in which both neutron and proton numbers are even and all orbits may be considered as doubly occupied.

The result of this rule is that nuclei with odd charge number, Z, possess many fewer isotopes than nuclei of even charge number. The other fact appearing from the table is that in nuclei of even charge number the even isotopes, in which the number of neutrons is even. have a greater abundance than the odd isotopes. in which the number of neutrons is odd. It seems that the latter nuclei. containing particles in less stable orbits, originally have been formed in smaller numbers than the isotopes having an even number of neutrons and greater binding energies.

Among the p-active nuclei two general rules may also be observed. First, that p-active nuclei which are located close to stable nuclei usually decay with a long lifetime. Nuclei which are located farther from stability have shorter decay periods. The other regularity is that radioactive nuclei containing even numbers of protons and neutrons have longer lives than nuclei containing an even number of neutrons and an odd number of protons or an even number of protons and an odd number of neutrons. These nuclei in turn live longer than nuclei in which both the proton and neutron numbers are odd. These regularities may be understood in terms of the energies of nuclei. In terms of β-decay it has been mentioned that the lifetime will be short if a great amount of energy is liberated in the β-decay. The lifetime will be long if the transformation energy is small. The transformation energy is apt to be less if the decaying nucleus has relatively low energy. This will be the case if the nucleus is near the region of stability and if the nucleus contains an even number of neutrons and protons. Closer inspection of the table will show that the rules just mentioned are not universally valid and that there are quite a few exceptions. These exceptions occur whenever a 0-decay of the anomalous type is encountered, in which case, as has been mentioned, β-active substances have a relatively long lifetime.

The abundances of isotopes show a further marked regularity. Among the light elements the heaviest isotopes are frequently present in small abundance. Among the heavier elements the situation is reversed. It seems impossible to explain this fact on the basis of the stability of nuclei alone and it is likely that a hint is encountered here which may throw some light on the origin of the elements.

In this connection it is also of great interest to compare the abundance of various elements. The determination of the abundance of elements is much more difficult than the measurement of the ratio of isotopic abundances. The reason for this is that while isotopic composition is remarkably constant, at least in terrestrial materials, the mixtures of various elements depend quite strongly on whence one obtains the mixture. Other elements will be found to predominate in the crust of the earth than in meteorites, which are believed to have a composition similar to the interior of the earth. A still difierent composition is found in the study of the sun. Even if we restrict ourselves to the earth's crust, a different result is obtained if igneous rocks are studied, sedimentary materials, the sea or the atmosphere. Fig. j gives the best available guess as to the abundance of various nuclear species through-

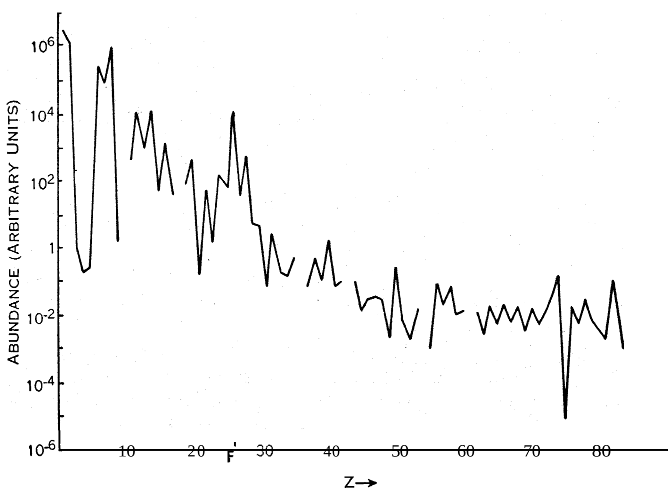


FIG. 5.— GRAPH OF ABUNDANCE OF ELEMENTS IN COSMOS AS A FUNCTION OF Z

out the cosmos. Fig. 5 is based on data taken from calculations of V. M. Goldschmidt. The units of the abundance are arbitrary. The abundance of Si has been set equal to 10,000 and all other abundances have been scaled in proportion.

The very great abundances of hydrogen and helium are immediately apparent. It will also be noticed that the lighter elements up to and including iron are much more abundant than the heavier elements. This has led to the suspicion that the lighter and heavier groups of elements have been formed by two basically different processes.

NUCLEAR STRUCTURE AND NUCLEAR FORCES

We are ignorant about the origin and nature of the nuclear forces. There is not even certainty that it is permissible to talk about forces within a nucleus in the customary sense of the word. Something is known, however. about the magnitude that forces between nuclear particles should have if these forces are to give rise to the effects that are observed.

A detailed theory of the interaction of slow neutrons with nuclei leads to the idea that there is very little interaction between the neutron and the nucleus until the neutron approaches to the distance of approximately one nuclear radius. At that distance the neutron is attracted to the nucleus with a strong force. The last statement is based on the fact that the union of a neutron with almost any nucleus releases a binding energy of several Mev. The facts so far described are summarized in the statement that the interaction between the neutron and other nuclear particles is a strong. short-range attraction.

If a proton approaches a nucleus the interaction at long distances is an electrostatic repulsion. By nuclear forces. of course. is meant the forces acting in addition to these electrostatic forces. As long as the proton is not in contact with the nucleus the effects of nuclear forces are considerably smaller than this electrostatic interaction. Attaching a proton to a nucleus releases a similar energy as when a neutron is attached. Thus, the interaction of the protons with other nuclear particles is again a strong. short-range attraction to which, of course. must be added the electrostatic repulsion. which acts over a greater distance.

Comparison of the binding energies of certain pairs of light nuclei leads to an important conclusion concerning nuclear forces. The first of these pairs is H^3 and He^3. The former consists of two neutrons and a proton, the latter of one neutron and two protons. The second known pair in the series is Li^7 and Be^7. The first is composed of three protons and four neutrons, the second contains four protons and three neutrons. The next pair is B^{11} and C^{11}, in which the numbers of protons and neutrons are five-six and six-five, respectively. In each of these pairs one member is obtained from the other if all neutrons are replaced by protons and all protons by neutrons. A large number of additional pairs of this type are known. For quite a few of these accurate determinations of the energy content of the nuclei are available. These energy contents differ because of the greater electrostatic repulsion prevailing in the nucleus which is more heavily charged than its partner. The remarkable fact is that the electrostatic repulsion is sufficient to explain the observed energy difference of the two nuclei in any of these pairs. We conclude that nuclear forces remain unchanged upon replacing all neutrons by protons and all protons by neutrons.

More detailed investigation of the behaviour of nuclei and also scattering experiments of protons on protons and neutrons on neutrons at various energies have led to a simple general rule. This is that neutrons and protons interact with each other in the same way as they interact with their own kind and that neutrons and protons are bound by the same forces within nuclei.

A detailed study of the proton-proton and neutron-neutron scattering at various energies has led to the conclusion that during such a scattering process the two interacting particles may exchange their charges. This exchange process gives rise to forces between the particles. It is likely, however, that these exchange forces account for only a portion of the total iorces acting within nuclei. In spite of the similarity of the behaviour of neutrons and protons, the charge does therefore influence nuclear binding, but it does so in a similar way as the spin. Particles with different charge or different spin may occupy the same orbit, whereas particles with the same charge and spin may not. Furthermore. the exchange of charge and spin exerts an influence upon the nuclear forces.

It is instructive to consider what happens if the lightest nuclei are built up by adding one neutron or one proton at a time. The first combination* that of a neutron and a proton. has a relatively low binding energy of 2.2 Mev. A somewhat greater binding energy is released if a neutron or proton is added (the values are 6.2 Mev and 5.4 Mev, respectively). If a fourth particle is attached in such a way as to build a helium nucleus a very great amount of binding energy is released. The total binding energy of the two neutrons and two protons in the helium nucleus is 28 Mev. The great stability arising from this large binding energy accounts for the appearance of α-particles in radioactive decay. If we now try to attach an additional neutron or proton to the a-particle we find that the fifth particle will not be bound at all. This will seem all the more remarkable if one considers that the α-particle is the only nucleus which fails to combine with a proton or a neutron. A glance at the chart of the previous section will show that mass number 5 is the only one absent among the nuclei up to mass number 2j6.

This situation is undoubtedly connected with the fact that according to the exclusion principle four and only four particles can be placed in the same orbit. Two particles in the same orbit must differ either in spin or charge or both. Now a nuclear particle can take two spin directions and two charge values (o for neutrons and $+1$ for a proton). Thus the maximum number of particles in the same orbit is four and we must consider the He^4 nucleus to consist of two neutrons with opposite spins and two protons with opposite spins. Since a fifth particle cannot differ by charge or spin from the four previous particles, the application of the exclusion principle indicates that the fifth particle must be accommodated in a new orbit. As a consequence, this particle will be more loosely bound and might, in fact, have a binding energy equal to zero. Properties of matter inside nuclei heavier than the helium nucleus have certain simple common characteristics. In particular, nuclear densities for these nuclei seem to be fairly constant so that the cube of the radius is proportional to the mass number, A, that is to the number within the nucleus. The total binding energy of the nucleus is also proportional to this number so that the binding energy per nucleon is constant. This latter statement does not apply very well to the heaviest nuclei for which the binding energy per nucleon shows a marked decrease. This, however, is caused by the coulomb repulsions between the protons within the nucleus rather than by any intrinsic change in the characteristic behaviour of nuclear matter itself. The fact that the volume and binding energy per nucleon is roughly a constant for all nuclei beyond helium has been ascribed to a "saturation" of nuclear forces. Apparently in the helium nucleus the nucleons have achieved a nearly optimal density and binding energy.

Many of the detailed properties of the nuclei were explained by the nuclear shell model (M. G. Mayer, H. Jensen et al., 1949). According to this model, individual nucleons are found in well-defined orbits within each nucleus. Each of these orbits is characterized by an orbital angular momentum, *i.e.,* a momentum around the centre of the nucleus; by a radial momentum. *i.e.,* a momentum away from and toward the centre of the nucleus; and a total angular momentum which is composed of the orbital angular momentum and the one-half unit spin momentum of the nucleon. Increasing angular momenta and radial momenta correspond to increasing energies. According to the Pauli exclusion principle, each orbit characterized by the appropriate momenta and by the spin may contain not more than one neutron and one proton. The orbits are filled in successively, those with lowest energy being filled first. The energies of these orbits can be calculated and one can therefore predict in which order the orbits of various characteristics will be filled up. One finds that a surprisingly low energy is encountered whenever an orbit has practically no radial momentum: that is, whenever the path of the nucleon can be considered as circular, provided that the angular momentum of the orbit and the angular momentum corresponding to the spin are lined up parallel to each other. There are several orbits of the kind just describe&which differ from each other by their orientation in the spherical field of the nucleus. When all these relatively low-lying orbits are filled up, one obtains a closed shell configuration and one arrives at a particularly stable nucleus.

The procedure mentioned above agrees with experiments particularly well for heavier nuclei. Application of these ideas shows that nuclei with unusual stability will result if the neutron number or the proton number happens to be either 50, 82 or 126. Stability of such nuclei was noticed before the explanation was given. The peculiar properties of the corresponding nuclei led to the designation of "magic numbers" for the numbers 50, 82 and 126. It is of interest particularly to mention the nucleus Pb^{208}, which is "doubly magic" since it contains 82 protons and 126 neutrons.

The nuclear shell model has been most useful in predicting angular momentum values for a great number of nuclear isotopes both in their lower state and in their excited state. The possibilities of β-decay and also the possibilities of emission of γ-rays are closely connected with these angular momenta. Therefore the shell model made it possible to obtain a consistent connection between β-decays, y-ray emissions and detailed nuclear structure.

The explanation of nuclear structure by the shell model is similar to the explanation of the periodic system with the help of the shell model of the electrons within atoms. A quantitative difference exists, however, in that in atomic physics the difference between incomplete shells and closed shells is more marked than it is in nuclear physics.

The nuclear shell model suggests that nucleons can move across nuclei in a relatively undisturbed manner. Indeed, if that were not so, it would be hard to understand why well-defined orbits may be ascribed to individual nucleons. This conclusion is somewhat surprising since all nucleons experience strong forces when entering or leaving a nucleus. We are therefore led to the following model of nuclear forces. When a nucleon approaches a nucleus, it is attracted into the interior of the nucleus and is therefore strongly accelerated. Inside the nucleus, the nucleon does not encounter any strong systematic change of the potential and is not exposed to any appreciable average force. It moves in this region almost as though the inside of the nucleus were free space. When leaving the nucleus, the nucleon will experience a strong retarding force, and will lose the kinetic energy which it acquired upon entering. The above discussion ignores the possibility of an energy loss of the nucleon which it may, suffer while traversing the nucleus but it gives a qualitative idea of the forces found inside a nucleus.

The nature of nuclear forces cannot be understood unless one considers both the field in a quiescent nucleus and that in a nuclear structure whose components experience violent motion and acceleration. The situation may be clarified by a comparison with the electric forces which confine the electrons to their orbits within the atoms. These forces have actually two manifestations. On the one hand, they influence the orbits of the electrons. On the other hand, they give rise to electroniagnetic radiation. The latter phenomenon occurs when the electric configuration within an atom suffers a sudden change and part of the electric field in the neighbourhood of the atom is shaken loose.

The situation is similar in the case of nuclear forces. On the one hand: they confine nucleons to their orbits. On the other hand, one has to expect that if a nucleus is subject to sudden and violent change, a peculiar nuclear radiation will be emitted. This nuclear radiation has been identified with at least some of the mesons which have been described above.

The nuclear radiations, that is, the mesons, differ in two basic respects from electromagnetic radiation. The first difference is that electromagnetic radiation may carry an arbitrarily small amount of energy. A meson, on the other hand. cannot carry an energy less than a certain given minimum amount. To this minimum energy a mass corresponds, according to Einstein's relation of equivalence of mass and energy. For the π-mesons, which have been most closely identified with nuclear radiation, this mass is approximately 270 times greater than the mass of the electron and is roughly one-seventh of the mass of a nucleon. The fact that the nuclear radiation has a minimum energy is connected with the short range of nuclear forces. As a result of this short range the time of vibration of nuclear radiation will necessarily be shorter than a certain minimum time. According to the mechanics of atomic systems, short times are necessarily connected with high energies. The existence of the mesons as a form of nuclear radiation nas first postulated by H. Yukawa. These mesons were then found in cosmic radiation and later in nuclear reactions and they possessed the qualitative features which had been predicted.

The second important difference between electromagnetic radiation and nuclear radiation as represented by mesons is connected with the electric charge carried by the radiation. Electric radiation does not carry a charge. Many mesons do. The π-mesons which are known to be connected with nuclear forces appear in three forms: the neutral π-mesons. the positive π-mesons which carry one positive unit of electricity and the negative a-mesons which carry a negative unit. In their interaction with nuclear matter these three kinds of T-mesons behave quite similarly. This fact is connected nith the rule mentioned above that nuclear forces act similarly on protons and neutrons. The spin of the a-mesons is known to be zero. that is. they do not carry an intrinsic angular momentum. Their mathematical description, however, exhibits a peculiar behaviour with respect to mirror reflections. It is a consequence of this peculiar property that emission of a a-meson does not in itself cause a change in the angular momentum of the emitting nucleon but it is likely to cause an exchange of angular momentum between the spin and the orbit of the nucleon.

Many other kinds of mesons have been observed and some of these may well be connected with nuclear forces in a manner similar to the connection existing in the case of the π-mesons. It will be. however. clear even to the most superficial observer that present hypotheses concerning nuclear forces have been introduced piecemeal, seem to consist of several independent statements and do not proceed by a cogent reasoning from a number of simple hypotheses. These are the marks of an unfinished theory. The final and complete explanation will probably contain unexpected elements and will probably form a more closed and simple pattern than the present disconnected set of assumptions.

ENERGY PRODUCTION IN STARS

The energy source responsible for the radiation of the sun and stars was the subject of speculation for many years. It was recognized long ago that no known chemical reaction could keep the sun supplied with energy for more than approximately 100.000 years. Yet there is geological evidence that the sun must have been radiating at its present rate for 500,000,000 years; *i.e.*, during the period in which living beings are certain to have inhabited the earth. More recent detailed theories of the interior of the stars did not lead to any suggestions as to some novel kind of chemical reaction (some kind of rearrangement of atoms or extranuclear electrons) which could account for the extremely great amounts of energy that the sun has emitted during its long history.

Somewhat more energy could be obtained from a slow gravitational contraction of the sun. It is not easy to construct a model of the sun (or stars), however, which would permit the sun to radiate at its present rate for more than a few million years without considerable change if gravitational energy were the main source of the energy radiated. Actually, a great concentration of mass near the centre of the sun could give rise to sufficiently high gravitational energies and a slow growth of this very dense core could account for the energy emission of the sun. In order to obtain the necessary energies one would have to assume near the centre of the sun densities of matter which are approximately 10^{12} times greater than the densities of water. Such high densities had been encountered only in the interior of nuclei.

It seems, therefore. most likely that the energy of the sun and stars results from nuclear transformations. The theory of the structure of the sun and stars has led to the conclusions that the central regions of these bodies are at temperatures approximately 40,000,000° to 50,000,000° F. At these exceedingly high temperatures atomic nuclei move with sufficiently high velocities so that occasionally they come in close contact and give rise to a nuclear reaction. Actually the average energy of atomic nuclei inside the sun is only 2,000 or 3,000 ev. This energy is rather low compared with the energies usually encountered in nuclear reactions. If the kinetic energy in the sun were as high as the kinetic energy of protons or a-particles which are used in the laboratory to produce reactions, then nuclear reactions on the sun would probably go to completion in a very short time and the sun would explode, rather than produce energy at a steady rate. The small kinetic energy of nuclei in the sun has the consequence that nuclear reactions take billions of years to go to completion.

It is, of course, of interest to find put which specific nuclear reactions supply the energy of the sun. While there are numerous reactions which might. in principle, be considered, practically all of them were eliminated as the actual source. Some reactions would proceed too rapidly and result in burning up the nuclear fuel too quickly. Other reactions, in which heavily charged nuclei participate, proceed so slowly that they could not produce sufficient energy. In 1937 H. Bethe and others discussed this question and arrived at the conclusion that there are two series of reactions which jointly or separately may explain the behaviour of the sun and the stars. One of these series is the following: a proton collides with a C^{12} nucleus and is captured: the capture process is accompanied by the emission of y-rays; the resulting N^{13} nucleus is β-active and transforms into C^{13}; a second proton collides with the C^{13} nucleus and is captured, again emitting y-rays; by this process a stable N^{14} nucleus is formed; the latter captures a proton, emitting the capture energy as y-rays; an O^{15} nucleus results; this nucleus is β-active and transforms to N^{15}; finally a collision of a proton and N^{15} gives rise to C^{12} and an a-particle. This series of reactions can be summarized in the following formulas:

$$C^{12}+H^1\rightarrow N^{13}+\gamma$$
$$N^{13}\rightarrow C^{13}+e^+$$
$$C^{13}+H^1\rightarrow N^{14}+\gamma$$
$$N^{14}+H^1\rightarrow O^{15}+\gamma$$
$$O^{15}\rightarrow N^{15}+e^+$$
$$N^{15}+H^1\rightarrow C^{12}+\alpha.$$

It will be noted that as a result of the series four hydrogen nuclei have disappeared and one helium nucleus has been formed. The original C^{12} nucleus has been reproduced at the end of the reactions. Apart from the energy released in y-rays and kinetic energy, the net reaction can be written:

$$4H^1\rightarrow He^4+2e^+.$$

Indeed, hydrogen and helium seem to be the most abundant constituents of the sun. We have seen in earlier discussions that the building up of the helium nucleus releases more energy per unit mass than any other type of nuclear reaction. Thus the proposed mechanism employs the most abundant materials in the sun in the most effective manner.

The other series of reactions is the following:

$$H^1+H^1\rightarrow H^2+e^+$$
$$H^2+H^1\rightarrow He^3+\gamma$$
$$He^3+He^3\rightarrow He^4+H^1+H^1.$$

The net result is the same as in the previous series, namely the transformation of four protons and two electrons into a helium nucleus.

UTILIZATION OF THE ENERGY OF THE NUCLEUS

The release of nuclear energy for practical purposes may be classified as controlled or explosive. Both historically and technically the two aspects are closely connected. Nuclear explosives were a key factor in the great armaments race among the major powers which began at the end of World War II. Consequently, a full account of all important developments was often available to the general public only a considerable time after they occurred. Quantitative information was in general withheld if it had any bearing on the design of weapons. However, by the time of the Geneva Conference on the Peaceful Uses of Atomic Energy in 1955, all essential information then available on the nonexplosive release of energy by fission had been published. The processes involved may be described as follons.

If a uranium or thorium nucleus is hit by a neutron of appropriate energy nuclear fission results with considerable probability (see section on nuclear reactions). The two approximately equal fragments into which the nucleus separates carry a total energy of almost 200 Mev in the form of kinetic energy. Some of the energy released is present as internal energy of the fragments and a part of this internal energy splits neutrons off these fragments.

As a result of each fission process a few neutrons are obtained in addition to the fission fragments. These neutrons can enter further heavy nuclei. they cause fission and give rise to more neutrons. In each one of the steps the neutrons are multiplied. This results in a rapid increase in the total number of fissions and leads, nithin a short time. to a number of neutrons and a number of fissions comparable with the number of nuclei in the available material.

The multiplication of neutrons and the corresponding multiplication of fission processes is called a chain reaction. This repeatedly branching chain of reactions makes it possible that starting with a few neutrons one may end with so great a number that a substantial fraction of the myriads of nuclei is eventually involved in the process.

The simple type of chain reaction described here explains the functioning of the atomic bomb. When this reaction is initiated in an appropriate piece of material, energy is released so rapidly that a violent explosion results. In explosions carried out so far the energy released is equivalent to that produced by many thousands of tons of T.N.T. Fortunately none of the materials occurring in nature is capable of supporting a simple chain reaction that would give rise to an "atom bomb" type of explosion. In both thorium and ordinary uranium an additional reaction exists which competes with the fission process and renders the process harmless. This competing process is the absorption of **a** neutron in thorium or U^{238} according to the reactions:

$$Th^{232}+n\rightarrow Th^{233}+\gamma$$
$$U^{238}+n\rightarrow U^{239}+\gamma.$$

In order to produce atomic bombs materials are needed in which competing processes do not occur. Such a material is U^{235}, an isotope which occurs in the natural mixture of uranium with an abundance of 0.7%. Separation of this isotope from naturally occurring uranium was carried out on a large scale in the United States during World War II.

Another material which can support a simple chain reaction and which can be used in atomic bombs is Pu^{239}. Plutonium is an element which carries two more charges than uranium and is the first element that has been artificially made and handled in considerable quantity. Plutonium is obtained from the abundant isotope of uranium, U^{238}. As mentioned above, neutron bombardment transforms this element to U^{239}. This material by two successive β-decay processes becomes Pu^{239}. The latter material was also produced in the United States during World War II.

Energy of the fissionable materials may also be released in a steady manner without any explosion. In order to accomplish this, the energy released in the fission processes must be removed by heat conduction. The energy which has been conducted can then be utilized as a source of power. The excess neutrons created in the fission process must also be absorbed so that instead of a multiplying chain reaction there is a chain reaction in a steady, self-sustaining state. In the process of neutron absorption frequently artificial radioactive products are generated which can be used in research and for medical purposes.

Up to the mid-19 jos, the use of nuclear reactors in producing activities for research had been perhaps of greatest importance. This usefulness is due to the fact that a radioactive atom has precisely the same chemical behaviour as its known radioactive counterparts or isotopes. Thus a radioactive carbon or sulphur atom will behave precisely in the same way as a normal carbon or sulphur atom. Because of its activity, however, it can be easily discovered in the most minute quantities. Thus, one can trace the path of substances introduced into a living system or into a piece of machinery throughout its passage and incorporation in the system.

There is no difficulty in constructing a reactor in which the neutron population remains steady. In order to accomplish this, the neutrons produced in fission must be disposed of either by absorbing them in other nuclei or by allowing them to escape through the surface of the system. In every case one will construct the chain reacting system in such a way that the ratio between neutron loss and neutron gain can be regulated. The regulation can be achieved by lowering into the reactor a neutron-absorbing substance such as a rod containing boron. Neutrons are then consumed in the reaction

$$B^{10}+n\rightarrow Li^{7}+He^{4}.$$

When the system starts to operate there are only a few neutrons around, produced by the cosmic rays or other causes. The neutron-absorbing substance is then withdrawn so that the neutron loss becomes less than the gain of neutrons caused by fissions. The neutrons start to multiply and soon the neutron density and the rate of fission reaches the level at which the system is to be operated. At this time the neutron-absorbing rod is reinserted to an extent that neutron absorption and neutron production are just equal. When the operation of the system is to be shut off, the neutron-absorbing substance is pushed in farther so that the neutron loss exceeds neutron production. The number of neutrons then decreases to the small value that it had originally.

The rate at which such a system releases energy is proportional to the neutron density. The density, in turn, may be regulated at will by choosing the instant at which the neutron-absorbing material is reinserted into the pile and the increase in neutron density is stopped. From a practical point of view the rate of energy release is limited, however, because it is possible to carry out of the system a limited amount of energy in the form of heat. If more energy is produced than can be carried away, this results in an increased temperature of the entire system. As a consequence the system may shut itself off or, failing to do this, may blow up. The main problem to be solved is, therefore, not the production of energy but its control and utilization.

The regulation of the level at which the neutron density is to be kept is greatly facilitated by the fact that some of the neutrons are produced in the fission process with some delay. The delay results from the fact that some fragments of fission undergo a β-decay before they emit a neutron. The lifetime of such a β-decay process ranges from a second to a minute and neutrons are emitted with delays of corresponding duration. These delayed neutrons are utilized in operating the chain reacting system. The system is operated under such conditions that the neutrons produced instantaneously in the process are slightly fewer than the neutrons absorbed or otherwise lost in the system. Under the circumstances' the reacting system always has to wait for these delayed neutrons in order that effective neutron multiplication can take place. The multiplication of neutrons is thus slowed down and there is plenty of time to adjust the neutron-absorbing material when the neutron density and energy production approach the desired values, or when there is an excessive increase in power production.

It is possible in principle to construct chain reacting systems of rather small extension and small weight. Nevertheless, there are serious problems in the practical use of such energy sources, although their lightness and power would be highly desirable in aircraft. The reason is that the fission process and also later nuclear processes accompanying it emit considerable amounts of radiation in the form of neutrons. β-rays and y-rays. Ii these were allowed to escape everyone who approached the chain reacting machine would be killed. The system must be surrounded with an absorbing shield which is thick enough to reduce these dangerous radiations to an exceedingly small fraction of their original intensity. In order to achieve this purpose the shield must be heavy. This sets a severe limitation on the use of nuclear energy in machines that are small and easily moved. It is nevertheless expected that nuclear energy will prove extremely useful. While the apparatus which produces energy is of necessity both heavy and bulky, once it is set up it can function for a long time without being supplied with additional nuclear fuel. In the long run added fuel will be needed but the weight of the raw material is completely negligible compared with the weight of the coal needed for the same energy production. Thus nuclear power plants are independent of heavy raw materials. At the same time they will be more easily constructed than hydroelectric plants.

The materials which can be most easily used in constructing nuclear power plants are the same as those needed for the atomic bomb. They are the materials in which nuclear fission occurs with greatest ease without too many competing processes which absorb neutrons. It is also possible to build up a nuclear power plant using only common uranium, a substance which cannot be used in atomic bombs. The reason for this is the following. Ordinary metallic uranium cannot sustain a nuclear chain reaction because more neutrons are absorbed in the isotope, U^{238}, than are produced by fissions in both isotopes. Neutron multiplication can be obtained if some appropriate material, such as carbon, is added to the system. The neutrons produced in fission are slowed down by repeated collisions with carbon nuclei. Finally the neutrons are transformed into thermal neutrons and the slowing down process ends. The U^{235} reacts preferentially with these slowed-down neutrons. In spite of the fact that U^{235} is present in the normal isotopic mixture to an extent of 0.7%, successful collisions between slow neutrons and U^{235} become frequent enough to give rise to a sufficient number of fissions and an excess of neutron production. The processes 'described need only common materials like uranium and carbon, but the neutron excess obtained in this way is small and losses must be carefully avoided. Such neutron losses always occur at the surface of the chain reacting system. These surface losses can be reduced by making the machine bulky.

If a chain reacting system is built up from ordinary uranium many of the neutrons produced are absorbed in the abundant U^{238}. The resulting U^{239} decays into Pu^{239}, a material which is usable in more convenient plants and also in atomic bombs. It should be noticed that every process of useful atomic energy production is closely connected with the destructive use which can be made of this great energy source.

In contrast with the situation for the release of energy by fission, information on the energy release by fusion was not fully available in the mid-1950s. The very existence of systematic attempts to make hydrogen bombs in the U.S. was not public knowledge until late 1949. In early 1950, Pres. Harry S. Truman ordered a full-scale attack on the problem. The exceedingly high temperatures necessary for the thermonuclear reactions made laboratory experiments difficult. The most readily available method for producing such temperatures was to explode an ordinary fission bomb. This was done in the tests in the spring of 1951. The resulting measurement of the rates of reaction together with intensive theoretical work and some imaginative innovations of design made possible actual tests of weapons in 1952 and later. A test of an apparently similar type of weapon was reported in the U.S.S.R. in 1953, and a British hydrogen bomb test was performed in 1957. There are two features of these weapons which have received considerable public attention. The first is their great energy release: they are rated as megaton weapons; *i.e.*, equivalent to several millions of tons of T.N.T. on a scale such that the first atomic bombs exploded over Japan were 20,000-ton weapons. The second is the very large quantity of fission product radioactivity they release.

The existence of systematic attempts by the U.S. and Great Britain to produce controlled thermonuclear reactions on earth was first announced at the Geneva conference in 19jj. The problem is one of considerable difficulty because the extraordinarily high temperatures required make it hard to confine the reaction to a region of space.

HIGH-ENERGY EXPERIMENTS ON NUCLEI

The construction of a variety of high-energy particle accelerators and the considerable improvement in particle detection techniques in the decade after 1945 made possible a number of important experiments.

The primary purpose of many of the experiments was the search for new elementary particles and the systematic study of their properties. Once the characteristics of the new particles had been established. the experiments often could give information on nuclear structure. The study of π and μ mesons illustrates this situation. When a negative π or μ meson is slowed down in solid matter, it usually will form a mesic atom. Such atoms have nuclei like those of ordinary atoms, but a negative meson moves on a Bohr orbit around the nucleus. The orbits of the meson are smaller in size than the corresponding electron orbits by the ratio of the electron to meson mass and their binding energy is larger by the inverse of that ratio. Just as in ordinary atoms, a transition from one Bohr orbit to another results in the emission of a photon. (In heavy elements and for the larger Bohr orbits photon emission by the meson is less probable than the Auger effect, in nhich the energy released by the transition is transferred not to a photon but to one of the electrons of the mesic atom.) Because of the higher binding energy of mesons. the most energetic photons emitted by π and μ mesons in light atoms such as carbon and beryllium are X-rays rather than visible light. In the case of the a meson. these mesic X-rays can be measured accurately by comparing them with X-rays emitted in electron transition in medium heavy elements. Such measurements led to a precise determination of the a meson energy level separations. and indirectly to a very accurate measurement of the π meson mass. In fact, the measurements were so precise that it was possible to detect small deviations from Coulomb's law for the electric force betn-een nucleus and the a meson. These deviations had been predicted as early as 1934 on the basis of the quantum theory of radiation. but had previously not been supported by such direct and clear-cut evidence. In the case of μ mesons, it was the heavier μ mesic atoms which were studied mostly at first, and the results, together with those from electron scattering by nuclei. led to a much more accurate picture of the distribution of charge in the nucleus (V. Fitch and J. Rainwater. 1953). It turned out that for heavy elements the radius (actually square root of the average value of the square of the radius) of the charge distribution was given by $r = r_0A^{1/3}$ where r, $= 1.2 \times 10^{-13}$ cm. This result was in contrast with earlier estimates of the radius which had given r_0 between 1.3 and 1.5×10^{-13} cm.

The "small" value of r_0 was confirmed by the study of electron scattering by nuclei (R. Hofstadter and coworkers. 1953), in experiments which eventually led to a quantitative determination of the shape of the charge distribution. The difference in the values of r_0 just mentioned is not a discrepancy; the nucleus has a different apparent radius depending on what method is used to look at it. The larger values are obtained from such methods as fast neutron scattering in which the finite range of interaction of nuclear forces makes the nucleus appear larger.

Another discovery in elementary particle physics which made possible an entirely new kind of insight into nuclear structure was that of the so-called .I-hyperfragments (M. Danysz and J. Pniewski. 1953). These are nuclei in which a neutron or proton is replaced by a Λ^0 particle. The resulting system lasts about 10^{-10} sec., which is the time it takes a free Λ^0 to decay into proton and π-meson. The great virtue of the Λ^0 from the point of view of the study of nuclear structure is that the Pauli principle does not restrict the states a single Λ^0 can occupy in a nucleus formed of neutrons and protons.

Another discovery came out of experiments using proton beams of 100–400 Mev energy. It was found that those protons which are scattered without loss of energy are very strongly polarized; *i.e.,* the scattered protons have spins almost all of which point to one side of the plane determined by the line of flight of the incident and scattered proton. On the other hand, for incident proton energies of 10 Mev the polarization effect is very small. Similar effects were found for neutrons. This remarkable polarization of high-energy particles made possible a series of important investigations on the spin dependence of nuclear forces.

The importance of high-energy investigations for nuclear physics was emphasized with the discovery of the antiproton (O. Chamberlin and coworkers. 195j). 'The existence of this psrticle as well as the very probable existence of the antineutron n-as indispensable for the consistency of nearly all then existing attempts at a fundamental theoretical interpretation of nuclear properties. It was somewhat comforting to the theoreticians. whose attempts (since 1935) at a quantitative theory of nuclear forces had been pretty nell frustrated, to find that after all one of their basic ideas was correct. In any case. the interaction of antiprotons and antineutrons nith nuclei provides another very important piece of evidence about the nature of nuclear forces.

(E. Te.; M. L. A.; A. S. Wn.)

NUDISM. This article deals with the conscious, intentional movement to practise nudity without separation of the sexes which commenced at about the beginning of the 20th century in the German *Nacktkultur* ("naked culture") groups. Prior to World War I they consisted largely of middle-class persons of rather strong nationalistic tendencies. Between the two world wars, the movement expanded considerably not only in membership but in its range of opinions. extending from the most conservative to the most radical. Several books and magazines describing, and some of them advocating, nudism were published.

Mainly following the German example, nudist societies were formed in England, France, Scandinavia and a few other European countries. During the 1930s similar societies were formed in the United States and Canada. The nudist movement was hindered by World War II. It has not made much progress in most of the Roman Catholic and Latin countries.

Nudist groups have been organized as membership societies or as proprietary enterprises. They have dreamed and talked of self-sustaining agricultural and industrial colonies in a suitable environment which would adopt the simple manner of life and humanitarian democracy of nudism. Such colonies as enclaves in a predominantly clothed society are hardly feasible. For the immediate future only private terrains for leisure time and recreational use are practicable. The next step may be the setting aside of some of the public baths and parks for nudist use, as has been done in a few German cities.

Prevailing moral conventions, legalized in many jurisdictions, render it difficult, especially for women, to join nudist organizations. While census enumeration of extra-legal groups is not possible, there are probably not more than several hundred thousand such members in the nhole world. There is perhaps a somewhat larger number who practise nudism in small family and private groups.

The Rationale of Nudism. — Man originated as a nude animal, perhaps covered with fur. The habit of clothing the body has varied greatly in time and place. The need for protection from cold climate and from harmful animals and plants, and decoration of the body produced various types of garments.

Cultural evolution gave rise to secondary reasons for clothing. Wealth and property rights attached a symbolic meaning to dress. The garb and ornamentation became indicative of rank and wealth. The apparel has often had a ceremonial and ritual significance. Property rights in women emphasized the concealment of the female body. These factors led to powerful dress conventions, and often to ridicule and persecution of unconventional raiment, and especially of the nude body.

There arose the belief that it is immodest and indecent to expose the human. and especially the female. body, and the sexual organs of both sexes. Shame has usually been experienced at violations of these conventions as to clothing and penalties have been imposed upon such violations.

The nudist movement is a reaction against these dress conventions Nudists have argued that clothing cuts off the human body from the air and sunlight, and that the practice of nudity is beneficial for health, and thereby improves human beauty. It aids the rearing and education of the young by acquainting and accustoming them to the sexual traits of both sexes, whereas concealment of the body from infancy creates many harmful mental complexes.

Under society's conventions nudity is forcibly and gratuitously associated nith sex in the youthful mind. The practice of nudism aids sex education, is the best preparation for mating and marriage, and is a powerful eugenic factor by uniting the healthiest human beings.

Its advocates hold that nudism creates a higher standard of sincerity and frankness between the sexes! by removing the last artificial barrier. It helps to destroy the notion that sex is peculiarly. and perhaps perilously, mysterious and harmful. especially in women. It weakens sex segregation and strengthens human solidarity. It encourages comradeship between the sexes in work and play, and emphasizes the disutility of clothing in many respects.

Nudism has been criticized and attacked from somewhat different points of view. On the one hand, it is alleged that the sexual areas. such as the pubic hair, the female breasts and the masculine reflex, namely, the penile erection, arouse sexual emotions (in public) and are therefore indecent and unfit to be seen.

On the other hand, it is asserted that the art of dress conceals much ugliness, and enhances the variety and beauty of human existence. Furthermore, nudism, by complete exposure, is accused of decreasing visual sex stimulus, though tactile, olfactory, auditory and gustatory stimuli may be increased. Nudism is therefore alleged to be puritanical and ascetic.

The argument against nudism that the human body, or any part of it, is indecent in the sense that it necessarily and almost inevitably arouses passionate feelings, especially in the male sex, is refuted by nearly every observer of nudist practices. Shame, or a painful consciousness of guilt at the sight of the body, disappears almost immediately. This demonstrates that it is due to artificial modesty caused by prevailing conventions of dress, and is not inherent.

Nudists hold that the movement has psychological and sociological significance for the education of the young and the relations between the sexes, and that it may aid the spread of democracy by eliminating status symbols and artificial insignia of inequality.

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NUER, a Nilotic people, some 300.000 in number, who live in the marshy and savanna country on both banks of the Nile in the southern Sudan. They are a cattle people, devoted to their herds, although milk and meat must be supplemented by the cultivation of millet and the spearing of fish. in which the many rivers! streams and lakes of their country abound. Since the land is flooded for part of the year and parched for the rest of it, the people lead a transhumant life, spending the rainy season in permanent villages built on the higher ground and the dry season in riverside camps where there are water and pasturage even at the height of the drought.

Politically, the Nuer form a group of tribes. There is little unity and much feuding within a tribe; the frequent homicides are settled. if they are settled at all, by payments of cattle etiected through the mediation of a priest of the leopard skin. Such unity as they display is partly due to the fact that each tribal territory is owned by one or other patrilineal clan. The members of a clan have in their territory a slightly privileged status, although they form a minority of its population. The majority belong to other clans or are descendants of the neighbouring Dinka people, large numbers of whom have been subdued by the Nuer and incorporated into their society.

In each tribal area the men are divided into six age sets. A boy is initiated into his set at puberty with various rites, including the cutting of six deep cuts, running from ear to ear, across his forehead. All boys initiated during a period of about six years belong to the same set. Then there is a four-year interval during which no initiations take place, at the end of which a new age set is formed.

Marriage, which is polygynous, is marked by the giving of cattle by the bridegroom's people to the bride's kin, both paternal and maternal, and by betrothal and wedding ceremonies. The levirate is practised; and since it is held that every man must have at least one male heir, it is the custom for a man's kin to marry a wife to his name and to beget children by her should he die unmarried.

The Nuer clans are composed of lineages to which the Nuer attach great importance, and everyone knous his exact genealogical relationship to every member of his lineage and clan. Apart from these agnatic relationships, they attach importance also to kinship ties through their mothers and to affinal ties, and a Nuer can establish a kinship link of one sort or another with most of the people he meets.

The Nuer may be said to be a very religious people. They pray and sacrifice beasts of their flocks and herds to a spirit associated with the sky, but also thought to be ubiquitous, like the air. This spirit is conceived of as a single creative spirit in relation to mankind as a whole, but it is also figured in different representations in relation to different social groups, such as clans, lineages and age sets, and it may then be symbolized by material forms, often animals or plants. See also NILOTES.

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NUEVA ECIJA, an agricultural province in central Luzon, Republic of the Philippines, drained by the Pampanga river. Area 2,120 sq.mi. Pop. (1948) 467,769 (1959 est.) 573,040. The eastern part of the province is mountainous but the central and western portions are a part of the level central plain of Luzon. It is the leading rice producing province (in tonnage). Other crops are sugar cane. tobacco, corn, onions and other vegetables. Cabanatuán, pop. (1959 est.) 66,971, on the left bank of Pampanga river, is a chartered city, the provincial capital, and the center of commercial activity. The western part of the city is primarily commercial (theatres, shops, rice mills, etc.); the eastern part is the site of the government buildings, provincial hospital and schools, but has some commercial activity.

The principal towns are San José, Gapán, Cuyapo and San Antonio. After World War II, Nueva Ecija became the principal centre of dissident activities by the rebellious Hukbalahaps. (AN. C.)

NUEVA ESPARTA, a state in Venezuela, consists of about 70 islands and cays extending for a distance of some 320 mi. along the Caribbean coast. Area 444 sq.mi. Pop. (1950) 75,899, of which about 95% lived on Margarita Island (*q.v.*), the largest and most important of the group.

The capital of the state is La Asunción. The state has important fisheries; 75% of Venezuela's commercial catch takes place in the northeastern area, of which Nueva Esparta forms a major segment. Pearl fishing is important but less so than in the past. There is a small amount of agriculture and a few handicrafts—hammocks, straw hats, pottery and roof tiles. (L. WE.)

NUEVA SAN SALVADOR: see SANTA TECLA.

NUEVA SEGOVIA, a small department of Nicaragua, in the central highlands adjacent to Honduras. Area 1,593 sq.mi. Pop. (1950) 27.078. of which 80% was rural. The largest town and departmental capital is Ocotal, pop. (1950) 2,672. Most of the population is in highland basins and valleys in the central part of the department; the remainder of the department is very sparsely settled, owing to rugged relief, poor soils and lack of transportation facilities.

The settled basins and valleys, some with fertile volcanic soils, produce coffee, livestock, corn, wheat, vegetables and subtropical fruits. A second class road, 1j mi. long, connects Ocotal with the Inter-American highway. (C. F. J.)

NUEVA VIZCAYA, a province of the Republic of the Philippines, in north central Luzon. Area 2,627 sq.mi. Pop. (1948) 82.718; (1959 est.) 101,330. At the junction of the Sierra Madres and the Central Cordillera, it is principally mountainous terrain and is drained by the headwaters of the Cagayán river and its longest tributary, the Magat.

Agricultural products are rice, corn, tobacco, coconuts and livestock. The capital is Bayombong, pop. (1959 est.) 17.246. Solano, Bambang. and Bagabag are other principal towns; all four are in the Magat valley. (AN. C.)

NUEVO LAREDO, a border city in the Mexican state of

Tamaulipas. across the Rio Grande from Laredo, Tex. Pop. (1950) 57,669. The town has a bullring and some night life for the visiting tourist. Irrigation of the contiguous area by waters from the Rio Grande brought some growth and wealth to the city in the 1950s. At Nuevo Laredo begins the highway leading to Mexico City (757 mi.) via Monterrey. northern Mexico's industrial centre. Ciudad Victoria, and Ciudad de Valles.

The railway from San Antonio to Mexico City also passes through Nuevo Laredo. The city is a cattle and oil centre of growing importance. (J. A. Cw.)

NUEVO LEON, a northern state of Mexico. Pop. (1960) 1,063,399. Area, 25.136 sq.mi., with its capital at Monterrey (*q.v.*). Crossed by paved trunk highways and railways between Laredo, Tex., the gulf port of Tampico, and Mexico City. the state is a major industrial section and an important agricultural region lying just north of the Tropic of Cancer. With an average altitude of about 5,500 ft., the Sierra Madre Oriental runs southeasterly through the state.

The climate is arid and semiarid in the north, where sandy wastes are covered with cactus and scrub. The eastern slopes are endowed with vegetation, and the mountainous sections are covered with forests; subtropical valleys in the east permit sugarcane cultivation.

There is considerable irrigation. Though there are a number of rivers and streams, none is navigable. Water for irrigation is in part drawn from the international Falcón dam. jointly constructed by Mexico and the United States for hydroelectric power, flood control and agricultural purposes.

Nuevo León produces few minerals, but quantities of cotton, citrus, sugar, cereals (especially maize and wheat) and vegetables. Its fibres have importance, notably *ixtle* from agaves (cactus), which also furnish distilled liquor, mescal. The main importance of Nuevo León lies in its industries. Its iron- and steelworks and smelting plants mere the first heavy industry in Latin America, and in addition it supports numerous textile enterprises, a large beer factory, and other industrial activities.

Nuevo León became a state in 1824. It was occupied by U.S. forces in the Mexican War. The state has no Indian population and its standard of living is near the highest in Mexico. It has well developed air connections and good schools, colleges and hospitals. (J. A. Cw.)

NUFFIELD, WILLIAM RICHARD MORRIS, 1ST \:ISCOUNT (1877–). British automobile manufacturer, nas born Oct. 10, 1877, at St. John's, Worcester. He began work in a cycle repair shop and shortly set up his own business, which included making motorcycles.

In 1912 he began producing the Morris Oxford car, which became extremely popular. Morris put together a huge organization comprising a large number of motor vehicle manufacturers, and was chairman of the British Motor corporation (created by merger of Morris Motors Ltd. and the Austin Automobile company) when he retired in 1952. He was raised to the peerage in 1934 and created viscount in 1938.

Well known as a philanthropist, Lord Nuffield was responsible for creating the Nuffield Trust for Advancement of Medicine, the Nuffield Institute of Medical Research (at Oxfordj, the Dominion Scholarships fund, and Nuffield college at the University of Oxford. He established a charitable trust, the Nuffield foundation, in 1943 and endowed it with Morris Motors, Ltd. stock valued at £10,000,000. (H. J. SG.)

NUISANCE, that which gives offence or causes annoyance, trouble or injury. In English law nuisance is either public or private. A public or common nuisance is defined by Sir J. F. Stephen as "an act not warranted by law, or an omission to discharge a legal duty. which act or omission obstructs or causes inconvenience or damage to the public in the exercise of rights common to all His Majesty's subjects" (*Digest* of *the Criminal* Law). *A* private nuisance is an act or omission which causes inconvenience or damage to a private person. There must be some sensible diminution of these rights affecting the value or convenience of the property. "The real question in all the cases is the question of fact, whether the annoyance is such as materially to interfere with the ordinary comfort of human existence" (Lord Romilly in *Crump* v. *Lambert,* 1867, L.R.3 Eq. 409). A private nuisance, differing in this respect from a public nuisance, may be legalized by uninterrupted use for 20 years.

The remedy for a public nuisance is by information, indictment. summary procedure or abatement. An information lies in cases of great public importance, such as the obstruction of a navigable river by piers. In some matters the law allows the party to take the remedy into his own hands and to "abate" the nuisance. Thus, if a gate be placed across a highway, any person lawfully using the highway may remove the obstruction, provided that no breach of the peace is caused thereby. The remedy for a private nuisance is by injunction, action for damages or abatement. An action lies in every case for a private nuisance; it also lies where the nuisance is public, provided that the plaintiff can prove that he has sustained some special injury. In such a case the civil is in addition to the criminal remedy. In Scotland there is no practical distinction between public and private nuisances, the remedy against either being interdict or damages. The law as to what constitutes a nuisance is substantially the same as in England.

There is a list of statutory nuisances in the Public Health (Scotland) Act 1867, and amending acts. The American law on the subject is practically the same as the English law.

NULLIFICATION (STATE INTERPOSITION) was a doctrine that asserted the right of a state in the American federal union to prevent within its borders the enforcement of an act of the federal government not authorized by the G.S. constitution as interpreted by the highest legislative authority of the state. The doctrine reached its most advanced point of theoretical development and application in 1832 in South Carolina. The best explanations of nullification are to be found in the writings of John C. Calhoun (*q.v.*), who may have promulgated the doctrine in order to forestall a secession movement in his state. Calhoun and his precursors, who had produced in South Carolina an incipient form of the doctrine, disclaimed originality for their basic ideas, arguing that they were derived from Jefferson's Kentucky resolutions of 1798, Madison's Virginia resolutions of 1798 and report of 1799, and the Kentucky resolutions of 1799.

The resolutions that Jefferson drafted for the Kentucky legislature in 1798 asserted that the constitution of the United States was a compact subscribed to by the states, which had delegated specific powers to the federal government and retained all others; "that the government created by the compact mas not made the exclusive or final judge of the extent of the powers delegated to itself"; and that the states could declare null and void within their boundaries'those acts that they deemed not authorized by the C.S. constitution.

Although the Kentucky resolutions of 1799 used the word nullification and referred to the states as sovereign and independent, they were not incompatible with the view of Madison and others among his contemporaries that sovereignty in the United States was divided between the federal and state governments. Neither Jefferson nor Madison repudiated the view generally held by the framers of the constitution that the federal judiciary possessed an implied power to pass upon the constitutionality of federal and state legislation, but they denied that the states must accept its decisions as final in all cases.

Calhoun's view of the judiciary was the same as Madison's, but he rejected unequivocally and explicitly the theory of divided sovereignty. He based his interpretation of nullification on the premise that each of the states was completely sovereign, and as such, when acting through a special convention capable of ratifying the U.S.constitution or revising the state constitution, could either nullify an unconstitutional federal act or withdraw from the union.

Calhoun's most distinctive contribution to the theory of nullification was his rationale of it as an integral part of the American system of government, with aims that were positive, conservative, peaceful and national. For Calhoun, nullification was the means by which a minority in the nation, if it happened to be in the majority in a single state, could utilize a state government to force the national majority either to compromise with the minority by consenting to a revision of federal legislation or to obtain a constitutional amendment that would grant an undisputed authority to the federal government to overrule the constitutional opinion of the nullifying state. He expressed confidence that the practical outcome of nullification mould be compromise or constitutional amendment, for, he argued, the national majority would surely prefer peaceful and orderly procedures to the alternatives of anarchy or civil war.

What happened in South Carolina and the national capital in 1832 and 1833, he could reasonably interpret as a vindication of his expectations. In Nov. 1832 a special state convention in South Carolina, taking the position that the delegated power of congress to levy imports was intended solely for the purpose of raising revenue and for no such purpose 'as encouraging manufactures. declared the tariff laws of 1828 and 1832 unconstitutional, announced that they would become null and void in the state after Feb. 1. 1833. and warned that secession would be the consequence of federal coercion.

On Dec. 10, 1832, Andrew Jackson issued a presidential proclamation denouncing and refuting the doctrine of nullification, and in Jan. 1833 a bill was introduced in congress authorizing the president to use force to collect import duties. However, the same congress that had passed the tariff bill of 1832 in June and that was to approve the Force bill adopted the compromise tariff of 1833 on March 1. From Calhoun's standpoint, South Carolina's action had forced representatives of the national majority in congress to reconsider and to compromise with the minority.

Never in U.S. history has nullification. as it was expounded by Calhoun, been tested in all of its ramifications. although, before 1865, one of its strands or another was present in numerous federal-state disputes.

In South Carolina. the one state where an ordinance of nullification was approved by a special state convention, the controversy was settled before attempts were actually made to stop collection of import duties.

Following the supreme court decision in the case of *Brown* v. *Board of Education* (1954), declaring racial segregation in the public schools to be unconstitutional, nullification was once again discussed in the south by defenders of segregation. but no state government chose to imitate what South Carolina did in 1832. Instead, the course generally followed was to adopt state-interposition resolutions similar to the Virginia resolutions of 1798 and to avoid compliance wherever and whenever litigation, evasive legislation or an absence of federal-court decrees would permit.

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NULLITY OF MARRIAGE, a judicial declaration that a marriage was null and void ab *initio* (from the beginning). In the 12th century the Roman law doctrine of nullity of marriage mas developed in order to deal with hard cases under the principle of the indissolubility of marriage laid down by the Church of Rome, whose canons at that date governed the matrimonial law for the whole of Christendom. Nullity could be sued for on the grounds of affinity, into which the law of adoption entered very largely, or a previous unconsummated marriage, which latter was a ground for nullity in England as late as 1750. There were, and continue to be in Roman Catholic countries, various other grounds for nullity, but the grounds of nullity in England are at present limited to the following: (1) Where the parties are not by reason of age (14 for a male and 12 for a female), mental capacity, or otherwise, capable of contracting marriage; (2) where the parties are within the prohibited degrees of affinity or relationship; (3) where one of the parties is already married; (4) where one of the parties does not freely consent to marry the other or does not understand the nature of the contract or ceremony; (5) where certain forms have not been observed; (6) where the form of marriage is essentially polygamous. Forms of marriage which offend against these rules are void ab *initio.* If at the time of the marriage one of the parties is and continues to be incapable of consummating the marriage by reason of some incurable physical defect, or of some incurable mental disability on the part of the man preventing him from consummating the marriage, or on the part of the woman resulting in her refusal of marital rights, the marriage may be annulled on the petition of the other party. A person may claim as a ground of nullity that he or she was insane at the time of the marriage. For the prohibited degrees of affinity see MARRIAGE.

The Royal Commission on Divorce which reported in 1913 recommended the following additional grounds of nullity of marriage: (1) When the other party, though of sufficient understanding to consent to a marriage, is at the time of the marriage either of unsound mind in other respects, or in a state of incipient mental unsoundness which becomes definite within six months after marriage, and the first party is at the time of the marriage ignorant of the defect, provided that (a) the suit is instituted within a year of the celebration of the marriage; (b) there has been no marital intercourse after discovery of the defect; (2) where the other party at the time of the marriage is subject to epilepsy or to recurrent insanity, and such fact is concealed by such party or his or her parents or either of them, or by anyone who has control over such party and is aware of the intended marriage, and the first party remains ignorant of the fact at the time of the marriage, subject to the same limitations for petitioning as in (1) above; (3) where one of the parties at the time of the marriage is suffering from a venereal disease in a communicable form, and the fact is not disclosed to the other party; (4) where a woman is pregnant by some other man at the time of the marriage and the husband is ignorant of the fact; (j) where there has been wilful refusal. without reasonable cause to allow intercourse, and where in fact there has been no intercourse owing to such refusal. See also DIVORCE.

See W. Rayden, *Practice and Law in the Divorce Division* (2nd ed., *by* C. Mortimer, 1926); Sir L. Dibdin, *Reforinatio Legum Ecclesiasticarum,* vol. iii (1912); Report of the Royal Commission on Divorce and Matrimonial Causes (1913). (W. LA.)

United States.—Three different situations relating to the nullity of marriage must be distinguished. A marriage may in the first place be totally void. No suit is necessary for its annulment and third parties can set up the fact of its invalidity. This, for example, is generally true of a bigamous marriage. Secondly, a marriage may be voidable at the election of one of the parties. No judicial decree is in theory necessary, though it is customary to secure a judicial declaration of nullity. Nonage of a party generally permits him thus to avoid the marriage, rendering it invalid ab *initio,* but until avoided by the act of the party it is valid, and third parties have no rights to contest its validity. Thirdly, as in the cases of marriage within the prohibited degrees of affinity, a suit to annul the marriage may be essential and such suit must be brought within the lifetime of one of the parties. The decree of annulment also relates back to the time of the marriage. The chief tendencies manifested by the many statutes in this field, apart from specifying the grounds for annulment, relate to: preserving the legitimacy of children born prior to the decree of annulment; making all annulments dependent upon judicial action and, in some instances, permitting the court in its discretion to deny or withhold relief; limiting the right to sue for annulment to a short space of time after discovery of the cause for annulment; permitting courts to award alimony upon decreeing annulment; allowing the injured party to a subsisting marriage to bring suit for its annulment; permitting courts in their discretion to hold trials for annulment in camera.

The grounds for annulment commonly recognized are: bigamy, impotency, nonage, marriage within the prohibited degrees of affinity, noncompliance with an essential statutory formality, mental incapacity existing at the time of the marriage. Among grounds that are recognized in some States by legislation, though not generally recognized, are: fraud, duress or mistake in the granting of consent to marriage, wilful refusal of a party to consummate the marriage by sexual intercourse, venereal disease or other serious illness existing at the time of the marriage and unknown to the other party, pregnancy due to some third party at the time of marriage and unknown to the other party. The causes for annulment are now generally specified by statute and these vary from State to State. Wide legislative activity in this field is due to the fact that in the United States no courts succeeded to the jurisdiction of the English ecclesiastical courts. Consequently no action for annulment on grounds entertained by the English ecclesiastical courts could be maintained in the absence of statute though equity courts would entertain such actions on grounds other than the canonical disabilities. Under such a theory the intervention of the legislature became necessary and in short time legislation expanded to bring the entire field within its control. (J. M. LA.)

NUMANTIA, an ancient hill fortress in northern Spain, in the province of Soria (Old Castile), overhanging the village of Garray, near the town of Soria, on the upper Douro. Here, on a small isolated high plateau in the middle of the valley, was the stronghold which played the principal part in a famous struggle between the conquering Romans and the native Spaniards during the years 154–133 B.C. Numantia was especially concerned in the latter part of this war from 144 onward. It was several times unsuccessfully besieged. Once the Roman general Hostilius Mancinus with his whole army was compelled to surrender (137). Finally, Scipio Aemilianus, Rome's first and only general in that age, with some 60,000 men drew round the town 6 mi. of continuous entrenchments with seven camps at intervals. After 15 months (134–133) he reduced by hunger the 6,000–8,000 Numantine soldiers, much as Caesar afterwards reduced Alesia in Gaul. The result was regarded as a glorious victory, and in Roman literature the fall of Numantia was placed beside the fall of Carthage. The site was, under the Roman empire, occupied by a Roman town called Numantia, and the Itinerary tells of a Roman road which ran past it. It is a "monumento nacional" of Spain, and has yielded remarkable discoveries to the skillful excavations of Dr. Schulten (1905–1910), who has traced the Celtiberian town, the lines of Scipio and several other Roman camps dating from the Numantine Wars. (F. J. H.)

NUMA POMPILIUS, second legendary king of Rome (715–672 B.C.), was a Sabine, a native of Cures, and his wife was the daughter of Titus Tatius, the Sabine colleague of Romulus. He was elected by the Roman people at the close of a year's interregnum, during which the sovereignty had been exercised by the members of the senate in rotation. Nearly all the early religious institutions of Rome were attributed to him. He set up the worship of Terminus (the god of landmarks), appointed the festival of Fides (Faith), built the temple of Janus, reorganized the calendar and fixed days of business and holiday. He instituted the flamens (sacred priests) of Jupiter, Mars and Quirinus; the virgins of Vesta, to keep the sacred fire burning on the hearth of the city; the Salii, to guard the shield that fell from heaven; the pontifices and augurs, to arrange the rites and interpret the will of the gods; he also divided the handicraftsmen into nine gilds. He derived his inspiration from his wife, the nymph Egeria, whom he used to meet by night in her sacred grove. After a long and peaceful reign, during which the gates of Janus were closed, Numa died and was succeeded by the warlike Tullus Hostilius. Livy tells a curious story of two stone chests, bearing inscriptions in Greek and Latin, which were found at the foot of the Janiculum (181 B.C.), one purporting to contain the body of Numa and the other his books. The first when opened was found to be empty, but the second contained fourteen books relating to philosophy and pontifical law, which were publicly burned as tending to undermine the established religion.

No single legislator can really be considered responsible for all the institutions ascribed to Numa; they are essentially Italian, and older than Rome itself. Even Roman tradition itself wavers; *e.g.,* the jetiales are variously attributed to Tullus Hostilius and Ancus Marcius. The supposed lawbooks, which were to all appearance new when discovered, were clearly forgeries.

See also ROME: Ancient History.

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NUMBER means a positive integer such as 17, a real quantity such as a or -2, or an element of any of various abstract mathematical generalizations of the system of positive integers and the system of real numbers. These generalizations include complex numbers, quaternions and other hypercomplex numbers, modular numbers and transfinite cardinal and ordinal numbers; all these types of numbers will be defined below.

POSITIVE INTEGERS

Definition of Cardinal Numbers.—The concept of a positive integer arose in prehistoric times from recognition of the fact that the number of elements in any class (say the number of sheep in a herd) can be represented in various ways (say by a pile of stones). The essential idea is that there must be a one-one correspondence between the sheep in the herd and the stones in the pile. By this we mean that it must be possible to pair off one sheep with each stone, in such a way that no sheep is counted twice, and no sheep and no stones are left over.

In the same spirit, modern mathematicians define a cardinal number as a mark associated with a class, and with all other classes in one-one correspondence with this particular class. Thus, the integer 5 is the mark associated with the class of fingers on a hand and with all other classes whose elements can be paired off with the fingers on a hand.

A large variety of marks to represent the different positive integers have been developed by different civilizations. These are discussed elsewhere (see NUMERAL SYSTEMS). The positional notation developed by the Hindus and Arabs, in which the position of a digit to the left of the decimal point indicates the power of the radix or base ten involved, is incomparably superior to earlier systems. However, it is not to be supposed that the base ten has any unique qualifications. Our interest here is not in systems of notation or effective computation (see ARITHMETIC; COMPUTING MACHINES, ELECTRONIC; OFFICE MACHINES AND APPLIANCES) but in the fundamental ideas which underlie the use of number. Two of these are addition and multiplication.

Addition and Multiplication.—If a and b are the integers (cardinal numbers) for two classes A and B having no elements in common, and if these classes be combined to form a new class S, then the integer s representing the class S is called the sum of a and b, and we write $s = a + b$.

From this definition we easily prove the commutative and associative laws of addition,

$$a + b = b + a \tag{1}$$

$$a + (b + c) = (a + b) + c \tag{2}$$

Here and below the equality sign means that the classes represented by the two sides of the equation can be placed in one-one correspondence. Thus, both $a + (b + c)$ and $(a + b) + c$ represent the combination of three classes A, B, C without common elements, having a, b, c elements, respectively.

Similarly, there may be a classes, each of which contains the same number b of elements, while no two of these classes have an element in common. If all these classes are combined to form a new class P, the integer p representing P is called the product of a and b, written $p = a \times b$.

From this definition, one can also prove the commutative and associative laws of multiplication,

$$a \times b = b \times a \tag{3}$$

$$a \times (b \times c) = (a \times b) \times c \tag{4}$$

as well as the distributive law, which asserts that

$$a \times (b + c) = (a \times b) + (a \times c) \tag{5}$$

Brief further discussions of laws (1)–(5) may be found elsewhere (see ASSOCIATIVE LAWS; COMMUTATIVE LAWS; DISTRIBUTIVE LAW); formal proofs may be found in textbooks on mathematics (see G. Birkhoff and S. MacLane, A Survey of Modern Algebra, ch. xii [1953]). Informal graphical proofs follow.

For example, $a \times b$ is the number of elements in a rectangular array of a rows and b columns: rotation through 90° converts this into a rectangular array of b rows and a columns. Again, $a \times (b + c)$ is the number of elements in a rectangular array of a rows and $b + c$ columns. This array is the sum of two rectangular arrays without common elements, having respectively a rows and b columns, and a rows and c columns. This is $(a \times b) + (a \times c)$.

The laws (1)–(5) are often called the five fundamental laws of arithmetic; in addition, the special unit law

$$a \times 1 = a \tag{6}$$

is evident. Other laws also follow from a detailed logical analysis of the situation. For example, equality satisfies the reflexive law, that $a = a$; the symmetric law, that $a = b$ implies $b = a$; and the transitive law, that $a = b$ and $b = c$ imply $a = c$. Moreover, addition and multiplication are single-valued operations, so that if $a = b$, then $a + c = b + c$ and $a \times c = b \times c$. To explain the relation of such laws to our definitions, consider the statement that $a = b$ implies $a + c = b + c$. This means that if there is a one-one correspondence between two classes A and B, and if C is any class having no elements in common with A or B, then there is a one-one correspondence between the combination (sum) of A and C and that of B and C.

However, a good understanding of the laws of arithmetic is possible on the basis of (1)–(6) alone.

Ordinal or Inductive Definition.— In the last two sections the concept of a positive integer was based on the concept of a class and general principles of the logic of classes. But it is also possible to take a more formalistic view and to base arithmetic on laws (1)–(6) without referring to the idea that integers represent classes.

We must first know the order of the integers (*i.e.,* which positive integer follows which). Then if we start with the principle that $a + 1$ is the successor of a (number following a), and apply repeatedly the special case

$$a + (b + 1) = (a + b) + 1 \tag{2'}$$

$c = 1$ of the associative law, we readily get the addition table. Thus, we get $5 + 1 = 6$, $5 + 2 = 5 + (1 + 1) = (5 + 1) + 1 = 6 + 1 = 7$, etc.

Similarly, the multiplication table can be constructed ordinally from the unit law (6) and the following special consequence

$$a \times (b + 1) = (a \times b) + (a \times 1) = (a \times b) + a \tag{5'}$$

of the distributive laws (j) and (6). Thus, we get $5 \times 1 = 5$, $5 \times 2 = 5 \times (1 + 1) = (5 \times 1) + 5 = 10$, etc.

Hence, we can say that the identities (2), (5), (6) imply all the arithmetic of positive integers, since they tell us how to add and multiply any two positive integers.

G. Peano put this principle in an even more striking form about 1900. He first characterized formally the sequence of positive integers by the following postulates: (i) each positive integer n has a successor, written n^+; (ii) $m^+ = n^+$ implies $m = n$; (iii) there is just one positive integer, called 1, which is not the successor of any number; (iv) any set C of positive integers which includes 1, and which includes n^+ if it includes n, must include every positive integer. Condition (iv) is called the principle of finite induction; it is intuitively evident since C includes 1, includes $2 = 1^+$ since it includes 1, includes $3 = 2^+$ since it includes 2 and so on indefinitely. It is really used above when we state that (6) and (5') define $a \times m$ for all m.

Peano then developed the entire arithmetic of positive integers from postulates (i)–(iv), without making any other assumptions. He first constructed the addition and multiplication tables as we did above, but introducing $m + 1 = m^+$, (2′), $m \times 1 = m$ and (5′) as definitions. He then proved laws (1)–(5). The chain of reasoning involved is long (see C. C. MacDuffee, An *Introduction* to Abstract Algebra [1940]). We give here the special case $m + 1 = 1 + m$ of the commutative law as a sample. The law $1 + 1 = 1 + 1$ is evident. Assuming $1 + n = n + 1$, we have $1 + n^+ = (1 + n)^+$ by definition, $(1 + n)^+ = (n + 1)^+$ by assumption and $(n + 1)^+ = (n^+)^+ = n^+ + 1$ by definition. Hence the set of positive integers m for which $m + 1 = 1 + m$ is true includes 1, and includes n^+ if it includes n; hence, by postulate (iv), it includes every positive integer.

The other proofs make similar use of postulate **(iv).** Using it, we can further prove the cancellation laws

$$a + m = a + n \text{ implies } m = n \tag{7}$$

$$a \times m = a \times n \text{ implies } m = n \qquad (a \neq 0) \tag{8}$$

The proof of the laws of cancellation in terms of the concepts of class and one-one correspondence alone, and without the use of finite induction, is difficult for reasons which will appear later in the discussion of transfinite cardinal numbers.

Order Properties.— We can easily define the relation $a \leqq b$ in terms of classes, to mean that there is a one-one correspondence between a class A containing a elements and a subset of a class B containing b elements. In this definition, we include B as a subset of itself.

From this definition, it is easy to prove that one can add and multiply inequalities. Thus,

$$a \leqq b \text{ implies } a + c \leqq b + c \tag{9}$$

$$a \leqq b \text{ implies } a \times c \leqq b \times c \qquad (\text{if } c \geqq 0) \tag{10}$$

The restriction $c \geqq 0$ in (10), like the restriction $a \neq 0$ in (8), is added to provide for later generalizations; it is automatically fulfilled in the case of positive integers. Again, $a \leqq b$ and $b \leqq c$ imply $a \leqq c$. In addition,

for any a, b, either $a \leqq b$ or $b \leqq a$; if both hold, then $a = b$ (11)

However, the proof of this, like the proof of (7)–(8), is not easy without the use of finite induction; *i.e.,* no simple proof based on the concepts of class and correspondence is known.

Peano's definitions show that we can define addition and multiplication of positive integers in terms of the order relation. This is because m^+ is defined by the properties that $m^+ > m$, and that $n > m$ implies $n \geqq m^+$. It is curious that we can conversely define order in terms of the operation of addition. In fact,

$a + x = b$ has a solution in positive integers if and only if $a < b$ (12)

Subtraction and Division.—We have not introduced subtraction and division as fundamental operations for the simple reason that they can be defined as the inverses of addition and multiplication, respectively. Thus, the difference $a - b$ of two numbers a and b is defined as a solution x of the equation

$$b + x = a \tag{13}$$

and the quotient $\frac{a}{b}$ of a by b as a solution y of the equation

$$b \times y = a \tag{14}$$

If we restrict ourselves to positive integers, differences and quotients need not always exist (cf. $3 + x = 2$, $3 \times y = 2$), but if they do, laws (7)–(8) guarantee that they are unique.

Furthermore, the usual laws of operation, such as

$(a - b) = (c - d)$ means $a + d = b + c$

$(a - b) + (c - d) = (a + c) - (b + d)$

$(a - b) \times (c - d) = (a \times c + b \times d) - (a \times d + b \times c)$ (15)

and (see FRACTION)

$$\left(\frac{a}{b}\right) = \left(\frac{c}{d}\right) \quad \text{means } ad = bc$$

$$\left(\frac{a}{b}\right) + \left(\frac{c}{d}\right) = \frac{(a \times d) + (b \times c)}{bd}$$

$$\left(\frac{a}{b}\right) \times \left(\frac{c}{d}\right) = \frac{a \times c}{b \times d} \tag{16}$$

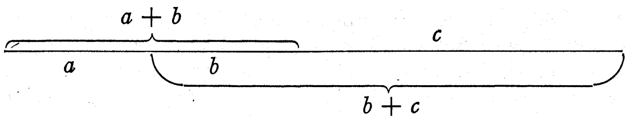
can be proved from laws (1)–(5). This is one reason why laws (1)–(5) are called the fundamental laws of arithmetic.

THE REAL NUMBER SYSTEM

Number as Quantity.— Mankind was early led to the concept of a real number by the need for symbols to represent such geometric quantities as lengths, areas and volumes and such physical quantities as weight and (more recently) electric charge.

The characteristic features of such quantities are that (1) two quantities of the same kind can be added by some obvious geometrical or physical operation (such as laying two segments next to each other on a straight line), and (2) any quantity can be divided into parts. The second feature, of infinite divisibility, is the crudest way of expressing the principle that the real number system is continuous, and not discrete like the system of positive integers.

The commutative and associative laws (1)–(2) of addition are frequently intuitively obvious from the physical definition of addition. Thus, in the case of lengths, it is obvious that $a + (b + c) = (a + b) + c$ since both represent the sum of three segments of lengths a, b, c in order on a line:



It is also obvious that $a + b = b + a$ since the segment $a + b$ can be transformed into the segment $b + a$ by rotation through 180°.

In representing geometrical or physical quantities by numbers, it is usually necessary to choose first an arbitrary unit, such as a foot, a square inch or a pound.

This unit of quantity is assigned arbitrarily the numerical value 1, and exact multiples of this quantity (*i.e.*, sums of an integral number of unit quantities) are assigned corresponding integral values. Since the entire addition table for positive integers can be constructed from the associative law for positive integers (2′), it is clear that the sum of two such quantities must be represented by the sum of the corresponding positive integers.

Multiplication; Number as Ratio.—A simple definition of the product of two quantities is not always possible. For example, if we define the product of two lengths a and b as the area of the rectangle with sides a and b, it may logically be objected that this is a quantity of a different kind.

In order to get around this logical difficulty, the Greeks suggested that a number a should be considered as representing the ratio between a certain quantity and the unit quantity, and never as representing the quantity itself. Thus, 160 lb. is a weight; the number 160 is the ratio of this weight to the weight of a pound.

This idea that numbers are dimensionless ratios has wide applicability. Thus, it leads to plausible "proofs" of the laws of multiplication. For example, the hypothesis that $a \times (b \times c) = (a \times b) \times c$ for all real numbers is given substantial support by the fact that both quantities may be regarded as respresenting the volume of a box of sides a, b, c. The laws $a \times b = b \times a$ and $a \times (b + c) = (a \times b) + (a \times c)$ can be given similar plausible geometric interpretations in terms of areas.

But these plausible arguments are not proofs in any rigorous sense. They depend not only on postulates for geometry, but also on definitions of area and volume.

The only known way of getting rid of these embarrassing difficulties is to define real numbers abstractly in terms of the system of positive integers, deducing all properties of real numbers by pure logic from these definitions and properties of the positive integers, and using geometrical and physical concepts only to suggest possible postulates and definitions. In this way the properties of real numbers may be made to depend on pure logic and the concept of a class alone (see MATHEMATICS, FOUNDATIONS OF).

We shall follow this abstract procedure henceforth.

Rational Numbers.—If we assume that division (except by zero) and subtraction are always possible, we are led inevitably from the system of positive integers to the system of rational numbers (*i.e.*, of positive and negative fractions and integers, and zero).

Thus, let us assume that every equation $by = a$ with positive integral coefficients a, b has a solution y. This corresponds to the idea that a quantity a can be divided into any positive whole number b of equal parts. Let us try also to preserve the five fundamental laws (1)–(5) of arithmetic and the cancellation law (8).

By (8), $by = a$ can have only one solution, which we write $\frac{a}{b}$. It may be shown that the usual rules (16) for adding and multiplying fractions must hold. For example, if $by = a$ and $dz = c$, then $bdy = ad$, $bdz = bc$; and so $bd(y + z) = bdy + bdz = ad + bc$, which proves that $\frac{a}{b} + \frac{c}{d} = \frac{(ad + bc)}{bd}$. We can also prove

$$\frac{\left(\frac{a}{b}\right)}{\left(\frac{c}{d}\right)} = \frac{ad}{bc} \tag{17}$$

whence division by fractions as well as by integers is positive in our new system.

Conversely, we can prove that the rules (16) do give a system in which laws (1)–(12) are valid (we let $\frac{a}{b} > \frac{c}{d}$ mean that $ad > bc$ for positive fractions); in most cases, the proof may be reduced to the corresponding law for the positive integers, by substitution in (16) and cancellation.

Similarly, suppose we assume that every equation $\frac{c}{d} + y = \frac{a}{b}$ has a solution. This hypothesis is suggested by the properties of positive and negative electric charges in physics, by the fact that distance on a straight line can be measured in two directions (right = positive and left = negative), etc.

However, it is not necessary to denote the solution of $\frac{c}{d} + y = \frac{a}{b}$ by such a complicated symbol as $\frac{a}{b} - \frac{c}{d}$. In fact, by (11), either $\frac{a}{b} = \frac{c}{d}$, $\frac{a}{b} > \frac{c}{d}$ or $\frac{a}{b} < \frac{c}{d}$. Hence, by (12), which amounts to saying that $\frac{a}{b} + \frac{x}{y} = \frac{c}{d}$ has a solution if and only if $\frac{a}{b} < \frac{c}{d}$, either $\frac{a}{b} = \frac{c}{d}$ or $\frac{c}{d} + y = \frac{a}{b}$ has a positive solution $\frac{f}{e}$, or $\frac{b}{a} + z = \frac{c}{d}$ has a positive solution $\frac{h}{g}$. Corresponding to these three cases, we write

$$\frac{a}{b} - \frac{c}{d} = 0,\ \frac{a}{b} - \frac{c}{d} = \frac{f}{e} \text{ and } \frac{a}{b} - \frac{c}{d} = -\left(\frac{h}{g}\right)$$

Moreover, instead of proving (15), we can derive the rules for operating and negative fractions and zero from

$$0 + a = a \qquad a \times 0 = 0 \tag{18}$$

and the mysterious law

$$(-1) \times (-1) = 1 \tag{19}$$

These in turn are necessary consequences of our laws (1)–(8). Thus, if we define 0 as $1 - 1$, by adding a -1 to both sides of $0 + 1 = 1$, we get $0 + a = a$. Multiplying through $0 + 1 = 1$ by a, we get $a \times 0 + a = a = 0 + a$, whence (canceling) $a \times 0 = 0$. Finally, multiplying the equation $1 + (-1) = 0$, which defines (-1), through by -1, me get $(-1) + (-1)$ X $(-1) = 0$ by (5), (6) and (18). Adding 1 to both sides, we get (19) after reduction.

A more thorough study would reveal that a considerable reduction in the number of postulates (fundamental laws needed to imply the others) is possible. Thus, all the laws for the positive fractions can be deduced from the associative law for addition, the distributive laws $a \times (b + c) = (a \times b) + (a \times c)$ and $(a + b) \times c = (a \times c) + (b \times c)$, the unit laws a X $1 = 1 \times a = a$, and $1 + 1 \neq 1$.

Irrational Numbers.—Fractions were employed as early as 1700 B.C. by the ancient Egyptians, but it was not until Pythagoras (525 B.C.) that the need for other numbers, like $\sqrt{2}$, was discovered. The need for such irrational numbers is amply corroborated in modern mathematical analysis, where they play a fundamental role in the integral calculus, trigonometry, etc. Pythagoras showed that the ratio x of the diagonal of an isosceles right triangle to the length of a side must satisfy the equation $x^2 = 2$ (Pythagorean theorem). However, no fraction $\frac{m}{n}$ can satisfy $\left(\frac{m}{n}\right)^2 = 2$; that is, $m^2 = 2n^2$ has no solution in integers. For 2 divides m^2, an even, and it divides $2n^2$, an odd, number of times.

Eudoxus pointed out (375 B.C.) that although $\sqrt{2}$ could not be represented exactly by any one fraction, it could be represented as a limit of a sequence of fractions (see NUMBER SEQUENCES). Thus, we can represent $\sqrt{2}$ in the form of an infinite decimal: $\sqrt{2} = 1.4142 \ldots$; this amounts to specifying $\sqrt{2}$ as the limit of the sequence of decimal fractions

$$1, \frac{14}{10}, \frac{141}{100}, \frac{1414}{1000}, \frac{14142}{10000}, \cdots$$

These ideas are discussed from the Greek point of view in the tenth book of Euclid's Elements (300[?] B.C.).

Their clear exposition from the modern point of view is due to G. Cantor (1871). Real numbers, including both rational and irrational numbers, are defined by Cantor as infinite sequences $x = (x_1, x_2, x_3, \cdots)$, $y = (y_1, y_2, y_3, \cdots)$, $\cdots$, of fractions x_n, y_n, $\cdots$, which converge in the sense that $(x_m - x_n)$, $(y_m - y_n)$, $\cdots$, approach zero as m, n increase indefinitely. We regard x as the limit of the sequence $(x_1, x_2, x_3, \cdots)$.

Equality is defined by making $x = y$ mean that $x_n - y_n$ approaches zero as n increases indefinitely. Addition and multiplication are defined by

$$\begin{aligned} x + y &= (x_1 + y_1, x_2 + y_2, x_3 + y_3, \cdots) \\ x \times y &= (x_1 \times y_1, x_2 \times y_2, x_3 \times y_3, \cdots) \end{aligned} \qquad (20)$$

Laws such as (1)–(17), valid for rational numbers, can be extended to all real numbers by the principle of continuity. For example, each approximating term $(x + y)_n = x_n + y_n$ of $x + y$ is equal to the corresponding approximation $(y + x)_n = y_n + x_n$ of $y + x$; hence, $(x + y)_n - (y + x)_n = 0$ for all n, and $x + y = y + x$ by definition of equality. In general, the principle of continuity states that laws involving continuously varying functions like $x + y$ and $x \times y$, which are valid for arbitrarily good approximations x_n, y_n, $\ldots$ of x, y, $\cdots$ must be also valid for the limit values x, y, $\cdots$.

Another interesting definition of real numbers is due to R. Dedekind (1872). By a section in the class R of fractions, we mean a division of all fractions into two classes L and U, such that $x \leqq y$ for every x in L and y in U. Each fraction (rational number) r determines a section: L consists of the $x \leqq a$ and U of the $y \geqq a$. The other sections define the irrational numbers; thus, the section dividing the fractions into the $x < \sqrt{2}$ and the $y > \sqrt{2}$ (more precisely, the positive y uith $y^2 > 2$) may be regarded as defining $\sqrt{2}$. Dedekind's definition can be proved to be equivalent to Cantor's.

The real numbers defined by this process have so far been found adequate for the mathematical treatment of most geometrical and physical quantities such as length, area, weight, electric charge, etc. Not only are the fundamental laws (1)–(6) of arithmetic, the cancellation laws (7)–(8) and the order properties (9)–(11) true. but division (except by zero) and subtraction are always possible. Finally, we have the property that any increasing sequence $x_1 < x_2 < x_3 \cdots$ whose terms are all bounded above by a fixed constant c must tend to a limit.

We shall now discuss other types of numbers; in every case, we shall have to lose some of the properties of real numbers.

GENERALIZATIONS

Complex Number System.—It is clear that the equation $x^2 = -1$ can have no real solution since the square of any real quantity is positive or zero. But we can introduce $i = \sqrt{-1}$ as an imaginary number and preserve those laws (1)–(8) and (15)–(19) of addition and multiplication which do not involve the relation $a \geqq b$. To do this, we must clearly introduce all combinations $a + bi = a + b \times \sqrt{-1}$; these are the so-called complex numbers. Moreover, we must put

$$(a + bi) + (c + di) = a + c + bi + di = (a + c) + (b + d)i,$$
$$(a + bi) \times (c + di) = ac + (ad + bc)i + bdi^2 = (ac - bd) + (ad + bc)i$$

If we define addition and multiplication of complex numbers by these formulas, laws (1)–(8) and (15)–(19) will be satisfied. For example, it can be verified by substitution that the equation $(c + di)z = (a + bi)$ has the solution

$$z = \frac{(a + bi)}{(c + di)} = \frac{a}{(c^2 + d^2)} + \left[\frac{b}{(c^2 + d^2)}\right]i$$

Furthermore, any quadratic equation $Ax^2 + Bx + C = 0$ with real coefficients has complex roots

$$\frac{(-B \pm \sqrt{B^2 - 4AC})}{2A}$$

since even if $B^2 - 4AC = -D$ is negative, the numbers

$$\frac{(-B \pm \sqrt{D}i)}{2A}$$

can be found as complex numbers.

This is a special case of the fundamental theorem of algebra, which asserts that any polynomial equation $x^n + a_1x^{n-1} + \ldots + a_n = 0$ with real or complex coefficients has a complex root (see COMPLEX NUMBERS; EQUATIONS, THEORY OF). Thus from a strictly algebraic standpoint, no further generalization is called for.

Although the theory of algebraic equations is greatly simplified by the use of complex numbers, it is necessary to sacrifice the properties of order. If, as by (11), either $a \geqq 0$ or $a \leqq 0$, then by (9) either $a \geqq 0$ or $-a \geqq 0$; in either case, by (10), $a^2 = (-a)^2 \geqq 0$. That is, there is no way in which we could define order so as to satisfy (9)–(11), and make negative numbers have square roots.

Complex numbers are useful not only in pure mathematics (theory of equations and function theory); they are used in discussing alternating electric currents and simplify the solution of many problems in mechanics.

Quaternions and Hypercomplex Numbers.—If we are willing to sacrifice the properties of order, and the commutative law of multiplication as well, we can obtain an interesting further extension of the complex number system, the so-called quaternions (*q.v.*).

Quaternions are numbers of the form $a + bi + cj + dk$, where a, b, c, d are real.

The sum $(a + bi + cj + dk) + (a' + b'i + c'j + d'k)$ is defined as $(a + a') + (b + b')i + (c + c')j + (d + d')k$. Multiplication is defined from the equations (generalizing $i^2 = -1$), $i^2 = j^2 = k^2 = -1$ $ij = jk = ki = -ji = -kj = -ik = -1$. Laws (1), (2), (4)–(8) are satisfied, and subtraction and division (except by zero) are possible. Further, any polynomial equation with quaternion coefficients has a quaternion root.

For many years quaternions were widely used in solving physical problems, but since about 1900 their use in physics has been replaced by that of the vector calculus.

The construction of quaternions can be further generalized. For any set of n^3 real coefficients C_k^{ij}, we can define a linear algebra, or system H of hypercomplex numbers, as follows. The elements of H are the expressions $a_1\epsilon_1 + \ldots + a_n\epsilon_n$, where the "units" $\epsilon_1, \ldots, \epsilon_n$ take the place of the special quaternions 1, i, j, k, and are the same for all elements; $a_1, \cdots, a_n$ are arbitrary real numbers. The sum of $a_1\epsilon_1 + \ldots + a_n\epsilon_n$ and $b_1\epsilon_1 + \cdots + b_n\epsilon_n$ is defined as $(a_1 + b_1)\epsilon_1 + \cdots + (a_n + b_n)\epsilon_n$. Their product is defined as the sum $a_1b_1\epsilon_1^2 + a_1b_2\epsilon_1\epsilon_2 + \ldots + a_nb_n\epsilon_n^2$, where the $\epsilon_i\epsilon_j$ are given by $\epsilon_i\epsilon_j = C_1^{ij}\epsilon_1 + C_2^{ij}\epsilon_2 + \ldots + C_n^{ij}\epsilon_n$.

Although the study of hypercomplex numbers forms an interesting branch of algebra (see ALGEBRAS [LINEAR]), the complex numbers and quaternions are the only systems of hypercomplex numbers nith real coefficients in which multiplication is associative and division is possible.

Algebraic and Transcendental Numbers.—Numbers which, like $\sqrt[3]{5}$ and $\sqrt{-1}$, represent roots of polynomial equations $a_0x^n + a_1x^{n-1} + \ldots + a_n = 0$ with integral coefficients, are called algebraic numbers. It can be shown that any sum, difference, product or quotient of algebraic numbers is again algebraic, and that so is any root of a polynomial equation whose coefficients a_i are all algebraic numbers. For this reason, algebraic numbers form a closed subsystem of the system of complex numbers, which can be studied without using limits or other infinite processes.

Algebraic numbers have many fascinating properties (see NUMBERS, THEORY OF).

Real or complex numbers which are not algebraic are called transcendental. In 1851 Joseph Liouville first proved the existence of transcendental numbers; in 1873 Charles Hermite proved that the base e of natural logarithms was transcendental and in 1882 Ferdinand Lindemann proved that a was transcendental. We now know that the vast majority of real numbers are transcendental (see *Infinite Cardinal Numbers*, below).

Modular Numbers: Fields.—Another interesting class of modular number systems, each containing a finite number of elements, can easily be constructed from the positive integers. For each prime number $p = 2, 3, 5, 7, \ldots$, consider the integers $0, 1, 2, \ldots, p-1$. The sum $a + b$ and product $a \times b$ of any two of these integers are defined as the remainders of the ordinary sum $a + b$ and product $a \times b$, when divided by p. Thus, if $p = 3$, then $2 + 1 = 0$ and $2 \times 2 = 1 = 4 - 3$; the complete addition and multiplication tables are

+	0	1	2
0	0	1	2
1	1	2	0
2	2	0	1

×	0	1	2
0	0	0	0
1	0	1	2
2	0	2	1

These number systems satisfy conditions (1)–(6), and subtraction and division (except by zero) in them is always possible. They were first studied by K. F. Gauss (*Disquisitiones Arithmeticae* [1801]).

Number systems satisfying laws (1)–(6), in which subtraction and division (except by zero) are always possible, are called fields. All the fields having a finite number of elements are known—they are called Galois fields; for each prime power p^n, there is exactly one having p^n elements. An interesting theorem, proved by J. H. M. Wedderburn in 1910, asserts that for systems containing only a finite number of elements, the commutative law of multiplication is a consequence of the other laws (see FIELDS).

Hypercomplex number systems with coefficients in a modular field or any other field can be constructed just as easily as if the coefficients were in the field of real numbers.

Infinite Cardinal Numbers.—In the definition of a cardinal number given at the beginning of this article, there is nothing stated which requires the class to be finite. Thus, it is perfectly legitimate to ascribe the mark d (denumerable infinity) to the class J of all positive integers and every other class which can be put in one-one correspondence with J.

Similarly, it is perfectly legitimate to ascribe the mark c (power of the continuum) to the class $R\#$ of all real numbers and every other class which can be put in one-one correspondence with $R\#$.

The definitions of addition and multiplication are still valid, as are the proofs of the basic laws (1)–(6) of arithmetic. The definition of the relation $a \leqq b$ is also valid, and laws (9)–(11) can be proved for infinite numbers as well as for finite numbers; only (11) offers any difficulty.

In fact, we can even define exponentiation for infinite as well as finite cardinal numbers. But we must avoid the usual elementary definition $a^n = a \times \ldots \times a$ (n factors) and define a^s as the cardinal number of the class of all single-valued functions (see CALCULUS, DIFFERENTIAL AND INTEGRAL) or rules f assigning to each element x in a class of b elements a single value $y = f(x)$ in a class of a elements. One can then prove easily the usual laws of exponents

$$(a \times b)^s = a^s \times b^s,\ a^{s+t} = a^s \times a^t,\ (a^s)^t = a^{s\times t} \qquad (21)$$

One can also connect the infinite cardinal numbers c and d by the interesting formula

$$c = 2^d \qquad (22)$$

The main loss in dealing with infinite cardinal numbers is that the laws (7)–(8) of cancellation are no longer valid. In fact, for every infinite cardinal number γ, it can be proved that

$$\gamma = \gamma + 1,\ \gamma + \gamma = \gamma,\ \gamma \times \gamma = \gamma \qquad (23)$$

These equations imply that every infinite class can be placed in one-one correspondence nith a proper subclass of itself. For example, there is an obvious one-one correspondence hetrveen the class J of positive integers 1, 2, 3, . . ., and the class E of even integers 2, 4, 6, . . .; another between J and the class O of odd integers 1, 3, 5, . . .; it follows from the definition of addition that $d + d = d$.

From $y = y + 1$ we easily get $y + 1 = y + 2$, while $y + \gamma = y$ implies $2 \times y = 1 \times y$; hence, neither law of cancellation holds. For this reason it is impossible to extend the system of finite and infinite cardinal numbers to larger systems in which subtraction or division are possible.

From $y + y = y$ it can easily be shown that the class of all integers $\pm n$, 0 has the same cardinal number d as the class of positive integers; from $y \times \gamma = y$, it follows that the class of all rational numbers $\pm \frac{m}{n}$ also has the cardinal number d; this is even true of the class of all algebraic numbers.

This suggests the conjecture that perhaps the class $R\#$ of all real numbers also has the cardinal number d. We shall now disprove this. It would mean that all real numbers could be written in a sequence, S, just as the integers 1, 2, 3, . . ., can be so written.

First let us imagine the numbers of this sequence to be written in decimal form. Now certain rational numbers admit of double representation, as is evident from the fact that 0.879999 . . = 0.880000 . . . Let us agree, in all such cases, to use the mode of representations by 9s, so that every number shall have a *unique decimal* representation. We may now construct another number $0 \cdot x_1x_2x_3 \cdots$ as follows. Let the first digit x_1 after the decimal point be chosen apart from 0 and the first digit (after the decimal point) of the first number of S, let x_2 be chosen apart from 0 and the second digit of the second number of S; and so on. There will then be defined a number in decimal form which is obviously distinct from all the numbers of S, which disproves our conjecture.

This disproof by the diagonal process of G. Cantor can be generalized so as to apply to any cardinal number. Thus, there is an infinite sequence of distinct infinite cardinal numbers: $d < 2^d = c < 2^c < 2^{2c} < \ldots$. It is not known whether or not there are others in between the ones listed.

Since the cardinal number of the class of algebraic numbers is d, the preceding argument proves that there exist real transcendental numbers and, in fact, that there are infinitely more transcendental numbers than algebraic numbers.

Infinite Ordinal Numbers.—Consider the infinite sequence of non-negative integers 0, 1, 2, 3, . . . It has the property that every nonempty subset has a first member (so-called well-ordering property). It was observed by Cantor that one can extend this sequence in exactly one way without losing the well-ordering property. Indeed, there must be a first infinite ordinal ω after all the integers, a first ordinal $\omega + 1$ after ω, a first ordinal $\omega + 2$ after $\omega + 1$ and so on. Immediately after the sequence $\omega, \omega + 1, \omega + 2, \ldots$, there must be a first ordinal 2ω, followed by $2\omega + 1$, $2\omega + 2, \ldots$; then $3\omega, 3\omega + 1, \ldots$. Evidently this process of ordinal numeration can be continued, giving numbers of the form (*see* NUMBER SEQUENCES)

$$\begin{array}{l} 0, 1, 2, \ldots \\ \omega, \omega + 1, \omega + 2, \ldots \\ 2\omega, 2\omega + 1, 2\omega + 2 \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ \omega^2, \omega^2 + 1, \omega^2 + 2, \ldots \\ \omega^2 + \omega, \omega^2 + \omega + 1, \omega^2 + \omega + 2, \cdots \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \end{array}$$

We can identify each ordinal number a in this sequence with the set of κ preceding a, in order. Thus, 3 corresponds to the ordered set (0, 1, 2), ω with the ordered sequence of all non-negative integers and so on.

If we do this, we can define $\alpha + \beta$ as the result of laying the sequence β after the sequence α, $\alpha\beta$ as the result of substituting the sequence β for each term of the sequence a and α^2 as $\alpha\alpha$. These definitions are consistent with the notations we have introduced; however, $1 + \omega = \omega \neq \omega + 1$ and $\omega 2 = \omega \neq 2\omega$, so that neither addition nor multiplication is commutative. On the other hand, both operations are associative, $(\alpha + \beta)\gamma = \alpha\gamma$

$+\beta\gamma$, and we rescue the one-sided cancellation laws, $\alpha+\beta = \alpha+\gamma$ implies $\beta = \gamma$, $\beta\alpha = \gamma\alpha$ implies $\beta = \gamma$.

There seems to be no reason why the process of ordinal enumeration of the elements of a class C cannot be continued indefinitely until all the elements of the class have been counted. That is, it is plausible to assume that every class can be well ordered. Using this assumption, one can prove that $\alpha + \alpha = \alpha$ and $\alpha^2 = \alpha$ for all infinite cardinal numbers. However, inasmuch as no infinite class not equivalent to (*i.e.*, in one-one correspondence with) the class of integers has ever been constructively well ordered, this assumption must still be accepted with reservations (see MATHEMATICS, FOUSDATIONS OF).

Ordered Fields.—In each of the preceding generalizations of the real number system, we have lost either the order properties (9)–(11), as in the cases of complex, quaternion and modular numbers, or the possibility of subtraction and division, as in the cases of infinite cardinal and ordinal numbers. We shall now show that there exist ordered fields, not contained in the real number system which have both the order properties and the arithmetic properties of the rational and real numbers.

Consider the class of infinite formal power series

$$a(x)=a_{-m}x^{-m}+a_{-m+1}x^{-m+1}+\cdots+a_0+a_1x+a_2x^2+\cdots \qquad (24)$$

which begin with an arbitrary positive or negative integral power $a_{-m}x^{-m}$ of the symbol x with real nonzero coefficient a_{-m}. To add two such series, add corresponding coefficients; thus, $c(x) = a(x) + b(x)$ means $c_n = a_n + b_n$ for all n. To multiply, let the coefficient c_n of x^n in the product $c(x) = a(x)b(x)$ be the sum of all products a_ib_j such that $i+j = n$; thus

$$(x+x^2-x^3+\cdots)(2x^{-2}+3x^{-1}-4+\cdots) = (2x^{-1}+5-3x+\cdots).$$

Define $a(x) \geqq 0$ to mean that $a_{-m} \geqq 0$ in (24). Finally, add 0 to the system, using (18) to define addition and multiplication by zero.

With these definitions, the fundamental laws (1)–(6) can easily be proved. It is also easy to show that subtraction is always possible. Further, division (except by zero) is always possible; thus,

$$\frac{1}{(1-x)} = 1+x+x^2+\cdots$$

as in the familiar high-school formula. Hence, the formal power series (24) and 0 form a *field* (*see* above). Finally, if we define $a(x) \geqq b(x)$ to mean $a(x)-b(x) \geqq 0$, the order properties (9)–(11) hold.

In fact, the only property of real numbers which is not shared by our new system is the completeness property: that any increasing sequence of real numbers, whose terms are all bounded above by a fixed quantity, must tend to a limit. In fact, the increasing sequence $-1 < -\frac{1}{2} < -\frac{1}{4} < \cdots$, whose terms are all bounded above by 0, does not tend to a limit in our new system. For example, it does not approach 0, since $-x$ separates 0 from every term of the sequence. Since it can be proved that any ordered field with the completeness property is equivalent to the real number system, we cannot hope to obtain any closer analogue of the real number system. *See* also NUMBERS, THEORY OF

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NUMBERS is the fourth book of the Pentateuch, as the five books of the Law, or of Moses, have come to be called. The three previous books carried on the story of Israel's history from the creation, through the captivity in Egypt and the escape therefrom, down to the sojourn at Sinai. Numbers traces out the march from Sinai, the wanderings in the wilderness and the final arrival on the steppes of Moab within sight of the Promised Land. Like the other books of the Pentateuch, it consists of earlier (JE) and later (P) sources; see BIBLE: *Old Testament*. But, although the sources come from different ages and from writers of different schools of thought, yet if its significance is properly to be apprehended, it is necessary to remember that for more than 2,000 years it has been a complete whole. See also PENTATEUCH.

The book falls naturally into three sections which follow a chronological sequence: (1) chaps. i–x, 10 (P), Israel's sojourn at Sinai, the census and the promulgation of various laws by Moses; (2) chaps. x, 11–xxii, 1 (JE and P), incidents which occurred during the wanderings between Sinai and the arrival at the steppes of Moab; these incidents seem to have been chosen mainly for the purpose of casting light on the religious history and character of the people and also to explain the meaning of various place names (cf. Taberah and Kibroth hattaavah, xi, 3, 34); they also attempt to give an account of the origin of some religious objects of worship (*e.g.*, the brazen serpent, xxi, 4–11); (3) chaps. xxii, 2–xxxvi (mainly P), the sojourn on the steppes of Moab, the incident of Balaam, the second census and the giving of additional laws, together with various other incidents.

The middle section contains important passages from J and E: the 12 spies, the rebellion of Korah and Balaam's mission to Balak (no signs of P). J, E and P can be readily separated in chaps, xi and xii. To E belongs the passage describing the outpouring of the Spirit on Eldad and Medad and the remarkable prayer of Moses in xi, 29, "Would God that all Yahweh's people were prophets that Yahweh would put his Spirit upon them," *cf.* the idea that Christians are "priests unto God" (Rev. i, 6). As usual, the J and E elements possess such a vivid character as to render them familiar to ordinary readers; contrast P's legislative and statistical style, and his diffuseness (which reaches a climax in chap. vii). The most illuminating example of the difference between JE and P is found in the passage that occurs after the first long section of P describing the order of march of the several tribes and the position of the ark in the very centre of the host, both when encamped and on the march. In x, 30, Moses entreats Hobab, the son of Reuel, his father-in-law, to come with the Israelites to be "eyes" unto them; and in x, 33, it is stated that the ark went before them to seek out a resting place for them. It is clear that these statements directly contradict P's elaborate scheme, according to which the people march mechanically, tribe by tribe, with the ark in the very centre of the square, and guided by the pillar of cloud by day and the pillar of fire by night. Moses, instead of simply following the pillar of cloud, requests Hobab to determine the line of march and select the sites for encampment. No clearer proof could be desired of the nature of early methods of compilation than that the detailed account in chaps. i–x, 28, should be immediately followed by two short paragraphs in palpable contradiction of the whole plan of camp and march so elaborately worked out in the preceding narrative.

Of very great interest is the account of Korah's revolt in chap. xvi, which is composed of J, E and P in a most intricate manner. Literary analysis has unraveled three stages of development: (1) two *Reubenites*, Dothan and Abiram, rebel against the civil authority of Moses; (2) Korah the Levite, with 250 Issaelites, rebels against the religious authority of Moses and Aaron; and (3) Korah at the head of 250 *Levites* protests against the priestly privileges of Aaron (for details see the commentaries). The analysis (which is generally accepted) is of extreme value for the difficult study of the history of the Levites (*q.v.*).

Another very important narrative is that of Balaam (*q.v.*). It includes a number of poetical quotations which help to determine its date and also indicate the value of poetry in its bearing on history. Also in xxi, 14, we have a poetical quotation from a lost volume of early poetry entitled "The Book of the Wars of Yahweh." Deborah's song was probably originally in this book; and when we compare its statement as to Israel's full fighting strength, viz., 40,000 men, with the statements in the prose of Numbers as to 600,000 men and more, we at once realize how much closer to actual facts we are brought by early poetry than by the later prose of writers like P. Perhaps it is in chap. xxxi that we have the clearest proof of P's nonhistorical character. There we are told that 12,000 Israelites, without losing a single man, slew every male Midianite, children included, and every Midianite woman that had known a man, and took so much booty that there had to be special legislation as to how it should be divided. But if this were actual fact, how could the hlidianites have ever reappeared in history? And yet in Gideon's time they were strong enough to oppress Israel.

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NUMBERS, THEORY OF. The theory of numbers is corcerned, in its elementary parts, with properties of the integers, or whole numbers, 0, ± 1, ± 2, $\cdots$. Examples of such properties which emerged in ancient times are these: the Chinese knew in 500 B.C. that $2^p - 2$ is divisible by p, for prime numbers p; Euclid (300 B.C.) proved that there exist infinitely many primes (otherwise, if p could be the greatest prime, then as a contradiction a larger prime would divide M + 1, where M denotes the product $2 \cdot 3 \cdot 5 \cdot\,.\cdot p$ of all primes up to p). While most results of this vast and beautiful subject, dealing with the universally familiar whole numbers, are easy to understand, the proofs of many use the deepest resources of mathematics, and some of the most interesting conjectures are still unproved.

Topics in the theory of numbers will be treated under the following headings:

I. DIVISIBILITY AND PRIMALITY

1. Elementary Definitions; Factorization Into Primes.—If a and b are integers, and a = bc for some integer c, then b is called a *factor* or divisor of a; abbreviated $b|a$, read "b divides a"; thus $1|a$ and $a|a$ for every integer a. A prime number is an integer $p(> 1$ such that p has no positive factors except 1 and p; examples are 2, 3, 5, 7, 11. Other integers greater than 1 are called composite.

Every integer greater than 1 is either itself a prime or can be expressed as a product of primes in only one way (except for rearrangement of factors). This fact, known as the "fundamental theorem of arithmetic," is usually proved by means of a property given by Euclid, namely, if a prime p divides ab, then p divides a or b. To establish this property Euclid showed that if d is the greatest common divisor (g.c.d.) of a and b, then there exist integers x and y satisfying ax + by = d (see Residue Classes below). Assuming this, suppose that $p|ab$ but not a; then since p is a prime, the g.c.d. of p and a is 1, ax + py = 1, abx + pby = b, hence $p|b$.

The symbol (a,b) is frequently used for the g.c.d. of the integers a and b, assumed not both zero. If $(a,b) = 1$, a and b are called relatively prime, or coprime, and a is described as prime to b.

Several independent proofs of the fundamental theorem of arithmetic, based on mathematical induction, have appeared (H. Hasse, 1928; E. Zermelo, 1934; Ferdinand Lindemann, 1933).

See ARITHMETIC.

2. Residue Classes: Euler's Theorem.—Let m denote a given positive integer. Every integer a can be expressed in the form a = qm + r, where q is an integer (the quotient on division by m) and r, the remainder, has one of the m values 0, 1, $\cdots$, $m - 1$. Two integers a and b having the same remainder r are said to be congruent modulo m, abbreviated a $\equiv$ b mod m. Clearly this is equivalent to saying that $m|a -$ b. All integers congruent modulo m to a given integer are considered as forming a residue class modulo m. There are m residue classes.

If a $\equiv$ b mod m, $(a,m) = (b,m)$. If $(a,m) = 1$ we may therefore say that the residue class of a modulo m is prime to m. Those residue classes which are prime to m are said to form a reduced system of residue classes mod m. For example, if $m = 12$, the reduced system is represented by the four residues 1, 5, 7 and 11.

L. Euler introduced the symbol $\phi(m)$ to denote the number of reduced residue classes mod m, or what is equivalent, the number of positive integers prime to m and not exceeding m. For example, $\phi(1) = 1$, \$(?) $= p - 1$ for any prime p. One easily proves that $\phi(mn) = \phi(m) \cdot \phi(n)$ if $(m,n) = 1$, and $\phi(p^r) = p^r\left(1 - \frac{1}{p}\right)$ for any prime p and positive integer r. This facilitates the evaluation of $\phi(m)$; *e.g.*, $\phi(12) = \phi(2^2) \cdot \phi(3) = 2.2 = 4$, as noted earlier.

Let a be prime to m. If $r_1 - r_2$ is not divisible by m, the same is true of $ar_1 - ar_2$. It follows that if $r_1, r_2, \cdots, r_h$ (where h = $\phi(m)$) constitute a reduced residue system mod m, then ar_1, ar_2, $\cdots$, ar_h comprise the same residues in a different order. Hence the difference of the products $ar_1 . ar_2 \ldots ar_h$ and $r_1 r_2 \ldots r_h$, which can be written $r_1 r_2 \ldots r_h(a^h - 1)$, is divisible by m. Since $r_1 r_2 \ldots r_h$ is prime to m, m divides $a^h - 1$.

This result, that $m|a^{\phi(m)} - 1$ if a, m are coprime, is known as Euler's theorem (1760). Fermat's theorem (1640) is the special case for a prime p, $a^{p-1} \equiv 1 \bmod p$ if $(a,p) = 1$.

By the same argument, the m residues ax (x = 0, 1, $\cdots$, $m - 1$) are incongruent mod m, if $(a,m) = 1$; hence the congruence ax $\equiv$ k mod m is solvable, for any k. Hence, if $(a,b) = 1$, then for any given integer k there exist integers x, y satisfying ax + by = k.

Primitive Roots.—It can be shown that if $(a,m) = 1$, the least positive e such, that $a^e \equiv 1 \bmod m$ must divide $\phi(m)$. If e = $\phi(m)$, a is called a primitive root *of m;* and the powers 1, a, a^2, $\cdots$, a^{e-1} comprise a reduced set of residues mod m. Primitive roots have importance in various applications involving nth powers; *e.g.*, in solving binomial congruences such as $x^n \equiv$ k mod m. K. F. Gauss proved that primitive roots exist only when $m = 2, 4, p^k$, or $2p^k$, where p is an odd prime.

3. Congruences in One Unknown.—If a $\equiv$ b mod m and c $\equiv$ d mod m, it is easily seen that a + c $\equiv$ b + d, a − c $\equiv$ b—d, and ac $\equiv$ bd mod m. Hence, if $f(x)$ is a sum of terms $a_0 + a_1 x + \ldots + a_n x^n$ with integral coefficients, then $f(a) \equiv f(b)$ mod m, if a $\equiv$ b mod m. Hence, in searching for solutions (called roots) of the congruence $f(x) \equiv 0$ mod m, one can confine oneself to incongruent solutions mod m. The *number of* roots is the number of incongruent solutions mod m: *e.g.*, $x^3 \equiv 1$ mod 7 has precisely three roots, *viz.* x $\equiv$ 1, 2, 4.

Let m_1, m_2, $\cdots$, m_k be k positive integers, coprime in pairs, $m = m_1 \cdots m_k$. A method of solving the k congruences x $\equiv r_1$ mod $m_1, \ldots,$ x $\equiv r_k$ mod m_k, for an integer x, uniquely determined mod m, was known to the Chinese in the first century A.D., and is called the "Chinese remainder theorem." This leads to the result that the number of solutions of $f(x) \equiv 0$ mod m is the product of the numbers of solutions of $f(x) \equiv 0$ mod m_i ($i = 1$, $\cdots$, k). The search for roots of $f(x) \equiv 0$ mod m can thus always be reduced to the case where m is a power of a prime. In certain cases there is a systematic way of deriving the solutions mod p^{r+1} from those mod p^r.

In the special case m = p there holds an important theorem formulated by J. L. Lagrange (1768). If $(p,a_n) = 1$, the congruence $f(x) = 0$ mod p is said to be of degree n. Lagrange proved that the number of roots of $f(x) \equiv 0$ mod p does not exceed the degree n.

As an application, consider $f(x) = x(x - 1)$ (x − 2)$\cdots$(x − p + 1) − $(x^p -$ x). This is a polynomial of degree $p - 1$ at most, and $f(x) \equiv 0$ mod p for each of x = 0, 1, $\cdots$, $p - 1$ (by Fermat's theorem). This contradicts Lagrange's theorem unless every coefficient is divisible by p. Hence, the sum of the products n at a time of 1, 2, $\cdots$, $p-1$ is divisible by p if $n \leqq p-2$; while (by the coefficient of x),

$$1\cdot 2\cdot 3\cdots(p-1) \equiv -1 \pmod p$$

a result known as Wilson's theorem.

Since $x^{p-1}-1=(x^{\frac{1}{2}(p-1)}-1)(x^{\frac{1}{2}(p-1)}+1)$, it follows from Fermat's and Lagrange's theorems that each of the congruences $x^{\frac{1}{2}(p-1)} \equiv 1$ and $x^{\frac{1}{2}(p-1)} \equiv -1 \pmod p$ is satisfied by exactly $\frac{1}{2}(p-1)$ residues x mod p. Anticipating the following section, note that if a is any of the $\frac{1}{2}(p-1)$ quadratic residues of p, then $a \equiv x^2$, $a^{\frac{1}{2}(p-1)} \equiv x^{p-1} \equiv 1$. Accordingly, a is a quadratic residue or nonresidue of p according as $a^{\frac{1}{2}(p-1)} \equiv 1$ or $-1 \pmod p$. Putting $a=-1$ we obtain that the congruence $x^2 \equiv -1 \pmod p$ is solvable if $p \equiv 1$, but unsolvable if $p \equiv 3 \pmod 4$.

On pairing factors equidistant from the two ends, Wilson's theorem gives $(1\cdot 2\cdot 3\cdots\frac{1}{2}(p-1))^2 \equiv (-1)^{\frac{1}{2}(p+1)} \bmod p$. Hence if p is a prime of the form $4n+3$, $1\cdot 2\cdot 3\cdots\frac{1}{2}(p-1) \equiv \pm 1 \bmod p$. The sign $+$ or $-$ in the last case was investigated by Dirichlet and others. Since -1 is a quadratic nonresidue of p, and since the product of an even (odd) number of quadratic nonresidues is a quadratic residue (nonresidue), the sign is $(-1)^m$, where m is the number of quadratic nonresidues in the series $1, \ldots, \frac{1}{2}(p-1)$. An interesting expression found for m is $\frac{1}{4}(p+1)-\frac{1}{2}(1+h(-p))$, where $h(-p)$ denotes the number of classes of positive, primitive binary quadratic forms of discriminant $-4p$ (see Binary Quadratic Forms, below). In particular, it follows that there are more quadratic residues in the first half of the interval from 1 to $p-1$, than in the second half, if p is a prime $4n+3$.

Numerous generalizations of Fermat's and Wilson's theorems have been found. One due to Gauss (1801) is as follows: if P denotes the product of the integers less than and prime to n, then $P \equiv -1 \bmod n$ if n is 4, p^k, or $2p^k$, where p denotes an odd prime; but $P \equiv 1 \bmod n$ otherwise.

4. Quadratic Residues: **The** Quadratic Reciprocity **Law.**—A quadratic residue of m is an integer a prime to m such that $x^2 \equiv a \bmod m$ is solvable for x. Other integers a prime to m are called quadratic nonresidues. Let m be an odd prime p, and consider the squares $1^2, 2^2, \ldots, (p-1)^2$. Since $p|x^2-y^2$ implies that $p|x-y$ or $x+y$, which can hold (if x, y are distinct numbers of the set $1, 2, \cdots, p-1$) only if $y=p-x$, it is plain that there are exactly $\frac{1}{2}(p-1)$ incongruent quadratic residues of p. Example: every square prime to p is of the form $pn+R$, where if $p=3$, $R=1$; if $p=5$, $R=1$ or 4; if $p=11$, $R=1$, 4, 9, $5(\equiv 4^2)$, or $3(\equiv 5^2)$.

By extensive experiment Euler had found in 1783 a theorem of great simplicity, expressing a deep property of numbers. In 1785 A. M. Legendre rediscovered the same result, which he formulated as follows. Let p and q denote distinct odd primes. Then unless $p \equiv q \equiv 3 \pmod 4$ the two congruences $x^2 \equiv p \pmod q$ and $y^2 \equiv q \pmod p$ are both solvable or both unsolvable; but if $p \equiv q \equiv 3 \pmod 4$, one and only one of the two congruences is solvable.

Legendre introduced the useful symbol $(a|p)$, defined to equal $+1$ if a is a quadratic residue of p; -1, if a is a nonresidue; 0, if $p|a$. Then the above result takes the form

$$(p|q)(q|p)=(-1)^{\frac{1}{2}(p-1)\frac{1}{2}(q-1)}$$

for any distinct odd primes p and q. He called this the "reciprocity law." His proof was incomplete. In 1795, Gauss, at the age of 18, discovered the same lam, and alter a year of strenuous effort found a complete proof. Later he found 6 different proofs; and more than 50 proofs have appeared since.

The result at the end of the preceding section can now be expressed by $a^{\frac{1}{2}(p-1)} \equiv (a|p) \bmod p$, true also if $a \equiv 0$. Hence follow the following properties of the Legendre symbol: (1) $(a|p)=(b|p)$ if $a \equiv b \bmod p$; (2) $(ab|p)=(a|p)(b|p)$; (3) $(-1|p)=(-1)^{\frac{1}{2}(p-1)}$; and by another device, $(2|p)=1$ if $p \equiv \pm 1 \bmod 8$, $(2|p)=-1$ if $p \equiv \pm 3 \bmod 8$.

The usefulness of the Legendre symbol was increased by C. G. J. Jacobi, who, defining $(a|p_1p_2\cdots p_n)=(a|p_1)(a|p_2)\cdots(a|p_n)$, and $(a|-k)=(a|k)$ if a is positive, found that the "reciprocity law" still holds for any odd numbers p and q not both negative. Example: determine whether $x^2 \equiv 30 \pmod{71}$ is solvable; $(30|71)=(2|71)(15|71)=(+1)(-)(71|15)=-(-4|15)=-(-1|15)=+1$; the congruence is solvable (with $x=\pm 32$). Example: of what primes is 3 a quadratic residue? $(3|p)=(-1)^{\frac{1}{2}(3-1)\frac{1}{2}(p-1)}(p|3)=+1$ if $p\equiv 1$ (mod 4 and mod 3), and if $p \equiv -1$ (mod 4 and mod 3); *i.e.*, $p \equiv \pm 1 \bmod 12$.

Other "reciprocity laws" have occurred in various generalizations; *e.g.*, one involving complex integers (see Algebraic Numbers, below) occurred in Gauss's researches on biquadratic congruences.

5. Factorization of Numbers; Mersenne Primes.—The labour involved in factoring a large number of, say, 20 or more digits is still prohibitive. By expressing the number in special forms, it is possible to obtain limitations on the form of possible prime factors; thus, if $N=x^2+ky^2$, where $(x,y)=1$, then $-k$ must be a quadratic residue of each prime factor of N. Factor stencils have been developed to facilitate this process. A machine constructed by D. H. Lehmer ("A Photo Electric Number Sieve," American Mathematical Monthly, 40, 1933) makes it possible to test numbers of about 17 digits in a few hours.

The best table of primes is D. N. Lehmer's List of Prime Numbers from 1 to 10,006,721 (Carnegie Institution of Washington, D.C., 165, 1914).

"Perfect numbers" owe their origin to the number mysticism of the Pythagoreans (500 B.C.). A perfect number is an integer equal to the sum of its divisors less than itself. The five least are: $6(=1+2+3)$; 28; 496; 8,128; 33,550,336. Euclid gave the example $2^{p-1}(2^p-1)$, which is perfect if and only if 2^p-1 is a prime.

All even perfect numbers are of Euclid's type (Euler). No odd perfect number has ever been found.

Numbers of the form 2^p-1 are called Mersenne numbers, because in 1644 Father Marin Mersenne made a statement which implied that if $p \leqq 257$, 2^p-1 is prime only for $p=2, 3, 5, 7, 13, 17, 19, 31, 67, 127, 257$. Subsequent work has yielded the following results: 2^p-1 is known to be prime for $p=2, 3, 5, 7, 13, 17, 19, 31, 61, 89, 107, 127$; its factors are completely known for $p=11, 23, 29, 37, 41, 43, 47, 53, 59, 67, 71, 73, 79, 113$, and partially known for $p=83, 97, 131, 151, 163, 167, 173, 179, 181, 191, 197, 211, 223, 229, 233, 239, 251$; it has been proved composite for $p=101, 103, 109, 137, 139, 149, 157, 199, 193$ and 227 (H. S. Uhler, 1948–49), 241 (R.E. Powers, 1934), 257 (M. Kraitchik and D. H. Lehmer, 1932). Several primes larger than $2^{127}-1$ (E. Lucas, 1876) were found in 1951. The national bureau of standards Western Automatic computer gave, in 1952, the three next Mersenne primes 2^p-1 ($p=521$, 607, 1,279).

The ancient Greeks knew that regular polygons of 2^hm sides, where $m=3$ or 5, can be constructed by the Euclidian (straightedge and circle) operations. Gauss, at the age of 17, proved that these constructions are so performable if and only if m is a product of distinct "Fermat primes," *i.e.*, primes of the form $F_n=2^{2^n}+1$. If $n=0, 1, 2, 3, 4$, we get the primes 3, 5, 17, 257, 65,537. But F_n is composite for $n=5, 6, 7, 8, 9, 11, 12, 18, 23, 36, 38, 73$.

II. REPRESENTATION BY FORMS

1. Binary Quadratic Forms.—Many special quadratic forms, such as $x^2 \pm ay^2$ or $x^2+y^2+z^2$, had been investigated by particular methods, before Lagrange and (especially) Gauss systematized their theory, and established general methods of attack. The guiding general principle was the linear transformation.

Consider for example a form in two variables and of the second degree (*i.e.*, a binary quadratic form) $f=ax^2+bxy+cy^2$. A number m is said to be represented by the form f if there exists a pair of integers u, v not both zero (called a *representation* of m by f) satisfying $au^2+buv+cv^2=m$. The representation is called *primitive* if the g.c.d. (u,v) is 1. We shall give a version of Gauss's method of finding whether a number m is represented by f.

The basic idea is that we treat not f alone, but an entire class *of forms equivalent, for this purpose, to* f. *If we apply to* f *a linear transformation*

$$x = \alpha X + \beta Y, y = \gamma X + \delta Y \qquad (1)$$

f *is transformed into* $F = AX^2 + BXY + CY^2$ *in nen* variables X *and* Y, while $A = a\alpha^2 + b\alpha y + cy^2$, *etc. On solving equations* (1) *for* X *and* Y, we *find*

$$(a6 - \beta\gamma)X = \delta x - \beta y, (\alpha\delta - \beta\gamma)Y = -\gamma x + \alpha y$$

Hence, in order to ensure that to each *pair of integers* x *and* y *corresponds one* and *only one pair of integers* X *and* Y, *and conversely, ne shall assume that the* transformations which we *apply are unimodular, that is,* $\alpha, \beta, \gamma, \delta$ *are integers, and* $\alpha\delta - \beta\gamma = 1$. *Clearly the same numbers* m *are then represented by both forms* f *and* F, *and any* representation x, y *of* m *in* f *corresponds uniquely to the representation* $X = \delta x - \beta y$, $Y = -\gamma x + ay$ *of* m *in* F.

The forms f *and* F, *related by a unimodular transformation, are termed equivalent. The result of applying* several unimodular *transformations in succession is easily seen to be another unimodular transformation, called their product. All forms equivalent to a given one are equivalent to one another, and are said to constitute a class of forms.*

If $A = a\alpha^2 + b\alpha y + cy^2$ *where* $(\alpha, y) = 1$, *then by section* 2 *we can choose integers* β and δ *such that* $\alpha\delta - \beta\gamma = 1$. *Consequently, any number* A *represented primitively by* f *is the first* coefficient *of some form* $AX^2 + BXY + CY^2$ *equivalent to* f. *It can be* shown *that if* β, δ *is one solution of* $\alpha\delta - \beta\gamma = 1$, *the most general solution is* $\beta + h\alpha$, $\delta + ky$, *where* k *is any integer; and that* B *is then replaced by* $B + 2kA$

The determinant of the form f *is defined to be the number* $d = ac - \frac{1}{4}b^2$. *It can be* shown *that* the *determinants of equivalent forms are equal. (See* ALGEBRAIC *FORMS.)*

The last result holds also for quadratic forms in n *variables.* We *shall later use the terms determinant, class, representation, etc., for such forms, to* which *these terms can be extended in an obvious way. If a quadratic form* f *is written in the form* $\sum a_{ij}x_ix_j$ *(summed for* $i, j = 1, \ldots, n$*), one can always suppose that* $a_{ij} = a_{ji}$, *and the determinant of* f *is the determinant* $|a_{ij}|$. *(See* DETERMINANT.*)*

So far, a, b, c may *denote any real numbers.* We *have* $af = (ax + \frac{1}{2}by)^2 + dy^2$. *Hence if* $d > 0$, $a \neq 0$, and af is positive *for any* x *and* y *not both zero; accordingly,* f represents only *numbers of one sign, that of* a, *But if* $d < 0$, f represents both *positive and negative numbers. If* $d > 0$, *we call* f *definite*; specifically, *positive-definite* if also $a > 0$; *if* $d < 0$, f is called *indefinite.*

The treatment of definite and indefinite forms now diverges. *It is easily* shown *that any* positive-definite *form is equivalent to precisely one form* $Ax^2 + Bxy + Cy^2$ satisfying

$$-A < B \leqq A \leqq C, \text{ with } B \geqq 0 \text{ if } C = A \qquad (2)$$

This form is called the reduced form in the class. We *illustrate the process of reduction nith the form* $f = 15x^2 - 44xy + 33y^2$ of *determinant* $495 - 22^2 = 11$. *Put* $x = x_1 + ky_1$, $y = y_1$. Then f becomes $15x_1^2 + (-44 + 30k)x_1y_1 + (\cdot\,\cdot)y_1^2$; *to get* $-44 + 30k$ *between* -15 *and* $+15$ *take* $k = 1$, $f_1 = 15x_1^2 - 14x_1y_1 + c_1y_1^2$; *here* $c_1 = 4$ *since* $15c_1 - 49 = 11$. Now *treat similarly the smaller coefficient* c_1, *and replace* x_1 *by* x_2, y_1 *by* $2x2 + y_2$, *obtaining* $f_2 = 3x_2^2 + 2x_2y_2 + 4y_2^2$, *which is reduced. The result of combining the transformations is* $x = 3x_2 + y_2$, $y = 2x_2 + y_2$, which *transforms* f *directly into* f_2.

Hereafter me assume f *integral; i.e.,* a, b, c *are integers. The* g.c.d. *of* a, b, c *is called the divisor of* f. *If this* g.c.d. *is* 1, f *is called primitive. To avoid fractions* write $D = -4d = b^2 - 4ac$, *called the discriminant of* f

We *prove in the case* D *negative that there are only a finite number of classes of integral, positive-definite, binary quadratic forms of a given discriminant* $D = -A$. *This number* is *equal to the number of reduced forms satisfying* (2), *nith* $4AC = A + B^2$. *By* (2), $4A^2 \leqq 4AC = A + B^2 \leqq A + A^2$, whence

$$A^2 \leqq \frac{\Delta}{3}, \text{ and } B^2 \leqq \frac{\Delta}{3}$$

To find all reduced forms of discriminant $-A$ we *may proceed as follows. Give* B *in turn each integer value such that*

$$B^2 \leqq \frac{\Delta}{3} \text{ and } 4|\Delta + B^2$$

factor $\$(A + B^2)$ *as* AC *in all* ways *satisfying* $|B| \leqq A \leqq C$. *Discard* forms *such that* $B = -A$ *or such that* $C = A, B < 0$.

The number of classes of primitive, positive-definite, binary quadratic forms of discriminant D *will be denoted by* $h(D)$.

Example: Find the reduced forms of discriminant -44. *Necessarily* $B = 2b, b^2 \leqq \frac{11}{3}$. If $b = 0, \frac{1}{4}(44 + B^2) = 11 = 1.11$; *if* $b = \pm 1$, $\frac{1}{4}(44 + B^2) = 12 = 2\cdot 6 = 3\cdot 4$. *This yields four reduced forms:* $x^2 + 11y^2$, $3x^2 \pm 2xy + 4y^2$, $2x^2 + 2xy + 6y^2$. *The last is* imprimitive, with *divisor* 2; *hence* $h(-44) = 3$.

The *reader can verify that* $h(D) = 1$ *in the* twelve *cases*

$$-D = 3, 4, 7, 8, 11, 12, 19, 27, 28, 43, 67, 163 \qquad (3)$$

the reduced form being $x^2 + xy + \frac{1}{4}(1 - D)y^2$ *or* $x^2 - \frac{1}{4}Dy^2$.

An *automorph of* f *is a unimodular transformation carrying* f *into itself. Every* f *has the trivial automorph* $x = x_1$, $y = y_1$; *and its negative* $x = -x_1$, $y = -y_1$. *The form* $a(x^2 + y^2)$ *has the additional automorphs* $x = y_1$, $y = -x_1$; *and its negative. The form* $a(x^2 + xy + y^2)$ *has six automorphs, of* which $x = x_1 + y_1$, $y = -x_1$, *is typical.* All *positive-definite forms* not *equivalent to these* two *hat-e only the two trivial automorphs. It is easily proved that all the unimodular transformations carrying* f *into* F *are obtained by applying to* f *any automorph of* f, followed *by a fixed unimodular* transformation of f *into* F.

We *can now* *solve the problem of finding all primitive representations of* A *by* f *in the* following *manner,* which *applies equally* well *to indefinite* forms *(see Automorphs and* Reduction *of Indefinite* Binary *Quadratic Forms*, below). We *noted above that to each primitive representation* (α, y) *of* A *by* f *corresponds a form* $Ax^2 + Bxy + Cy^2$ *equivalent to* f, *where* B *is uniquely determined mod* $2A$. *Equating discriminants,* $B^2 - 4AC = D$. *Hence* we *start by finding all solutions* B *of*

$$B^2 \equiv D (\text{mod } 4A),\ 0\ 4\ B < 2|A| \qquad (4)$$

For each such B *construct the form*

$$Ax^2 + Bxy + \left(\frac{(B^2 - D)}{4A}\right)y^2 = F_B.$$

By reducing both f *and* F_B *to reduced forms* we *determine whether* f *is equivalent to* F_B, *and if so can construct all unimodular transformations carrying* f *into* F_B. *The* coefficients α, y *of these transformations give all the primitive representations of* A *by* f. *Different solutions* B *of (4) cannot yield the same representation.*

Example: Find all representations of 15 *by* $f = 3x^2 + 2xy + 4y^2$. *The solutions of* $B^2 \equiv -44$ *(mod 60),* $0 \leqq B < 30$, *are* $B = 4, 14, 16, 2b$. *If* $B = 4$, $F = 15x^2 + 4xy + y^2$, *which is* equivalent *to* $x_1^2 + 11y_1^2$ *under the transformation* $x_1 = 2x + y$, $y_1 = -x$; *the corresponding representations in* $x_1^2 + 11y_1^2$ *are therefore* 2, -1 *and* -2, $+1$. *Similarly,* $B = 26$ *yields* 2, 1 *and* $-2, -1$ *in* $x_1^2 + 11y_1^2$. *If* $B = -14$, $F = 15x^2 - 14xy + 4y^2$, and *we find the representations* 1, -2 *and* -1, 2 *in* f; $B = 16$ *yields similar representations in* $3x^2 - 2xy + 4y^2$. *Thus there are eight representations of* 15 *in the system of three reduced forms,* two *of them in* f.

By a set of representations of A *in* f, *we mean the set obtained from a given representation by applying the automorphs of* f. *This has a meaning even in the indefinite case when the number of automorphs may be infinite. The preceding process proves the* following *important result formulated by P. G. L. Dirichlet and equally true* when f *is indefinite:*

Theorem: The number of sets of primitive representations of an integer A by *the system (one form from each class) of binary quadratic forms of a given discriminant* D *is equal to the number of solutions of (4).*

In a large number of special cases, this theorem provides immediate information on the number of representations in single forms. This is obviously true in the 12 *cases in (3). For example, taking* $D = -4$, we *obtain the* following *result: a positive integer* A *is represented primitively as a sum of two squares if and only if* A *contains no prime factor of the form* $4n + 3$ *and* A

is not divisible by 4; and then the number of representations is $4 \cdot 2^k$, where k denotes the number of distinct prime factors of A of the form $4n + 1$.

By counting the primitive representations of $\frac{A}{s^2}$, for square factors s^2 of A, various formulas are obtainable for the number of sets of all representations by the system of reduced forms of discriminant D; one such formula, in the special case

$$(A, 2D) = 1, \text{ is } \sum_{k \mid A} (D|k)$$

i.e., the sum of the Legendre symbols $(D|k)$ for all the positive divisors k of A. Thus, in particular, the only positive integers A not represented by $x^2 + y^2$ are those containing a prime factor $4n + 3$ to an odd power; while, if $A = 2^e p_1^{a_1} \cdots p_r^{a_r} t^2$, where the r ($\geqq 0$) distinct primes p_i are of the form $4n + 1$, and no prime in t is of that iorm, then the number of all representations of A as $x^2 + y^2$ is $4(a_1 + 1) \cdots (a_r + 1)$.

2. Genera of Quadratic Forms; Formulas for Number of Representations. — The last theorem provides a general formula for the number of representations of a number by a system of several classes of forms. A smaller system of great importance, of which many general properties are known is the genus.

A natural approach to the notion of genus may be derived from the following observations. If an integral form say $f = ax^2 + bxy + cy^2$, represents a number A, say $f(u, v) = A$, then obviously the congruence $f \equiv A \bmod m$ is solvable (with $x = u$, $y = v$) whatever be the modulus m. However, $2x^2 + 7y^2 \equiv 1 \pmod{p^r}$ is solvable for every prime p and positive r, and hence solvable for every m; *e.g.*, with $3x \equiv 1$, $3y \equiv 1$, if $p \not\equiv 3$, with $5x \equiv 3$, $5y \equiv 1$, if $p \not\equiv 5$. But $2x^2 + 7y^2$ does not represent 1. The situation here is that there is associated with $2x^2 + 7y^2$ another class of forms, that of $x^2 + 14y^2$, which while not equivalent to $2x^2 + 7y^2$, is "equivalent to it for all congruencial purposes." And $x^2 + 14y^2$ does represent 1. The two classes, represented by $x^2 + 14y^2$ and $2x^2 + 7y^2$, happen to constitute a "genus." As another example, $x^2 + y^2$ happens to be in a genus of one class, and $x^2 + y^2$ represents a positive integer A if and only if the congruence $x^2 + y^2 \equiv A \bmod m$ is solvable, for all m.

We shall call two integral forms *equivalent* in the field of reals if each is transformable into the other by linear transformations with real coefficients; *e.g.*, if $n = 2$, both must be positive-definite, both negative-definite, or both indefinite. Two forms are defined to be in the same genus if they have the same determinant d, are equivalent in the field of reals, and if for every modulus m (the modulus $2^n d$ being in fact sufficient) each is equivalent to a form whose coefficients are congruent mod m to the corresponding coefficients of the other.

There are several other sets of properties which distinguish a genus. Two quadratic forms in n variables are in the same genus if and only if they have the same determinant d and there exists a linear transformation, nhose coefficients are rational numbers with denominators prime to $2^n d$, transforming one form into the other. For example, $2x^2 + 7y^2$ is carried into $x_1^2 + 14y_1^2$ by the transformation

$$x = \frac{(x_1 + 7y_1)}{3}, \quad y = \frac{(x_1 - 2y_1)}{3}$$

The proof of the necessity of this criterion was completed for $n > 3$ only in 1940 by C. L. Siegel.

Historically speaking, genera have usually been characterized by means of sets of (more or less) easily computable invariants; Gauss (1801, $n = 2$), G. Eisenstein (1847, $n = 3$), H. J. S. Smith (1867, $n \geqq 3$), H. Minkowski (1884), B. W. Jones and G. Pall (1944). The most important of these are illustrated in the following section for $n = 3$.

Equivalent forms are in the same genus. A genus consists of a finite number of classes. If $n \geqq 4$, indefinite forms are in genera of one class; this is true also if $n = 3$, save in certain exceptional cases. It is probable that there are only finitely many classes of primitive, positive-definite forms in genera of one class; there are none in more than 35 variables (W. Magnus, 1938), and probably none in more than 10 variables. As an example, the three primitive forms of discriminant -44, preceding (3) in the above section on *Binary* Quadvatic Forms, constitute a genus of three classes. The form $x_1^2 + \ldots + x_n^2$ is in a genus of one class only if $1 \leqq n \leqq 8$.

Some writers prefer to define "class" by means of transformations of determinant ± 1, instead of Gauss's $+1$. Perhaps the main reason for preferring $+1$ is the following theorem formulated by Gauss: every genus of primitive, binary, quadratic forms of discriminant D contains the same number of classes. The situation if $n \geqq 3$ is somewhat different.

Consider a genus of primitive forms in $n(\geqq 2)$ variables. We assume the forms to be positive-definite, while mentioning that C. L. Siegel (1936), with a suitable meaning for sets of representations, has extended the results which follow to indefinite forms. Let h denote the number of classes in the genus, and select one form $f_i (i = 1, \ldots, h)$ from each class. Let w_i denote the number of automorphs of f_i. The quantity

$$\frac{1}{w_1} + \cdots + \frac{1}{w_h}$$

is called the weight *of* the genus. A remarkable formula for this was suggested for $n = 3$ by Eisenstein, and was proved and generalized to any n by H. J. S. Smith (1867) and Minkowski (1884). Further, under certain restrictions, the total number of primitive representations of an integer m by the system of forms f_i of a genus mas shown to be equal to the weights of certain related genera.

These results were generalized in 1935 by Siegel, to yield a formula for the numbers of representations (suitably weighted) of forms in k variables by a genus of forms in n variables; the case $k = 1$ is that of representation of numbers stated in the following paragraph.

Let $f_i(A)$ equal the number of representations of A by f_i. Then

$$\frac{\dfrac{f_1(A)}{w_1} + \cdots + \dfrac{f_h(A)}{w_h}}{\dfrac{1}{w_1} + \cdots + \dfrac{1}{w_h}} = \frac{\pi^{\frac{1}{2}n} A^{\frac{1}{2}n-1} S(A)}{\Gamma(\frac{1}{2}n) \cdot d^{\frac{1}{2}}} \tag{1}$$

where d denotes the determinant of f, $\Gamma(\frac{1}{2}n)$ is the well-known gamma-function (for which $\Gamma(m) = 1 \cdot 2 \cdot 3 \cdots (m-1)$ if m is a positive integer), $S(A)$ denotes the product extended over all primes p, $S(A) = \chi(2) \cdot \chi(3) \cdot \chi(5) \cdot \chi(7) \cdots$ where

$$\chi(p) = \lim_{r \to \infty} p^{-(n-1)r} f(A, p^r)$$

while $f(A, p^r)$ (which can be evaluated by various methods) denotes the number of solutions of the congruence $f \equiv A \pmod{p^r}$. This general expression simplifies remarkably when n is even, and provides a neat formula for the number of representations of an integer A by a genus; hence by a form if the genus consists of one class.

We select several examples. Let $r_n(A)$ denote the number of representations of A as a sum of n squares. For example, $r_4(13) = 112$, since $13 = 3^2 + 2^2 + 0^2 + 0^2 = 2^2 + 2^2 + 2^2 + 1^2$, and we can permute and change signs of 3, 2, 0, 0 in 48 ways, of 2, 2, 2, 1 in 64 ways. Set $A = 2^k m$, m odd, $k \geqq 0$. If $n = 2, 4, 6, 8$ (when the genus of $x_1^2 + \ldots + x_n^2$ consists of one class), $r_n(A)$ has the following expressions in terms of the positive divisors d of m:

$$r_2(A) = 4 \sum_{d|m} (-1)^{(d-1)/2}$$

$$r_6(A) = 4\{(-1)^{(m-1)/2} 4^{k+1} - 1\} \sum_{d|m} (-1)^{(d-1)/2} d^2$$

$$r_4(A) = 8\{2 + (-1)^A\} \sum_{d|m} d$$

$$r_8(A) = \frac{16}{7} |8^{k+1} - 15| \sum_{d|m} d^3$$

Similar expressions have been obtained for many other forms in genera of one class; and for special forms of A by forms in genera of more than one class. For example, if A is of the form $4r + 3$,

$r_{10}(A) = 12\sum(-1)^{(d+1)/2}d^4$, and if A is even there is a simple expression for $r_{12}(A)$.

The formula for $r_4(A)$ was first obtained in 1828 by C. G. J. Jacobi, by equating coefficients in the expansions of certain elliptic functions. In a series of 18 articles (1858–65), J. Liouville stated without proof several identities and derived from them expressions for the number of representations by numerous quadratic forms.

The proofs of these identities are elementary, although as shown by E. T. Bell, many can be paraphrased from elliptic function identities by replacing sine and cosine terms by more general odd and even functions.

As an example we quote one of Uspensky's identities. Let $F(x, y, z)$ denote a function odd with respect to x, and even with respect to y, z; *i.e.*. $F(-x, y, z) = -F(x, y, z)$ and $F(x, -y, -z) = F(x, y, z)$. Then $2\sum F(\delta - 2i, d + i, 2d + 2i - \delta) = \sum F(d + \delta, i, d - 6) + 2T - U$ where the summations extend over all integral solutions of $n = i^2 + d6$, with d and δ positive. Both T and U are zero unless $n = s^2 (s > 0)$, in which case

$$T = \sum_{j=1}^{2s-1} F(2s - j, s, 2s - j),\ U = \sum_{j=1}^{2s-1} F(2s, j - s, 2j - 2s)$$

By various specializations of this formula, James Victor Uspensky obtained a large number of expressions for the numbers of representations by quadratic forms in two, four, six, eight, and ten variables; and all the known and certain new relations connecting binary quadratic class numbers for various determinants.

H. D. Kloosterman and V. Tartakowsky showed, about 1924, that (1) gives an asymptotic formula for the number of representations by a single form f_i, if $n \geqq 4$. (See Distribution of Primes. Asymptotic *Formulas*, below.)

3. The Numbers Represented by a Quadratic Form; Universal Forms; Representation of Zero.—We shall make certain observations about the numbers represented by an integral quadratic form. As we implied earlier, a genus has the property that if $f \equiv A \bmod m$ is solvable for every m, and if A has the necessary sign when **j** is positive- or negative-definite, then some form in the genus of f represents A. For example, the two forms $f = x^2 + y^2 + 10z^2$ and $g = 2x^2 + 2y^2 - 2yz + 3z^2$ are representative of the two classes of a certain genus of determinant 10. It is easily proved that $f \equiv A \bmod p^r$ is solvable for every A and p, except when $p = 2$, r is large enough, and A is of the form $4^h(16k + 6)$. Hence f and g represent between them all positive integers not of the form $4^h(16k + 6)$. It might be supposed that f and g would each represent all large numbers not of the excluded form. It is easily proved that f represents all even numbers not of the excluded form; and Hansraj Gupta (1941) stated the odd numbers up to 20,000 not represented by f: 3, 7, 21, 31, 33, 43, 67, 79, 87, 133, 217, 219, 223, 253, 307, 391, 679, 2,719. But examples exist of two ternary classes in the same genus which do not represent the same large numbers.

In any case, if the genus of f consists of one class, the numbers represented by f can be determined by investigating the solvability of the congruences $f \equiv A \pmod{p^r}$. In this way we find that $x^2 + y^2 + z^2$ represents all positive integers not of the form $4^h(8k + 7)$, and that $x^2 + y^2 + z^2 + t^2$ represents all positive integers.

V. Tartakowsky (1925) showed that each class of positive-definite forms in five or more variables represents all the large numbers represented by its genus. This is not quite always true when n = 4, but the exceptions are known. It is definitely false (save in the trivial case of "improperly equivalent forms" such as $3x^2 \pm 2xy + 4y^2$) for binaries.

A quadratic form is called *universal* if it is positive-definite and represents all positive integers, or indefinite and represents all nonzero integers. Every universal binary is equivalent to xy. Every universal ternary with even cross-product coefficients was shown by L. E. Dickson to be equivalent to $2xy - Hz^2 (H$ odd) or $2xy + y^2 - Hz^2$ ($H \equiv 2 \bmod 4$); if any cross-product coefficient is odd, A. Oppenheim shoned it to be equivalent to $xy - Hz^2$. Srinivasa Ramanujan (1917) examined the forms $ax^2 + by^2 + cz^2 + dt^2$, where a, b, c, d are positive integers, $a \leqq b \leqq c \leqq d$; he found at most 54 such forms which may represent all positive integers. Dickson completed the proof of their universality in 1927. A complete proof, including forms with odd cross products, that there are only finitely many classes of positive-definite, universal quaternaries, was first given by A. E. Ross. Dickson proved that every universal ternary is a zero form.

A zero form is a form which represents zero. for values of its variables not all zero. The theorem that every indefinite form in five or more variables is a zero form was formulated by A. Meyer (1884). Trivially, a binary form is a zero form if and only if its discriminant is a square. We shall suppose a ternary or quaternary to have been transformed into the form $f_3 = a_1x_1^2 + a_2x_2^2 + a_3x_3^2$ or $f_4 = a_1x_1^2 + a_2x_2^2 + a_3x_3^2 + a_4x_4^2$, and shall formulate necessary and sufficient conditions for such a form to represent zero. The symbol $(a, b)_p$ may be defined (see Quadratic Residues, above) as follows, by writing $a = p^\alpha m$, $b = p^{\alpha'}m'$, where m and m' are prime to p, and a, a' are integers:

if $p > 2$, $(a, b)_p = (-1|p)^{\alpha\alpha'}(m|p)^{\alpha'}(m'|p)^\alpha$

if $p = 2$, $(a, b)_2 = (-1)^{(m-1)(m'-1)/4}(2|m)^{\alpha'}(2|m')^\alpha$

The conditions are expressed in terms of the "characters"

$$c_p(f_3) = (-a_1a_2, -a_1a_3)_p,\ c_p(f_4) = (a_1, a_2)_p(-a_3, -a_4)_p$$

The former is an invariant of f_3 under rational linear transformations. The latter is needed for our present purpose only when $a_1a_2a_3a_4$ is of the form s^2k, where k is a quadratic residue mod p^r; *i.e.*, $(k|p) = 1$ if $p > 2$, $k \equiv 1 \bmod 8$ if $p = 2$. Evidently, $c_p(f_3) = 1$ unless $p|2a_1a_2a_3$. We state finally: f_3 is a zero form if and only if $c_p(f_3) = 1$ for every p; f_4 is a zero form if and only if $c_p(f_4) = 1$ for every prirne p such that $a_1a_2a_3a_4$ is of the above-specified form.

The theory of quadratic forms in rational coefficients, and for rational values of the variables, is much simpler than that in the domain of integers; attention should be drawn to Hasse's elegant development of this theory in the *Journal* fur Mathematik for 1923.

4. Automorphs and Reduction of Indefinite Binary Quadratic **Forms.**—Any real, irrational number θ can be expanded into a continued fraction

$$a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cdots}},\ \text{abbreviated } a_0 + \frac{1}{a_1 +}\ \frac{1}{a_2 +}\cdot$$

where the a_i are integers, and $a_1, a_2, \ldots$ positive. Indeed, we can write

$$\theta = a_0 + \frac{1}{b_1}$$

where a_0 is an integer and $b_1 > 1$; then write

$$b_1 = a_1 + \frac{1}{b_2}$$

where a_1 is a positive integer and $b_2 > 1$; and so on. Since 8 is irrational, the process cannot terminate. The rational fraction

$$\frac{p_n}{q_n} = a_0 + \frac{1}{a_1 +}\ \frac{1}{a_2 +} \cdots \frac{1}{a_n}, (p_n, q_n) = 1,\ q_n > 0$$

obtained by stopping at a_n, is called the nth convergent to 8. It can be proved that

$$|\theta - \frac{p_n}{q_n}| < \frac{1}{q_n^2};\ \text{and that } \frac{p_n}{q_n}$$

is a closer approximation to 0 than any other rational fraction with denominator not exceeding q_n.

Lagrange observed that the continued fraction is periodic if and only if 0 is a root of a quadratic equation of the type $a - b\theta + c\theta^2 = 0$, where a, b, c are integers. Here

$$\theta = \frac{(b+r)}{(2c)}$$

where $r^2 = D = b^2 - 4ac$. As a typical example, consider $a = 40$, $b = -45$, $c = 12$, $D = 105$. Then

$$\theta = \frac{(-45+r)}{24} = -2 + \frac{(3+r)}{24},\ b_1 = \frac{24}{(r+3)} = \frac{(r-3)}{4} = 1 + \frac{(r-7)}{4}$$

$$b_2=\frac{4}{(r-7)}=\frac{(r+7)}{14}=1+\frac{(r-7)}{14},\quad b_3=\frac{14}{(r-7)}=\frac{(r+7)}{4}=4+\frac{(r-9)}{4}$$
$$b_4=\frac{4}{(r-9)}=\frac{(r+9)}{6}=3+\frac{(r-9)}{6},\quad b_5=\frac{6}{(r-9)}=\frac{(r+9)}{4}=4+\frac{(r-7)}{4}$$
$$b_6=\frac{4}{(r-7)}=b_2$$

Hereafter, the period $b_2, \ldots, b_5$ recurs.

The preceding discussion should help to explain Gauss's method of reduction of binary quadratic forms of a positive nonsquare discriminant D. Instead of a single reduced form (as in the case $D < 0$), each class contains a chain of reduced forms. In the case of $f = 40x^2 - 45xy + 12y^2$ this chain consists of the forms $\phi_1 = -2x^2 + 7xy + 7y^2$, $\phi_2 = 7x^2 + 7xy - 2y^2$, $\phi_3 = -2x^2 + 9xy + 3y^2$, $\phi_4 = 3x^2 + 9xy - 2y^2$. These correspond to the period of the recurring continued fraction above, and can be obtained from f by applying in order the following unimodular transformations:

$x \to -y$, $y \to x - 2y$, to get $12x^2 - 3xy - 2y^2$ (not yet reduced); to the latter form, $x \to -y$, $y \to x - y$ to get ϕ_1; then, $x \to -y$, $y \to x + y$, ϕ_2; $x \to -y$, $y \to x - 4y$, ϕ_3; $x \to -y$, $y \to x + 3y$, ϕ_4; $x \to -y$, $y \to x - 4y$, giving $\phi_5 = \phi_1$; etc. In general, $ax^2 + bxy + cy^2$ is reduced if and only if $ac < 0$, $b > 0$, $0 < r - b < 2|a| < r + b$, where $r = \sqrt{D}$.

To complete the theory given under Biizary Quadratic *Forms,* above, we observe that all the automorphs of a primitive form $ax^2 + bxy + cy^2$ of discriminant D are given by

$$x = \tfrac{1}{2}(t - bu)X - cuY,\ y = auX + \tfrac{1}{2}(t + bu)Y$$

where t, u range over all integral solutions of Fermat's equation (usually called Pell's equation), $t^2 - Du^2 = 4$. If D is a positive nonsquare integer, Fermat's equation can be shown to have a least solution T, U in positive integers (which can be found from a single period of the continued fraction for $\sqrt{D}$), and all integral solutions t, u are given by

$$\tfrac{1}{2}(t + u\sqrt{D}) = \pm\left(\tfrac{1}{2}(T + U\sqrt{D})\right)^k,\ k = 0, 1, 2, \ldots$$

I. Schur (1918) showed that $\frac{1}{2}(T + U\sqrt{D}) < D^e$, with $e = D^{\frac{1}{2}}$.

5. Diophantine Equations.— Diophantus of Alexandria (250 A.D.) mas the first to treat systematically the solutions of equations or systems of equations in integral (or sometimes in rational) values of the unknowns. Such problems are called after his name. Infallible methods are available only for a few special cases, such as a system of linear equations, or a single quadratic equation. For a fuller discussion, see DIOPHANTINE EQUATIONS; FERMAT'S LAST THEOREM.

We noticed in the preceding section that if D is any positive integer (not a square), then $x^2 - Dy^2 = 1$ has infinitely many integral solutions. An important theorem of A. Thue and C. L. Siegel shows that on the contrary, if $f(x, y)$ is of degree $\geqq 3$ (and is not a power of a linear or quadratic function), and if c is a given nonzero number, then $f(x, y) = c$ has at most a finite number of integral solutions.

III. TOPICS IN ANALYTIC NUMBER THEORY

1. Gauss's Class-number Conjecture.— The *Riemann* Zeta *Function Conjecture.*—We saw under *Binary* Quadratic *Forms* above that the number $h(D)$ of classes of primitive binary quadratic forms of discriminant D is finite, and noted 12 negative discriminants for which $h(D) = 1$. No other negative D satisfying $h(D) = 1$ has ever been found. L. E. Dickson showed in 1922 that there are no others up to $-D = 15.10^5$, and D. H. Lehmer carried this in 1933 to -5.10^9. In 1934, H. Heilbronn and E. H. Linfoot proved that at most one other negative D exists satisfying $h(D) = 1$.

On the other hand, if D is positive, the tables show numerous values of D such that $h(D) = 1$, and indeed Dirichlet showed that there are infinitely many positive integers D with this property.

In *Disquisitiones Arithmeticae* (1801), art. 303, will be found Gauss's conjecture that, as D tends to infinity through negative values, $h(D)$ tends to infinity. This conjecture was first proved by Heilbronn in 1934. Some of the developments preceding and following Heilbronn's proof are of interest. The analytic tools used in proving this and later results to be described began their development in the 19th century. Lejeune Dirichlet, who called his great memoir of 1839, "Diverse Applications of Infinitesimal Calculus to Number Theory," is generally regarded as the founder of analytic number theory. After Dirichlet, it was G. F. B. Riemann who made the most fundamental advance.

The "Riemann Zeta Function" which he introduced, may be defined by means of the series

$$\zeta(s) = 1 + \frac{1}{2^s} + \frac{1}{3^s} + \frac{1}{4^s} + \cdots$$

Here s is a complex variable, taking values of type $s = \sigma + it$, where a and t are real numbers, and $i^2 = -1$. The series is convergent only if $a > 1$, but determines by a process known as analytic continuation, a function defined and "regular" for all complex values s, except that it has a pole (a kind of infinity) at the point $s = 1$. A great deal is known about this function today. Riemann, in 1859, knew that $\zeta(s) = 0$ if s is any negative even integer, and that all the remaining zeros of $\zeta(s)$ satisfy $0 < a < 1$ and lie symmetrically about the straight lines $a = \frac{1}{2}$ and $t = 0$. Riemann conjectured that all these "nontrivial" zeros of $\zeta(s)$ lie on the straight line $a = \frac{1}{2}$. Up to 1952 it was not known whether this was true or false.

It may be mentioned that G. H. Hardy proved that there are infinitely many zeros on the line $\sigma = \frac{1}{2}$, and that E. C. Titchmarsh has located all zeros up to $t = 200$.

The Riemann zeta function conjecture poses one of the most significant unsolved problems of modern mathematics. A conjecture similar to Riemann's can be made for a somewhat more general set of functions,

$$L(s, \chi) = \sum_{n=1}^{\infty} \frac{\chi(n)}{n^s}$$

known as the Dirichlet L-functions. We will not describe the $\chi(n)$, except to say that they are called characters, and have values $+1$ or 0 or roots of unity. The conjecture that there are no zeros of the L-functions with real part $a > \frac{1}{2}$ is known as the Generalized Riemann Hypothesis (G.R.H.).

These conjectures are connected with several interesting questions. It seemed to be important to deduce results by assuming the truth of the G.R.H., in the hope that they might throw some light on the subject. For example, Hardy and J. E. Littlewood proved in 1923 on the basis of the G.R.H. slightly modified, that every sufficiently large odd number is equal to the sum of three odd prime numbers (see *The* Goldbach Problem, below). Again, in 1913, E. Hecke proved that if the G.R.H. holds true for all real-valued characters χ, then Gauss's conjecture about $h(D)$ follows. These results did not prove that every large odd number is the sum of three primes, or that $h(D)$ tends to infinity, but they have an interesting aftermath. In the case of Hecke's result the climax came in 1934. M. Deuring proved in 1933 that if $\zeta(s)$ has at least one zero with real part greater than $\frac{1}{2}$, then $h(D) = 1$ for only a finite number of negative discriminants D, and this was soon followed by the theorem of Heilbronn and Linfoot mentioned earlier. Then L. J. Mordell proved in 1934 that if $\zeta(s)$ has at least one zero nith real part greater than $\frac{1}{2}$ then $h(D)$ tends to infinity. Finally, Heilbronn proved in 1934 that if there exists at least one real character χ for which $L(s) = 0$ for a values with $a > \frac{1}{2}$, then $h(D)$ tends to infinity. Thus by Hecke's work, Gauss's conjecture is correct if the Riemann hypothesis is true for all real characters χ; and by Heilbronn's work, Gauss's conjecture follows if the Riemann hypothesis for real characters χ is false.

It follows that Gauss's conjecture is true, but nothing can be concluded about the truth of the Riemann hypothesis itself. In passing, it should be mentioned that S. Chowla immediately revised Heilbronn's proof to make it independent of Hecke's work. C. Siegel immediately followed with a brief proof that

$$\frac{\log h(D)}{\log |D|} \to \tfrac{1}{2} \text{ as } D \to -\infty$$

thus giving an actual measure of how rapidly $h(D)$ tends to infinity. Siegel's formula has made possible other developments, such as I. M. Vinogradow's startling achievement of 1937, when he proved (without any unproved hypothesis) that every large odd number is a sum of three odd primes.

2. Distribution of Primes; Asymptotic Formulas.— In 1837 Dirichlet proved that there are infinitely many primes in any arithmetic progression my + n(y = 0, 1, 2, $\cdots$), where m and n are any given coprime integers, m positive. In his article, analytic methods using fairly deep results from the theory of functions were first introduced into the theory of numbers. A number of special cases, notably my $\pm$ 1, have been proved by strictly elementary methods. It is not known whether quadratic expressions such as $x^2 + 1$ represent infinitely many primes. However, if $f = au^2 + buv + cv^2$ is primitive and not negative-definite, if (m, n) = 1 and the congruence $f \equiv n \bmod m$ is solvable, then f represents infinitely many primes of the form my + n.

Consider two functions $f(x)$ and $g(x)$ which tend to infinity with x. Examples are $\pi(x)$ = the number of primes up to x; and the function $\dfrac{x}{\log_e x}$ If the ratio $\dfrac{f(x)}{g(x)}$ tends to 1 as a limit when x tends to infinity, we say that $f(x)$ is asymptotic to $g(x)$, abbreviated $f(x) \sim g(x)$. The difference $f(x) - g(x)$, or ('error" in approximating $f(x)$ by $g(x)$, may then still become large with x, but will be of smaller order of size than $g(x)$. It is frequently important to estimate the magnitude of this error. The notation used for this purpose is illustrated by the equation $(x + 1)^3 = x^3 + O(x^2)$; which means that there exists a positive constant c such that, for all sufficiently large values of x, $|(x + 1)^3 - x^3| < cx^2$; here, $|3x^2 + 3x + 1| < 7x^2$ if $x > 1$. Generally, if F is a positive function of x, $O(F)$ denotes a function of x which, for all sufficiently large x, does not exceed cF in absolute value, where c is a positive constant. Examples: $\sin x = O(1)$, $(\log x)^{10} = O(x)$.

P. L. Chebichev gave asymptotic formulas for

$$\sum \frac{1}{p} \text{ and } \Pi \left(1 - \frac{1}{p}\right)$$

where p ranges over the primes less than x; and proved Bertrand's postulate on the existence of a prime between x and $2x (x \geqq 2)$. Asymptotic formulas for a (x) had been suggested by Legendre and Gauss. The simplest formula is $\pi(x)$,— ~ / l o g proved independently by J. Hadamard and C. de la Vallée Poussin in 1896. A closer approximation is given by

$$\int_2^x \frac{dx}{\log_e x}$$

the error being proved by Littlewood (1924) to be $O(xe^{-t})$, with $t^2 = k \log x \log \log x$ (k a positive constant); and improved by N. Tchudakov (1947) to $t = (\log x)^\delta$, $\delta = 0.6 - \epsilon$. The Riemann zeta function hypothesis discussed above is equivalent to the statement that the error is $O(x^{\frac{1}{2}} \log x)$.

We state a few of the simplest examples of asymptotic formulas for number-theoretic functions. For Euler's function (see Residue classes, above)

$$\phi(n), \phi(1) + \phi(2) + \cdots + \phi(n) = \frac{3n^2}{\pi^2} + O(n \log n)$$

The number of pairs of integers u, v satisfying $u^2 + v^2 \leqq x$ is $\pi x + O(x^{\frac{1}{3}})$. This exponent $\frac{1}{3}$ can be lowered, though it must exceed $\frac{1}{4}$, and exceedingly delicate analysis has gone into proving that we can take the exponent as low as $\frac{13}{40}$. If x is a prime, the least primitive root of x is $O(x^{\frac{1}{4}+\epsilon})$, where ϵ is any desired positive. number (see Primitive Roots, above). If $r(x)$ denotes the number of representations of the integer x as a sum of three squares, and x is not of the form $4n$ or $8n + 7$, then $\log r(x) \sim \log \sqrt{x}$ (Siegel, 1935).

A recent development of interest is the elementary proof of the fact that $\pi(x) \sim x/\log x$, by Atle Selberg (1949). His method also was applied to prove Dirichlet's theorem on the infinitude of primes in an arithmetic progression. In the same year, an elementary proof of Dirichlet's theorem based on algebraic numbers was published by H. Zassenhaus.

An interesting, as yet unproved, conjecture states there exist infinitely many pairs of primes differing by two (*e.g.*, 3, 5; 197, 199); such pairs are called twin primes. However, if their number is infinite, they are distributed much more sparsely than the primes themselves, since, as was shown by Viggo Brun in 1921, the sum of the reciprocals of the twin primes is finite, while the sum of the reciprocals of all primes is infinite.

IV. ADDITIVE THEORY OF NUMBERS

A typical problem of the additive theory of numbers may be described as follows. Consider a set S of integers $a_1, a_2, \ldots$; *e.g.*, S might contain the primes, or the cubes of primes, or the squares. Let $r(n)$ denote the number of representations of a positive integer n as a sum of s elements a_i of S. The problem is to find out what we can about $r(n)$; *e.g.*, whether $r(n)$ is always positive; or positive for all sufficiently large n; or to obtain an exact or approximate formula for $r(n)$.

1. Partitions. In particular, if $S = (1, 2, 3, \cdots)$, consists of all positive integers, the number s of summands is unrestricted, repetitions are allowed, and order is irrelevant, we have the problem of "unrestricted partitions"; *i.e.*, of expressing a positive integer n as a sum of positive integers. Thus 4 has five partitions: 4, 3 + 1, 2 + 2, 2 + 1 + 1, 1 + 1 + 1 + 1.

A number of interesting facts can be proved by elementary methods, such as representing a partition by an array of dots, and collecting these dots in different orders. Thus: the number of partitions of n into m parts is equal to the number of partitions of n into parts the largest of which is m. If $p(n)$ denotes the number of partitions of n, then

$$1 + \sum p(n)x^n = \frac{1}{\{(1-x)(1-x^2)(1-x^3)\cdots\}}$$

called a generating function for $p(n)$. Generating functions are constructible for partitions variously restricted; *e.g.*, into odd parts, unequal parts, parts of the form $5n \pm 1$, etc. By transformation of generating functions results such as the following appear (those stated being first given by Euler): the number of partitions of n into unequal parts is equal to the number of its partitions into odd parts; if $E(n)$ is the number of partitions of n into an even number of unequal parts, and $U(n)$ the number into an odd number of unequal parts, then $E(n) - U(n) = 0$ unless n is of the form $\frac{1}{2}k(3k \pm 1)$, when $E(n) - U(n) = (-1)^k$. Again, the number of partitions of n into parts which differ by at least 2 is equal to the number of partitions into parts of the form $5m \pm 1$.

Among the most important recent developments, we should mention an asymptotic formula for $p(n)$, developed by Hardy and S. Ramanujan (1917); and an exact expression for $p(n)$ by an infinite series, presented by H. Rademacher (1937).

2. The Waring Problem, and Related Problems.— Interest in forms capable of representing all positive integers goes back to Diophantus, of the 3rd century, who (according to Bachet de Méziriac, 1621) assumed that every positive integer is a sum of four squares. Fermat (1636) stated that: "every number is either triangular or the sum of two or three triangular numbers; every number is either a square or a sum of two, three, or four squares; either pentagonal, or the sum of two, three, four, or five pentagonal numbers; and so on ad infinitum whether it is a question of hexagonal, heptagonal, or any polygonal numbers." (If billiard balls are stacked into a triangle, the number of balls will be $1 + 2 + \ldots + x = \frac{1}{2}x(x + 1)$, called a triangular number. Generally, a *polygonal number* of order m is given by $x + \frac{1}{2}(m-2)(x^2 - x)$, where $x = 0, 1, 2, \cdots$; the squares are obtained when $m = 4$.) Fermat's theorem is that every positive integer is a sum of m polygonal numbers of order m.

This theorem was proved for squares by Lagrange (1772), for triangular numbers by Legendre (1798), for the remaining cases by Cauchy (1813–15).

In 1770 E. Waring stated an extension of the four square theorem in the direction of higher powers: every positive integer is a sum of at most 9 (positive, integral) cubes, also a sum of at most 19 fourth powers, at mosf 37 fifth powers, and in general of a limited number (whose least value we will denote by $g(k)$) of kth powers. That at least 9 cubes are required follows from the fact that 23 and 239 cannot be represented by sums of fewer cubes. The son of the great Euler noticed an integer which requires at least $2^k - 2 + [(\frac{3}{2})^k]$ kth powers. Here the symbol $[t]$ denotes the greatest integer in t.

The function $G(k)$ giving the least number of kth powers required to represent all but a finite number of positive integers is of even greater interest. Evidently $G(k) \leqq g(k)$. By Lagrange's result, $G(2) = g(2) = 4$.

Starting about the middle of the 19th century, the finiteness of $g(k)$ was gradually proved by means of elementary but complicated methods, first for $k = 4$, then for $k = 3, 5, 6, 7, 8, 10, 12$ and 14; and finite upper bounds to $g(k)$ (which, except for $k = 3$, were not best possible) were obtained. The problem of finding anything general about $g(k)$ or $G(k)$ seemed hopeless until D. Hilbert, in a famous paper of 1909, proved the fact that $g(k)$ is finite for every k. His proof is not exactly elementary, since it is based on the transformation of a 5-fold integral (in his first presentation, a 25-fold integral). The transcendental character of his proof was eliminated by various writers, but it is still a pure existence proof and gives no method of estimating $g(k)$.

The really great invention which opened up the whole subject was the work (1917) of Hardy and Littlewood, and Ramanujan. A very important step depended on H. Weyl's previous investigation of exponential sums. By use of A. L. Cauchy's integral formula, an expression can be constructed for the coefficient c_n in the expansion of

$$(1 + x^{1^k} + x^{2^k} + \cdots)^s = \sum_{n=0}^{\infty} c_n x^n$$

Briefly, the main contribution of Hardy and Littlewood to Waring's problem and similar problems mas that they invented a way to prove that if $s \geqq (k - 2)2^{k-1} + 5$, at most a finite number of coefficients in the above expansion vanish, and hence $G(k) \leqq (k - 2)2^{k-1} + 5$, and that they found an asymptotic expression for c_n, that is the number of ways n can be expressed as a sum of s kth powers. Later they found smaller bounds for $G(k)$.

Although Hardy and Littlewood proved that every sufficiently large integer is a sum of 19 fourth powers, 41 fifth powers, $\cdots$, 425 eighth powers, etc., they did not compute actual limits beyond which these facts would hold true. Hence their work gave no immediate information about the size of Waring's constant $g(k)$. In the hope of being able to prove Waring's original statement with the best possible values $g(k)$, L. E. Dickson urged certain of his students about 1930 to find lower limits to the constants in the Hardy-Littlewood analysis. R. D. James succeeded in this, and proved $g(6) \leqq 183$, $g(7) \leqq 322$, $g(8) \leqq 595$, in 1934; but the limits given by the Hardy-Littlewood method soon became impracticable.

The next and most important step came from the great Russian mathematician, I. M. Vinogradow. Vinogradow's earlier researches on the Waring problem had appeared in 1924; his methods were similar to those of Hardy and Littlewood, but led more rapidly to certain results. In his later work he made very important improvements, and found results which for large k were much better than those previously obtained. In particular, he ultimately proved $G(k) \leqq k(3 \log k + 10)$.

With the appearance of Vinogradow's new results, L. E. Dickson in the U.S. and S. S. Pillai in India investigated the possibility of proving the Waring conjecture in the original sense with best possible values $g(k)$, and both arrived independently in 1936 at an "almost complete" solution. Let $q = [(\frac{3}{2})^k]$. They proved that $g(k) = 2^k + q - 2$ if $k \geqq 7$, and

$$(\tfrac{3}{2})^k - q \leqq 1 - (\tfrac{1}{2})^k (q + 3) \qquad (1)$$

This condition is satisfied if $k \leqq 400$, and possibly for every k. When (1) does not hold, the formula for $g(k)$ is different, but was determined except for those values k (if any) satisfying

$$(\tfrac{3}{2})^k - q = 1 - (\tfrac{1}{2})^k (q + 2) \qquad (2)$$

The exceptional case (2) was finally solved in 1944 by I. Niven. Further, (although his proof may require minor corrections) Pillai proved that $g(6) = 73$ in 1940. Accordingly, Waring's problem was completed (1944) as regards $g(k)$, except when $k = 4$ and 5.

The best results for these cases were those of Dickson (1933) that $19 \leqq g(4) \leqq 35$, $37 \leqq g(5) \leqq 54$; and Davenport (1942 and 1939), that $G(5) \leqq 23$ and $G(4) = 16$. The latter is a best possible result, since the infinitely many numbers $16^h \cdot 31$ require 16 fourth powers. It was, up to 1944, the only best possible result known for $G(k)$, $k \geqq 3$.

In 1909 (except for an omission supplied by A. Kempner in 1912) A. Wieferich proved that $g(3) = 9$. In the same year Edmund Landau showed that $G(3) \leqq 8$. In 1944 U. V. Linnik gave a proof (a lacuna being later filled) that $G(3) \leqq 7$. Dickson proved in 1939 that every number except 23 and 239 is a sum of eight cubes. Numerous generalizations of the Waring problem have been investigated, such as sums of kth powers of primes, integral valued polynomials, etc.

3. The Goldbach Problem. In an exchange of letters (1742) between Euler and C. Goldbach, it was conjectured that every integer is a sum of three primes, and every even integer a sum of two primes. Not considering 1 as prime, and omitting the even prime 2, we may formulate these conjectures for odd integers $\geqq 9$ and even integers $\geqq 6$.

No essential progress was made in solving this problem until the result (1923) of Hardy and Littiewood based on the G.R.H. (see *Gauss's* Class-number *Conjecture*, above). In 1930, L. Schnirelmann proved that every positive integer can be represented by a sum of at most 800,000 primes. This number was lowered to 2,208 by N. P. Romanoff in 1935; to 71 by Heilbronn, Landau, and H. F. Scherk in 1936; to 67 by G. Ricci in 1937. Supplementing the analytic methods of Hardy and Littlewood by powerful new methods of his own, Vinogradow proved that every sufficiently large odd number is a sum of three odd primes, in 1937. In the first award of the Stalin prizes in 1941, Vinogradow received a first prize of 100,000 rubles for his work on the Goldbach problem.

V. DIOPHANTINE APPROXIMATION

1. Geometry of Numbers.—A lattice (in the plane) is the configuration formed by two systems of equidistant parallel lines. The points of intersection form a *point* lattice. A lattice L can he defined analytically by two linear forms with real coefficients and integer variables: if x and y take all integral values, the points with rectangular co-ordinates $(\alpha x + \beta y, \gamma x + \delta y)$, where $\alpha, \beta, \gamma, \delta$ are given real numbers, form a point lattice. The four points $O = (0, 0)$, $P = (\alpha, \gamma)$, $Q = (\beta, \delta)$, $R = (\alpha + \beta, \gamma + \delta)$ are the vertexes of a "fundamental parallelogram," of area $\Delta = \alpha\delta - \beta\gamma$ (which we assume not zero). In particular, if $\alpha = \delta = 1$, $\beta = \gamma = 0$, the lattice consists of all points (x, y) with integral co-ordinates. Any linear transformation $x = ax' + by'$, $y = cx' + dy'$, where a, b, c, d are integers and $ad - bc = \pm 1$, produces a different system of parallelograms based on the same point lattice. The lattices so derived are said to be *equivalent*. The area Δ of a fundamental parallelogram is the same for equivalent lattices.

Consider a parallelogram with centre at 0, and with two lattice points. P_1 and Q_1 of L as midpoints of adjacent sides. Let the area of the parallelogram be 4k. If $k = \Delta$ (which is least possible), there are at least 8 points of L on the boundary, but none (except 0) in the interior of the parallelogram. This fact is a special case of a famous theorem of Minkowski, which asserts that any simple, closed, convex region R symmetrical about O, and of area greater than 4Δ, contains within it points of L other than 0. One may think of R as the interior of a parallelogram or of an ellipse. This theorem can be extended to n dimensions.

Other important theorems of Minkowski (some of the proofs of which use the above theorem on convex bodies) concern sets of n linear forms $\xi_i = \alpha_{i1}x_1 + \ldots + \alpha_{in}x_n$ ($i = 1, \cdots, n$), with real coefficients α_{ij}, and n integral variables $x_1, \cdots, x_n$. Supposing, for simplicity that $n = 2$, me have $\xi = \alpha x + \beta y$, $\eta = \gamma x + \delta y$.

Let D denote the absolute value of the determinant $\alpha\delta - \beta\gamma$, and assume $D \neq 0$. One theorem asserts that there exist integers x and y not both zero, such that $|\xi\eta| \leqq \frac{D}{\sqrt{5}}$. A second theorem states that if b and c are positive numbers such that $bc \geqq D$ (*e.g.*, if $b = c = \sqrt{D}$), then there exist integers x and y not both zero such that $|\xi| \leqq b$ and $|\eta| \leqq c$. Both these theorems extend to n dimensions. A third theorem asserts that if p and a are given real numbers, we can find integers x and y such that

$$|(\alpha x + \beta y - \rho)(\gamma x + \delta y - \sigma)| \leqq \tfrac{1}{4}D$$

The obvious extension to n linear forms would have $\frac{D}{2^n}$ on the right. The case $n = 3$ was proved by R. Remak in 1923, but the cases $n \geqq 4$ had up to 1945 defied attempts at proof. The case $n = 4$ was proved by F. J. Dyson in 1948. After 1938, powerful methods of investigating certain nonconvex regions mere developed by L. J. Mordell, H. Davenport and K. Mahler.

2. Diophantine Approximation.—The literature on the approximation of irrational numbers by rational fractions is very extensive. We saw, by continued fractions, that if θ is any irrational number, there are infinitely many rational fractions

$$\frac{P}{q} \text{ such that } \left|\theta - \frac{p}{q}\right| < \frac{1}{q^2}$$

A different proof (which is based on Dirichlet's principle that if $n+1$ objects are in n boxes, then at least one box contains two or more objects) is worth giving, because it extends easily to n-dimensional problems. Let (x) denote $x - [x]$; *i.e.*, the fractional part of x. The $Q + 1$ numbers (0), (θ), (2θ), $\cdots$, $(Q\theta)$ define $Q + 1$ points distributed among the Q intervals

$$0 \text{ to } \frac{1}{Q}, \frac{1}{Q} \text{ to } \frac{2}{Q}, \cdots, \frac{(Q-1)}{Q} \text{ to } 1$$

At least one interval must contain two numbers, say $(q_1\theta) = q_1\theta - p_1$, $(q_2\theta) = q_2\theta - p_2$, where p_1, p_2, q_1, q_2 are integers, and $0 \leqq q_1 < q_2 \leqq Q$. Hence $p = p_2 - p_1$ and $q = q_2 - q_1$ satisfy

$$|q\theta - p| < \frac{1}{Q}, \left|\theta - \frac{p}{q}\right| < \frac{1}{qQ} \leqq \frac{1}{q^2}$$

If θ is irrational, there will be a larger Q_1 such that

$$|q\theta - p| > \frac{1}{Q_1}$$

new approximations can be determined by means of Q_1. An extension of this argument proves the result of Dirichlet: If $\theta_1, \theta_2, \cdots, \theta_k$ are any real numbers, then one can find integers $p_1, \cdots, p_k$, and q such that

$$\left|\frac{p_i}{q} - \theta_i\right| < \frac{1}{q^{1+1/k}}, \ (i = 1, \cdots, k)$$

if at least one θ_i is irrational there are infinitely many solutions p_i and q.

In 1884 L. Kronecker proved that if θ is any irrational number there are integers n such that $(n\theta)$ is as near as we please to any number in the interval 0 to 1; briefly, $(n\theta)$ is dense on the interval (0, 1). Moreover, as proved about 1912, this distribution is uniform over the interval (0, 1); *i.e.*, if I denotes a subinterval of (0, 1) of length I_1, and if n_I of the points ($), (2θ), $\cdots$, $(n\theta)$ fall in I, then $\frac{n_I}{n} \to I_1$, as $n \to \infty$. In Mathematisclze Annalen, 77 (1916), Weyl proved that a necessary and sufficient condition for uniform distribution of the numbers $(f(n))$, $n=1$, 2, 3, $\cdots$, is that $\frac{1}{n}\sum_{k=1}^{n} e^{2\pi i h f(k)} \to 0$ as $n \to \infty$ for every integer h.

Transcendental Numbers.—Any real number which is not algebraic (see below) is called *transcendental*. Interest in transcendental numbers perhaps first arose in connection with the classical problem of "squaring the circle," which could be performed by Euclidean constructions if and only if the number a were expressible by means of square roots and rational operations. The impossibility of this construction was demonstrated when F. Lindemann proved the transcendence of π in 1882.

Liouville proved a theorem which shows how to obtain as many transcendental numbers as we please (1851). It states that if ξ is a real algebraic number of degree η and K is any constant, then there exist at most a finite number of rational fractions

$$\frac{p}{q} \text{ such that } \left|\frac{p}{4} - \xi\right| < \frac{K}{q^{n+1}}$$

Hence a number with a sufficiently rapid sequence of rational approximations is transcendental (*e.g.*, this is true of .10100100010$\cdots$).

Among the numbers known to be transcendental me may mention $e, \pi, \log_e 2, 2^{\sqrt{3}}, e^\pi$. In 1900, Hilbert proposed the problem of proving that if a and β are algebraic numbers, a not 0 or 1, and β is irrational, then α^β is transcendental. This was proved in 1934 by Alexis Gelfond and T. Schneider, independently.

VI. GENERALIZATIONS OF ARITHMETIC

1. Algebraic Numbers.—Gauss was the first to extend the notions of arithmetic (integrality, divisibility, primality, etc.) to systems other than the ordinary integers. He defined a complex number $a = a_0 + a_1 i$ (where a_0, a_1 are rational numbers and $i^2 = -1$) to be a complex integer if a_0 and a_1 are ordinary integers. Ordinary integers will hereafter be called *rational* integers. Divisibility is defined as usual : $b|a$ if $a = bc$ in complex integers. The number $a_0 - a_1 i$, called the conjugate of a, may be designated by a'. The product aa' is the rational integer $a_0^2 + a_1^2$, and is called the *norm* of a. If $a = bc$, then $a' = b'c'$, $aa' = (bb')(cc')$, so that the norm of b is a factor (in the ordinary sense) of the norm of a. The only complex integers which divide all complex integers are those of norm 1, the units ± 1 and $\pm i$. If $b|a$ then the associates ub of b, where u is any unit, are also factors of a. If the complex integer p (not a unit) has no factors other than its associates and units, p is called a *prime*. It turns out that $p = p_0 + p_1 i$ is a complex prime if the norm of p is a rational prime of the form $4n + 1$, or if $p = \pm(1 \pm i)$, or if p is the associate of an ordinary prime of the form $4n + 3$. One proves that $p \mid ab$ only if $p \mid a$ or $p \mid b$, and deduces the fundamental theorem of arithmetic in the system of complex integers. Virtually all the theorems of ordinary theory of numbers have analogues among complex integers.

E. E. Kummer, in studying Fermat's equation $x^n + y^n = z^n$ (See FERMAT'S LAST THEOREM), developed the theory of integral elements in the fields generated by nth roots of unity (Gauss's case is $n = 4$), and found (about 1847) that the fundamental theorem of arithmetic does not always hold true in such systems.

To illustrate this, consider the system of numbers $a = a_0 + a_1\theta$, where $\theta^2 = -5$ and the a, are rational numbers; a is called integral if the a, are rational integers. The conjugate a' is now $a_0 - a_1\theta$ and the norm of a is $aa' = a_0^2 + 5a_1^2$. As before, if $b|a$, then the norm of b divides the norm of a. Hence the units (of norm 1) are ± 1. The number $1 + \theta$ (of norm 6) must be a "prime," since neither 2 nor 3 are norms. This prime $1 + \theta$ is a divisor of $(1 + 0)(6 + 5\theta) = -19 + 11\theta = (-1 + 3\theta)(4 + \theta)$. But $1 + \theta$ is not a divisor of $4 + 0$, since the norm 6 does not divide the norm 21. Hence the fundamental theorem of arithmetic (with many of its consequences) does not hold.

If θ is a real or complex solution of an algebraic equation of the type $a_0x^n + a_1x^{n-1} + \cdots + a_n = 0$, where the coefficients a, are rational numbers, θ is called an algebraic number. It is called an algebraic *integer* if it satisfies such an equation with $a_0 = 1$, and $a_1, \cdots, a_n$ integers. Examples are i and $\sqrt[3]{6}$. One frequently considers the algebraic integers in a given algebraic field, which consists of all numbers of the form $b_0 + b_1\theta + b_2\theta^2 + \cdots + b_r\theta^r$ with rational coefficients b,. The sum, difference, and product of two algebraic integers in a field are easily seen to be algebraic integers in the same field.

2. Ideals.—Suppose that S is the system of all algebraic integers, denoted by a, $b, \cdots, s$, t in a given algebraic field. Divisibility, units, associates, etc. are defined much as in the preceding two examples. Factorization into primes may not be unique.

However, by adjoining to the system S a set of ideals, presently to be defined, the fundamental theorem of arithmetic can be made to hold.

If $a = bc$, then clearly the set of all multiples sa of a (where s ranges over all the integral elements of S) is included in the set of all multiples sb of b. Thus the notion of divisibility of integers can be replaced by the notion of inclusion of one set in another. The set of all multiples sa of a given number a will be called an ideal, more specifically, a principal ideal. More generally, an ideal is a set of numbers in an algebraic field, such that if u and v are any numbers in the set then $su + tv$ are in the set, where s and t range over all the integers of the field. In the case of rational integers, if u and v are any rational integers not both zero, then the set of numbers $su + tv$ is the same as the set of numbers md, where d is the g.c.d. of u and v; hence every ideal is then principal. The same is true in Gauss's case of numbers $a_0 + a_1 i$. But the field generated from $\theta^2 = -5$ contains nonprincipal ideals.

The product of two ideals is the ideal obtained by multiplying each element of one by each element of the other, and then constructing all combinations $su + tv$ (s and t integral, u and v in the ideal). The principal ideal consisting of all multiples sa of a will be denoted by (a); the ideal consisting of all combinations $su + tv$ by (u, v). It can be shown that every ideal in an algebraic field can be expressed in this way by one or two terms. The ideal (1) plays the role of the number 1; i.e., for any ideal $\mathfrak{a}$, $(1)\mathfrak{a} = \mathfrak{a}$. An ideal whose elements are algebraic integers is called integral. A prime ideal is an integral ideal with no divisors except itself and (1). The fundamental theorem of arithmetic can be shown to hold in an algebraic field, if each algebraic integer a is replaced by its principal ideal (a), and the system is enlarged to encompass all the integral ideals of the field: every ideal which is not a prime can be expressed as a product of prime ideals in only one way.

This may be illustrated in the above example with $\theta^2 = -5$ as follows. Let $\alpha = (1 + \theta, -1 + 3\theta)$, $\beta = (1 + \theta, 4 + \theta)$, $\gamma = (6 + 5\theta, -1 + 3\theta)$, $\delta = (6 + 5\theta, 4 + \theta)$. The ideals $\alpha, \beta, \gamma, \delta$ are easily shown to be prime ideals (of respective "norms" 2, 3, 23, and 7), and the factorization of $(-19 + 11\theta)$ into prime ideals is simply $\alpha\beta\gamma\delta$. The factorizations previously given were $\alpha\beta\cdot\gamma\delta = (-19 + 11\theta) = \alpha\gamma\cdot\beta\delta$, and it is not surprising that $\alpha\beta | \alpha\gamma\cdot\beta\delta$ without dividing $\alpha\gamma$ or $\beta\delta$.

3. *Algebras, and Their Arithmetics.* Other generalizations of number are found in the extensive theory of linear algebras, which we will illustrate only very briefly. A simple example is the algebra of quaternions (see QUATERNIONS). These are symbols of the form $a = a_0\cdot 1 + a_1 i_1 + a_2 i_2 + a_3 i_3$, where we will suppose the a_r to be rational numbers, and the basal elements $1, i_1, i_2, i_3$ satisfy the multiplication table $1\cdot b = b\cdot 1 = b, i_1^2 = i_2^2 = i_3^2 = -1, i_1 i_2 = i_3 = -i_2 i_1, i_2 i_3 = i_1 = -i_3 i_2, i_3 i_1 = i_2 = -i_1 i_3$. Algebraic operations are performed in the usual way, except that multiplication is in general not commutative (e.g., $i_1 i_2 \neq i_2 i_1$), and the order of multiplication must be preserved. The resulting algebra has many applications, physical and geometrical. The question here is, what shall be meant by an integral quaternion?

In 1886, R. Lipschitz defined a to be integral if the co-ordinates a_i are rational integers, and was able to prove the following result resembling the fundamental theorem of arithmetic. Define a', the conjugate of a, to be $a_0 - a_1 i_1 - a_2 i_2 - a_3 i_3$. The product aa' will be found to be $a_0^2 + a_1^2 + a_2^2 + a_3^2$, a rational integer called the norm of a, abbreviated $N(a)$. From $a = bc$ follows $a' = c'b'$, and hence $aa' = (bc)(c'b') = b(cc')b' = (bb')(cc')$, or $N(a) = N(b)N(c)$. The units are the eight quaternions $u = \pm 1, \pm i_1, \pm i_2, \pm i_3$ of norm 1. If b is a left divisor of a (i.e., $a = bc$ in integral quaternions), then the right associates bu are also left divisors of a. A prime quaternion is an integral quaternion a (not a unit) such that if $a = bc$ in integral quaternions, then b or c is a unit. It is easily proved that a quaternion is prime if and only if its norm is a rational prime number; e.g. $1 + i_1$ of norm 2, $2 + i_1 - 2i_2 + 2i_3$ of norm 13. Factorization into primes is in general not unique. For example, $3 = (1 + i_1 + i_2)(1 - i_1 - i_2) = (1 + i_1 + i_3)(1 - i_1 - i_3)$, yet the primes $1 + i_1 + i_2$ and $1 + i_1 + i_3$ are not right associates. However, suppose now that a is primitive, i.e. that a_0, a_1, a_2, a_3 are relative-prime, and that $N(a)$ is not divisible by 4. Factor $N(a) = p_1 p_2 \cdots p_r$ into rational primes, not necessarily distinct, but in a definite order. Lipschitz's result is this: there exist prime quaternions $t_1, t_2, \dots, t_r$ of respective norms $p_1, p_2, \dots, p_r$ such that $a = t_1 t_2 \cdots t_r$; this factorization into primes is unique, for the given order of $p_1, \dots, p_r$, except that we can introduce unit factors in the trivial way illustrated by $t_1 t_2 t_3 = (t_1 i_1)(-i_1 t_2 i_3)(-i_3 t_3)$. This theorem yields a large number of arithmetical applications; e.g., he proved thereby the formula for the number of representations of integers as a sum of 4 squares.

However, the definition of integral quaternion was somewhat arbitrary. A. Hurwitz was led by natural considerations to define a to be integral if the a_r are either all integers, or all halves of odd integers. For example, $\frac{1}{2}(1 + i_1 - i_2 + i_3)$ is integral, of norm 1. The resulting arithmetic is better behaved with respect to the prime 2 (it being unnecessary to restrict $N(a)$ to be not divisible by 4,— but still necessary to assume a primitive).

We owe, finally, to L. E. Dickson an adequate and unique characterization of a system of integral elements in any linear algebra (*Algebras and Their Arithmetics* [1923]). This includes Hurwitz's system and the theory of algebraic integers as special cases, and has formed the basis of much subsequent work.

The first half of the 20th century saw many extensions of the theory of numbers to various algebraic systems. Not all theorems extend easily, and some lead to rather surprising results. The prospects for original research were, by mid-20th century, by no means exhausted.

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NUMBER SEQUENCES. A *number sequence* is a set of numbers arranged in some order so that for each pair of numbers of the set it is determined which one of the pair precedes the other. The simplest kind of example is a finite sequence, such as 9, 15, 7, 2, $\frac{3}{2}$, where the order of precedence is from left to right. A different sequence is obtained from the same set of numbers by rearrangement, as, for example, 15, 2, 7, 9, $\frac{3}{2}$. The term infinite sequence usually refers to an unending succession of numbers, such that after each one appears a next following, as, for example, 1, 4, 9, 16, $\cdots$, n^2, $\cdots$. Such an infinite sequence is a function of a variable ranging over the positive integers and is sometimes called a simple infinite sequence. It is frequently convenient to allow repetitions in such a sequence. Other types of sequences are sometimes useful in mathematics, as, for example, the rational numbers in their usual order. (See also NUMBER: *Infinite Ordinal Numbers.*) A double infinite sequence is a function of two variables each ranging over the positive integers. It may be thought of as a set of numbers arranged in a rectangular array instead of in a line. Thus, a double sequence is not an instance of the definition given at the beginning of this article but requires an extension of that definition.

Types of Simple Sequences.— These include arithmetic progressions, harmonic progressions and geometric progressions. An arithmetic progression is a sequence such that the difference of two successive terms of the sequence is always the same number, d. If the first term is a, then an arithmetic progression may be written in the form

$$a,\ a+d,\ a+\ 2d,\ a+3d,\ \cdots.$$

It may be shown by mathematical induction that the nth term of the sequence is given by the formula $a+d(n-1)$, and the sum of the first n terms by the formula

$$\tfrac{1}{2}n[2a+(n-1)d].$$

A harmonic progression is a sequence the reciprocals of whose terms form an arithmetic progression. 4 geometric progression is a sequence such that the ratio of two successive terms is always the same number $r(\neq 1)$. If the first term is a, then a geometric progression may be written in the form

$$a,\ ar,\ ar^2,\ ar^3,\ \ldots.$$

The nth term is ar^{n-1}, and the sum of the first n termsis given by the formula

$$\frac{a(1-r^n)}{1-r}$$

These formulas are readily proved by mathematical induction. If r is numerically less than one, the expression for the sum of the first n terms approaches $\frac{a}{(1-r)}$ when n increases without limit. In this case $\frac{a}{(1-r)}$ is called the sum of the infinite geometric progression or geometric series

$$a+ar+ar^2+\cdots+ar^{n-1}+\cdots.$$

Definition of Irrational Numbers.—Simple infinite sequences of rational numbers may be used to define irrational numbers. For example, $\sqrt{2}$ may he defined by the decimal sequence 1, 1.4, 1.41, 1.414, $\cdots$, whose successive terms may be determined by any one of the customary methods of computing square roots. A sequence $a_1, a_2, a_3, \ldots, a_n, \ldots$ to be used in defining a number must be a regular sequence, in the sense that to every positive number ϵ there corresponds an integer n such that the numerical value of a_m-a_n is less than ϵ whenever m is greater than n. Two regular sequences $a_1, a_2, a_3, \cdots$ and $b_1, b_2, b_3, \ldots$ define the same number when a_n-b_n approaches zero as n becomes infinite. Algebraic operations on regular sequences are readily defined. This method of constructing the real-number system by the use of regular sequences of rational numbers is due to G. Cantor (*Math. Annalen*, vol. v [1872] and vol. xxi [1883].) It is found that regular sequences of real numbers always have real numbers as limits so that no iurther extension of the number system in this direction is necessary.

Solutions of Equations.—Infinite sequences appear in Sir Isaac Newton's method of finding solutions of numerical equations. Thus, if a_1 is sufficiently close to a root of an equation $f(x)=0$, the formula

$$a_2=a_1-\frac{f(a_1)}{f'(a_1)},$$

where $f'(x)$ is the derivative of $f(x)$, gives a closer approximation. Repeated use of this formula gives a sequence $a_1, a_2, a_3, \ldots$, of closer and closer approximations to the desired root. This sequence may be proved to be regular in accordance with the definition given above. A similar method may be employed to approximate solutions of differential equations. but in this case sequences of functions appear in place of number sequences.

See DIFFERENTIAL EQUATIONS. ORDINARY.

Summability of Infinite Series.—The term infinite series is frequently applied to the indicated sum of the terms of an infinite sequence $a_1, a_2, a_3, \ldots$ when one wishes to consider the existence and value of the limit as n approaches infinity of the related sequence $s_1=a_1$, $s_2=a_1+a_2$, $s_3=a_1+a_2+a_3$, $\cdots$. When this limit exists and is finite, the infinite series is said to converge. In the consideration of infinite series which do not converge, various methods of summation have been invented which associate with the series other sequences than the sequence $s_1, s_2, s_3, \cdots$ defined above. For example, E. Cesaro considered the sequence $t_1=s_1$, $t_2=\frac{(s_1+s_2)}{2}$; $t_3=\frac{(s_1+s_2+s_3)}{3}\cdots$. This sequence may have a limit when the sequence $s_1, s_2, s_3, \ldots$ does not; but when the latter does have a limit, the former always has the same limit. In the study of functions by the use of associated infinite series of functions, the series may fail to converge for some values of the independent variable. In some cases of this sort the value of the function may still be recovered from the series by use of a suitable method of summation.

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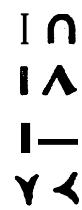
NUMENIUS (2nd century A.D.), Greek philosopher, important as a forerunner of the Neoplatonism of Plotinus. was a native of Apamea in Syria. Though generally classed as a Neo-Pythagorean, he is more accurately described as a Platonist. His hierarchy of three gods—the first. identical with Plato's "idea of the good." existing in self-contained transcendence; the second, the demiurge of Plato's *Timaeus*, which forms and rules the universe: and the third, the universe itself—seems to represent an attempt to get a systematic theology out of Plato's dialogues with the help of ideas borrowed from Xristotle and looks at first sight very like the hierarchy of being in Plotinus. But his first god is an Aristotelian "intellect," not the Plotinian "One"; and his second is much closer to Plotinus' higher soul than to his intellect. The works of Numenius, however. were much studied in the school of Plotinus.

BIBLIOGRAPHY.—For the surviving fragments of Numenius *see* F. Thedinga, *De Numenio philosopho Platonico* (1875). *See* also T. Whittaker, *The Neo-Platonists*, 2nd ed. (1918); A. H. Armstrong, *The Architecture of the Intelligible Universe in the Philosophy of Plotinus (1940)*. (A. H. AG.)

NUMERALS. Just as the first attempts at writing came long after the development of speech, so the first efforts at the graphical representation of numbers came long after people had learned to count. Judging by the habits of primitive tribes of the present as well as by the oldest trace that we have of written or sculptured records. the earliest numerals were simple notches in a stick. scratches on a stone, marks on a piece of pottery or the like. Having no fixed units of measure, no coins. no commerce beyond the rudest barter. no system of taxation and no needs beyond those of a savage. there was no necessity for written numerals until about the beginning of what we call historical times.

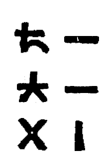
Early Forms.—The earliest numerals of which we have definite record were simply straight marks for the small numbers. with some special form for ten. These symbols appear in Egypt as early as the 1st dynasty (c. 3400 B.C.), and in Mesopotamia as early as c. 3000 B.C. These dates long precede the first known inscriptions containing numerals in India (c. 3rd century B.C.), in China (3rd century B.C.) and in Crete (c. 1200 B.C.).

Egyptian hieroglyphic, c. 3400 B.C. . . . . . .
Egyptian hieratic, c. 3400 B.C. . . . .
Cretan inscriptions, c. 1200 B.C. . . . .
Sumerian and later, c. 3000 B.C. . . . .



Someuhat later it is not uncommon to find a group mark before ten is reached. For example, four has a special symbol in certain Hindu types, as follows:

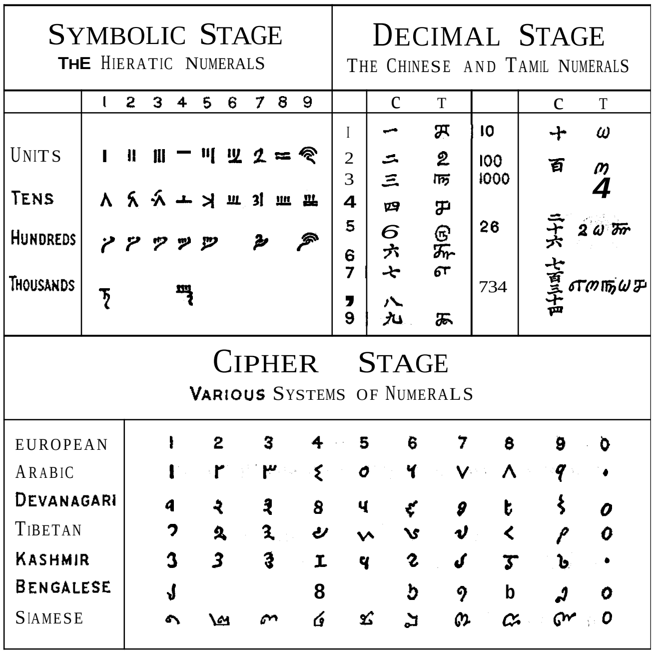
Asoka's time, 3rd century B.C. . . . . . .
Nānā Ghāt, and century B.C. . . . .
Saka, c. 1st century B.C. . . . .



Nasik, 1st or 2nd century . . . .

Kuṣana, *c.* 150 . . . .

Early Hindu Symbols for 1 and 4.—Even to-day a Chinese merchant may write one and four in the forms I and X respectively, instead of using the classical symbol. This use of a symbol for four may, in fact, have preceded the Western habit of taking



THE DEVELOPMENT OF NUMERALS THROUGH THE SYMBOLIC, DECIMAL AND CIPHER STAGES

ten as the first group number, and the Etruscan and Roman use of V or Λ for five may have been a hand symbol in use before the X was taken for ten.

The vertical marks, I, II, III, etc., may possibly be representations of the fingers held as used in counting and computing, a linguistic trace of which is found in the word *digit*. The horizontal marks may be representations of computing rods as they lie on a table. The vertical symbols were preferred in Mesopotamia and the Mediterranean region, and the horizontal ones in the Far East, where 一, 二, and 三 were commonly used for one, two, and three, 二 and 三 being cursively written to give us our present 2 and 3.

It therefore appears that the primitive numerals were I, II, III, IIII, and so on, as we find in Egypt and the Grecian lands, or 一, 二, 三, and probably so on as we usually find in the East, each going as far as the simple needs of people required. The idea of a group figure would naturally have occurred to merchants as soon as there developed a need for numbers beyond 10 or 12 (as was the case in Egypt and Babylon). Once the idea was suggested, probably influenced by the ten fingers, symbols were invented for smaller units, as in the case of those used for four and five as stated above. These naturally suggested special symbols for each of the numbers from one to ten or even farther, and the use of the additive principle to build up larger numbers, as in the Roman XXII. The idea of special symbols for larger groups, as for 20, 30, and so on, was a natural extension.

Cuneiform Numerals.—Around Babylon, clay was abundant; and in the damp clay tablets they impressed their symbols, then baking these tablets in the sun or in a kiln, thus forming historical documents that were practically as permanent as stone. Since the pressure of the stylus gave a wedge-shaped symbol, the writings are known as cuneiform (Lat. *cuneus*, a wedge, +*forma*, a shape) inscriptions.

For our purposes some leading principles will suffice. The symbol for 1 served also for 60, 3,600, and in general for 1×60^n; similarly the symbol for 10 served for 10×60^n, the context telling what particular value was indicated. The symbols could be made either with the pointed or the circular end of the stylus, as follows:

or one or ten

There was also a symbol for 100, but in general the scribe preferred to make use of the symbol for 60, thus:

$$=100, \;=60+60+10+10+10+10+10+1+\tfrac{1}{2}=171\tfrac{1}{2},$$
$$=60+60+10+\tfrac{1}{2}=130\tfrac{1}{2}.$$

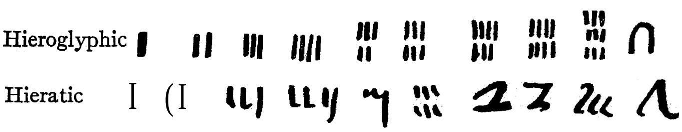
Following the general custom of the race to use small numbers instead of large ones, the Babylonians employed a subtractive principle, as we do in saying "a quarter to three" instead of "three quarters past two," and "three minutes to six" instead of "57 minutes after five." This appears in such numerals as

$$10+10-1=19, \quad\text{and}\quad =20-3=17.$$

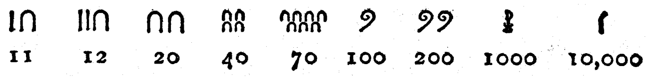
A similar custom is seen in Hebrew number names, in the occasional use of IV. for four and IX. for nine in the Roman inscriptions. The Romans also used unus de *viginti* for 19, and duo de *viginti* for 18, occasionally writing these numbers as XIX. (or IXX.) and IIXX., respectively. On the whole, however, the subtractive principle was little used in the numerals of the classical period.

FROM SMITH, "HISTORY OF MATHEMATICS"
THIRTEENTH CENTURY FINGER SYMBOLISM
From the *Codex Alcobatiensis*, in the Biblioteca Nacional, Madrid

Egyptian Hieroglyphics.—The Egyptian numerals in hieroglyphic writing differed somewhat from those in the hieratic and demotic, but the last two were degenerate forms of the first, with certain additions. It will suffice to call attention to the principles of the first and second. In doing so, however, it should be observed that the Egyptians generally wrote from right to left, as in the Semitic script, but the hieroglyphics were occasionally written from left to right or (as also the Hieratic) from top to bottom. The numerals from 1 to 10 were as follows:

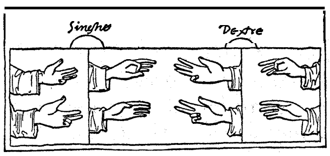


The hieroglyphic symbols for certain larger numbers were as follows:



It will therefore be seen that the general plan of the hieroglyphic notation was to have special symbols for powers of 10, and to repeat these as necessary. The Hieratic had special symbols for 5, 7, 8, and 9—a step toward the later Hindu system. The Hieroglyphic was similar in principle to the Etrusco-Roman, except that the latter introduced special numerals for 5, 50, and 500.

Greek Numerals.—The Greeks had two important systems of numerals, besides the primitive plan of repeating single strokes, as in III III for six. Their predecessors in culture—the Babylonians, Egyptians, and Phoenicians—had generally repeated the units up to nine, with a special symbol for ten, and so on. The early Greeks also repeated the units to nine, and probably had various symbols for ten. In Crete, whose early civilization was so much influenced by that of Phoenicia and Egypt, the symbol for ten was 一, a circle was used for 100, and a rhombus for 1,000. Cyprus also used the horizontal bar for ten, but the precise forms



FROM SMITH, "HISTORY OF MATHEMATICS"
FIFTEENTH CENTURY FINGER SYMBOLISM
From *Sama* of Pacioli, Venice, 1494

are not of so much significance as that the grouping by tens, with special symbols for certain powers of ten, was characteristic of the early systems of the Near East.

The Greeks, entering the field much later, and influenced as to their alphabet by the Phoenicians, based their first elaborate system chiefly on the initial letters of the numeral names. This was a natural thing for all early civilizations, since the custom of writing out the names for large numbers was at first quite general, and the use of an initial by way of abbreviation of a word is universal. These initial numerals, in modern characters, were

Π, pi, for ΠΕΝΤΕ (pente), five;
Δ, delta, for ΔΕΚΑ (*dekà*), ten; often written like O;
H, an old Attic breathing, like our h, later represented by a special symbol like ‘, for HEKATON (hekaton), hundred;
X, chi, for XIΛIOI (chil'ioi), thousand;
M, mu, for MΥPIOI (myr'ioi, *mur'ioi*), ten thousand.

These numerals were frequently combined, thus:

ΠΔ or ΠΔ, pente-deka, for 5×10, or 50;
ΠΗ, *pente-hekaton*, for 5×100, or 500;
ΠΜ, *pente-murioi*, for 5×10,000 or 50,000.

This system appears in records of the 3rd century B.C. but was probably used much earlier. In the 2nd century of our era it was described by the grammarian Herodianus, and hence characters are often spoken of as Herodianic numerals. They are more properly called Attic numerals, being the ones always found in the Attic inscriptions.

As early as the 3rd century B.C. another system came into use, running parallel to the initial-letter one, being better adapted to the theory of numbers, and being more difficult of comprehension by the trading class. It consisted in assigning nine letters of the alphabet to the numbers 1–9, nine letters to the numbers 10, 20, 30, ..., 90, and nine letters to the numbers 100, 200, 300, ..., 900. Since, however, there were only 24 letters in the Greek alphabet, three were added, namely the Phoenician *vau* (shaped like our letter F), *koph* or *qoph* (shaped somewhat like our letter Q, which indeed is derived from the same source, and represented below as Q), and a character known in modern times as *sampi* (and then shaped somewhat like the Greek π, but tipped about 45° to the right and represented below as &). An earlier form of this last symbol was &. The numerical values of the letters were therefore as follows:

Units . .	A	B	Γ	Δ	E	[F]	Z	H	Θ
	1	2	3	4	5	6	7	8	9
Tens . .	I	K	Λ	M	N		O	Π	[Q]
	10	20	30	40	50	60	70	80	90
Hundreds .	P		T	T	Φ	X		Ω	[&]
	100	200	300	400	500	600	700	800	900

The thousands were often indicated by placing a bar to the left of the numeral, thus:

/A = 1,000 /B = 2,000 /I = 10,000 /Σ = 200,000

The myriads (MΥPIOI, *myrioi*, ten thousands) were represented by such symbols as

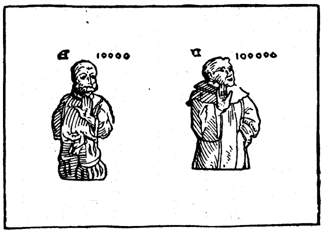
M or $\overset{\Upsilon}{M}$, for 10,000, $\overset{\Delta}{M}$ for 4×10,000, or 40,000, etc.

Such numeral forms were not particularly difficult for computing purposes, once the operator was able automatically to recall the meaning of each. To be able to express 10,407 by MΥZ would have seemed to a Greek considerably simpler than by our system. The capital letters were used by the Greeks, the small letters being a relatively modern invention.

Hebrew **Numerals.**—By the 2nd century B.C. at the latest, the Hebrews had established a system of alphabetic numerals similar to the one used by the Greeks. The alphabet being exhausted when the symbol for 400 was reached, the letters for 400 and 100 were combined by early writers to represent 500, and similarly up to 900. Later scholars used the final forms of the letters for 20, 40, 50, 80 and 90 (that is, the form of the letter that would be used at the end of a word) to represent 500, 600, ..., 900. The scheme then appeared as follows:

Units . .	א	ב	ג	ד	ה	ו	ז	ח	ט
	1	2	3	4	5	6	7	8	9
Tens . .	י	כ	ל	מ	נ	ס	ע	פ	צ
	10	20	30	40	50	60	70	80	90
Hundreds . .	ק	ר	ש	ת	ך	ם	ן	ף	ץ
	100	200	300	400	500	600	700	800	900

Roman Numerals.—The direct influence of Rome for such a long period, the superiority of her numeral system over any other simple one that had been known in Europe before about the 10th century, and the compelling force of tradition explain the strong position that the system maintained for nearly 2,000 years in commerce, in scientific and theological literature, and in belles *lettres*. It had the great advantage that, for the mass of users, the memorizing of the values of only four letters was necessary—V, X, L, and C. Moreover, it was easier to see three in III than in 3, and to see nine in VIIII than in 9, and correspondingly easier to add numbers—the simplest of all the operations.



FROM SMITH, "HISTORY OF MATHEMATICS"
SIXTEENTH CENTURY FINGER SYMBOLISM
From the *Abacvs* of Johannes Aventinus, Nürnberg, 1522

As in all such matters, the origin of these numerals is obscure, although the changes in their forms since the 3rd century B.C. are well known. Of the various theories that of Mommsen (1850) has had the widest acceptance. This was that the use of V for 5 is due to the fact that it is a kind of hieroglyphic representing the open hand with its five fingers. Two of these gave the X for ten. Three of the other symbols, he asserted, were modifications of Greek letters not needed in the Etruscan and early Latin alphabet. These were *chi*, which appears in inscriptions not only as X but also in such forms as ⊥, ↓, and which later became the L that was arbitrarily chosen for 50; theta, Θ, which was selected for 100, being finally changed to C under the influence of the word *centum* (hundred); and *phi*, Φ, to which was assigned the value 1,000, and which finally took the forms (I), and M, the last being chosen because of the word *mille* (thousand). There is considerable epigraphical evidence in support of these contentions made by Mommsen. (See the bibliography for other theories.)

The oldest noteworthy inscription containing numerals representing very large numbers is on the *columna* rostrata, a monument erected in the Roman forum to commemorate the victory of 260 B.C. over the Carthaginians. In this a symbol for 100,000, which was an early form of (((I))), was repeated 23 times, making 2,300,000. This illustrates not only the early Roman use of repeated symbols, but also a custom which extended to modern times—that of using (I) for 1,000, ((I)) for 10,000, (((I))) for 100,000, and ((((I)))) for 1,000,000. The symbol (I) for 1,000 frequently appears in various other forms, including the cursive ∞. All these symbols persisted until long after printing became common. In the middle ages a bar (*vinculum*, *titulus*) was placed over a number to multiply it by 1,000, but this use is not found in the Roman inscriptions. When the bar appears in early manuscripts it was merely for the purpose of distinguishing numerals from nouns, as in the case IIVIR for *duumviri*. We also find in the middle ages such forms as |$\overline{\text{X}}$| or |X| for ten hundred thousand and |$\overline{\text{M}}$| for one thousand hundred thousand.

Of the later use of the numerals, a few of the special types are as follows:

(1) $\overline{c}$. $\overline{\text{lxiiij}}$. ccc·1·i, for 164,351, Adelard of Bath (c. 1120).
(2) II DCCC.XIIII, for 2,814, Jordanus Nemorarius (c. 1125).
(3) MCCLVI, for 1,656, in San Marco, Venice.
(4) cIↄ Iↄ Ic, for 1,599, Leyden ed of Capella, 1599.
(5) IIIIxxet huit, for 88, a Pans treaty of 1388.
(6) four Cli.M, for 451,000, Baker's arithmetic (1568).
(7) vj.C for 600 and CCC.M for 300,000, Kecorde (c. 1542).

The first represents the use of the vinculum; (2) represents the place value as it occasionally appears in Roman numerals; (3) illustrates the not infrequent use of ɑ (like ᴅ, originally half of (I), the symbol for 1,000); (4) illustrates the persistence of the old Roman form for 1,000 and 500, and the subtractive principle so rarely used by the Romans for a number like 99; (5) shows the use of quatre *vingt* for 80, commonly found in French manuscripts until the 17th century, and occasionally later, the numbers often being written like iiij^{xx}, vij^{xx}, and so on; (6) represents the coefficient method, "four C" meaning 400, a method often leading to forms like ijM or IIM for 2,000, as shown in (7).

The Maya Use of Place Value.—Evidence of some appreciation of place value is found in various systems of notation. For example, the cuneiform inscriptions contain frequent examples like ıttı (using ı to represent the vertical wedge and *t* to represent the tens symbol), in which the first ı stands for 60 and the last ı for one, the number being 81. Similarly the later Roman forms occasionally contain cases like II . CX for 2,110, although these are not examples of the systematic use of place value as we understand it. In Yucatan, however, the highly developed Maya civilization used, for calendar purposes, a system of numerals based upon a scale which has elements of both 5 and 20, the horizontal bar (—) representing 5 and the dot (·) representing unity. The following are examples:

The Mayas also had a symbol for 0 in connection with which the place value clearly appears, as follows:

, 1 twenty and no units

, 15 twenties and no units

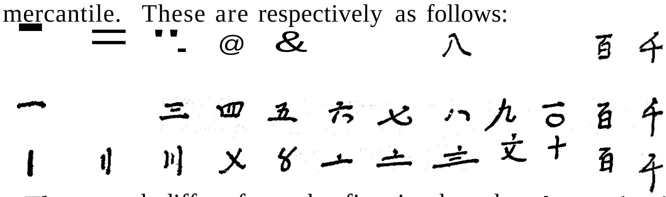
, 17×20 and no units (our 340)

The next number after 17 X 20+19 is 360, which then became a kind of super-radix, as follows:

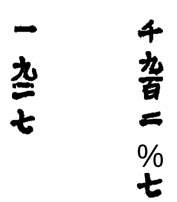
, 19×360+13×20+13=7,113.

The Maya numerals seem to have been used for writing numbers rather than for calculation.

Chinese Numerals.—The Chinese have three general systems of numerals—the ancient national, the modern national, and the mercantile. These are respectively as follows:



The second differs from the first in that the place value is used, the circle ○ being used for our zero. The date 1937 is here shown in the two systems, the numbers being written downwards, as usual.



Modern Traditional

Sanskrit and Arabic Numerals.—By way of comparison of the modern Sanskrit and Arabic forms, the two are here shown:

Sanskrit (Devanāgarī)

Eastern Arabic, 10th century

Modern Arabic . . .

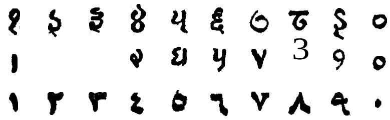
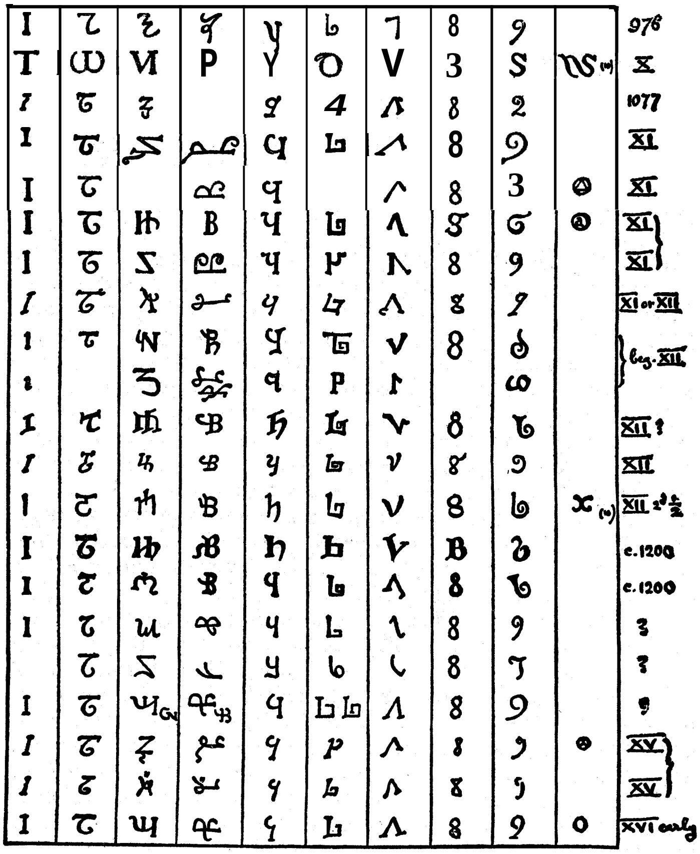


TABLE OF CHANGES OF THE HINDU-ARABIC NUMERALS IN EUROPE
From G. F. Hill's *The Development of Numerals in Europe*, Oxford, 1915
Reproduced by permission of the author and the Oxford University Press



Our Common Numerals.—Several different claims, each having a certain amount of justification, have been made with respect to the origin of our present numerals, commonly spoken of as Arabic but preferably as Hindu-Arabic. These include the assertion that the origin is to be found among the Arabs, the Persians, the Egyptians, and the Hindus. It is not improbable that the intercourse between traders served to carry such symbols from country to country, so that our numerals may be a conglomeration from different sources. The country, however, which first used, so far as we know, the largest number of our numeral forms is India. The 1, 4, and 6 are found in the Aśoka inscriptions (3rd century B.C.); the 2, 4, 6, 7, and 9 appear in the Nānā Ghāt inscriptions about a century later; and the 2, 3, 4, 5, 6, 7, and 9, in the Nasik caves of the 1st or 2nd century of our era—all in forms that have considerable resemblance to our own, our 2 and 3 being well-recognized cursive derivations from the ancient = and ≡. None of these early Indian inscriptions gives any evidence of place value, or of a zero that would make our place value possible. Hindu literature gives some evidence that the zero may have been known before our era, but we have no actual inscription containing such a symbol before the 9th century.

The first definite external reference to the Hindu numerals is in a note by Severus Sebokht, a bishop who lived in Mesopotamia c. 650. Since he speaks of "nine signs," the zero seems not to have been known to him. By the close of the 8th century, however, some astronomical tables of India are said to have been translated into Arabic at Baghdad, and in any case the numerals became known to Arabic scholars about this time. About 825 al-Khowârizmî wrote a small book upon the subject, and this was translated into Latin by Adelard of Bath (c. 1120) under the title of *Liber Algorismi de numero Indorum*. There is some reason for believing that the numerals found their way into Europe even earlier than into Baghdad, but the earliest European manuscript that is known to contain them was written in Spain in 976. The table on preceding page shows their subsequent development until the time of printing.

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NUMERAL SYSTEMS. There is no language without some numerals; the notion of unity and plurality is expressed at least in the formation of "one" and "two," though "two" is often equal to "much," thus concluding a numeration that has just only started. It is doubtful whether even systemless numeration really exists, as it is mostly reported of peoples who are but vaguely known. The eastern languages of Australia, in spite of the occurrence of numerals for "three" and even "four," and in a less degree the western languages, Yuin-Kuri, Wiradhuri, Kamilaroi, and the southern central languages have been suspected of it. It remains doubtful whether Tasmania practised systemless or pair numeration. The Pygmies of the Andaman islands and Malacca form numerals for "one" and "two," yet sum up only with units, not with pairs. So with the Chiquito in South America.

The Pair System.—The pair system has numerals for "one" and "two" and forms the following numerals by addition to the "pair": $3=2+1$, $4=2+2$, $5=2+2+1$, etc. It is found in Australia among tribes ethnologically the oldest—the Kulin-Kurnai of the south-east, the Narrinyeri of the south; several of them count up to "ten" in this manner. A pure pair system still occurs in many Papuan languages of Torres straits and the adjacent coast of New Guinea. In Africa it is practised by the Bushmen. In South America it is found among the ethnologically oldest tribes—the Fuegian tribes: Yamana and Halakwulup, the Guayaki and Shipaya, and the Ges-Tapuya tribes.

The pair system starts from the parts of the human body that exist in pairs, like eyrs, ears, hands, feet. The pair system is also found in various associations with later numeration systems. The formation of a dual with the personal pronoun (and substantive) can be traced back to those times.

The Quaternary System.—The quaternary system forms the numerals above "four" by composition: $5=4+1$, $7=4+3$, $8=4+4$ (or 2×4), $9=(2\times4)+1$, $16=4\times4$. In this consequent type, however, it is but seldom met, *e.g.,* in California with the Salina and traces of it with the Chumash. In California the four quarters of the sky play an important part in religion, mythology and custom.

The Hexad System (Senary System).—When further developed to a duodecimal system this is the most useful of all as it permits of more divisions without fractional numbers than any other system, and in later stages it has been repeatedly introduced especially for astronomy or in metrical or monetary systems. In primitive numeration it has a rather limited dispersion in north-west Africa, e g, in the Huka, the Bulanda, the Apko; traces of it are to be met with among the Bube on Fernando Po.

The Quinary System.—The quinary system in its pure form, where for instance $10=2$ hands, $25=j$ hands, is found only in Saraweka, a South American Arowak language. Everywhere else it is combined either with the decimal or the vigesimal system.

The Vigesimal System.—The vigesimal system takes 20 as a basis, so as to make 20×20 the numeral next in height, if the numeration goes as far as that. It may combine either with the quinary system forming a quinary vigesimal system or more rarely and only in younger forms with the decimal system, and then becomes a decimal vigesimal system The quinary vigesimal system is frequently combined with the pair system, so that the numbers 3 and 4, often also 6. 7. 8, 9, and further 12 and 13, are formed according to the pair system.

These systems start with the fingers and the toes. Therefore "five" often means "hand," "ten" means "the two hands," 11 "one at the foot." 20 "both the feet (and hands)" or "the whole man."

The quinary vigesimal system is found sporadically in almost all the Australian linguistic groups; in nearly all the Papuan languages of the (north) east coast and exterior of New Guinea. in the oldest Melanesian languages of New Caledonia, the Loyalty islands, etc. In Asia-Europe it occurs in the border languages: Ainu, Chukchi, Koryak, in Burushaski (*q.v.*), and in the Himalaya group of the Tibeto-Burman languages.

The decimal vigesimal system is found in the Munda languages of India and in Tibeto-Chinese groups of the Himalayas, in Nicobarese, in the north (and south) Caucasian languages. With the Indo-European and the Semitic languages the dual form for 20 seems to point to a former vigesimal system. The Sumerian, too, shows traces of it. Basque practises a full (decimal) vigesimal system, so that forms like soixante-dix, quatre-vingt, quatre-vingt-dix in French are to be explained.

In Africa the vigesimal system occurs in upper Guinea, and its hinterland, from the Senegal to the Cross river, in a series of Bantu, Nande, Togo and Niger languages, and in some east Bantu languages, in the Hamitic Kunama (and Barea) and in the Bantu languages Konde and Sango.

In North America it is found in Eskimo and in the north-west in Bellacoola and Haida and several languages of California, together with Pawnee (Caddo). This system mostly as decimal vigesimal is dominant in Mexico, Central America, even in the languages of the high civilization of the Aztecs and Maya. In South America the vigesimal system is found both in the progressive civilization of the Chibchas and with a great many primitive tribes belonging to nearly every linguistic group save the Gez-Tapuya and the tribes south of the Gran Chaco.

The quinary vigesimal system, especially its older form combined with the pair system, appears to have originated in the culture cycle (*Kulturkreis,* culture area) of the totemistic-patriarchal progressive hunters; a culture type in which the human body in art (sculpture), clothing and adornment has gained greatest importance and is most cared for. According to that the vigesimal system, too, agrees up to 20 with the parts of the body.

In north-western Africa on the coast of upper Guinea a quadragesimal system has developed, derived from a vigesimal system. Its origin is due to commercial reasons, as the monetary standard in this region is a set of 40 cowries.

The Decimal Systems.—The decimal systems are superior to the vigesimal systems in taking as a basis a smaller numeric unity more easily applied, and render possible shorter forms of the numbers. Two forms are known, the quinary decimal system and the pure decimal system. In the quinary decimal system the numbers of the second pentad are formed by composition with "five" ($6=5+1$, $7=5+2$, etc.) or by the pair system (especially $6=3\times2$, $8=4\times2$) or by subtraction (especially $9=10-1$). It seems to have originated in the matriarchal soil-tilling culture. The great quantity of agricultural products which had to be counted, arranged, stored, and brought to market required to be frequently repeated and counted quickly, and thus led to this system. In the languages of this culture numeral unities have developed which spring from the special grouping of certain products: a dozen, a brace, score (three score), etc.

In Australia and in the Papuan languages it is found isolated and in rudimentary form; with the Melanesians it is fully displayed. In Asia it originally dominated the two great families of the Austroasiatic and the Tibeto-Chinese languages. Whether a quinary or a pure decimal system was the original numeration in the Ural-Altaic languages cannot be ascertained. In Africa the great majority of the languages show originally a quinary decimal system, especially the Bantu and the semi-Bantu languages and the majority of the Nilotic, Wule, Ngo-Nke and Manfu languages. So too, in North America; but neither in Mexico, Central America, nor in South America has the system spread widely.

With the pure decimal system there is no partition of the decad into two pentads and therefore the compound character of the numerals from five to ten is not met with. The whole system becomes simpler and its forms are better fitted for general application. The pure decimal system seems to have originated in the culture-cycle of the nomadic herders, who, in counting their large flocks of horses, cows, camels, sheep, etc., needed to employ high numbers with more facility. From the aristocracies of the nomadic herders it has spread everywhere, and it is now found in all nations of high culture on the whole globe, except those of Mexico and Central America, where the number 20 was used in astronomy, and thus was safe from competition. (W. Sc.)

NUMERATION: *see* NUMERALS; ARITHMETIC.

NUMIDIA, the classical name of a territory in the northern part of Africa. When the Romans first came into conflict with Carthage in the 3rd century B.C., the name was applied to the whole country from the river Mulucha (now the Muluya), to the frontier of the Carthaginian territory. Numidians were divided into two great tribes, the Massyli on the east, and the Massaesyli on the west, the limit between the two being the river Ampsaga. At the time of the second Punic war, the eastern tribe was governed by Massinissa, who took the side of the Romans, while Syphax, king of the Massaesyli, led the Carthaginians. At the end of the war, the Romans confiscated the dominions of Syphax, and gave them to Massinissa, whose sway extended from the frontier of Mauretania to the boundary of the Carthaginian territory, also south and east to the Cyrenaica, so that the Numidian kingdom surrounded Carthage except towards the sea. Massinissa, who reached a great age, retained the whole of these dominions till his death in 148 B.C. and was succeeded in them by his son Micipsa, who died in 118. For the war with Rome which followed the death of Micipsa, *see* JUGURTHA.

After the death of Jugurtha, the western part of his dominions was added to those of Bocchus, king of Mauretania, while the remainder continued to be governed by native princes until the civil war between Caesar and Pompey, in which Juba I. was defeated by Caesar. Numidia in the more restricted sense became for a short time a Roman province under the title of Africa Nova, but after the battle of Actium it was restored to Juba II., who had acquired the favour of Augustus. In 2; B.C., Juba was transferred to the throne of Mauretania, including the whole western portion of the ancient Numidian monarchy as far as the river Ampsaga, while Africa Nova was rejoined to the province of Africa; together with Africa Vetus it was governed by a proconsul, and was the only senatorial province in which a legion was permanently stationed. In A.D. 37 the Emperor Gaius sent a legatus of his own to take over the command of the legion (*see* AFRICA, ROMAN). Under Septimius Severus (A.D. 193–211) Numidia was separated from Africa Vetus and governed by an imperial procurator (*procurator* per *Numidiam*); finally, under Diocletian, Numidia became one of the seven provinces of the diocese of Africa, being known as Numidia Cirtensis, and after Constantine as Numidia Constantina. During this period it reached a high degree of civilization, and was studded with numerous towns, the importance of which is attested by inscriptions and by the massive remains of public buildings.

The invasion of the Vandals in A.D. 428 reduced it to a condition of decay; and the invasion of the Arabs in the 8th century again brought desolation on the land, which was aggravated by misgovernment till the conquest of Algeria by the French in 1833.

Chief towns of Numidia under the Romans were: in the north, Cirta, the capital, which still retains the name Constantine given by Constantine, and Hippo Regius, the see of St. Augustine; to the south, Theveste (Tebessa) and Lambaesis (Lambessa), connected by military roads with Cirta and Hippo respectively. Lambaesis was the seat of the legion III. Augusta, and the most important strategic centre.

For account of Roman remains, *see* AFRICA, ROMAN.

NUMIDINAE: *see* GUINEA FOWL.

NUMISMATICS (from the Latin *numisma*, a coin) is the study of coins and medals. Coins were first issued in the east and west in the 8th century B.C., and since then their use has spread over the whole civilized world. Unlike many objects in everyday use, they have always been highly prized by their owners, and were therefore frequently hoarded. As is still the custom in the east, it was usual to bury treasure for safety, with the result that the contents of such ancient and mediaeval savings banks are frequently turned up by the spade to-day. Coins are themselves the most imperishable of antiquities. The result is that they still exist in vast numbers of forgotten generations out of all proportion to other remains of the culture with which they were contemporary. The study of coins may therefore be expected to yield a considerable amount of information about the past, although we must be careful not to exaggerate their importance. Coins give us some idea of the wealth and importance of ancient states and cities. A study of the find-spots of coins gives an idea of their circulation in ancient times, and it is sometimes possible to make deductions about the extent of the dominion of a particular state from this; chronological analyses of finds, by reasoning from known dates to pieces of which the dates are hitherto unknown, has often given valuable results. The argument from find-spots has to be used with care, as commercial reasons frequently explain the finding of coins far from their original mints. Thus, the frequent finds of Roman gold of the early empire in India do not show that the Romans ruled there, but corroborate Pliny's reference to the tremendous drain on Rome for gold to pay for Indian luxuries; to go to the other end of the world, the huge finds of Arab silver coins in Scandinavia were brought there to pay for furs for the wealthy Abbasids and Samanids. At all times certain currencies have acquired especial popularity and have wandered far; such were in ancient times the tetradrachms of Athens and the staters of Philip II.; in mediaeval times, the dinars of the early caliphs and the ducats of Venice, and in modern times the Mexican and Maria Theresa dollar and the English sovereign.

Commercial and economic history can thus learn much from coins; their depreciation reveals times of economic stress; the base Roman antoniniani of the third century tell their tale as readily as the inflated paper currency of Germany in 1919. The imitation of the Edward I. penny on the Continent shows how welcome a really good coin was in those days of base deniers.

Coins and medals have preserved a series of portraits which throw light on the characters of their issuers. Of particular value is the light thrown by coins on ancient religion and mythology.

As datable objects they are above all valuable as the grammar of art. Not only do they throw light on local forgotten schools and preserve representations of long-lost masterpieces, but it is from them that the chronology of ancient art has been fixed. A long series of coins of a Greek town, ranging from the archaic period to the decline of art, sets a standard of comparison which enables sculpture and other objects to be dated.

The principal metals in which coins are struck are electrum, gold, silver, copper and bronze.

Electrum is a natural mixture of gold and silver which was used for the earliest Greek coins struck in Asia Minor (Lydia) until Croesus replaced it by pure gold. Electrum was the metal of the great 5th century coinage of Cyzicus. An artificial electrum was used in the 5th and 4th centuries in Carthage and Sicily.

Gold was the great currency of Asia, of the later Lydian kings, of the Achaemenids, of the Kushans and most Indian dynasties till the 12th, and again in the 17th century. In Europe it is not found till the great coinages of Philip II., Alexander III. and Lysimachus of Macedon; in Europe we find it in the Roman and Byzantine empires and their successors till the 8th century; it was revived in the 12th century with the great commercial currencies of the Italian republics and from the middle of the 14th century became the standard of the northern countries of Europe also.

In the ancient world silver was the currency of early Greece and of Republican Rome, and of the 9th to the 14th century in Europe generally; it was the currency of the Parthians, and on the whole of the Sassanians, and of the Asiatic state of the middle ages.

Bronze or copper was the early currency of Rome and Northern Italy and of China till modern times: it first appears in Greece towards the end of the fifth century, and here as usual in its later numismatic history throughout the world was used only for small change.

Lead has only been occasionally used for coins; the only lead currencies of any note are those of the Andhras of ancient India and the modern coinages of the Malay States. Iron was occasionally used in the ancient world and during World War I in Germany. Nickel was used in Bactria, 3rd century B.C., and has been extensively used in modern currencies since the middle of the 19th century. The only prewar aluminum coinage was that for British East Africa in 1908, but it was not a success. Aluminum and aluminum-bronze were used for a number of the post-World War I currencies of modern Europe.

GREEK COINS

A coin may be defined as a piece of precious metal stamped with some mark or type or inscription showing that it is issued by some authority which guarantees its weight and purity. Coins as we know them are not older than the 8th century B.C. Traces of more primitive currencies which preceded them survived into historic times. Passing over the stage of barter, when a superfluity of one necessity of life was exchanged by its owner for another necessity of which he was in want but could not so easily supply, it is found that certain things, notably oxen and instruments of husbandry, early became standards of value and were used as mediums of exchange. Among the Romans, for example, fines were exacted in cattle down to the end of the 5th century B C. and the etymology of *pecunia* from *pecus* sho s that coined money took the place of cattle. With the passing of a pastoral civilization and the transition to an agricultural community with its multiplicity of products, a demand for some more convenient medium and for small change was felt. There is abundant evidence of the use of agricultural implements and household utensils as currency in the ancient world. In China for example the earliest coins of the 8th century B.C. are models of the spades and bill-hooks which preceded them, with the addition of a proper coin-inscription showing they were issued by authority. In pre-historic Europe there were in Gaul hoards of small bronze celts which seem to have been used for currency. The most certain survival of this coin in the Mediterranean world is the iron or bronze spit (*obeliskos*—whence the name obol for a small coin). Hoards of these spits have actually been found in circumstances which show that they were currency. The most remarkable of these hoards of spits is that found in the Heraeum in Argos, dedicated by Pheidon himself—whether as specimens of demonetized currency or as standards set up in connection with Pheidon's reforms or simply dedicated specimens of the usual currency is disputed; similar bundles of spits in bronze and iron have been found in Etruria. In Homer basins, tripods and axes were used as gifts and prizes in a nay which shows that they were a recognized standard of wealth. With the invention of the scales these more or less clumsy currencies disappeared and the metal itself is used; a definite weight takes the place of a particular shape. In all countries from the 10th to the 5th centuries B.C. existed hoards of broken bronze or silver, sometimes shapeless, sometimes cast in the form of bricks or plates; later it is regularly in the form of bars which could be broken and weighed. There are finds of silver of this kind from Assyria of the 8th century B.C. and from Egypt and south Italy of a little later. The Egyptian finds frequently contain Greek silver coins chopped in a way which shows they were considered only as bullion. In Italy in particular rude chunks of copper (aes rude) were regular currency from early times to the 3rd century B.C as is known from literary references and from finds. Caesar wrote that the ancient Britons used iron bars of a definite weight, and specimens still survive; excavations have also confirmed the accuracy of Plutarch's reference to the iron money of the Spartans.

The large oblong Roman bronze pieces with a type on either side form a kind of transition from metal bars to coins although they are not earlier than some Roman coins. In any case it is a short step from the use of metal by weight to its use in pieces of definite weights with a stamp of some kind guaranteeing it is what it professes to be, so that it can be paid without weighing; at this stage it becomes a coin. It is in this form that coinage first appears in Greece and India.

Period I. 750–480 B.C.—Ancient writers—Xenophanes in the 6th and Herodotus in the 5th century—ascribe the invention of coinage to the Lydians; the latter says they were the first to strike coins of gold and silver. This definite statement probably refers to a period after the beginnings of coinage when Croesus of Lydia struck coins of pure gold and pure silver. There is, however, evidence of an earlier coinage of Lydia and Ionia of electrum, a natural mixture of gold and silver, the "white" gold of the Greeks; these early pieces, as the finds at Ephesus show, belong to the 8th century B.C. They are little globules with a variety of stamps which suggests that they are private issues and not issues of a state authority; this early coinage is irregular in weight and quality and unsystematic in character and it is not until the issues of Croesus that there is in Asia Minor an undoubted coinage by a state authority. The types on his gold and silver coins are the same, the heads of lion and bull facing one another and reverse a double incuse square caused by the anvil in striking.

In contrast to this early electrum coinage, irregular, alike in quality, types and shape, is the almost contemporary earliest coinage of Greece proper, even the oldest specimens of which, unlike the electrum, are at once recognizable as coins to the least trained eye. These coins are of silver and capable of definite attribution. The oldest are those of Aegina, and if the not early but persistent ancient tradition which says that coinage was invented by Pheidon, king of Argos, is correct, these would be his coins. The type of Aegina is a turtle—an animal associated with Aphrodite—on the obverse, an incuse square on the reverse. That the coins of Aegina are the earliest is supported by the fact that the Aeginetic standard is the most common on the earlier coins of the islands, the Peloponnese and Greece proper. It was later supplanted by the Euboic-Attic standard, the adoption of which by Solon for Athens led to its wide dissemination. By the end of the 6th century the practice of striking coins was well established in many centres. Corinth with its pegasi—from their type of a pegasus—struck staters on its own standard, a variant of the Attic and began to strike not long after Aegina. It is not improbable that Periander was the institutor of the Corinthian coinage which became one of the great commercial currencies of the Greek world. The date of origin of the coinage of Athens is still uncertain; the well known types of the head of Athena on the obverse and her attribute the owl on the reverse date from the middle 6th century and are the earliest coins with a type on both sides and the earliest also to bear a human head The exact attribution to Athens of its Solonian and pre-Solonian coins is still disputed. By the institution of the "owls," a type of coin, obverse deity and reverse an attribute of the deity, was developed which had a far-reaching effect on the development of coin-types. The head of the king on an English penny goes back to the head of Athena through the deified head of Alexander and the Britannia on the reverse similarly can be traced back to the owl. Other important towns like Thebes and trading centres like Corcyra began to issue coins about this time but a number of important towns seem to have still been content to use the currency of their neighbours. In the 6th century also are the earliest coins of Africa in the issues of the Spartan colony of Cyrene with its badge the silphium plant, the cultivation of which was its great source of revenue. Coinage was also begun by the Greek colonies in south Italy and Sicily; these latter are of a characteristic fabric. Instead of the thick dumpy piece with a type on the obverse only and an incuse square on the reverse which are common to the cities and islands of Greece, these are broad thin pieces with the type struck on both sides, in relief on the obverse. incuse on the reverse. There still exist many coins of this type of Tarenturn, Metapontum, Croton, Rhegium, Zankle (Messana), etc. By the time of the Persian R'ars coinage was a familiar feature of everyday life in the cities of the Greek world. Traders and colonists had carried the art to Cyrene in North Africa from Sparta, to south Italy from Corinth, and to Sicily from Athens and the Peloponnese. In Asia Minor also coinage spread southward and had reached Cyprus but not yet Crete. The Phoenicians and Egyptians were already familiar with Greek coins but did not attempt to copy the invention; in the north however the silver mints of Thrace and Macedon were beginning to be worked vigorously and not only the Greek cities but the barbarian tribes, also, who employed Greek legends on their coins, were actively striking.

The various coinages of this early period (down to 480 B.C.) have a number of features in common. One of the most remarkable to the modern eye is the absence of inscriptions; these are either non-existent or consist only of the initial letter or letters of the town issuing the coin. The device of the town was originally sufficient for local circulation but as coins began to go further afield it became necessary to add some indication of its name. The earliest coin legends are therefore very brief: a *koppa* for the initial of Corinth, a Φ (phi) for Phocaea, Σ Γ (Su) for Sybaris, ΑΘΕ for Athens, and so on. The earliest inscriptions of any length are still written from right to left. Long inscriptions like "I am the badge of Phanes" above a stag on an archaic coin of Ephesus or "the stamp of Gortyna" on an early coin of the Cretan mint of Gortyna are remarkable exceptions and important as showing the original nature of inscriptions and of the types themselves. They show that the genitive, which is the usual form of the name when written in full, although nominatives are not very rare, is explanatory of the type.

Types.—The types in the early period are mainly taken from the animal world; they include domestic—particularly the bull—wild animals, birds and insects (the bee at Ephesus); fabulous creatures are also common like the griffin at Abdera, the pegasus at Corinth, the Chimaera, etc.; the vegetable world is also represented, notably by the silphium plant at Cyrene. Representations of the human figure are rarer and later than other types to appear, but once the human head became established as *a* coin-type, its use spread rapidly and widely and with the disappearance of the incuse square and coming of the double typed coin a head began to be regularly used as one of the types. Complete human figures are rare and are represented either kneeling or standing, both very stiffly like the Poseidon at Poseidonia; the nymph and satyr or centaur common in Thrace hardly deserves the name of a group; elaborate compositions like the Hercules and Hesperides at Cyrene and the flight of Aeneas at Aeneia are quite unique.

With the coming of legends on coins it was no longer necessary that the main type should be the badge of the town, which is frequently relegated to the reverse or becomes merely a symbol or disappears altogether to give the artist a subject more worthy of his talents. Except in the doubtful case of the earliest electrum, coinage was always a matter for the ruling authority whether civic or regal and the earliest types are chosen to show who these are. That coinage was early recognized as too important a right for private ownership is seen from the traditions which associate all the great lawgivers, Pheidon, Solon and Lycurgus, with the institution or improvement of coinage. The sanctity of the republic's right of coinage is seen in the coinage of cities ruled by tyrants, who never put their name or other indication of their existence on the coins, although they occasionally made alterations in the types, as when Peisistratos added the head of Athena to the Athenian coins or when Anaxilos of Rhegium introduced the mule-chariot type in memory of his Olympic victory.

The early types are generally chosen from simple motives. Many of them are a punning allusion to the name of the town like the lion at Leontini, the seal at Phocaea, the goat at Aegae or the quince at Melos, or the sickle-shaped harbour at Zancle. Sometimes it is chosen from the history of a town like the figure of the mythical founder Taras at Tarentum or the Minotaur and Labyrinth at Cnossos. Types like the ear of corn at Metapontum allude to the fertility of the country about. Thrace and Macedon are notable for their huge silver octodrachms with the type of a local hero in a chariot drawn by two bulls. In Italy, Croton takes as its type the tripod of Apollo like its mother city Zacynthus. Poseidonia has a statue of Poseidon brandishing his trident. Naxos in Sicily, whose founders came from Naxos in the Aegean, has a head of Dionysos who was born in the Aegean island. Himera has a cock, a punning allusion to the name of their town for the cock proclaims the dawning of day (*hēmera*). Selinus has another punning type, the wild parsley leaf (*selinon*). Toward the end of the 6th century B.C., Syracuse introduces the celebrated type of the head of Arethusa, the nymph of a spring in Ortygia, which was in the next century to become the most famous of Greek coin types. The reverse, a victorious chariot, became a popular one in other towns. The finest specimen of this type of late archaic style is the *Demareteion* commemorating the victory over Carthage in 480. The head of Arethusa on the obverse wears the laurel wreath of the victorious and beneath the chariot on the reverse is a lion, the emblem of conquered Africa. This type of obverse spread throughout Sicily; the main types of Sicilian towns in the 5th century are local nymphs and river gods. At Catania we have the river god Amenanos; Gela has a manheaded bull swimming, a personification of the river Gelas.

Period **II. 480–336 B.C.**—The finest period in Greek coinage begins after the Persian Wars and runs to the accession of Alexander the Great in 336 B.C. The first half of this period is transitional and is marked by a great advance in technical skill, an increased delicacy in the treatment of details and greater freedom of movement in the treatment of the human figure. In the last eighty years of this period the art of engraving coins reached the highest standard it has ever attained: the head of a divinity is now established as the obverse type and is usually represented in very high relief—many of the finest are shown facing; the engravers sign their coins which show that they were artists of note and not mere artificers: the names of great artists otherwise unknown have been thus preserved. The types are very varied and almost entirely based on local mythology, although latterly the fine bigae and quadrigae types became popular in allusion to Olympic victories. The type first introduced in Athens—obverse head of *a* deity and reverse badge of the city—grows increasingly popular and towards the end of the period is almost regular. Inscriptions become general although still frequently contracted. The period is marked by a geographical extension of coining and an increase in its quantity; with the decline of the Persian empire, the cities of Asia Minor, Phoenicia and Syria show an increasing activity; the opening of the mints of Emporiae in Spain and Messalia in Gaul bring the art of coinage to the other end of the known world. Towards the end of the period the rise of Macedon under Philip II. led to the closing of many mints in northern Greece, and his coinage foreshadows the great imperial coinages of Alexander the Great. The second half of the 5th century witnesses a great expansion of the monetary influence of Athens at the expense of her allies.

The coinage of the period is mainly silver; the Aeginetic standard gradually yields to the Attic: electrum disappears except at Lampsacus and Cyzicus and sporadically at Syracuse and Carthage. Gold is continued in the darics of the Persian kings in the east and in the fine series of Lampsacene staters; with the decline of Persian power the Great King's monopoly of gold was usurped by various rulers in Cyprus and Caria. The late 5th and 4th century gold coinages of Syracuse, Tarentum and Cyrene are extensive. Toward the end of the period we have the institution of Philip II's gold stater, the first great gold coinage of the world. In the latter part of the 5th century the first copper coins were issued and soon replaced the infinitesimal small silver coins which had hitherto served as small change.

The greatest commercial currency of the 5th century was the silver coinage of Athens, as contemporary references and the huge finds still made all around the Mediterranean show. It was imitated in Central Asia and Arabia which shows the extent of its penetration. The Corinthian stater continued to be an important coinage although its circulation was more limited. The same is true of Cyzicene staters: these great currencies remain more conservative than their contemporaries which are not affected by the same commercial considerations; care is taken to avoid the slightest change, hence the long survival of the now obsolete *koppa* on the coins of Corinth or the archaic use of E for H at Athens.

The feature of the period is the development of the general type—head of a deity on obverse and reverse, the badge of the city—which usually has some reference to the deity also. We find the latter prevailing in time so that when the old type has no reference to the deity chosen, it is dropped. The gradual abandonment of these old types gave a freer choice to the artist and the simple figures of animals, plants, fabulous animals, etc., give way to mythological groups. Symbols begin to appear on coins and are usually the marks of magistrates or otherwise mark the issues and change constantly. Occasionally we find the old badge of the town relegated to a subordinate position, like the tunny fish at Cyzicus. Names of towns and magistrates are written at greater length and those of artists begin to appear. Types are occasionally labelled like the Zeus at Locri Epizephyrii or the Ajax at Locri Opuntii.

Predominance of Athens.—The causes of the predominance of Athenian currency were firstly the development of rich silver mines in Laurium in the beginning of the 6th century, which provided the money to build the ships which defeated the Persians at Salamis in 480 and secondly the prosecution of her policy of prohibiting silver issues by any city or state that came within her power, whether as tributary or as a member of the alliance in which she was the predominant partner. The members of the Confederacy of Delos while nominally retaining their monetary rights bowed to the practical advantages of a common coinage—which was that of Athens. The fine quality of its silver, the accuracy of its weights and its numerous subdivisions made the Athenian tetradrachm welcome everywhere so that Athens gained the monetary hegemony in addition to the political. In 453 Aegina became tributary to Athens, which at once put a stop to the issue of the "tortoises" and the stater of Aegina practically disappeared from the international market where it had so long competed with the "owls." Eretrea on its conquest in 445 lost its right of coinage as did its neighbour Carystus. Tenos, Naxos and other Aegean islands also ceased coining. In Asia Minor, Miletus, Cnidos and other tributaries of the Confederacy issued only small change.

One notable exception is that of Melos, which had refused to enter the League and therefore could still continue its staters. Samos and Lesbos kept up their issues but they were allies of equal status to Athens; Ephesus which entered the Confederacy in 469 continued to coin silver till 460, but there was seemingly some special arrangement in this case. Aeolis, Mysia, and Troas only struck small change. Several towns of the south coast of Thrace, like Abdera, continued their coins but these with their different standards did not compete with those of Athens in the markets of the Aegean. Phocaea, Mytilene and Cyzicus continued their electrum in the 5th century but their silver ceases. The Athenian tetradrachms thus became predominant in the Aegean and beyond, completely ousting local currencies. If we occasionally find autonomous staters, it is a sign of rebellion or shows that the town in question entered the League with special reservations. With the first news of the disasters in Sicily a general defection began and the days of the economic supremacy of Athens were soon over. The Spartans seized the mines of Laurium in 413 and cut off the supply of silver. In 407 Athens was reduced to such financial straits that the gold statues of Victory from the Parthenon were melted down for an emergency coinage; in the next year she had to have recourse to a coinage of bronze which had an unfavourable reception as it could not, like the infinitesimal silver pieces, be carried in the mouth. After being almost extinct, Athenian coinage revived after Conon's successes in 394. On the formation of the second League against Sparta, her allies however struck coins on equality with Athens and used a common type of the infant Hercules with their own reverses and their own standards. Such staters are known of Ephesus, Cnidus, Rhodes, Samos, Cyzicus and other islands and towns of Asia. This diversity of standard in the League shows that there was no monetary convention. Among the rising coinages of this period one of the chief was that of Rhodes founded in 408. Its silver and gold coins have the punning type of the rose and head of Helios. Rhodes had its own standard and its rapidly increasing commerce spread its coinage and standard quickly in the Mediterranean. In 376 Athens regained its hegemony over the islands but for a generation only. Its coinage again became abundant but never regained a predominance over the numerous local coinages which had sprung up since the end of the 5th century. In addition to Rhodes the important mints of Amphipolis and Larissa begin to issue their beautiful coins and many smaller towns open their numismatic history. The ancient coinages of Samos and Chios disappear before Athenian vengeance in the middle of the 4th century but other towns of Asia and the islands, Cnidos, Ephesus, Tenedos, and notably Cyzicus, testify in their coins to the great prosperity which their autonomy brought them. Corinth and its colonies continued to issue their staters of the old types uninterruptedly up to their conquest by Philip II. and even then did not lose the right of coinage. With this exception however the great revival of autonomous coinage in the early 4th century was short-lived. Philip II. became politically supreme, and economically his gold and silver mines enabled him to drive the gold of Cyzicus and the silver of Athens from the market, but the Attic standard was to survive in the tetradrachm of Alexander. In 404 the people of Aegina after half a century of exile returned to their homes to resume the issue of their celebrated staters but replaced the turtle of the obverse by a tortoise.

The 5th century saw the beginning of one of the finest and most interesting series of silver coins, that of Elis. From about 471 when Elis became a city to its conquest by Macedon in 322 the staters form a continuous series. The whole land was sacred to the Olympian Zeus and his symbols, the thunderbolt or eagle clutching its prey, are usual types along with a Victory in various attitudes—running to crown a victor, standing or seated with outspread wings—the latter type was copied by Pistrucci for the Waterloo medal in 1815. At a later period the head of Zeus appears as does that of Hera and also the fine head of the nymph Olympia. The legend is always FA for (F)*aleion* and the long obsolete digamma survived to the end of the coinage in the middle of the 1st century B.C. The types and the additional legend *Olympikon* occasionally found show a close connection with the Olympic games which the Eleians claimed to control. There is an interesting numismatic record at Pisa of the successful effort on the occasion of the 104th Olympiad by the Pisatans to regain their ancient right of controlling the games which they had lost when the Eleians destroyed their city in 572 B.C.

Italy and Sicily.—It is in the west in Italy and Sicily that work of the finest period is seen in greatest profusion. In Italy, Tarentum, the capital of Calabria, continued its type of Taras on a dolphin on its silver. In the middle of the 5th century the agonistic type of a horseman appears and Taras is relegated to the reverse; the celebrated Tarentine cavalry are thus commemorated down to the middle of the 4th century. About 340 Tarentum issued a series of very beautiful gold coins with a head of Persephone and, reverse, the infant Taras appealing to Zeus enthroned. These gold coins, like sudden issues of gold elsewhere, were really a money of necessity.

In Lucania, Heraclea, founded in the middle of the 5th century, issues fine staters with a helmeted Athena and Heracles seated, strangling, or wrestling with a lion. Metapontum interrupts the monotony of its ear of corn type with a most striking head of its founder Leucippus. Other mints of the time are Neapolis, with its types the siren Parthenope and her father, the manheaded bull Archelous; Velia, with its head of a nymph and reverse the eastern type of a lion attacking a bull; Thurium, with its unusually fine head of Athena and the powerful bull on the reverse, and Terina, remarkable for its beautiful treatment of the Victory type.

It is in Sicily, particularly in Syracuse, that the engraver's art reaches a perfection never attained elsewhere before or since; from the middle of the 5th to the middle of the 4th century every coin is the work of an artist. In the 5th century Syracuse began to dominate the politics of Sicily as Athens was doing in the Aegean, and her artists spread the influence of her coin-types everywhere. The coins of Syracuse showed many varieties of the heads of Arethusa and Persephone and the chariot of the reverse was found capable of very varied treatment. After the middle of the 5th century her artists began to sign their work and we

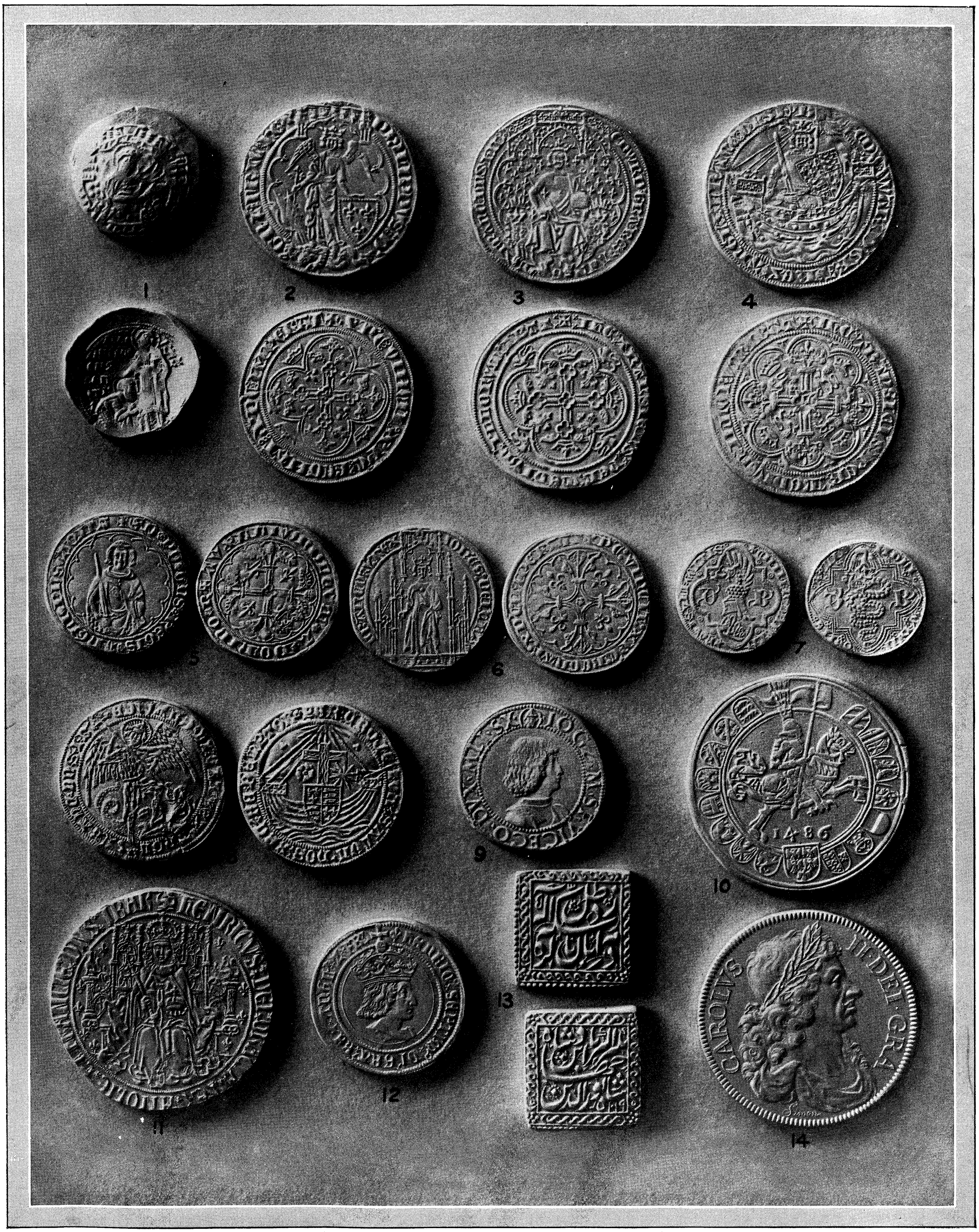
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

ANCIENT GREEK COINS

1. **Electrum** stater of Lydia. **2. Electrum** stater of **Ephesus. 3.** Gold stater of Croesus. 4. Daric of Persia. 5. Alliance of **Siris** and **Pyxus. 6.** Knossos with Minotaur and Labyrinth. 7. Stater of Thasos. 8. Tetradrachm of Athens. **9.** Stater of **Corinth. 10.** Gold stater of **Lampsacus. 11.** Stater of **Aegina. 12.** Stater of Philip II. **13.** Stater of Alexander the **Great.** 14. Decadrachm of Syracuse. 15. Stater of Rhodes. **16.** Stater of Lysimachus. **17.** Tetradrachm of Alexander the Great. 18. Tetradrachm of Antiochus Hierax. **19.** Late tetradrachm of Athens. **20.** Tetradrachm of **Ptolemy I.** 21. Tetradrachm of **Cleopatra. 22.** Gold **100** litrae of Syracuse

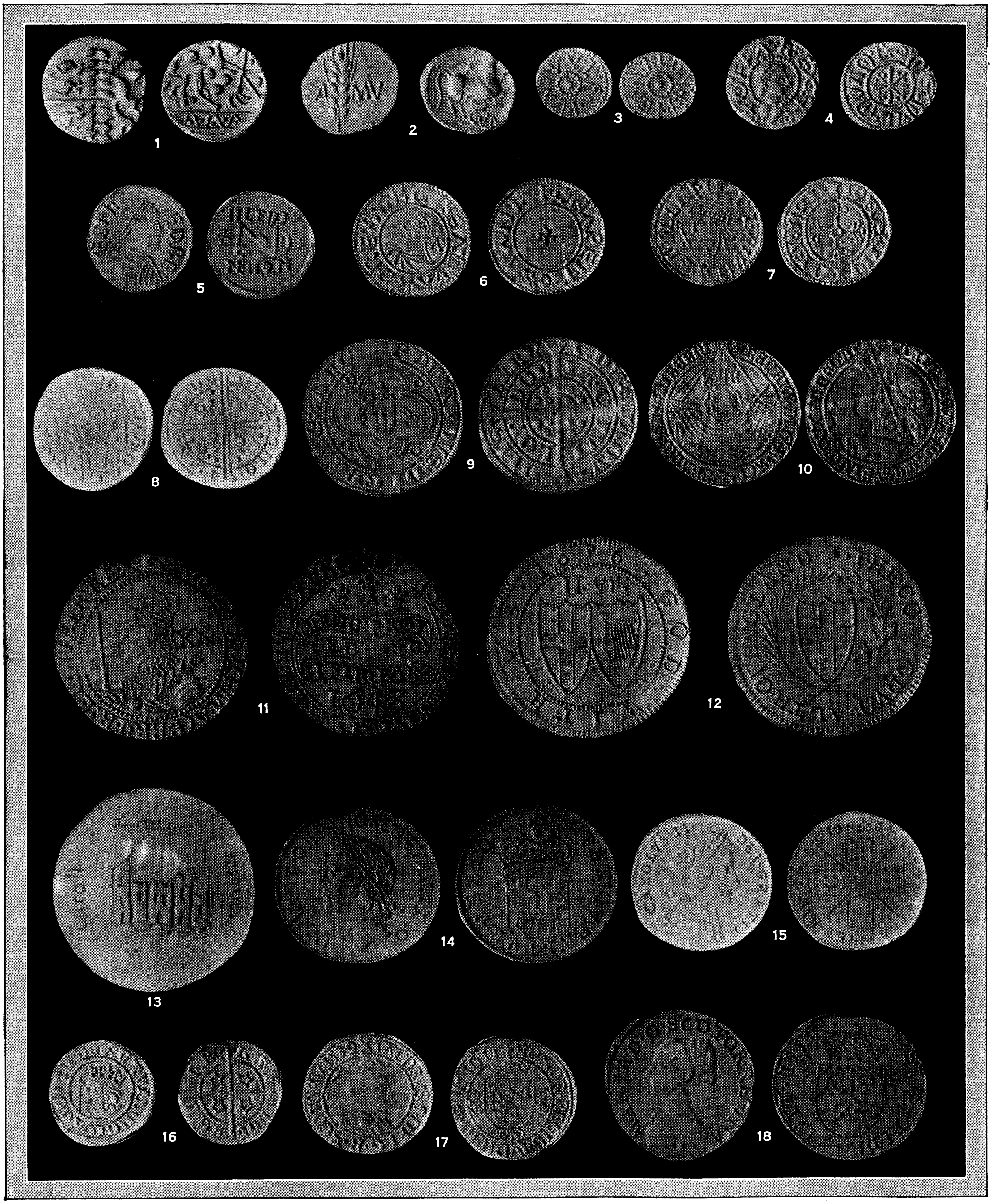
GREEK, ROMAN AND EARLY MEDIAEVAL COINS

1. Delphi, c. 480 B.C. 2. Istrus, 4th century B.C. 3. Syracuse, c. 410 B.C. 4. Egypt, 271–46 B.C. 5. Magnesia, c. 190 B.C. 6. Nero and Agrippina, A.D. 54–55. 7. Constantine Jun., 317–37. 8. Constans, 337–50. 9. Honorius, 395–423. 10. Tiberius Constantine, 578–582. 11. Offa of Britain, 757–796. 12. Coenwulf of Britain. 796–822. 13. Conrad II., 1024–39. 14. Edward the Confessor, 1042–66. 15. Thuringia (Germany), 1190–1200. 16. Frederick II., 1226–50. 17. Florin (gold) of Florence, 1252–1300. 18. Ducat (gold) of Venice, 1280–89. 19. Henry III. of England, 1257. 20, 21. Louis IX. of France, 1226. 22. Philip II. of France, 1270–85



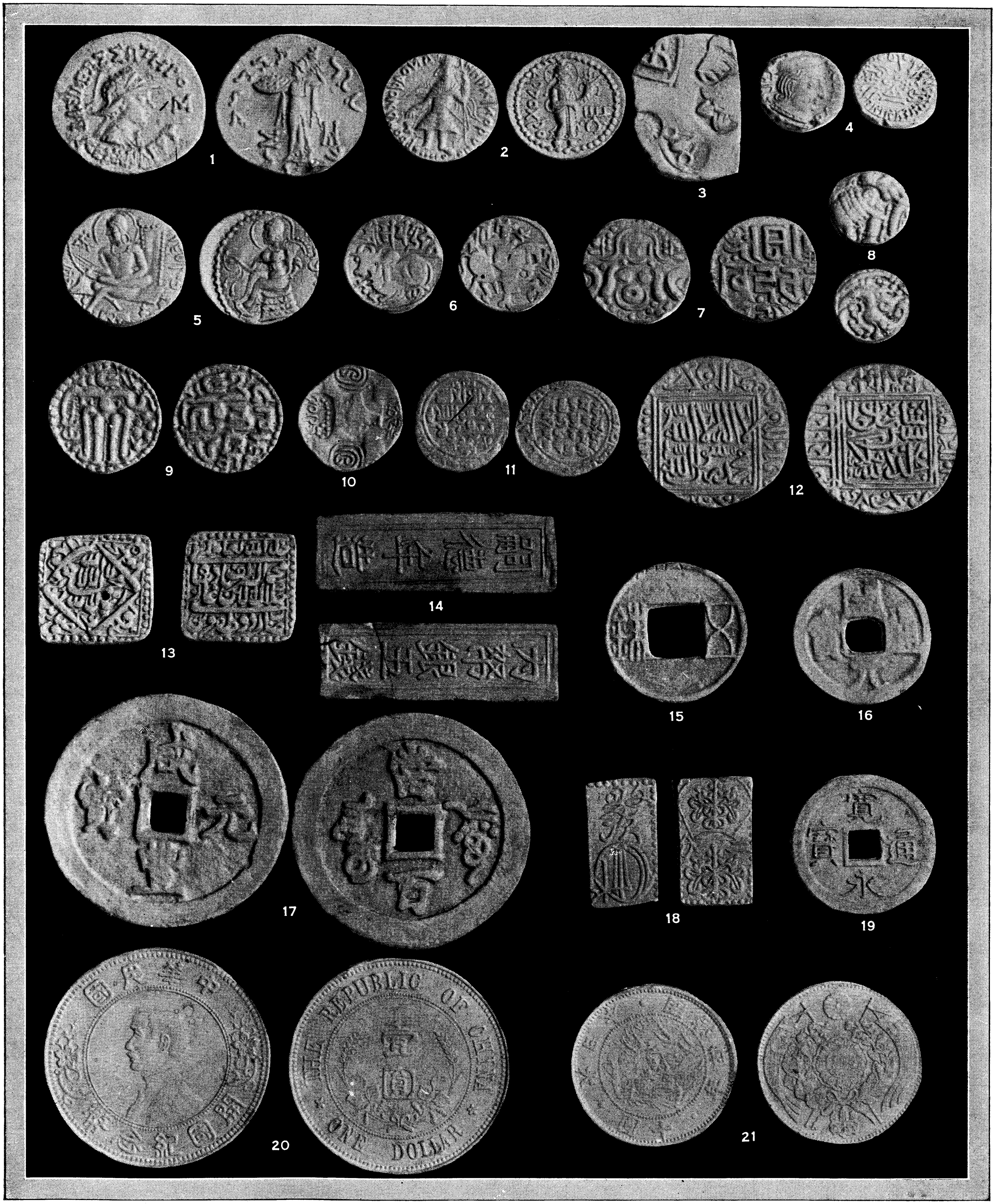
MEDIAEVAL AND LATER EUROPEAN AND ASIATIC COINS

1. Byzantine cup-shaped coin of Andronicus II. (1282–1328). Byzantine. 2. Philip VI. of France (1328–50). 3. Florin (gold) of Edward III. of England (1344). 4. Noble (gold) of Edward III. 5. The Black Prince (1368). 6. John II. (The Good) of France (1350–64). 7. Visconti family of Milan (1354–85). 8. Edward IV. of England (before 1471). 9. Milan (1479–94). 10. Austria (1486). 11, 12. Henry VII. of England. 13. The Great Mogul Jahangir (1610) India. 14. Charles II. "Petition" crown made by Thomas Simon



BRITISH COINS

1. Ancient British stater. 2. Stater of Cunobelinus (Cymbeline) 1st century A.D. 3. Northumbrian styca (copper). 7th century A.D. 4. Penny of Offa. 8th century. 5. Penny of Alfred. 6. Penny of Edward the Martyr. 7. Penny of William I. 8. Gold penny of Henry III. 9. Groat (fourpenny piece) of Edward I. 10. George noble (6s.8d.) of Henry VIII. 11. Unite or sovereign (gold) of Charles I. 12. Half-crown of the Commonwealth. 13. Colchester siege-piece. 14. Broad of Oliver Cromwell. 15. Guinea of Charles II. 16. Penny of David II. of Scotland. 17. Bonnet-piece of James V. of Scotland. 18. Ryal of Mary Queen of Scots



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

ANCIENT AND MODERN ORIENTAL COINS

1–13. INDIAN. 1. Tetradrachm of Menander. Graeco-Indian, c. 2nd–1st century B.C. 2. Stater of Kanishka. 3. Punch-marked, c. 3rd century B.C. 4. Western satrap. Silver, 1st century B.C.–4th century A.D. 5. Samudragupta, 4th century. 6. Samantadeva. 7. Govindachandra. 8. Chera, mediaeval. 9. Massa of Ceylon, c. 1200. 10, 11. Mahmud of Ghazna, 11th and 12th century. 12. Sher Shah rupee. 13. Mohur (gold) of Akbar. 14. ANNAM. Tu Duc, 1847–83. 15–17, 20. CHINESE. 15. Five-chu piece (copper), c. A.D. 500–550. 16. Kai Yuan, A.D. 618–627. 17. Hsien Feng, struck for Chinese Turkistan. 20. Republic. 18–19, 21. JAPANESE. 18. 2 *bu* piece (gold). 19. Sen. 21. Modern gold 10-yen piece

NUMISMATICS

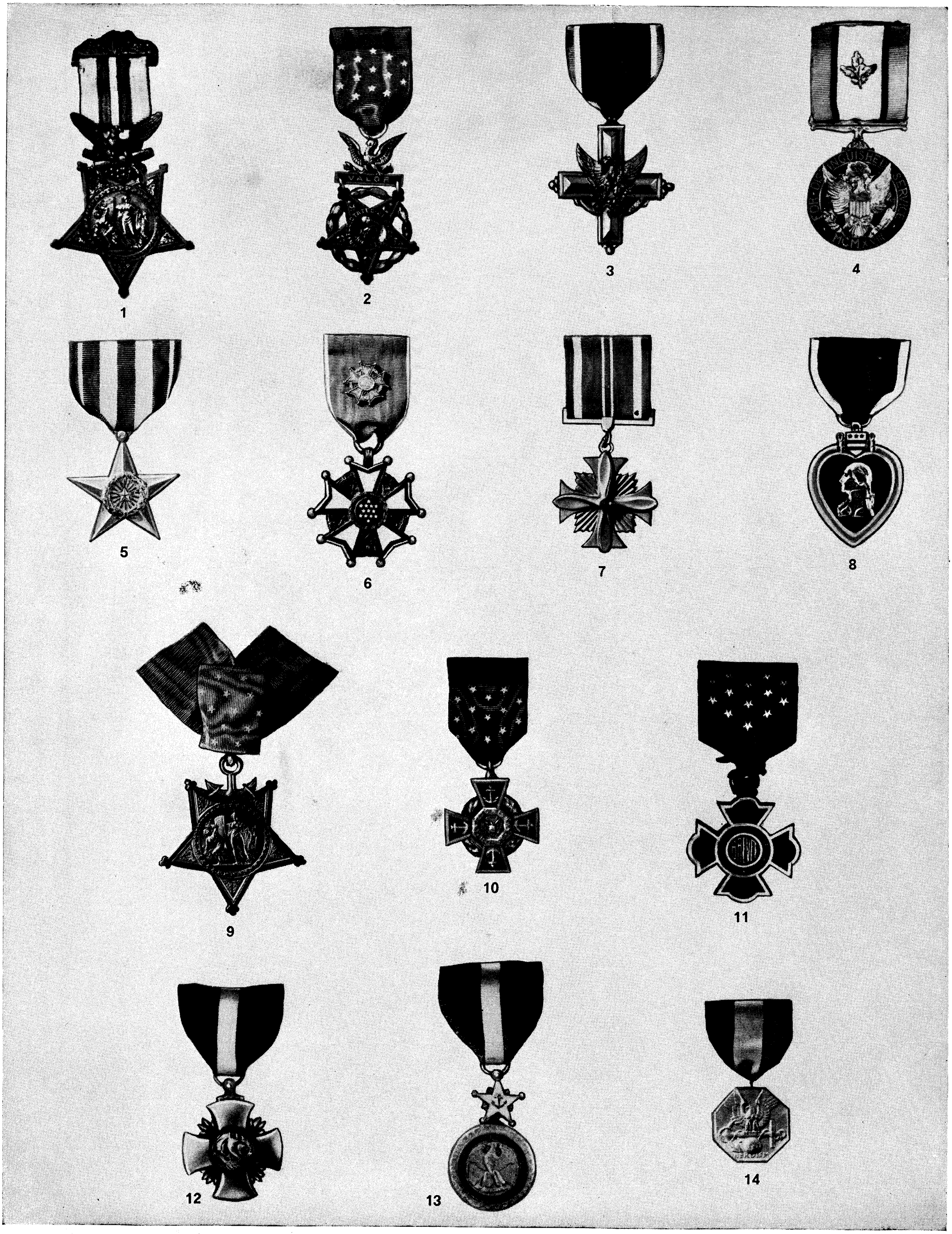
BY COURTESY OF THE AMERICAN NUMISMATIC SOCIETY

EARLY AMERICAN COLONIAL AND UNITED STATES COINS

1. The New England shilling, the first coin made by the colonists. Struck in Massachusetts. 2. The Pine Tree shilling, 1652. Made by John Hull in Boston. 3. The Lord Baltimore sixpence. Made in England for Maryland about 1659. 4. The St. Patrick farthing brought from Ireland by Mark Newby in 1681 and used in New Jersey. 5. The Rosa Americana twopence made in England for the American Colonies in 1722 and 1723. 6. A copper token made about 1737 by John Higley at Granby, Connecticut, to pass for threepence. 7. A halfpenny made in England for Virginia in 1773. 8. A cent made by the State of Connecticut from 1785 to 1788. 9. A cent made by Vermont in 1785 and 1786. 10. A cent made by New Jersey from 1785 to 1788. 11. A cent made by Massachusetts in 1787 and 1788. 12. The Nova Constellatio cent msde for the United States in 1785 before the Mint was established. 13. The half disme, 1792. One of the first coins made in the Mint, and said to have been made from silver furnished by George Washington. 14. The first type of cent, 1793. 15. The first type of half eagle (five dollar gold piece). 16. The first type of the silver dollar. 17. The Confederate half dollar. Four only were made at the New Orleans Mint

FIFTEENTH, SIXTEENTH AND SEVENTEENTH CENTURY MEDALS

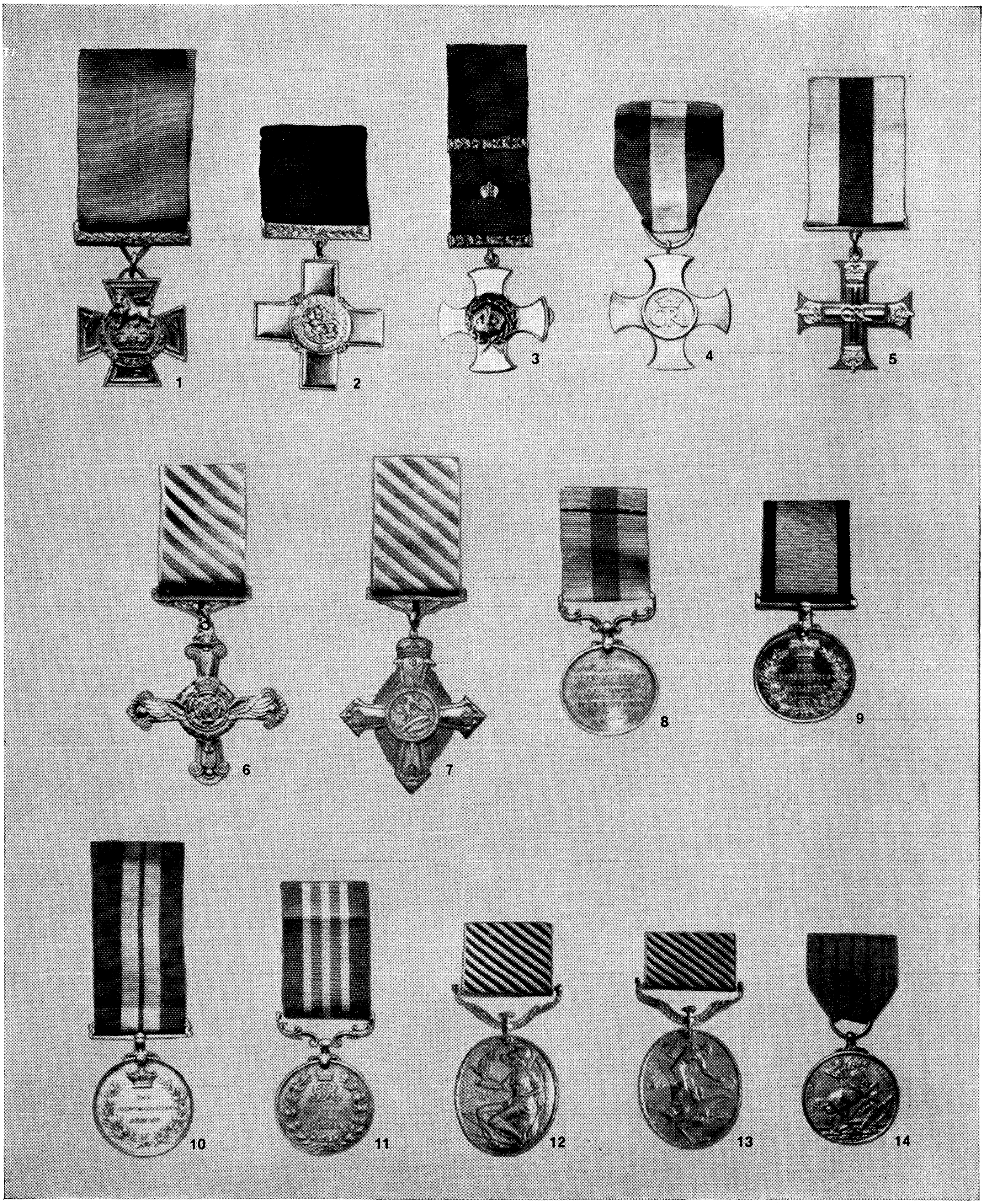
1. John VII., by Pisanello, 1438
2. Christoph Tetzel, by M. Gebel, 1528
3. Vittorio Gambello, by himself, 1508
4. Giovanni Toscani, by Lysippus
5. Edward Courtney, by Pastorino, 1556
6. Marie de Médicis, by G. Dupré
7. George Monck, by Thomas Simon, 1660



BY COURTESY OF THE SMITHSONIAN INSTITUTION, U.S. NATIONAL MUSEUM

U.S. MILITARY AND NAVAL MEDALS AND DECORATIONS

ARMY MEDALS: 1. Medal of honour, 1st design, 2nd type ribbon. 2. Medal of honour, 2nd design. 1st type ribbon. 3. Distinguished service cross, 2nd design. 4. Distinguished service medal (oak leaf cluster for 2nd award). ALL SERVICES: 5. Silver star. 6. Legion of Merit (officers). 7. Distinguished flying cross. 8. Purple Heart. NAVY AND MARINE CORPS MEDALS: 9. Navy medal of honour. 10. Navy medal of honour (combat), World War I. 11. Marine Corps brevet medal. 12. Navy cross. 13. Distinguished service medal. 14. Navy and Marine Corps medal



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BRITISH ORDERS, CROSSES AND MEDALS

1. Victoria cross
2. George cross
3. Distinguished service order and bar
4. Distinguished service cross
5. Military cross
6. Distinguished trying cross
7. Air force cross
8. Distinguished conduct medal
9. Conspicuous gallantry medal
10. Distinguished service medal
11. Military medal
12. Distinguished flying medal
13. Air force medal
14. George medal

can thus prove, what is frequently obvious, that other towns borrowed engravers from Syracuse. The Syracusan coinage is mainly silver. During the siege by the Athenians, beautiful little gold coins were struck with reverse Hercules strangling a lion. With the prosperity following the enemy's defeat, Syracusan art reaches its zenith. As the *Denzareteion* commemorates the defeat of the Carthaginians, so the great series of decadrachms perpetuates the victory of 412. The agonistic types and word *athla* on some of them show that they were distributed at the games held to celebrate the victory; their types mere widely copied and their engravers, Kimon and Euainetos—otherwise quite unknown—have gained a place among the world's greatest artists. In the 4th century the coinage becomes somewhat stereotyped and has no longer any originality. We may note the issues of electrum by Dion in 357–353 and of gold by Timoleon, who introduced the Pegasus type from Corinth on his coinage.

Among other cities of Sicily we may note the fine series of Agrigentum of the 5th century with its beautiful double eagle type and the Camarina type of the river god Hipparis and the nymph Camarina on a swan. Himera before its destruction in 408 issued some very interesting types, such as the nymph Himera sacrificing while Silenus beside her bathes at the thermal spring for which Himera was noted; or Pelops in his chariot, referring to a victory of a Himeran at the Olympic games which Pelops is said to have founded. Segesta, Eryx and other cities already Carthaginian use Greek types and artists but have Punic legends. The nymph Segesta and the river god Crimissos are the best types of Segesta while Selinus abandons its parsley leaf and issues a number of very remarkable types, notably that of Apollo and Artemis in their quadriga with reverse the god Silenus sacrificing at an altar, a type which refers to the cessation of the plague as a result of appeals to Apollo as healer. In conclusion we may mention the wonderfully realistic Silenus with his wine cup at Naxos.

Period **III. c. 336–c.** 100 **B.C.**—Alexander's conquest considerably extended the sphere of Greek influence and in this period there is a further extension of coinage. Egypt, hitherto coinless, now produces the richest series of the Hellenistic period. Bactria and Parthia, too, strike Greek coins. Spain and Mauretania begin to issue coins; in the north the Gauls, Britons and Germans begin early in the 2nd century to imitate Greek coins and soon learn to strike more independent issues. The influence of Alexander's coins is decisive in the coinages of his successors in their different kingdoms. Only a few free towns strike their own silver and even they tend to use Alexandrian types. The period produced a number of coins of alliances like the Achaean and Thessalian leagues. In the west the gradual advance of Rome is reflected in the coinages; local silver ceases earlier in Italy and Sicily than in Greece and Asia.

The accession of Alexander the Great in 336 inaugurates a new epoch in coin types. The main feature of the period from his accession to the conquest of Greece by Rome is the final establishment of the portrait coin as the regular type of a currency and the great preponderance of regal issues.

The portrait of a living monarch took nearly a century to establish itself on a coin. Philip II and Alexander the Great issued vast coinages throughout the ancient world but were content to put their names alone on the coin—latterly Alexander added the title "Basileus." After his death his deified portrait appeared on the coins of Lysimachus in Thrace and on the early coins of Ptolemy I in Egypt. It is not till 306 that we have a portrait of a living king on his coins when Ptolemy I appears, still as god with the aegis of Zeus. Seleucus I similarly puts himself on his coins as Dionysos; in time the divine attribute is dropped and the ruler appears as a mortal wearing only the royal diadem. In Macedon Arrhidaeus, Cassander and Antigonos still follow the types of Alexander, and the early coins of Demetrius Poliorcetes (306–283) are without a portrait. Soon, however. his own portrait appears, still with the horns that deify him. His successors have only types of deities. Pyrrhus does not appear on any of his extensive coinages but the last two kings of Macedon, Perseus and Philip V, have left very fine portraits. The kings of Pontus, notably Mithridates VI, have a magnificent series of portraits. The kings of Pergamon use the same portrait throughout, that of the founder of the dynasty, Philetairos I, and the Ptolemies in Egypt throughout their long series use only the head and legend of Ptolemy I, except on certain special issues. Among the early Seleucids Antiochus I was reluctant to drop the portrait of Seleucus I, but the portrait of the reigning monarch becomes the rule in this series; farther east we have the long series of portraits of the Arsacids and the unparalleled series of Bactrian and Indian kings. The smaller series of Persis gives some portraits, but they rapidly become stereotyped as do the coins of Elymais and Oman. The Jews, with that strict interpretation of the second commandment as is later the case among the Arabs, have no portraits, but the Nabathaean kings have.

The reverse types also show the influence of Alexander; seated deities become common and go back to the Zeus on the tetradrachms of Alexander, or standing deities which go back to the Nike on his gold. The Seleucids have commonly a seated Zeus or Apollo. The Parthian series is unusual—the reverse shows the king seated, (perhaps) Arsakes I, the founder of the dynasty, treated with the respect due to a deity. The king's name remains on the reverse in keeping with its development as the successor to a town name and does not yet appear alongside of the portrait. The ancient world did not know the custom of numbering kings of the same name; they are as a rule sufficiently distinguished by their epithets.

After the vast issues of gold by Philip II, Alexander and Lysimachus. gold is but rarely struck, except in Egypt. Silver is the general metal of coinage and the Attic standard, which Alexander had adopted for his tetradrachms, became the monetary standard of the world, except in Egypt; there is a great increase in the bronze coinage, the local issue of which does not seem to have been seriously restricted by sovereigns and suzerains.

As the greater part of the Greek world was now ruled by the Diadochi, their various coinages naturally formed the main currencies of commerce. A number of civic and other coinages still survived however. Third-century Athenian coinages are scarce except in bronze; occasionally as in 296 the issue of gold shows the straits to which the once wealthy city was come. In 229 when Macedon lost its supremacy over Athens and friendly relations were established with Rome a new era begins with the abundant issue of tetradrachms of the "new style" which went on for two centuries. The Athena of these coins is not the old one but a copy of the head of the Parthenos of Phidias and the owl on the reverse is now perched on a Panathenaic amphora. The AΘE still remains but a number of new legends and symbols are added to the reverse chronicling a long series of magistrates. Much light is thrown on the organization of the Greek civic mints from these names and symbols. The other great coin issuing city, Corinth, went on striking its stater till 229 when by its surrender to Doson the long series came to an end.

Rise **of** Rome.—The Roman conquest of Greece is reflected in the coinages. When the Romans overthrew Philip V in 197 or Perseus in 168 they professed to be restoring the liberties of the Greeks and it is clear from the resumed activity of the mints that the Greek cities were autonomous in one respect at least. After the defeat of Philip V the Thessalians formed a confederation with silver coins of the type of Zeus and Athena and the legend *Thessalōn;* a similar coinage was issued by the Boeotians. With the final overthrow of Macedon at Pydra in 168 begins the extensive issue of tetradrachms of Maronea and Thasos which became a great commercial currency for trade across the Danube with the barbarians, who continued to imitate them. Macedon itself as a Roman province issued tetradrachms bearing the names of Roman governors. In Asia after the defeat of Antiochus III at Magnesia we have an outburst of tetradrachms of Attic weight and local types at towns like Lampsacus, Smyrna, Magnesia and many others. Other cities similarly resumed the issue of Alexander tetradrachms, adding a small symbol to mark the town of issue—hliletus, Samos, Rhodes and many other Asiatic cities. These Alexander types continued down to the middle of the 2nd century when the Roman province of Asia was set up and the *cistophori* replaced them. The first cistophori, so called from the Dionysiac chest which formed the principal type, were first struck at Ephesus at the end of the 3rd century; the reverse is a bow in quiver between two serpents. The Pergamene kings popularized them and the Romans thus found it easy to substitute them for the Alexandrine tetradrachms with their undesirable associations. *Cistophori* were now struck in many Asiatic mints and bear the monogram of the town of issue. The last stage in the Roman conquest of the east was the defeat of Mithridates and those towns that had assisted him had their coins replaced by cistophori with the exception of Athens which obtained favoured treatment. The fact that Khodes resisted Mithridates and assisted Sulla enabled its autonomous silver coinage to survive down to the Civil War:—it was the last autonomous coinage of Greece.

In the west the rise of Rome in the 3rd century introduced a new factor into the history of Greek coinage. The first coinage to disappear was the Etrurian after a life of two centuries. Rome's early intercourse with the Greek cities of Italy is reflected in the Romano-Campanian coinage. In the south the Italian campaign of Pyrrhus left its mark on various coinages, notably at Tarentum which also has some exceptional numismatic records of Hannibal's occupation. The towns of Magna Graecia gradually lost their silver coinage under Roman influence although their bronze lasted till the 1st century.

In Sicily in the 3rd century Syracuse began to dominate the whole island in coinage as well as politically; the types are mainly imitations of those of the 5th and 4th centuries; the coins of the other towns have little claim to originality. The Punic Wars brought the Romans to Sicily where the Carthaginians had been established since the end of the 5th century and had struck coins of Syracusan and other Sicilian types with Punic legends and later with their own types. When Syracuse fell to Rome in 210, Sicily became a Roman province; henceforth only bronze was struck in it; these local coins continued into the first century, when the last trace of Greek coinage in the west disappears.

Period IV. c. 100 **B.C.–A.D.** 268.—Under the Romans many Greek cities and districts continued to issue their own bronze coins but the geographical area over which this was done became considerably restricted under the empire. In the west—Italy, Gaul, Spain and North Africa—the right of coinage was abolished quite early in the empire, the latest local issue of these regions being a coin of Babba in Mauretania of the reign of Galba. In the east, particularly in Asia, these local bronze coinages went on down to the time of Gallienus in 268, when the complete depreciation of the Imperial silver coinage, now bronze washed with silver, made the issue of bronze for small change pointless. The language of the inscriptions is Latin in the west and Greek in the east—with a few exceptions in the latter case. The Imperial gold (solidus) and silver (denarius) became the main currencies throughout the Roman empire.

Before dealing in general with the bronze of the Greek cities, we may note one or two local subsidiary silver coinages issued by the Roman emperors in continuation of important pre-conquest coinages. The largest series of these was the Egyptian or Alexandrian series which runs from Augustus to Diocletian. In addition to bronze, this series at first included tetradrachms of billon of gradually decreasing fineness, which continued the tetradachms of the Ptolemies; later it is of bronze only. The legends are always in Greek; the coins bear the emperor's head on the obverse and the reverse types are at first usual Roman types but after the end of the first century begin to include native Egyptian types in increasing numbers, often of peculiar interest. The reverses are dated in regnal years in Greek numerals. From the reign of Claudius II. there is only one denomination, a small thick bronze piece originally coated with silver, which is probably still the commonest of all ancient coins. The earlier bronze which occasionally, although not generally, rival the work of the Roman mint have in the 2nd century a characteristic bevelled edge.

In Syria silver tetradrachms continued to be struck, mainlv at Antioch but also at Tyre and a few other mints. These gradually became baser in the course of the early third century. Copper was also struck by the Romans at these mints and frequently bears the letters S C showing that this issue, as in Rome, was the prerogative of the Senate. Of several other local silver coinages the large series of drachms struck at Caesarea in Cappadocia from Tiberius to Commodus is the most important. The usual type is a local one of Mount Argaeus but common denarii reverses are also found.

A number of vassal states and protectorates continued to issue their own coinages in the precious metals until they became Roman provinces. The only gold coinage of this kind is that of the kings of the Bosporus who struck coins from the time of Augustus to the beginning of the 4th century with the Roman Emperor's head on one side and the local dynast's on the other. This coinage becomes gradually debased, passing from gold to electrum then to silver and billon and ultimately to copper in the 3rd century **A.D.** At the other end of the world, the kings of Mauretania continued to strike their own gold and silver until it became a Roman province in **A.D.** 40.

Bronze **Coinage.**—We now come to the regular series of Imperial Greek bronze coins which close the thousand years of Greece's numismatic history. They have no claim to artistic merit and are of local workmanship; therein they form a contrast to the regular Roman coins of the time which frequently attain a very high level. If they are devoid of artistic interest they have a very high historical and archaeological value.

The right of coinage is sometimes continuous and sometimes intermittently permitted by the Emperor or governor. Sometimes the right is held alternately by pairs of towns as in Moesia by Marcianopolis and Nicopolis. Coins are struck not only by single towns but jointly by alliances of towns (homonoia).

The general type is everywhere the same; obverse a bust and reverse a type of local interest. Under the Republic the Greek cities usually placed on the obverses of their coins an allegorical bust,—that of some local hero or of the "people" the "Senate" or the local city-goddess. The People (Demos) in Asia Minor is usually personified as a young male bust; the municipal council (Boule) and the Senate (Sunkletos) appear as young veiled females. The Tyche of the city appears as a female bust wearing a mural crown. The goddess Roma is found as a helmeted female, *e.g.,* at Smyrna. Pergamon and other towns of Asia Minor have Poseidon. Athena, Apollo and other well-known divinities are also found on the obverses.

Under the empire the usual obverse type is the head of the Emperor as on the regular Roman series. There are some notable exceptions. Macedonia for example had the head of Alexander the Great. Athens was privileged by Hadrian to use the head of Athena in place of the Emperor's. These are exceptions; the usual type is the bust of the Emperor and the obverse legend gives his name and titles in Greek, usually transcriptions or translations of his Latin titles, with occasionally some local allusion. The reverse type is reserved for the town of issue and the date when given is in a local era. The name of the town is in the genitive plural of the ethnic, very frequently with the addition of some proud epithet, of more or less significance. These epithets are of various kinds; many refer to the emperor either to flatter him or in memory of some benefit received. Some recall the origin of the inhabitants; Blaundus in Lydia, for example, calls itself Macedonian because it was originally a colony of Macedonian soldiers Very favourite adjectives are "autonomous" and "free" but the most highly prized is that of *Neokoros,* which in Imperial times signified that the town had built a temple in honour of the Emperor. Ephesus for example proclaims in the reign of Caracalla that it had built 3 imperial temples. Capitals of provinces call themselves Metropolis; the title "first city" of the province is also highly prized and occasionally disputed, as we see from the coin-legends of Nicomedia and Nicaea in Bithynia or of Smyrna and Ephesus in the province of Asia. Towns in Phoenicia and Syria which had a temple with the right of asylum call themselves ἱερά καὶ ἄσυλος; a number of maritime towns bear the title ναυαρχίς officially granted them by the emperor in recognition of their naval importance. Damascus calls itself "illustrious," Syedra "brilliant," Nicaea "greatest and best" and there are many such empty titles.

Besides the ethnic these coins very often bear the names of magistrates and other officials; in the early years of the empire these include a few governors and other officials sent from Rome, some of whom even have their portraits on their coins, like the younger Cicero at Magnesia. But throughout the series the names and titles of local magistrates are vastly more common. These throw a good deal of light on local life and administration.

It is the reverse types of this series of coins that give them their importance. The coins of Athens preserve representations of many statues famous in antiquity which have long since perished such as the Athena Parthenos of Phidias, the great Athena Promachos on the Acropolis visible far out at sea, or the Dionysos of Alcamenes. A coin of Elis preserves for us the Olympian Zeus of Phidias and Lacedaemon the Apollo of Amyclees. Local cults are everywhere illustrated and incidents in the lives of all the divinities of Greek mythology are common types. Not only do we have gods and goddesses but also all kinds of local deities like river gods and nymphs. Local celebrities are also recorded; thus we have Homer at several of the various towns that claimed him as a native notably Smyrna, Anacreon at Teos, Sappho at Eresos in Lesbos, Herodotus at Halicarnassus, Alcaeus at Mytilene which records on its coins a whole series of its famous men, the majority of whom are not otherwise known. Not only are famous Greeks commemorated; the travels of Hadrian in the provinces led to the issue of many specially fine coins, some of which bear the portrait of his favourite Antinous.

Agonistic types are very numerous on account of the great part played by games and festivals in the life of the time. Their celebration is frequently recorded on coins; sometimes we learn that the to n was not able to bear the expense and that officials or private individuals were ready to bear the expense in return for the honour of presiding and this is duly chronicled. In addition to the four great Hellenic Games we find many of more recent origin instituted in honour of the Emperor, like the Actian games in honour of the victory of Augustus at Actium, celebrated at Tyre and other towns, the Philadelphian in honour of Caracalla and Geta at Nicaea, etc., or in honour of local deities like the Panathenaic at Athens, or the Heraclean at Perinthus commemorated by a series giving the labours of Hercules. When two or more cities combined to have a joint festival, this is commemorated by a joint issue of coins. In conclusion we may mention a notable example of the preservation of a local tradition on a Greek imperial coin. On a coin of Septimius at Apameia in Phrygia we have as reverse type a man and woman in a chest or ark floating an water with a raven on the top and a dove flying above with a branch in her beak; to remove any doubt as to what scene is represented the ark is labelled ΝΩϵ and the coin is evidence of the local tradition that the ark rested on the mountain behind Apameia.

ROMAN COINS

It was comparatively late in her history that Rome emerged from obscurity and became a great city. The adoption of a coinage was one of the most significant signs of the change. In very early times Rome had reckoned values in oxen and sheep, hence the word *pecunia* (money), from the same root as *pecus* (head of cattle). Later she began to use bronze as a means of payment,—but as yet only in rough, unstamped lumps (Aes rude), not as coins. The later tradition represents her as ridiculously poor in the precious metals, and the little that we know confirms it.

The exact date at which Rome passed on to the use of metallic currency is subject to some doubt. It is certainly not earlier than 338 B.C. (the date proposed by E J. Haeberlin), and a strong case can be made for a date rather later. The Roman authors, who attributed the innovation to the king Servius Tullius, had no real knowledge of the facts. The first pieces issued were heavy cast coins of bronze (Aes Grave) representing the As, the unit, a pound of bronze and its subdivisions—semis, ($\frac{1}{2}$), triens ($\frac{1}{3}$), quadrans ($\frac{1}{4}$), sextans ($\frac{1}{6}$), uncia ($\frac{1}{12}$)—a cumbrous coinage that needed wagons to transport it. It seems to be a clumsy attempt to apply the Greek institution of coinage to the bronze system of Italy. But very soon afterwards silver also was issued in the Roman name; its superior convenience was soon felt and, after the First Punic War at latest, it ranked as the chief metal in the Roman market.

The earliest Roman silver coins were didrachms struck on a standard familiar in Campania and issued in part at least in that district. They are coins of a normal Greek pattern and with the small token bronze that accompanies them, were clearly meant to circulate in districts accustomed to Greek coins—that is to say in Cainpania and its neighbourhood, Lucania and Bruttium and to some extent Samnium and Apulia. The coinage, whether we regard it as primarily military or commercial, certainly arose in the course of the great wars, which ended in making Rome supreme in Italy by about 270 B.C. It represents one result of the closer contact of Rome with the Greek south.

The Aes Gsave, to a large extent, runs in series parallel to the silver, but can hardly have circulated in the same districts. It is simplest to regard it as the counterpart of the silver coinage, issued for Rome and her Italian allies, in North Italy, Latium, the Sabine country and, to some extent, Samnium and Apulia. As Haeberlin has demonstrated, Rome's first system of coinage is a dual one: it is only unified, when the more cumbrous Italic system yields to the ,Greek. Our knowledge of details is as yet very imperfect. There are variations in the weight of the *As* or pound, which do not answer to any obvious explanation; there is a reduction in the weight of the didrachm, which may or may not be due to inflation in the Pyrrhic War. We do not know how the didrachm and the As were related. Fortunately, the historical meaning of the coinage is clear. Rome began to open her doors to Greek ways and she was soon followed by her colonies in the South—Cales, Suessa, Teanum, which struck didrachms like hers—and by other colonies, in districts less Greek, which cast *Aes* Grave—Hatria in Picenum, for example, and Luceria in Apulia, or by independent cities such as Iguvium and Tuder in Umbria.

It was under the strain of the Punic Wars that Roman Republican coinage assumed the form in which we know it best. The denarius, traditionally assigned to 269–268 B.C., replaced the didrachm as the main Roman silver piece; it was equal in value to 10 asses, while its half, the quinarius, equalled j. its fourth, the sestertius 24. The As, originally a pound in weight, was reduced to about j oz.; then by slow descent to little more than 3 oz., again to 2 oz. and finally to 1 oz Gold was issued on two separate occasions, as an emergency coinage--once in 217 B.C., once perhaps earlier. One fact, which has been obscured by modern writers, is the issue of Aes Grave, with the reverse type, in great masses during the First Punic War; Rome was short of silver and fell back upon her native Italian bronze and the strain of the war led to inflation, expressed in the reduction of the weight of the bronze unit. the As.

By the end of the Second Punic War Roman coinage had assumed its lasting form. The denarius was without question the master coin. Second to it in importance came a second silver piece. three-fourths of it in weight, the "Victoriate" or "Victory coin," struck for foreign trade in the Western Mediterranean, South Italy and the Adriatic. It may only have been introduced just before or during, the Second Punic War. The As, now reduced to one ounce, was a tenth of the denarius in value. Pliny has recorded a change of tariff to sixteen to the denarius in the Second Punic War, while admitting that the value of ten to one still held in the pay of the soldiers As the coins themselves only show the new value much later, we are uncertain how far Pliny can be trusted. There was no gold coinage except in case of emergency.

The political supremacy of Rome in Italy afterward found expression in the supersession of all other Italian coinages. except a few of token copper in the South, by the Romans. This change did not take place very early or all at once—and favoured allies, such as Naples or Velia, probably coined in their own name longer than the Latin allies, with their closer bond with Rome: it was probably hardly complete before the end of the Second Punic War.

In the great period of expansion after 200 B.C., denarius and victoriate went out to conquer the markets of the world. In the West progress was rapid, but the East, with its abundance of coinage, offered a successful resistance. Rome in her Eastern wars learned to use Eastern currencies, gold staters of Macedon and silver tetradrachms of Athens or Asia, and brought them into her own service: it was thus that she could dispense with any gold coinage and be content with a silver piece of less value than a shilling. About 135–130 B.C. the value of the denarius was raised to 16 asses, in place of 10, and, after a period in which the two values conflicted, that of 16 won the day (c. 100 B.C.). The great Social War of 91–89 B.C., when the Italian allies almost overthrew Rome in their eagerness to share her citizenship, led to confusion and inflation. The policy of the Gracchi, with its demands for land settlement and foreign colonies, had necessitated great issues of money, and, as early as 122 B.C. the senate had begun to inflate, by issuing base, plated denarii among the good ones. This policy was now vastly extended: the silver became so mixed and impure, that no one could tell what he really possessed. To add to the confusion the As was reduced from 1 oz. to ½ oz.; and, finally, in 87 B.C., the state declared itself bankrupt by ordering that all debts should be cleared at five shillings in the pound (*quadrans* for *As*). A praetor, M. Marius Gratidianus, attempted to find a remedy by sorting out the good denarii from the bad: at the same time, a new coinage of pure silver (theoretically pure, at least) was issued. Sulla, however, on his return and triumph, butchered M. Marius and annulled his policy, insisting that the money of the state must be accepted at its issue value: but, in future, the senate used its powers with strict moderation. The bronze coinage was allowed to sink into the background. The only further development of the Republic was the introduction of a permanent gold coinage by Julius Caesar, after previous experiments by Sulla.

The control of the coinage was in the hands of the senate, acting for the sovereign people; major changes had to be sanctioned by the passing of special laws. The responsibility for the striking of coins was normally entrusted to a special commission of three, "tresviri aere argento auro flando feriundo," but also, if less commonly, to other officials, such as quaestors or curule aediles. Roman coins were issued not only at Rome, but also at other mints in Italy and, later, in the provinces. But it is probable that these outside coinages were not at first administered in any way differently from the home and that issues outside Italy occur but rarely until the time of Sulla. In the period after Sulla these provincial issues became more and more important and less and less dependent on the senate. The generals abroad assumed the right to issue money to their troops in their own name and the senate raised no objection. In the end this military coinage of the provinces gave birth to the imperial coinage.

Roman coinage was historical in a sense in which modern coinage is not, but it is only late in the Republic that this element becomes strong. Rome began by placing on the obverse of her denarius the helmeted head of Roma, the protectress of the city and on the reverse, the Heavenly Twins, Castor and Pollux, who "fought so well for Rome" at the battle of Lake Regillus in 494 B.C. These types, with their somewhat general reference to Rome's divine protectors, remained in vogue for more than a hundred years. Variety first began in the reverse types, when figures of deities driving chariots began to replace the Dioscuri—Diana or Victory driving a biga or Jupiter or Apollo driving a quadriga. From about the time of the Gracchi an even greater freedom begins to prevail, and, extends to the obverse as well. In the succeeding period the types vary from issue to issue, with rare and passing revivals of traditional types. The choice is dictated by two considerations (1) the family pride of the moneyer, who selectedincidents of interest from his family history (2) a natural interest in current politics, which leads the moneyer to select such types as can be brought into relation with current events.

A few examples will illustrate these tendencies. Sex. Pompeius Fostlus strikes a reverse, showing his ancestor Faustulus, the shepherd, finding the twins, Romulus and Remus, with the she-wolf; he probably strikes in the days of Tiberius Gracchus, when the thought of Roma Renascens, the "re-birth of Rome" was in men's minds—hence an appropriateness in the reference to her origins.

A group of moneyers of the year 118 B.C. issuing coins for the new colony of Narbo in Gaul, put on their reverses a Gallic warrior, probably Bituitus, king of the Arverni, in his war-chariot: in this case the public interest in Gaul has displaced any personal references. L. Tiburius Sabinus, striking c. 87 B.C., refers to the legendary Sabine king, Talicus, and to the rape of the Sabine women: the parallel between Rome's troubles with her neighbours in the past and in the present was obvious to all. Sulla, in the East, struck gold coins, with obverse types of Venus, whose favourite he claimed to be: later, in Rome itself, he commemorates his own triumph. Pompey the Great, perhaps in 61 B.C., struck a similar coin in honour of his Eastern victories, with a glance too at Africa, where his career of triumph had begun. The twenty years from 70 to 50 B.C. yield a host of references to history. M. Lepidus, probably the man who was afterwards triumvir with Octavian and Antony, has a gallery of family types, celebrating an earlier Lepidus, who at the age of 15 killed an enemy and saved a fellow-countryman in battle; the Marius Lepidus, who was sent to Alexandria to be tutor to King Ptolemy V. of Egypt in 200; the vestal virgin Aemilia, for whom Vesta miraculously rekindled the sacred fire; the Lepidus who restored the Basilica Aemilia and hung it with shields in 78 B.C. A. P. Hypsicus goes back still further to Neptune and his daughter, Leucronoe, the origin of his line.

With the outbreak of the great Civil War, the personal element burst out into full prominence. The coinage of Julius Caesar from the first bears the stamp of his personality and in the last year of his life the senate authorized him to place his portrait on the coins. Hitherto, the obverse of the coins had been considered the prerogative of a god or goddess: at the most, room might be made there for a hero of early days, such as Scipio Africanus. Caesar's own generation had begun to engrave the portraits of its fathers and now, at last, the portrait of the living man appears. Rome had come back to the monarchy, by whatever name she might call it. From this point to the end of the Republic, we have no true Republican coinage but only the preparations for the Imperial. Even the murderers of the tyrant Caesar in their last struggle for the Republic in the East, placed their own portraits on their coins. Brutus, on one famous reverse, set the daggers that had stabbed Caesar, with the comment EID. MAR. (the fatal Ides of March). Antony strikes in the East associating with himself first his wife in Rome, Octavia, later his Egyptian enchantress, Cleopatra. For his army and navy before the battle of Actium, he strikes denarii with the eagle and standards and prow on the reverse. Sextus Pompey, the pirate son of Pompey the Great, celebrates his chief naval victory over Octavian by a coin showing him as "son of Neptune"—proud title of a successful admiral.

The Roman bronze coinage never outgrew its conventional types. It grew to importance in the First Punic War, when the reverse represented the prow, the sign of sea power, the obverses the great gods of the state These types it kept throughout: the ordinary Latin word for the "tail" of a coin is "navis" (ship).

Augustus.—The Empire, founded by Augustus. has a dual aspect; on the one side it is a monarchy, based on the support of the troops; on the other it is simply an exalted magistracy of the Roman Republic, created with special powers to deal with special problems. The imperial coinage faithfully mirrors this duality. The Emperor, as paymaster of the soldiers, keeps in his own hands the issue of the precious metals; but he leaves to the senate, now the one representative of the Roman people, the right of issuing the token coinage of brass and copper. The mint of the senate is naturally in Rome itself. The imperial mint is early centralised in the same place, but it is important to note that Augustus began by striking his money for the troops in the provinces, continuing the practice of the generals of the late Republic. His mint was not the successor of the senatorial, but a new creation of his own. It was probably Caligula who opened the first mint in the capital. Henceforth gold and silver was normally struck in Rome. Provincial issues occur freely in times of civil war, but hardly to any extent otherwise. It was only in the 3rd century that a number of provincial mints came into being, to meet the needs of the chief armies, Antioch in Syria among the first. The example once given soon spread. By the time of Gallienus, imperial coins were struck in Viminacium, Siscia, Lugdunum, Mediolanum—perhaps at other mints too—as well as at Rome and Antioch; and from Aurelian on, the principle of the local issue of imperial coins is dominant. The senate struck mainly in Rome—at first only for Rome and Italy. The mark S.C., "senatus consulto," attests its authority. Antioch in the East and Lugdunum in Gaul also issue coins with this mark, which we must regard as also issued under senatorial authority. After the first two Emperors this coinage was probably current over the whole Empire; but it never played any large part in the East.

The commission of "tresviri" of the mint continued to exist as late as the 3rd century; but the names of these magistrates cease to appear on the coins before the death of Augustus. They may still have played a part in the senatorial issues; the imperial coinage fell within the range of the chief imperial officer of finance, the "a rationibus," and, under him, were administered by imperial procurators. The actual striking was entrusted to a staff of imperial freedmen and slaves. From an early date the Emperor began to exercise a controlling influence over the bronze token coinage also. The two mints may after a time even have been housed in the same building; at any rate the authority of the senate came to be more and more an empty form.

The Roman Republic had only known gold as an emergency or as a foreign coinage. Augustus from the first made his standard gold piece, the "aureus," the head of his system. The denarius however continued to be struck pure and of unimpaired weight; the coinage rested on a bi-metallic basis. The aureus weighed the forty-second part of a pound, the denarius the eighty-fourth; twenty denarii went to the aureus. The token coinage consisted of the sestertius and the dupondius, struck in brass, the fourth and the eighth part of the denarius respectively. The as, the fourth of the sestertius, and the quadrans, the fourth of the as, were struck in copper. Gold and silver were both struck almost pure. Base, plated denarii were not uncommon, but were the work of forgers. Under Caligula and Claudius, however, there is reason to think that the government abandoned its sound principles and condescended to make an unlawful profit by this device itself.

Later Imperial **Changes.**—Nero reformed the coinage, reducing the weight of the aureus to the forty-fifth part, that of the denarius to the ninety-sixth part of a pound. More important still, he added ten per cent of alloy to the hitherto pure silver. The relations of the coins to one another remained unchanged. Various more or less respectable motives for this reform have been suggested; and, so far as concerns the reduction of weight, there may have been justification for this measure of inflation. It is impossible to judge the debasement of the silver so charitably. It can be nothing but a device of a spendthrift government for meeting its obligations cheaply.

The evil consequences of Nero's debasement were slow to make themselves felt; but they were nevertheless disastrous. Again and again under stress of circumstances the government resorted to the same expedient. The percentage of alloy in the silver rose to as much as forty per cent under Septimius Severus.

Caracalla took the next step. He reduced the weight of the aureus to a fiftieth part of the pound and issued a new silver coin, the "antoninianus" or double denarius at the weight of about a denarius and a half. In the following period the aureus continued to decline in weight and the denarius, after a struggle, succumbed to the less honest double piece.

A final debasement of the silver by Gallienus at the crisis of his reign, when Valerian was a Persian captive and the West cut loose under an Emperor of its own, overtaxed the patience of a long-enduring public. The Antoninianus was no longer taken at its nominal value; confusion reigned and prices rose to absurd heights.

It was Aurelian, the "restorer of the world," who stabilized the coinage. The details of his work are obscure; what is certain is that his stabilization was so unpopular that it led to a riot, on the scale of a miniature civil war in Rome. A coin like the antoninianus was struck, but its value was reduced far below par. Gold was not restored on a reliable basis and the process of inflation began again. Diocletian had no choice but to deal summarily with this problem, before he could restore a coinage that deserved confidence.

Non-imperial Coinages.—In the West, local coinage in South Italy, Sicily, Gaul, Spain and Africa is found commonly under Augustus and Tiberius and sporadically, down to Galba. When this local coinage ceased, the duty of supplying the whole of the West fell on the mints of Rome, sometimes assisted by branches at Lugdunum (Lyons). In the East the case was very different. Coinage had been known there for so long, that the Romans found it expedient to leave a large part of the issues to local mints. Provincial silver or billon was struck in Asia, at Caesarea in Cappadocia, at Antioch in Syria, and at Alexandria in Egypt. Small change was issued freely not only in a number of provincial issues, but also at a vast number of city mints. It may fairly be said that the right to issue such small change was freely granted to almost every urban community. Under these circumstances the part assigned to imperial coinage was a restricted one. The aureus, indeed, had hardly a rival, the denarius circulated beside the provincial silver; but the token coinage in use was almost exclusively of local make. Not till late in the 3rd century did this local coinage succumb before the debasement of the imperial silver and the opening of provincial mints for imperial coin. The provincial coinage was, in its degree, a concern of the imperial government; the local coinage, however, was in theory independent. Its types are largely taken up with local interests; and, although reference to the Emperor or senate or people of Rome, is common, it is by no means universal and expresses a compliment rather than a definite acknowledgment of sovereignty.

Portraiture.—We have seen how under Julius Caesar interest in the living individual found expression on the coins in the form of portraiture. This tendency was developed to an immense degree under the Empire; but, as was only natural, interest was now focussed on the Emperor himself and the members of his family. Beside them there was no room for individual distinction. The Emperor, as head of the state, enjoys the right of portraiture on the obverse—a right which extended, at first sparingly, later more freely, to living Empresses or princes or to deceased members of the line. The reverse types, too, are full of his personality and his prowess. His victories, his triumphs, his distributions to the poor of Rome, his public shows, his measures for the welfare of Italy or the provinces, his arrivals and departures, his marriages, the birth of his heirs, his provision for the succession—these and many more, find constant reference on the coins. It is significant of the growth of imperial influence over the senatorial coinages, that, after a time, such reference is found as freely on the bronze coinage as on the gold and silver.

Religion still plays a large part. But even the great gods of the state are freely brought into connection with the Emperor and his protectors or as types of his qualities; and what is true of them is even more true of the minor deities, or virtues, who were so widely worshipped by the Romans. The virtues of the Emperor provide a symbolism fit to cover the whole of the imperial administration; his valour and victorious power, his care for the corn-supply of Rome, his spirit of constitutionalism, his liberality, his justice and his mercy. The coinage has throughout a strongly propagandist character. It serves to make known the achievements and to advertise the policies of the government.

The imperial system produced its own cult, the worship of those Emperors who, after death, were adjudged worthy of the honour of consecration. The worship of the "divi," as these deified Emperors were called, bulks large on the coins. They wear the radiate crown of the Sun-god as the symbol of their divinity;

while on the reverses appears the eagle, the symbol of the soul flown heavenwards, the pyre, the temple, or types of "Aeternitas," that world beyond time, conceived of as in the starry heavens, to which the soul of the good depart.

Diocletian.—Diocletian refounded the Roman Empire, but in a form that Augustus would hardly have recognized. The Emperor is now a monarch of the Eastern pattern, Even in his lifetime receiving something like divine worship.

The mints formed a section of the department of the chancellor of the exchequer and, under him, were administered by "rationales." The moneyers, like so many other professions of the age of Diocletian, were organized as a rigid caste, from which escape was barely possible. They were subject to severe discipline and terrible penalties for abuses: but, despite this, false coinage was immensely prevalent and flourished in the face of repression.

Diocletian in A.D. 296 completed the task which Aurelian had begun. He finally cleared away the depreciated coinages of the 3rd century and issued a new coinage, based on sound gold and silver coins. His gold piece was struck at sixty to the pound of gold, his silver at ninety-six to the pound of silver. His successors continued his policy in the main lines unchanged. Constantine substituted the *solidus,* a piece of $\frac{1}{72}$nd of the pound, for Diocletian's sixtieth; this standard found general acceptance and passed on to the famous "besant" of the Byzantine Empire. In the first thirty-five years of the 4th century silver was very sparingly struck. When its free issue was resumed, new denominations, the *miliarense* ($\frac{1}{1,000}$ of the gold pound) and *siliqua* ($\frac{1}{1,728}$ of the gold pound) soon replaced Diocletian's ninety-sixth. The silver came more and more to be struck below standard weight—that is to say, to become a subordinate token coinage, The basis of the system was the steady supply of a standard gold coin.

Whether Diocletian and his successors issued a regular coinage in bronze or copper is very doubtful. They certainly continued to issue the very base billon, which represented the last stage of the debasement of the double denarius.

Diocletian's reform must have brought some improvement on the chaos of the great anarchy of the third century. But one great evil persisted—the cost of Iiving remained high and would not come down. Diocletian's edict of A.D. 301 fixing maximum prices, was undoubtedly only one of a series of blows aimed at a recurrent social evil.

Influence of Christianity.—The spirit of the coinage undergoes a change, similar to that of its form. The divine Emperor dominates the entire coinage: even the gods hardly appear except as patrons of the new dynasty—Jupiter for Diocletian, Hercules for Maximian, Mars for Galerius, Sol for Constantius I. When Christianity, surviving the great persecution, received full tolerance and increasingly marked favours from Constantine, the pagan element in the coinage declined, Little of Christianity, however, took its place. For many years types and legends of a neutral character were preferred, though Christian signs and emblems—cross, monogram of Jesus Christ, *labarum* (Christian standard) begin to appear. There was in fact an unavowed truce between old and new. After Julian—who revived pagan types on his coins—notably the Apis bull of Egypt—the Christian element becomes stronger. The Emperor appears more and more as the defender of the faith, the imperial Victory shades off into the Christian angel. But the full development of the Christian tradition in coinage was reserved for Byzantium.

The Roman coinage of the East passes on without interruption into that of Byzantium. In the West, the Empire, succumbing to the barbarians in the late 5th century, left them its coinage as part of its legacy.

MEDIAEVAL AND LATER EUROPEAN COINS

With the fall of the Western empire, the coinage of the Byzantine empire became the great influence in European currency, The Byzantine period in coinage may be considered to begin in the reipn of Anastasius. The coins are in the three metals, but the silver is rare, and was probably struck in small quantities. At first the gold and silver are fine, but, towards the close of the empire, much alloyed. The gold coin is the solidus of Constantine, with its half and its third (semissis and tremissis). The Byzantine solidus (besant) throughout the middle ages was the gold coin of European trade until the introduction of Italian gold in the 13th century. The chief silver coin was the miliarision, and a smaller coin, the siliqua or keration.

In 498 Anastasius introduced a new copper coinage, bearing on the reverse, the following marks of value in place of a type: M, K, I and E, 40 nummi, 20, 10 and 5. These coins bear beneath the values the abbreviated name of the place of issue. Justinian I. added the regnal year in A.D. 538, his twelfth year; this is the first appearance of annual dating on European coinage. The money of this class shows extraordinary variations of weight, which reflect the state of the imperial finances. Under Basil I. the bronze money to all appearances was reformed, but the absence of marks of value makes the whole later history of the coinage in this metal very difficult. There was one curious change in the shape of the money. Early in the eleventh century the solidus begins to assume a cup-shaped form, and this subsequently became the shape of the whole coinage except the smaller bronze pieces. These coins are called *nummi scyphati.* The types, except when they refer simply to the sovereign, are of a religious and Christian character.

On the reverse of the oldest coins we have such types as a Victory holding a cross (other personifications all but disappear), but on those of later ones a representation of Christ or the Virgin Mary. Christ first appears on a coin of about A.D. 450, where He is represented marrying Pulcheria to Marcian. He does not appear again until the end of the 7th century, when His bust is introduced by Justinian II. From the 9th century Christ appears in various forms on the coins; about 900 we find the Virgin; a few years later saints, St. George, St. Michael, St. Theodore, etc., begin to appear. A remarkable type was introduced by Michael VIII. Palaeologus, who recovered Constantinople from the Latins in 1261, and issued coins with the Virgin standing in the midst of the walls of the city. Another notable type is the adoration of the Magi. The principal inscriptions for a long period almost invariably relate to the sovereign, and give his name and titles. The secondary inscriptions of the earlier coins indicate the town at which the piece was struck, and in the case of the larger bronze pieces, the year of the Emperor's reign is given. From about the 10th century there are generally two principal inscriptions, the one relating to the emperor and the other to the sacred figure of the reverse, in the form of a prayer. The secondary inscriptions at the same time are descriptive, and are merely abbreviations of the names or titles of the sacred personages beside the representations of whom they are placed. From the time of Alexius I. (Comnenus) the principal inscriptions practically disappear, and descriptive ones alone are given. These are nearly always abbreviations, like the secondary ones of the earlier period. The language of the inscriptions was at first Latin with a partial use of Greek; about the time of Heraclius Greek began to take its place on a rude class of coins, probably local; in the Sth century *Basileus* and *despotes* replace *Augustus;* by the 9th century Greek inscriptions occur in the regular coinage; and by the time of Alexius I. Latin has wholly disappeared. The Greek inscriptions are remarkable for their orthography, which indicates the changes of the language. In the 11th century we have a few metrical inscriptions, a practice commoner in Asia than in Europe. From the time of Justinian (6th century) onwards the profile which has been usual for centuries practically disappears from the coinage, and is replaced by a facing bust. The last Byzantine gold coin (a piece of John V., 1341–91) shows a figure of John the Baptist imitated from the Florentine coinage.

Cognate Groups.—Besides the regular series of the Byzantine empire, there are several groups connected with it. either because of their similarity, or because the sovereigns were of the imperial houses. These are the coinages of various barbarians, and the money of the emperors of Nicaea. of Thessalonica. and of Trebizond. The last groups consist of small silver pieces, which were prized for their purity; they were called Comnenian white-money (*ἄσπρα κομνήνατα*), the princes of Trebizond having sprung from the illustrious family of the Comneni.

The coinage of the other states of the West falls into well-defined periods which have been distinguished as (1) transitional period, from Roman to true mediaeval coinage, *i.e.*, from the fall of Rome (476) to the accession of Charlemagne (768); (2) true mediaeval period, during which Carolingian money was the currency of Western Europe; this covers the period from Charlemagne to the end of the Swabian house in 1286; (3) early Renaissance from the first issue of the florin at Florence in 1252 to the beginning of the classical Renaissance in the middle of the 15th century; (4) the Renaissance and (5) modern period.

Mediaeval. — The main feature of the mediaeval period is the disappearance of gold and rise of silver and the return of gold from the 15th century onwards. The inconvenience of gold money when it represents a very large value in the necessaries of life must have caused its abandonment and the substitution of silver by the Carlovingians. The denier (denarius) or penny of about 24 grains was at first practically the sole coin. The solidus in gold was struck but very rarely, perhaps as a kind of proof of the right of coining. The Byzantine solidus or bezant was used and probably the equivalent Arab gold. The new coinage spread from France, where it was first royal and then royal and feudal, to Germany, Italy, where the Byzantine types did not wholly disappear, England, Scandinavia, Castile and Aragon. In Germany and France feudal money was soon issued, and in Italy towns and ecclesiastical foundations largely acquired from the empire the right of coinage, which was elsewhere rare. The consequence of the extended right of coinage was a depreciation in weight, and in the middle of the 12th century the one-sided deniers called bracteates appeared in Germany, which were so thin that they could only be stamped on one side. The types of this whole second coinage are new, except when the bust of the emperor is engraved. The most usual are the cross; and the church as a temple also appears, ultimately taking the form of a Gothic building. There are also sacred figures, and more rarely busts in the later age.

The great precursor of the Renaissance was the emperor Frederick II. (1215–50). In his restoration of the gold coinage he had already been preceded by the Norman Duke of Apulia, who for the convenience of these Arab subjects and for commercial reasons also had continued the gold coinage of the Fatimids, the great currency at that time of all the western Muslims. Roger II. (1130–54) also struck Latin coins of his own as DVX APVLIAE, the first ducats. Frederick II., continuing the gold standard, also struck his own Roman gold money, solidi and half solidi, with his bust as emperor of the Romans, Caesar Augustus, and on the reverse the imperial eagle, in keeping with the obverse title. In workmanship these were the finest coins produced in the middle ages. It is not till the great Swabian that we get the final establishment of a worthy coinage, a necessity of their large commercial schemes. The famous gold florin was first issued in 1252 and at once became popular. The obverse type is the standing figure of St. John the Baptist, the reverse bears the lily of Florence. The weight was about 54 grains, but the breadth of the coin and the beauty of the work gave it dignity. The commercisl greatness of Florence and the purity of the florin caused the issue of smaller coins in almost all parts of Europe. Venice was not long in striking (in 1248) a gold coin of the same weight as the fiorin, but with the types of a standing figure of Christ, and the doge receiving the gonfalon at the hands of St. Mark, a type suggested by Byzantium. It was first called the ducat, the name it always bears in its inscription; later it is known as the zecchino or sequin. Though not so largely imitated in type as the florin, the extreme purity of the sequin made it a world currency down to the 19th century. Genoa likewise had a great gold currency, and the other Italian states struck in this metal. Many varieties of gold money appear in course of time in France, England and to a less extent in other countries. The need for heavier silver coinage caused the issue of the large denier (grossus denarius. gros or groat). This coin appears early in the 14th century. The types from the 14th century onwards are many and distinctly worthy of the art of the time, which as yet is purely decorative and conventional, so that portraits are not possible. The religious intention also is gradually giving way to the desire to produce a beautiful result, and the symbol of the cross is varied to suit the decorative needs of the coin. Heraldic subjects also appear, and in the shield, which is frequently a reverse type, we see the origin of the usual modern reverse of the most important coins.

With the classical Renaissance we find ourselves in the presence of modern ideas. It is a period of innumerable small states and kingdoms with no uniformity of coinage yet most modern series can be traced back to it. Its most remarkable characteristic is the revival of portraiture and from the 16th century with the opening of the new world the enormous increase in output of coins in gold and silver. With the institution of the German thaler in 1518, it speedily became the chief European piece in its metal, and to its popularity is no doubt due the large silver pieces of other countries — crowns, ecus and scudos.

In the west a number of coins carry on the Roman tradition. They cover the period from the 5th to the 8th centuries, and are of considerable historical significance. The types throughout are monotonous: the bust of a Roman emperor or local ruler, a cross of some kind, a Victory, etc. The style is quite barbarous. The classification of the earliest servile imitations of Roman and Byzantine money rests only on origin and is uncertain.

The following general series are distinguished: **(A)** The Vandals (Africa, 428–534) issued gold (?), silver and bronze from Hunneric (477–84) to Gelamir (530–34); the gold is anonymous. (B) The Suevians (Spain, 409–585) had little but imitations of Byzantine gold; but Richiar (448–456) issued a denarius in his own name. (C) The Ostrogoths (Italy, 489–553) were preceded by the Herulian Odoacer (476–94), who coined silver and bronze; their kings (including Theodoric, 493–526, and Totila or Badulla, 541–52) issued gold, silver and bronze in their own names, from Rome, Ravenna, Milan, etc. (D) The Lombards (Italy, 568–774) had no coins in their own names before Grimoald, duke of Beneventum (662–71); later there are gold solidi and thirds and silver from many mints. Gold was issued for the duchy of Beneventum in the 8th century. (E) The Burgundians (Gaul, to 534) first issued recognizable coins under Gondebald (473–516). (F) The Visigoths (South Gaul and Spain) had imitative gold thirds in the jth and 6th centuries; the kings' names appear from Leovigild (573–586) to Roderic (710–11). Sixty-one mints were in operation. (G) The Meroving Franks first issued under Clovis I. (481–511) coins recognizably Frankish (solidi and thirds). Royal names first appear on silver and copper under Theoderic of Austrasia (511–34) and Childebert I. of Pans (511–58). The chief Frankish inscribed coinage is, however, of gold solidi and thirds, from Theodebert I. (534–48), who broke down the Roman imperial prerogative and issued gold with his own name in full, to the beginning of the 8th century. The last Merovingians issued no coins in their own names, being mere puppets. From the middle of the 6th century the coins with kings' names are far less numerous than those bearing the names only of mints and moneyers; some 800 places (not only in what is now France, but in Germany, the Low Countries and Switzerland) are thus named. This coinage seems to have been intimately connected with the fiscal organization, though the generally accepted theory that the taxes collected in each place were there and then converted into money is by no means proved. Certain religious establishments also possessed the right of coining in their own name. The close of the Merovingian dynasty saw a revival of silver in the *saiga,* which heralded the introduction of the denier. (H) In England the Anglo-Saxons began with an imitative coinage similar to the Merovingian, viz., gold, *solidi* and *thirds,* and silver *sceattas* of about 20 grains troy, and *stycas,* first of silver, then of copper. The gold is rare and confined to the south; only two *solidi* are known, imitations of Honorius, with Runic legends on the reverse.

Portugal. — The coinages of the various countries of Europe from the end of Roman coinage and its imitations can be briefly mentioned in geographical order from west to east. The money of Portugal begins, after the expulsion of the Moors, with Alphonso I. (1112); it is exclusively regal, and not of great interest except as affording indications of the wealth and commercial activity of the state in the early part of the 18th century.

The early golds are of interest as by the arrangement of their type and inscription they try to look as like Moorish coins as possible.

Spain.—The coinage of Spain, after the reconquest from the Moors, is almost without exception regal. The Kingdom of Navarre had a coinage from the time of Sancho III. (1000–35). The series of Castile and Leon begins with Alphonso VI. (1053) with deniers and obols. Aragon first has coins under Sancho Ramirez I. (1063). Gold (as in Portugal imitated from Moorish money) is introduced in the middle of the 12th century. A plentiful coinage was issued after the union of the crowns in 1479. The Spanish dollar of the 17th and 18th centuries was one of the most widely circulating currencies in the West.

France. — In France in 755 Pepin the Short abolished the gold coinage of his Merovingian predecessors and introduced the silver denier (denarius = penny); the coinage became a royal prerogative once more and confined to a few mints. The denier, which at first weighed c. 1·28 gramme (19¾ grains), was for centuries the chief of European silver coins. Under Charlemagne the weight was slightly raised; the Caroline monogram appears and there are other modifications in the types. Charlemagne also issued money from various Italian, German and Spanish mints. He also introduced the obol, and struck gold (chiefly at Italian mints). Among his types must be noted the temple with the inscription XPISTIANA RELIGIO. Louis le Debonnaire (814–840) was the last Carolingian to strike gold. In the 9th century are perceptible the first traces of the movement which led to the extensive feudal coinage. The advent of the house of Capet made no great change in the system, but the feudal issues now become important. The most widespread denier was that of the abbey of St. Martin at Tours (denier tournois); the royal coinage was known as the *monnaie parisis*. Louis IX. (1226–70) effected a great reform late in his reign, making the sou (hitherto a money of account) into a real coin as the *gros* and introducing a gold coinage. Henceforward the coinage increases in complexity; in the 14th century it has great artistic merit, especially the gold; from the end of the 16th century it becomes conventional.

Belgium. — Passing on to Belgium, its coinage, which, except for the few mints operating under the Merovingians and Carolingians, does not begin until the 11th century, comprises many pieces struck by foreign rulers, and has little of an independent character in either the regal or the seignorial class. The most important coinages are those of the house of Burgundy and Charles V. and his son, and of the bishops of Liége. The coinage of Belgium approaches the French on the one side, the German on the other.

Switzerland. — The multitudinous coinage of Switzerland illustrates the varying fortunes of this central state, and its gradual growth and consolidation. First we have the gold money of the Frankish kings, among whose mints Basel, Lausanne, St. Maurice-en-Valais and Sitten (Sion) already appear. The silver deniers, which Charlemagne made the coinage of the empire, are issued by fewer mints; the dukes of Swabia began to strike at Zürich in the 10th century, and the empire granted during the 10th and down to the 13th century the right of coinage to various ecclesiastical foundations, bishoprics and abbeys. Bern was allowed a mint by the emperor Frederick II. in 1218, and other towns and seigneurs subsequently gained the same right. The demi-bracteate appears about the middle of the 11th century, and about 1125 is superseded by the true bracteate, which lasts until about 1300. The 14th century witnessed the rise of the Swiss confederation, and by degrees the cantons struck their own money. These, together with the coins of some few sees and abbacies, form the bulk of Swiss money of the mediaeval and modern periods. The separate cantonal coinage, interrupted by the French occupation, was finally suppressed in 1848, when a uniform currency was adopted.

Italy. — Italy, with Sicily, has special features. Here the barbaric coinages were mixed with the Byzantine issues which marked the recovery of the Eastern empire, and left a lasting influence in the north at Venice, and in the south at Beneventum. Later the Arab occupation of Sicily and the predominance of Arab coins left their mark in the curious Oriental coinages with Arabic inscriptions of the Normans of Sicily and of the Emperor Frederick II., mixed after his fashion with Latin coinage. The earliest money is that of the barbarian Ostrogoths and Lombards, and local Byzantine issues in Sicily. This is followed by the deniers of Charlemagne and his successors, succeeded by the gold currencies of the Normans and Frederick II. The age of the free cities is marked by the great coinages of Florence, Venice and Genoa, while the Angevin and Aragonese princes coined in the south, and the popes began to issue a regular currency of their own at Rome. The Italian princes of the next period coined in Savoy, and at Florence, Modena, Mantua and other cities, while Rome and the foreign rulers of the south continued their mintages, Venice and Genoa of the republics alone surviving.

The money of Florence, as may be observed, is disappointing in its art, for the great commercial currencies have to be conservative. The silver florin was first struck in 1189. It is heavier than the denier, weighing about 27 grains, and bears the lily of Florence and the bust of St. John the Baptist. These are thenceforward the leading types, the flower never changing, but the representation of the saint being varied. On the gold florin, first issued in 1252, the Baptist is represented standing, while in the contemporary silver florins he is seated. The latter have a rhyming legend, "Det tibi florere Christus, Florentia vere."

Venice as a mint rivals Florence in conservatism, and the early style is distinctly Byzantine; commercial reasons had to prevail in keeping coin types unchanged even in a great artistic city. The famous Venetian zechino or sequin, the rival of the florin of Florence, appears to have been first issued under Giovanni Dandolo (1284). On the obverse St. Mark gives the gonfalon to the kneeling doge, and on the reverse is a standing figure of the Saviour within an oval nimbus and a rhyming legend, "Sit tibi, Christe, datus Quem tu regis, iste ductus."

The series of the coins of Rome is rather of historical than of artistic merit. The popes begin to strike money under Adrian I. (A.D. 772–795), whose deniers are in a Byzantine-Lombard style. The coins of his successors, excepting few, down to Leo IX (1049) associate the names of pope and emperor. From Leo IX to Urban V (1362) there is no papal coinage. The Roman senate strikes from 1188 onward. We then see on the silver the style of the senate and Roman people, and ROMA CAPUT MUNDI. Some coins have the figures of St. Paul and St. Peter, others Rome seated and a lion. Charles of Anjou, King of Sicily (1263–85), strikes as a senator, and Cola di' Rienzo (1347–48) as tribune. The gold ducat of about 1300 imitates the types of the Venetian sequin. St. Peter there gives the gonfalon to a kneeling senator. The arms of the moneying senator next appear in the field. The papal coinage is resumed at Avignon; and Urban V, on his return to Rome, takes the sole right of the mint. From Martin V (1417) to Pius IX there is a continuous papal coinage. The later coins, though they have an interest from their bearing on the history of art, are disappointing in style. We have beautiful gold coins of Giovanni Bentivoglio, lord of Bologna, who employed Francia at his mint, and we know that the artist remained at his post after Julius II had taken the city. There are also pieces of Clement VII by Cellini, vigorous in design but careless in execution. There were papal mints at Ancona, Bologna, Piacenza, Parma, Ferrara and other Italian towns; and coins were also struck at Avignon from 1342 to 1700. When the Vatican City state was created in 1929 it was accorded the right of issuing its own coinage.

The coinage of Sicily, afterward that of the Two Sicilies, or Naples and Sicily, begins with the Normans. Theirs is a curiously mixed series. It begins with Robert Guiscard as duke of Apulia (1075) and Roger I of Sicily (1072). The gold money is almost wholly Arabic though Roger II struck the Latin ducat, the earliest of its class; the silver is Arabic, except the great Latin scyphati of Roger II with Roger III; the copper is Latin and Arabic. The gold series (*Augustales*) of the emperor Frederick II (1198–1250) shows the first sentiment of reviving classical art. its work far in advance of the age. These are Latin coins; he also struck small Arabic pieces in gold.

Under Conrad and Manfred there is little coinage, copper only, but with Charles I of Anjou (1266–85) the gold money in purely mediaeval style is beautiful, quite equal to that of his brother, St. Louis of France.

After this time there is a great issue of gigliati, silver coins with, for reverse, a cross fleurdelisée cantoned with fleur-de-lis.

Germany. — The money of Germany, with which we include Austria and Hungary is, like that of Italy, far too varied for it to be possible here to do more than sketch some of its main features. In the Frankish period mints were in operation at cities in the west, such as Mainz, Strassburg, Speyer, Treves, Worms, Cologne. Pepin issued denarii from Strassburg and Mainz; under his successors denarii and obols were also coined at other mints, as Bonn, Cologne, Spires, Treves. After the reign of Louis the Child (910–11) the Carolingian system war continued until the advent of the Swabians with Conrad III. (1138–52). In the succeeding period which ends with the introduction of the grossus and the gold coinage under Louis of Bavaria (1314–47), the uniformity of the currency disappears. In the west (in Lotharingia, including the southern Low Countries, the Moselle and Rhine-lands, in Frisia, Bavaria, parts of Franconia and Swabia) the denier continues; but elsewhere we find the bracteate. The right of coinage is acquired in an increasing measure by the feudatories of the empire. With the introduction of the regular gold coinage (consisting for the most part of florins) and the grossus in the 14th century, Germany enters on the modern period. From the 16th century the thaler (so called from Joachimsthal in Bohemia, where the counts of Schlick first struck the coin in 1518) dominates the silver currency. The thalers and other large coins of the 16th and 17th centuries are often good and always vigorous in workmanship. By the convention of 1857 the thaler was recognized as the unit for Berlin and the north, the florin of 100 kreuzers for Austria, the florin of 60 kr. for the south. A uniform system, based on the gold reichsmark of roo pfennigs, was established all over the German empire in 1876. Of particular currencies in Germany we must be content with the mention of some of the more important. Among the great rulers we note the dukes of Bavaria, who coined from Henry I. (948–5j), and issued fine thalers in the 16th century. The Counts Palatine of the Rhine coined from 1294, their mints being at Heidelberg, Frankfort, etc. The Saxon coinage begins with Duke Bernard (973) and includes a large series of bracteates and thalers, the latter being especially famous. The Brunswick coinage begins in the 11th century; besides its bracteates we note the large mining-thalers of the 16th and 17th centuries (up to ten thaler-pieces). There are good bracteates and thalers of the margraves of Brandenburg; from 1701 they coin as kings of Prussia. In Austria there is a ducal coinage from the 12th century; the gold florin of Florentine character appears under Albert II. (1330–1358). The marriage-coin of Maximilian and Maria of Burgundy (a 16th-century reproduction of a medal made by the Italian, Candida in 1479) is a striking piece, and in the 16th century there is a large series of fine thalers. The thalers of Maria Theresa became popular on either side of the Red Sea, and those of the date 1780 are still recoined for trade there. In Bohemia there is a ducal coinage from the early 10th century to 1192; then came the regal bracteates. Wenceslas II. (1278–1305) struck the first German grossus at Prague. The gold florin made its appearance under John of Luxemburg (1310–47). In Hungary the regal coinage begins with St. Stephen (1000). Charles I. of Anjou (1310–42) introduced the florin and grossus. Of historical interest is the money of John Hunyadi as regent (1441–52). The abundance of gold about this time and later shows the metallic wealth of the land. The same is true of the rich gold coinage of the Transylvanian princes in the 16th and 17th centuries. Of ecclesiastical coinages the most important are at Münster, Cologne, Mainz, Treves, Augsburg, Magdeburg, Spires, Würzburg, Salzburg. The Cologne series of coins is almost continuous from the Frankish period; the archbishops first received the right from Otto I., Brune (953–65) being the first to coin; from Pilgrim (1021–36) the series, issued at various mints in the Rhineland, is very complete down to 1802. The series of Treves ranges from Theodoric I. (965–75) to Clement Wenceslas (1794). The archiepiscopal coinage of Mainz begins with Willigis (975) and lasts until 1802; its mints included Erfurt, Bingen and many other places. The Salzburg series (beginning 996) is remarkable for its fine thalers (especially of Mathias Lang, 1519–1540). The patriarchs of Aquileia, who may be mentioned here, acquired the right of coinage from Louis II. in the 9th century, but the first who can be identified on the coins is Godfrey (1184); thence onwards there is an interesting series of denarii and smaller coins down to the early 15th century. Of cities with large coinages it is sufficient to mention Aix-la-Chapelle (from the time of Frederick I. to 1795), Frankfort-on-the-Main, Hamburg (with great gold pieces of the 16th and 17th centuries, up to 10 ducats) and Nuremburg.

Scandinavian Countries. — The origin of the coinage of the Scandinavian states: Norway, Denmark and Sweden, is clearly English and due to the Danish conquest of England. The Runic alphabet is employed, though not by any means exclusively, on many of the early coins of Denmark and Norway. The Norwegian series begins with Hakon Jarl (989–96), who copies the pennies of Aethelred II. In the second half of the 11th century begins a coinage of small, thin pennies, which develop into bracteates. Magnus IV. (1263–80) restores the coinage, more or less imitating the English sterlings of the time. Norway and Denmark were united under Eric of Pomerania in 1396. The money of Denmark begins with pennies of Sweyn (985–1014) which are copied from the coinage of Aethelred II.; the coins of Canute the Great (1014–1035) and Hardicanute (1036–42) are mainly English in character. With Magnus (1042–47) other influences, especially Byzantine, appear, and the latter is very strong under Sweyn Aestrithson (1047–76). Bracteates come in in the second half of the 12th century. The coinage is very difficult of classification until the time of Eric of Pomerania (1396). There are important episcopal coinages at Roskilde and Lund in the 12th and 13th centuries. Sweden has very few early coins, beginning with imitations of Olaf Skotkonug (99j) of English pennies and showing the usual bracteate coinage. The money was restored by Albert of Mecklenburg (1363–87). The thaler is introduced by Sten Sture the younger (1512–20). The money of Gustavus Adolphus is historically interesting. Under Charles XII. there is highly curious money of necessity. The daler is struck as a small copper coin, sometimes plated. The types include the Roman divinities. At the same time and later there was a large issue of enormous plates of copper, stamped with their full value in silver money as a countermark.

Russia. — The earliest Russian coinage begins with the princes of Kiev as early as the end of the 10th century; it shows strong Byzantine influence. The grand princes from the early 15th century struck curious little silver pieces. The coinage was modernized by Peter the Great, who introduced a regular gold coinage. The large silver and copper coins of his successors are very plentiful. Nicholas I. (1825–55) introduced a platinum coinage of about two-fifths the value of gold.

Other Countries. — The Christian coinages of the northern Balkan States are of great morphological interest. They are chiefly silver grossi, showing a mixture of Byzantine and Venetian influences. The Bulgarians had a regular silver coinage from Asien I. (1186–96) to John Sismana (1371–95). The Serbian coinage lasts from Vladislas I. (1234–40) to the middle of the 15th century. There is also a coinage of the Bans of Bosnia (late 13th to 15th century). The modern coinages of the Balkan States are of the 19th century only. The independent city of Ragusa is remarkable for the bold style of its early copper (13th century, inspired by Roman models of the 4th century) and the richness and variety of its later issues.

BRITISH COINS

The earliest coins struck in Britain were rude uninscribed imitations of the stater of Philip II. of Macedon (359–336 B.C.), one of the great currencies of the ancient world; they reached Britain through Gaul where they had been imitated by the various tribes there. The exact distribution of the earliest coins of this type found in Britain betaeen British and Gaulish mints is still uncertain. These coins are of gold of gradually diminishing purity and are at first uninscribed. Under Roman influence we have the introduction of silver and copper coins toward the end of the last century B.C.; inscriptions also now appear on the coins so that we can identify the coinage of Tincommius and Cunobelinus (Cymbeline) and others known and unknown to history. With the Roman conquest native coinage disappears and if we except the Roman coins from the mint of London in the 3rd and 4th centuries A.D., we have no British coinage again till the departure of the Romans. Gradually degenerating copies of Roman types formed the currency of Britain from the 5th to the 7th century, when we are once more able to attribute the coins to definite rulers. In the 7th century we have the extensive coinage of little silver pieces known as "sceats" with a considerable variety of types and legends in Runic letters, which enable some to be attributed, for example, to Peada, king of Mercia (655–57 A.D.).

About the same time in the kingdom of Northumbria we have the small copper coins known as "stycas," which record a long series of kings from Ecgfrith (670–85) onward. But it is from the reign of Offa (757–96) who introduced the silver "penny" that English coinage may be said to date. In its broad flat fabric, contrasted nith the thick fabric of its predecessors, it shows the influence of its Carolingian prototype but the designs are thoroughly Anglo-Saxon and the portrait of Offa, a remarkable piece of work, reaches a level not equalled again in English coinage till the reign of Henry VII. The inscriptions, obverse name of the king and reverse that of the moneyer, were to remain unchanged in form till the reign of Edward I; for the same period also the silver penny was the only English coin. A remarkable coin struck by Offa is his imitation of an Arab dinar of the Caliph al-Manṣūr with the additional legend OFFA REX, one of the few and exceptional gold coins of the Anglo-Saxon period. About the same time we find the Archbishops of Canterbury beginning to issue coins, the earliest being those of Jaenberht (766–90) bearing the names of the suzerain Offa also.

The kings of Kent and the kings of East Anglia also began to strike pennies: the rise of Wessex after the battle of Ellandune in 82j can be traced in the coinage; the earliest coins of Wessex were those struck at Canterbury by Ecgberht and his conquest of Kent, and the mints of Alfred's reign reveal how West Saxon power had expanded. The Danish invaders have also left extensive numismatic records, some of exceptional historical interest like the London coinage of Halfdan. The troubled state of the country is reflected in the many barbarous and hurriedly struck coins of this period. The peace and prosperity which returned after the peace of Wedmore (878) is seen in the improved workmanship of the coinage, with a more careful treatment of the portrait and a great variety of original work in the reverse types, a feature which was not long maintained. In the 10th century it became the regular practice to add the name of the mint as well as that of the moneyer on the reverse. In the edicts of the Council of Greatley (928) we have the earliest surviving mint ordinances. Coins were only to be struck at certain tonns and each town was to have only one moneyer with certain specified exceptions (*e.g.*, eight for London). The number of mints increased till in the reign of Aethelred II we have more than 70; from about his time also the king's portrait, which had only been occasionally used, became the regular obverse type on the coinage, while the reverse type also became stereotyped to some form of cross.

The Norman conquest made no change in the coinage or mint system and we even find that preconquest moneyers stayed in office and struck coins for William I. But the coin-types were now regularly changed partly as a source of revenue, for the moneyers had to make a payment when new dies were issued, partly as a check on forgery. The dies were made in London and sent to the country mints. The pennies of William II have nothing in their legend to distinguish them from his father's issues but students have been able to allot eight types to William I and five to his son. Forgers gave Henry I much trouble and one step he took to prevent it was to issue his later coins with a snick in the edge to show that the silver was good. The civil wars of Stephen's reign produced many interesting coins such as those struck in Matilda's name and the pennies of Eustace Fitzjohn and other barons.

Henry II ceased the practice of regularly changing the types which had been the custom since William I's reign and struck one type till 1180. In this type the work of the English mints reached its lowest level; the coins frequently have only a letter or two of the legends and fragments of the type. His second type, the "short-cross," so called from its reverse design, first issued in 1180, remained unchanged—including the name Henricus—not only by Henry II but also by Richard and John and Henry III till 1247. In 1247 Henry III coined the "long-cross" penny with the arms of the cross extended to the edge of the coin with a view to preventing clipping. He also reduced considerably the number of mints. In 1279 Edward I introduced a new type of penny obverse: bust of the king and reverse: long cross with three pellets in each angle, a type which was much imitated abroad and persisted in the silver coinage till the reign of Henry VII. The moneyer's name disappeared from the reverse legend and its place was taken by the name of the mint CIVITAS LONDON, etc. He also struck halfpennies and farthings to replace the cut pennies which had hitherto done duty for small change. He also introduced a groat or fourpenny piece (groat = gros = *grossus*, large *denarius*-penny) but the time was not yet ripe for this larger coin and it did not establish itself till Edward III's reign. The coins of Edward I, II and III cannot be distinguished by their legends; a minute study of them has, however, enabled them to be attributed satisfactorily.

Henry III had attempted to issue a gold coinage by striking the gold penny of the value of 20 pence silver, later raised to 24, but the difficulty of rating gold to silver proved insuperable and the coinage was withdrawn. In 1344 Edward III with the issue of his fine series, the florin, leopard and helm ($\frac{1}{2}$ and $\frac{1}{4}$ florin) again attempted without success to introduce a gold currency: the attempt was renewed with the noble and after various experiments with its weights a gold coinage was finally established in currency in 1351 with a noble of 120 gr. of gold and its subdivisions the half- and quarter-noble. The silver penny was reduced to 18 gr. and the groat first issued in the same year. The noble was valued at 6s. 8*d.* The obverse type of the noble, the king in a ship, is supposed to allude to the naval victory of Sluys. The reverse type is a floreate cross with considerable ornamentation. Edward IV distinguished his noble by a rose on the ship (rose-noble or ryal) and raised its value to 10*s.*, while a new gold coin, the "angel," was introduced to replace the old value of the noble at 6s. 8d.; the penny was reduced to 12 gr.

The angel is so called from its type of St. Michael and Lucifer. The reverse is a ship with a cross in front of the mast. The angel in the 16th century became the piece given to those touched for king's evil; it was struck for this purpose down to the reign of Charles I; it was not again issued as legal tender but small copies of it were struck by the later Stuarts and pretenders for presentation at the ceremony of touching for king's evil. The next important change in the coinage was not till the reign of Henry VII. This was the introduction of the sovereign, a large gold coin of 240 gr. current for 20*s.*; the obverse type was the king seated in an elaborate throne and the reverse a Tudor rose with a shield of arms in the centre. The same ruler also issued the first English shilling or testoon, a handsome coin with a fine portrait, in 1583, but this did not attain much currency. Henry VIII altered the types of the smaller silver coins by replacing the three-centuries-old cross and pellets by a long cross and shield while the inscription POSUI DEUM ADJUTOREM MEUM took the place of the mint legend; the stereotyped bust was replaced by an excellent profile portrait on the groat and the seated king on the penny; Henry VIII debased the gold and reduced the weight of the sovereign, the reverse type of which was now the royal arms supported by a lion and dragon. He introduced the gold crown of 5*s.* and half-crown and raised the angel to 7*s.* 6*d.*, introduced the George noble to take its old value of 6s. 8*d.*—so called from its type of St. George and Dragon. In 1544 he issued the base shilling or testoon of 12 pence and debased the silver coinage. It was in his reign that the archiepiscopal mints of Canterbury, York and Durham were abolished, the former having exercised its privilege for nearly eight centuries. When Edward VI again restored a coinage of fine silver he introduced the silver crown of five shillings, which took the name of the gold piece of the same value introduced a few years earlier. The reign of Mary is notable for the appearance of the portrait of her husband, Philip II of Spain, on the shilling.

Elizabeth continued her father's denominations and restored the purity of the silver coinage. By introducing the sixpence and threepence of silver she gave the groat its deathblow, although it and the twopence continued to be struck. She also introduced coinage by machinery (mill and screw) although it was not really established until after the Restoration. James I introduced a number of new gold coins, the most important being the "unite" or sovereign (20*s*.), so called from its legend (*Faciam* eos *in gentem unam*) alluding to the union of the crowns. In his reign the number of denominations in use reached its maximum. Charles I made no changes in the coinage of the last years of his father, but the Civil War and the king's financial difficulties added many new coins to the English series. These were 20*s*. and 10*s*. pieces in silver and the large gold pieces, *e.g.*, F3 pieces of Oxford and Shrewsbury, the fine Oxford silver crown by Rawlins with a view of Oxford behind the usual type of the king on horseback; the siege pieces rudely struck on pieces of silver plate at various Royalist strongholds show to what straits the king's party was reduced. Gnder James I and Charles I are found the first English copper coins, the "Harrington" farthings; they were not struck by the king but by contract. The coinage of the commonwealth is remarkable for the simplicity of its types and this is the only period of English coinage when the legends have been in English. A series of coins was struck with Cromwell's bust and superscription but, although not uncommon, they never seem to have been put into currency.

The modern coinage dates from the reign of Charles II. After issuing the old denomination of hammered money in the first two years of his reign, he replaced the unite or broad in 1662 by the guinea, so called from the provenance of its gold, still a 20*s*. piece. It was not until 1717 after various oscillations that its value was fixed at 21*s*. His silver coins were the crown, half crown, shilling, etc., all regularly and beautifully struck by Jan Roettier with the new mill which was then established at the mint. In 1672 he introduced the bronze halfpenny and farthing with the Britannia type. The finest coin of his reign is not a regular issue. It was the "Petition" crown made by Thomas Simon, engraver at the mint under the commonwealth, and bears on the edge a petition to the king that he might be given the same office under the new regime. The coinage of the 18th century calls for no remark; one may just mention the practice of recording the provenance of the metal of particular issues as in the VIGO issues of Anne struck from cnptured Spanish bullion in 1702, the Welsh Copper company shillings of George I and LIMA coinage of George II made of bullion brought by Anson from his voyage around the word. Toward the end of the century the scarcity of government silver was largely made good by Spanish dollars, nith or without a bust of George III countermarked upon them, and by tokens issued by the Bank of England while the deficiency in copper was made up by the private issue of vast numbers of tokens. In 1816 the great recoinage took place with the introduction of the sovereign and silver coins each with Benedetto Pistrucci's design, St. George and the Dragon. In 1848 in the reign of Queen Victoria the 2*s*. piece (florin) was issued and proved a most popular coin. The double florin which was first issued in 1887 did not take the public fancy and the practical disappearance of the crown piece also from circulation reflects the public prejudice against large coins. The gold sovereign was last struck in 1917 but it had disappeared from currency in 1914 soon after the outbreak of World War I, after a career of 300 years as sovereign, unite, guinea and again sovereign.

Wales has never had a regular coinage but there exist two unique coins of Welsh kings, a penny of Howel Dda (c. 910–40) and another of Llewellyn (1075–79).

Scotland. — The coinage of Scotland followed similar lines to that of England in regard to types and weights: the earliest coins are. silver pennies resembling the contemporary coins of England. The silver coins are baser and of inferior work but the more rare gold coins present several remarkably fine pieces of workmanship. The Scots coinage decreased in quantity after the union of the crowns in 1603 and ceased in 1709 after the union of the parliaments. The only extensive and varied coinage is that of Mary Queen of Scots.

Ireland. — Ireland had an extensive silver coinage in the 10th century, mainly copies of the Anglo-Saxon coinage by Danish kings, Sihtric III and his successors. The Anglo-Irish coinage began in 1177 with pennies and halfpennies of John, the only coins to bear his name which does not occur on the English coins. The quality of the coinage became more and more debased, reaching its final degradation under the Tudors. Gold mas never struck by the government but copper was introduced quite early. The Civil War, as in England, produced a number of siege-pieces, notably the Inchiquin and Ormonde money. James II in his campaign in Ireland issued vast numbers of gun-metal coins ranging from the 2/6 downward. These were to be cashed for silver when he regained the throne. They are unusual as they bear the date in months. Irish coinage under the British regime did not actually come to an end until the reign of George IV, the last issue being in 1822. In 1928 coinage by the Irish Free State was introduced.

We may note that the Isle of Man had its own coinage from 1709 under the Earls of Derby to 1864 under Victoria and that the Channel Islands of Jersey and Guernsey have had their own bronze coinage for over a century.

ASIATIC COINS

Achaemenids.—The ancient kingdoms of the nearer east, Sumerian, Assyrian, Babylonian and Hittite, had no coined money, nor had the earlier Achaemenids of Persia. Not till after Cyrus conquered Lydia in 546 B C did the Persians learn the art of coinage. It is not certain which Achaemenid ruler first struck coins but it was likely Darius Hystaspes (521–486) as Herodotus suggests. The coins of the dynasty were the daric (*i* e., the coin of Darius) of gold of very pure quality and the siglos in silver. Thus early we have the relationship of sovereign and shilling anticipated, for 20 sigloi (shekels) made a daric which weighed a little more than an English sovereign. The types of both coins were the same: obverse the Persian king in a kneeling position holding a bow in his left hand and a spear in his right; the reverse bears no type but only a rough irregular incuse caused in the striking. In shape they are roughly oval being struck from round or rather egg-shaped globules of metal. These pieces were uninscribed and remained in issue unaltered in type until the fall of the empire. The issue of gold was the royal prerogative, but the conquered Greek and other cities and states were allowed to issue silver and copper while a number of Persian satraps struck silver in their own names; to this latter class we owe a number of the earliest and finest portraits on coins. On the fall of the empire, various satraps, such as Mazaeus who ruled Babylon for his new master Alexander the Great. struck silver coins of their own.

Parthiam.——In the middle of the 3rd century the Parthians rebelled and cast off the Greek (Seleucid) yoke and soon became a great power in Persia. They had an extensive but monotonous coinage in silver (tetradrachms and drachms) and copper. The tetradrachms and drachms bear the bust of the king and Arsakes, the founder of the dynasty, seated holding the Parthian boa- on the reverse of the drachms. The usual reverse on the tetradrachms is the king seated receiving a wreath from a Victory or a city goddess. The coins do not bear the name of the issuer but that of Arsakes, the founder of the dynasty, and the inscriptions range in length from the simple (coin of) "king Arsakes" to legends such as (coin of) "the great king of kings, Arsakes, the just, the illustrious, the divine, the friend of the Greeks." After Phraates IV the coins are dated in the Seleucid era; on the later coins the Greek becomes corrupt and broken and is joined by an inscription in Pehlevi, a language then more intelligible to those who used the coins.

The kings of Persis, who became independent about the same time as Parthia, began their series with very fine portrait tetradrachms but the coins rapidly degenerated; their reverse type, a fire altar with or without attendant priests, was revived by the Sassanians so that it had a life of nearly 1,000 years; numerous debased silver, almost copper, tetradrachms of the rulers of Characene and of the Omani on the lower Tigris down to the sea still exist to record the names of forgotten rulers.

Sassanians.—In the beginning of the 3rd century A.D. Ardashir, a native Persian prince, overthrew the last remnants of Parthian power and founded the great Sassanian empire which ruled all western Asia. The Sassanian coinage was very extensive in silver and the early emperors regularly coined gold although the latter was rare. The copper coinage also seems to have been small. The coin types throughout the dynasty are the same for all metals; on the obverse is a bust of the king with a long legend of the form (Ardashir, etc.) "worshipper of Ahura Mazda, divine king of kings of Iran," and on the reverse a fire altar usually nith two attendant priests and the legend "the fire of (Ardashir or other emperor)"; from the time of Kobad the reverse legend gives the mint and the regnal year of issue. The standard of the gold coins is derived from that of the Roman solidi; the silver coins are drachms following the Parthian standard and are remarkable for their broad thin fabric which was copied by the Arabs for their silver coins. The execution of the portraits especially in the 3rd and 4th centuries is remarkably fine.

Caliphates. — The early Arabs were unacquainted with the art of coinage which had died out in Arabia with the extinction of the Himyarite kingdom in the south; it was not till the conquering armies of Islam had wrested Syria from the Byzantines in the east and overthrown the Sassanian empire of Persia in the west that they became acquainted with regular currencies and with the sudden accession of wealth found the need of one. At first they issued gold and bronze pieces imitated from contemporary Byzantine coins, modifying the cross on the reverse of the latter somewhat to suit Moslem susceptibilities; the earliest silver coins were copies of late Sassanian coins with the addition of *bismillah* (in the name of God) on the margin. The need for a purely Arab coinage worthy of the now vast Arab empire was soon felt and toward the end of the 7th century the fifth Omayyad caliph, ʿAbd al-Malik (A.D. 685–705), instituted a coinage more in keeping with the principles of Islam. This coinage was of gold, silver and copper and the names *dinar* (denarius aureus), *dirhem* (drachm) and *falus* (follis) were borroned from the Byzantines, as were also the weights of the gold and bronze. It is interesting that the gold and bronze kept the thick fabric of the Byzantine originals while the silver retained the thin fabric of the Snssanian drachms; it was some centuries before this distinction of fabric disappeared. The strict interpretation of some sayings of Mohammed on image-making had removed a vast field of activity from the Moslem mint engraver by limiting him to legends instead of types. This, however, gave Arab coins a historical value which the coinage of no other race possesses. From the earliest times they bear the mint and date and in time the ruler's name and title often with valuable genealogical data and titles of historical interest. Every Moslem claimant to sovereign power took the earliest opportunity of striking coins and we possess coins of rulers and pretenders known to have had the briefest reigns and in some cases their coins still testify to the existence of rulers unrecorded by history.

The dirhem of 'Abd al-Malik bears on the obverse the Moslem profession of faith: "There is no god but God: he has no associate" and around is the marginal legend: "In the name of God this dinar was struck at —— in the year ——." The reverse area has a quotation from Koran cxii, "God is alone; God is eternal: He begets not and is not begotten nor is there any one like unto Him." Around is Koran ix, 33: "Mohammed is the Prophet of God sent with guidance and the religion of truth to make it prevail over all other religions averse though the idolators may be." This type of coin, issued from Spain and Morocco to the borders of China, gave Moslem coinage the character which it held for centuries. In mid-8th century the ʿAbbāsids overthrew the Omayyad caliphate but at first made little change in the coinage. The long reverse formula was replaced by the simple statement "Mohammed is the Prophet of God" and in time the caliph's name was added and at the provincial mints that of the local governor and in the 9th century a second marginal inscription was added: "To God belongs the order before and after and in that day believers shall rejoice in the help of God" (Koran xxxi, 3–4). Among the more remarkable coins of this series are those of Hārūn al-Rashid (786–809) which bear the name of his vizier and boon companion the ill-fated Barmecide Ja 'afar, whose fame, like that of his master, has been spread by the *Arabian* Nights. The extensive gold coinage of the ʿAbbāsids became one of the great currencies of the mediaeval world and Offa in his efforts to found an English coinage imitated a dinar of al-Manṣūr (A.D. 754–775).

The ʿAbbāsid caliphate broke up in the 9th and 10th centuries and the succeeding independent governors regularly put their own names on the coins although they retained that of the caliph of Baghdad whose spiritual authority was still recognized. Among such dynasties were the Omayyads of Spain, who issued an extensive coinage mainly in silver from the middle of the 8th till the end of the 11th century, the Idrisids, Tūlūnids, 'Aghlabids and Ibhshidids, all short-lived dynasties in North Africa and Egypt, coining mainly in gold. In central Asia there was the extensive coinage of the Sāmānids of the days when Samarkand and Bukhara were great centres of culture and poured their wealth into northern Europe to buy costly furs, as the great finds of Arab coins around the Baltic show. The ʿAbbāsid coinage continued down to the 13th century but Baghdad mas almost its only mint in its latter days; its last coins were very handsome large gold pieces. Minor dynasties mainly of Persian origin were the Ṭā'hirids, Saffarids and Būyids whose silver coins are still valuable historical documents.

In the 10th century the Fātimid caliphate, of Shīʿa origin, arose in western Africa and in time conquered Egypt. Its extensive currency of gold introduced a new type of dinar with legends of the usual type but arranged in three concentric circles; they held Sicily for a time and the coins struck were imitated by their Norman successors. A little later the Turks arose in the west, swept before them the smaller dynasties and ultimately ruled all western Asia. As the Ghaznevids, they ruled in Afghanistan and part of India; Mahmud of Ghazni struck coins with inscriptions in Arabic and Sanskrit, the latter for his Indian dominions. His regular gold coinage and those of the great Seljuk Tughril Bey are among the last issues of the old type and in the 13th century we have a series of remarkable innovations. The descendants of the original Seljuk conquerors divided their conquests in western Asia into numerous small states. Their scarce gold coinage follows orthodox lines, while giving a wealth of historical information, but the most remarkable of their issues was an extensive series of large copper coins bearing a remarkable number of different types borrowed from all sources, ancient Greek and Roman and Byzantine. They seem to have taken a childish delight in reproducing any coin type or even picture that took their fancy. Such are the coins of Karā Arslān (1168–1174) with reverse the familiar Byzantine type of Christ seated or of Alpi (1152–1176) with the virgin crowning a Byzantine emperor. Their silver coins mere directly influenced by the aspers of the Byzantine emperors and more particularly by those of the empire of Trebizond. From the latter comes the type of a horseman with a mace over his shoulder, popular mith the Seljuks of Asia Minor. Notable among the silver coins of this period are those of Kai Khusru II (1236–45) with the Lion and Sun type, the horoscope of his beautiful Georgian wife whose portrait he even wished to put on his coins. It is these Turks, Seljuk, Ortukid and Ayyubid, who were the "Saracen" opponents of the Crusaders, the best knoun of them being Saladin, the Ayyubid sultan of Egypt and Syria; his silver coins and those of his family give their titles at great length to the exclusion of religious legends. During this period and a little later some of the most beautiful coins the Moslem world has produced were being struck by the Almohads and Almoravids in western Africa. These large thin pieces of fine gold bear long genealogical and religious legends written in a beautiful, often elaborate script. Ibn Baṭṭūṭa, the Moorish traveller, remarked that nowhere were. the dinars so large and beautiful as in his native land.

In the 13th century the Mongols swept through all Asia except India until checked on the Egyptian frontiers. Of the Mongol lines, the Khans of the Golden Horde in the north issued an extensive series of small silver coins; the greater and wealthier line of the Ilkhans of Persia struck large and handsome coins in all three metals, with the Khan's titles in Mongol on the reverse and the Mohammedan creed in the Shi'a form on the obverse. In Egypt the Bahri and later the Burji Mamluks struck a series of large gold coins down to the 16th century; their silver coins are more rare. In the 14th century the great Tamerlane (A.D. 1369–1404), a distant descendant of Jenghiz Khan, revived the power of the Mongols; the majority of his coins (silver and copper) bear the name of his nominal sovereigns Suyurghatmish and hlahmud on the reverse and the Kelima on the obverse. His son and ultimate successor, Shāh Rukh, introduced a new type of dirhem, obverse Kelima with the names of the first four caliphs on the margin and his titles on the reverse, which remained popular throughout the 15th, 16th and early 18th centuries; gold was not struck in Asia during this period. In the meanwhile the eastern half of the Moslem world was passing to the Ottoman Turks. Their coinage of gold and silver, which became gradually more and more base, and bronze is monotonous in its legends of stereotyped titles and mints only. Their wealth of mints gives their coins a certain historical interest as they trace the expansion and decline of Ottoman power in Europe, Asia and North-Africa. A notable feature of the Turkish coinage is the tughra, an elaborate monogram formed of the sultan's name and titles which occupies one side of the coin from the 16th century onward. Latterly Constantinople and Egypt were the only Turkish mints of importance. The coinage of Morocco rapidly degenerated in every way from the 16th century onward, though its most recent issues struck in Paris, Berlin and Birmingham show an improvement.

Persia. — The earlier coins of the shahs of Persia are descended through the Shaibanids from those of Shāh Rukh; at first they are large thin silver pieces of Central Asian style but in the 18th century the fabric changes and the coins become smaller and thicker as in India. The coins, especially the larger pieces, are remarkable for their fine calligraphy; the legends are usually in the form of rhyming couplets; gold is not common till the 18th century. Copper was not a regal but a local issue and each city issued its own. The coins are remarkable from the the fact that each city's has some type, usually an animal. Some of the products of the Persian mint are of huge size (for example, a gold piece of 80 tumans weighing over a pound) and were pieces struck for presentation to distinguished officials. In the latter part of the 19th century Nasr-ed-Din (1829–1896) abolished the provincial mints and instituted a coinage from a central mint in Tehran with European machinery. Henceforth the coins of Persia bear the portrait of the shah on the obverse and the "lion and sun" on the reverse.

Afghanistan. — The emirs of Afghanistan who became independent of Persia in the 18th century and carved out a kingdom at the expense of their neighbours in Persia, central Asia and India, struck coins in gold and silver on the standards of the Mogul emperors whose poetical legends they also copied. At the end of the 19th century a mint on European lines was established in Kabul and the high-flown distichs were replaced by a representation of a durbar hall. The Afghan coinage of the 19th century was mainly silver, although earlier gold also was common.

Of the various smaller modern dynasties which ruled central Asia till the Russian conquest, the emirs of Bukhara and of Khokand are notable for their extensive issues of gold pieces, to the practical exclusion of other metals.

India. — There is no reason to doubt the independent origin of coinage in India although it was soon so much modified by Greek influence that the question was long disputed. The earliest coins are pieces of silver, very commonly square, and of copper punched with various symbols on both sides. Of about the same date are the square and round cast copper pieces with similar but less varied symbols. These pieces circulated all over India and belong to at least the 4th century B.C. although they circulated after this date and may be somewhat earlier. Contemporaneously from the 3rd century onward are the copper coinages of numerous states and dynasties which show increasing Greek influence and whose few silver coins are directly influenced by the hemidrachms of the Greek rulers of northwest India of the 2nd century B.C. The types of these are of considerable mythological and religious interest. Technically they are interesting as showing the evolution of a type from a series of separate punches to the grouping of the punches on a die.

Early in the 2nd century B C. the Greeks of Bactria began to invade India and their coinage is remarkable for its fine series of portraits and for the number of names it records of rulers otherwise unknown. Prakrit legends begin to appear alongside of corrupt Greek; the Greek in time becomes more and more corrupt as the Greek rulers were replaced by Scythian and Kushan invaders who copied their types. The Greek deities gradually give place to Indian ones on the coins.

In the middle of the 1st century A.D. the Kushans founded a great empire in northwest India; they have left a wealth of gold and copper coins with legends in an Iranian language in a corrupt Greek character. During this period Roman gold in enormous sums went to India ,every year and was recoined there. The Kushan coins bear on the obverse the king sacrificing and on the reverse deities of all the religions of the time, Greek, Roman, Zoroastrian, Hindu and Buddhist. This type of king on obverse and deity on reverse became the general type of north Indian coinage for the next 1,000 years; the Kushan coinage continued, rapidly degenerating till the 4th or 5th century, over a much more limited area; the type was continued by the kings of Kashmir down to the 10th century and adopted and modified by the great Gupta emperors in the 4th century. The latter struck an extensive gold coinage with long legends in poetical Sanskrit and many' interesting types, often medallic in nature, but, on their coins for general currency at least, always betraying the Kushan prototype. Among the more notable Gupta coins are those that commemorate Sandragupta's horse-sacrifice, or those that record his skill as a lyrist, to which he also testifies in his inscriptions. The art and correct Sanskrit legends of these coins are in keeping with the great Hindu revival of the period.

In western India a dynasty of western Satraps of Persian origin had been ruling since the 1st century B.C. Their extensive coinage of silver only is dated and therefore of a historical value unusual in Indian or any early coinage. They look modern in that they bear on the obverse a bust of the ruler; they resemble Roman denarii and may have been influenced by them but their prototype is rather to be sought in the hemidrachms of the later Greek kings of India. This kingdom was overthrown by the Guptas at the end of the 4th century and they at once began to imitate this silver coinage not only locally but also in their own territory which seems previously to have had no silver coins. The barbarian Huns who destroyed the Gupta and other civilizations in the 6th century have left numerous coins, imitated from Sassanian, Gupta or Kushan prototypes. Degenerate copies of these seem to have been the coinages of northern India until the revival of various Hindu dynasties from the 10th century onward. A notable innovation was the neat silver coinage of the Shahis of Gandhara of the "bull and horseman" type in the 9th and 10th centuries. extensively imitated by the Mohammedan conquerors of India and the contemporary minor Hindu dynasties. The other type favoured by the mediaeval Hindu dynasties for their gold coinage was that of a seated goddess — going back to a Gupta reverse — and an inscription with the king's name on the other side.

The coinages of southern India form a class by themselves. In the later centuries B.C. and early AD. the Andras ruled a great kingdom in central south India; their coinage is mainly of lead and has types of the usual indigenous character.

The later mediaeval dynasties of south India struck coinages mainly of gold, the type of which is usually the badge of the dynasty; the Cheras of Malabar for example had an elephant and the Chalukyas of the Deccan a boar, the Pandyas a fish and the cup-shaped pieces of the Kadambas bear a lotus. The Chola dynasty introduced under northern influence the type of a king standing on obverse and on the reverse the king seated. which spread through south India and was taken to Ceylon by the Chola conquest and adopted by the local rajahs there. The great Hindu kingdom of Vijayanagar (Mysore) left a large series of small gold and copper coins with the types of various deities which had considerable influence on the modern coinages of southern India including those of the various foreign companies.

The earliest Arab invaders had reached India in the 8th century and founded a dynasty in Sind which has left numerous very small silver coins of the Omayyad type. Not till the 11th century was India seriously affected by Moslem invasions when Mahmud of Ghazna conquered the Punjab. His empire was short-liked. In 1193 the Ghorid Mohammed bin Sam defeated the allied Hindu forces and became lord of India. His descendants ruled northern India from Delhi till the hlogul conquest. Their coinage is varied and extensive, mainly gold and silver tankas (or rupees) of 178 grains. They are large thick pieces with the profession of faith on one side and the name of the king, mint and date on the other. A feature of this coinage is the unsuccessful attempt made by hfohammed III b. Tughlak (A.D. 1324–1357) to replace gold and silver coinage by brass tokens. Gold was hardly issued at all in the 15th and 16th centuries and for a time the coinage was mainly billon. Sher Shah (1539–45), one of the ablest of the line, issued a large silver currency of a type, carrying the Kelima and names of the four caliphs, which was imitated by the Mogul successor of the Suris.

During the latter half of the period of the sultans of Delhi, various dynasties made themselves independent; such were the rulers of Bengal, Gujarat, Jaunpur, Malwa, etc., whose coins all follow the standards of the central power. Those of Bengal are mainly silver rupees with rare gold; the currency of Jaunpur, gold and billon. Malwa and Kashmir gold and silver coins were square.

The coinage of Bāber and Humāyūn, the first two of the Mogul conquerors of India, are not extensive and are of central Asian types. With the next tno, the Great Moguls Akbar and Jahāngīr, is found a series unrivalled for variety and, within their limitations, beauty—the gold coins of Jahāngīr are noble examples of Moslem calligraphy, an art evidently cultivated as much as painting at his court. The mints of the Mogul coins reflect dynastic fortune—even Shāh Jahān's brief occupation of Balkh is at once recorded on a gold mohur. The close association in the Moslem mind betneen sovereignty and the right of the coinage is exemplified in the existence of the coins of many pretenders to the imperial throne, some of whom we know from history to have had the briefest spell of power. The general type throughout is the same. In the 16th century the type that goes back to Sher Shah prevails, the Kelima with the names of the first four caliphs and the emperor's titles on the other side; Aurangzib replaced the confession of faith by the mint and date and this remained the usual type till the end of the dynasty. The emperor's name is usually enshrined in a Persian couplet to the effect that the metal of the coins acquires added lustre from bearing the emperor's name. Nearly 50 such verses are found on Jahāngīr's coins. The latter's reign is also remarkable for the series of coins bearing the sign of the zodiac and the set of portrait mohurs, one of which represents him holding a wine cup. He also allowed his wife, Nūr Jahān, to strike coins in her own name, and she is also said to have inspired the issue of the zodiacal series. From the beginning of the 18th century the coins become stereotyped and the epigraphy loses its beauty Numerous native states began to arise and throw off the Mogul yoke, but to the middle of the 19th century they continued to coin on Mogul lines. The English and French East India companies for years copied the native types from the coinages and did not strike on European lines till the 19th century. The right of native states to mint their onn coinage nas gradually curtailed by the British governinent until there were very few independent coinages The most important native state mint at present is Hyderabad, which several years ago instituted a mint with European machinery. Before leaving India mention should be made of the extensive coinage in gold and silver with Sanskrit legends of Nepal, which is still being issued, the long series of cctagonal gold and silver coins of Assam struck down to the British conquest, and the brief coinage of Burma in the 19th century.

Chinese.—In spite of the very early references to money in Chinese literature, there is no reason to believe that the earliest coins are much older than the 7th century B C.; that is to say that coinage originated independently in the far east about the same time as it did in the west. The earliest Chinese coins are small bronze spades and knives, copies of the spades and bill-hooks and other small articles of husbandry that had been used for barter. The knives are about six inches long and bear the value and name of authority issuing it; *pu* money, a modified form of the spades, circulated widely in the 5th and 4th centuries B C. Small change was supplied by cowrie shells in this period, as it had been long before the invention of a coinage. There was an issue of bronze cowries in the 7th century B.C. Round money with a hole in the centre was issued as early as the 4th century but it was not till 221 B.C. that the reforming Shah Huang Ti (221–210 B.C.) superseded all other currencies by the issue of round coins of half an ounce (*pan-liang*), which were continued by the Han dynasty. This coin became gradually reduced and debased and was replaced in 118 B.C. by the emperor Wu Ti's five-chu piece which remained the coin of China for the next eight centuries; a break in the monotony of the regular coinage is formed by the archaistic innovations of the usurper Wang Xfang (A D. 9–22) who issued a modified form of the *pu* and knife currency and a new round coin (*ho tsien*). The history of Chinese coins is the history of a series of gradual debasement of the government currency until it is overwhelmed by the increasing activity of forgers and a new coin is instituted. On one occasion at least the most skilful of the forgers were given work at the government mints. The five-chu piece lasted till the rise of the T'ang dynasty uhen the emperor Kau Tsu in 618 issued the *Kai-yuan* coin which gave the coinage of all the far east its form till the end of the 19th century—a round coin with a square hole and a four character legend of the form "current money of (regnal period)." The southern Sung dynasty (A.D. 1137–1278) dated their coins on the reverse in regnal years and the Ming dynasty (A.D. 1368–1628) put the mint name on the reverse as did the Ching dynasty (AD. 1628–1911), the latter giving it in Manchu characters. Paper money has been in use in China since the 9th century and was current almost to the exclusion of regular coins under certain of the Mongol emperors, for example Kublai Khan, whose paper money is described by Xfarco Polo. For over 2.000 years the copper cash nith occasional multiples of it was the only coinage of China; gold and silver nere current by weight only, the latter in the form of boat-shaped ingots. The monotony of the series is only rarely broken as for example by the nail-mark of the emperor Wen-Teh on the Kai-yuan pieces, an issue of lead coins in the 12th century and the issue of large token pieces going up to 1.000 cash in value during the Tai Ping rebellion when the rebels held the copper mines. With the increasing popularity of Spanish colonial and Mexican dollars as a silver currency in China, several attempts were made to institute a silver coinage in the 19th century; not till the very end of the 19th century were mints established to strike silver and copper coins of European style in all the provinces. One of the last of these, a rupee of Szechwan, was the only coin of the Chinese empire to bear the head of an emperor. This was because it was intended to compete for Tibetan trade with the Indian rupee. Under the republic, coins nere at once struck nith the portraits of Sun Yat Sen and Yuan Shih Kai, and the various generals who have since been fighting for China have issued their onn coins nith their portraits. A feature of the issues of the latter has been the number of gold coins they have issued, for the first time in Chinese history. The very extensive series of talismans, coinlike in shape but usually larger should be noted. Many are Taoist and Buddhist in their legends and types; others are simply lucky pieces.

Japan.—The art of coinage was borron ed from China by Japan nhose first bronze coins nere issued in AD. 708. Tnelve different issues were made down to the middle of the 10th century, each of a different reign. For the next 600 years, however, no government coins were issued and the currency was supplied by imitations of contemporary Chinese coins made by the great nobles. In the 17th century the copper *kwan-ei* was first issued in 1624 and remained in vast variety the usual issue for over two centuries. The *ei-raku* and *bun-kyu* sen of the 19th century were 'the only other regular copper coins. Unlike China, Japan has had a gold and silver currency since the 16th century. The gold coins are large flat pieces in the shape of rectangles with circular corners, the largest size being *obans* and the smaller *kobans;* these bear various small official stamps and a large signature in ink of a mint official. They range in length from 6 in. to ½ in. Other gold pieces are the small rectangular pieces of 1 and 2 *bu* issued from time to time; round gold is rare and usually of provincial mints. There have not been many issues. of silver, usually in small rectangular pieces; the so-called bean money with the figure of Daikoku is not a currency but was made to add to the large, long silver presentation pieces to bring them up to a certain weight. A notable Japanese coin is the oblong silver piece struck in 1765 out of confiscated silver ornaments by an official named Taruna.

In 1869 a mint on European lines was established in Tokyo and gold, silver (yen or dollar) and copper have since been regularly issued from it. The *e* sen of Japan are not coins but amulets and bear figures of Daikoku, the god of wealth, Itsibu fishing, etc.

Korea.——Korea has had a bronze coinage of the Chinese style since the 12th century, but it is only with the institution of *Shang Ping* cash at numerous mints, with an elaborate system of dating or rather numbering the issues between 1790 and 1881, that its coinage becomes common. Attempts were made to establish a silver currency during the last years of its independence. Annam began by imitating Chinese coins and had a regular bronze coinage of its own on the Chinese model from the 10th to the 19th century. Silver became common in the 19th century in the form of narrow oblong bars. Annam also has its amulets or rather presentation pieces. These are in gold, silver, and copper with a variety of designs bearing auspicious inscriptions, quotations from the Chinese classics, etc., in addition to the king's name. The native coinage ceased when Annam became a French possession.

Siam.—Siam down to the middle of the 19th century struck gold and silver in the form of balls formed by doubling in the ends of a short thick bar of silver, and bearing the stamp of the reigning monarch. Since 1850 it has had a coinage on European lines with portraits and issues in gold, silver and copper and more recently in nickel.

The native kingdoms of the Malay Straits used lead for their coinage, these are usually round with Malay or rarely with Chinese inscriptions; an exception is found in the "hat money" of Pahang in the form of a hollow square with truncated pyramids and a Malay inscription along the bottom The spear money of the Nagas, the canoe-shaped and willow leaf money of the Shan States and the "snail shells" in silver of the more primitive parts of Burma can only be mentioned here.

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TECHNIQUE AND ART

The technique of production of coins and medals has remained in principle the same from the earliest period of coinage to the present day; the gradual introduction of more complicated machinery, while lessening the part played by human hand and eye in the later stages of the process, has never, unless the so-called photosculpture be acknowledged as an art, eliminated the part of the artist in producing in one form or other the actual relief of the coin or medal type.

Casting and Striking are the two sharply distinguished methods of production. The former, although it was little employed in antiquity save for large coins, may be described first, since it was the method that metal-workers used on a larger scale for the solid casting of statues, statuettes and decorative work, etc. A model was first built up in wax or clay. The process of carving the model out of a mass of wax was occasionnlly employed, sometimes partly combined with the building up process, but there is no evidence of this before the days of the Renaissance. Another method of producing the model, that of carving it in box-wood or pearwood or in fine stone, such as Solnhofen stone or slate, was brought to a high degree of perfection by the Germans of the Renaissance; it was almost unknown in Italy. The model once made was impressed in a mould of fine sand or other material, and a cast was made. Some of the German medallists of the Renaissance seem to have carved the design in reverse in clay (just as if they were carving a matrix in hard material) which was then baked and used as mould. In the case of small coins a number of moulds were often combined, with channels leading from one to the other. Tree-like sets of coins produced in the Far East by such casting *en chapelet* are still extant.

The coins produced by this process are seldom of precious metals and almost entirely negligible as works of art, being of the roughest kind. But the method was employed by all the greatest medallists, from the founder Pisanello, in the 15th century, onwards, in preference to the more mechanical process of striking. Casting was carried to a high degree of excellence (especially by the Germans), the ideal being to reproduce the wax model without subsequent chasing. The Italian medallists were sometimes content with the roughest representation of their work. Others depended on chasing with the burin or graver to remove the irregularities of the cast; and often the chasing was by an alien hand. Any coin or medal could be used as a model, for impressing in moulding material, so that a new cast could be made. The vast majority of the extant medals supposed to be of the 15th or 16th century are after-casts to the nth degree. Detail has disappeared and the actual diameter has decreased since metal contracts in cooling.

The Repousse Process (*q.v.*) can of course also be used in making medals, in shells, of which the two halves are worked separately. This process was especially favoured in Holland in the 17th century. The process of pressure-casting has also, it is said, been used in recent times. Plaquettes (which are small metallic reliefs, differing from medals in being primarily decorative, not commemorative, usually one-sided and more frequently rectangular than circular) are produced like medals.

Striking of coins or medals is done by means of dies, engraved in intaglio, and impressed on the metal by blows or pressure. It is the method of impressing a signet on wax applied to a hard material, the type of a coin being, indeed, in origin and principle the signet of the issuing authority. The die had first to be engraved in a hard material. Not until Roman times was iron and occasionally steel used for this purpose. The Greeks used bronze, and analysis of two of the extremely few Greek dies that have survived shows a proportion of frorn 18 to 22% of tin, the rest being copper with negligible impurities. Such proportions mean a very hard quality of bronze. Modern dies are all of steel.

Hubbing and Cutting. — The die can be cut direct in reverse as an intaglio gem is cut. Or a positive punch or hub can be carved in relief in hard metal, and hammered into a piece of softer metal, which can then be hardened for use as a die. Details which cannot be produced by hubbing in this way can be finished by direct cutting. Both methods were known to the ancients; though no ancient hubs, and very few ancient dies are preserved, examination of the struck coins reveals certain details which can only be due to hubbing. The amount of time and labour saved by hubhing is immense; with one hub many dies can be made, whereas if the design is represented by a die alone, when that breaks or wears out all the work has to be done again. The instruments used in antiquity by die-engravers were the graver or scauper and the dotting-punch. There is no evidence that they used the drill, although that instrument was in the hands of every gem-engraver. The fineness of the work, the almost microscopic detail, must have necessitated the use of magnifying glasses, and there is evidence, literary and material, that these were known to the ancients.

The Reducing Machine. — The second way of obtaining a die was invented in the 19th century and, greatly to the detriment of the art, ousted the method of cutting by hand. It involves the use of the reducing machine, which dates in origin from about 1839 (see MINT). The artist first makes a model in wax or plaster at least four times the size of the piece to be produced. This, reproduced in a nickel-faced copper electrotype, is placed in the machine, which works on the familiar principle of the pantograph. A tracer at one end of the proportional arm moves over the whole surface of the model. At the other end a cutting point, revolving rapidly, cuts an exact, mathematically reduced reproduction of the model. Thus is produced a punch which, when driven into another piece of soft steel, afterwards hardened, gives the die which can be used to strike the coin or medal. It is obvious that the die so produced is at least three stages removed from the artist's original model which may not be suitable for a small scale relief, however exact.

The result of the introduction of this machine has been that artists have ceased to trouble themselves about the final metallic product. Not having to cut the metal themselves, they have lost the sense of material. They model in wax or plaster, and the coins or medals which are struck from the dies produced without their intervention appear as if they were made of wax or plaster coloured to look like metal.

Preparing the Blanks. — In ancient times dies were cast, sometimes actually in globular form, more usually in a form approximating to that of the final product, with sufficient convexity to allow the metal to penetrate to the deepest recesses of the die. They could also be cut from bars. The thin blanks of the middle ages were clipped out of a sheet of metal; in modem times they are punched out of a rolled bar. In antiquity, the lower die, which produced the obverse, was let into an anvil. The upper (for the reverse) was on the end of a cylindrical bar. The blank being placed on the anvil die, the reverse die was placed above it, and a sledge-hammer brought down on the upper end of the bar. How far the blank was heated before being struck we do not know. Such a primitive method of striking, without a collar to keep the blank in shape, produced great irregularities, splitting of the edge, double-striking and the like. The Greeks were indifferent to such things. The methodical Roman was more careful, and his coins are less irregular in shape. The sledge-hammer blows of course placed great strain on the dies. The first invention to obviate that disadvantage consisted in placing the dies in a frame and hammering wedges in between frame and dies, thus forcing the latter on to the blank between them. In the reign of Julius II. (1503–17) Bramante began experimenting with a press for papal leaden seals; and Leonardo da Vinci also made experiments with a coining press, and more particularly in the process of drawing strips of metal to the right thickness and punching out blanks. Out of such experiments grew the screw-press, the essential advantage of which was that the upper die was brought down on the blank not with a blow, but with a gradual pressure.

Relief and Lettering. — Those qualities which make a coin most serviceable as currency are not necessarily favourable to its beauty as a work in relief. The Greeks, for instance, being pre-eminently sculptors, made their coins in high relief. They thus suffered in circulation. It was only in the 4th century of our era that the relief of coins began to become flat, making way for the flat pattern-like treatment which is characteristic of the middle ages. That was not due to a recognition of the suitability of such treatment so much as to the decay of technique. In the use of lettering the Byzantines made an effort at decoration, but the finest development of lettering as an art on coins was left to the Moslems. In the 16th century printing wrought disaster on medal lettering.

The 13th Century. — Frederick II attempted to revive the older Roman style; his gold augustale has a head in medium relief, inspired by the Roman gold of the Constantinian period. But this was *a* false start. The beautiful Gothic coinages of the 14th century in France, England, the Low Countries, Italy, etc., show the high-water mark of the flat pattern style, which is by far the most suitable for a coinage which has to be packed in rouleaux and circulates widely. The facing head ousted the profile under the Lower empire. In obedience to a Roman principle, the frontal pose was alone proper to the imperial majesty.

Toward the end of the 15th century the influence of the medal, for which the profile was alone suitable, made itself felt on the coinage and the facing head thus practically disappeared. The early testoons of the Sforzas at Milan are the supreme example of profile treatment in very low relief, the finest combination of portraiture with decorative treatment that coinage can show. So far as mere engraving was concerned the highest excellence was probably reached in the 17th century by artists like Nicholas Briot and Thomas Simon; and, so far as mere finish is concerned, Benedetto Pistrucci, William Wyon or Bertrand Andrieu leave nothing to be desired.

The problem of composing within a circular field was solved by the ancients. The posing of a head, the combining of two or more heads in a group, whether they are jugate or addorsed or opposed, were the main problems of the obverse. The jugate or accollate position was not attempted until the 3rd century B.C. and did not become common until Roman times. The confronted pose offers no difficulty, and pleased the Roman taste for symmetry; but the Greeks disliked it and it is not found on their coins before Roman times.

The Greeks liked symmetry, but it had to be dynamic and full of movement; while they knew all that need be known about what is called heraldic opposition. and occasionally used it, it never played much part in their designs.

The remarkable outburst of artistic effort in England in the middle of the 8th century, when a real profile portrait head of

Offa appears on his coins at a time when the designs of all other parts of Europe were entirely without merit, had no duration or repercussion, Not even the excellent ornamental designs on the Anglo-Saxon coinage of this time, due perhaps to Irish influence, inspired continental contemporaries to efforts for better coins. Equally without effect was such an innovation as the type of the sovereign seated in majesty on Edward the Confessor's penny, as on the great seal. France had to wait two centuries until Philip II (1270–85) ventured to introduce the majesty-type. The Norman Conquest caused a definite setback in English art.

Germany.— In the next period we must turn to German lands to find the first signs of relief from the degradation of the engraver's art. About 1125 the curious pieces known as bracteates, extremely thin and bearing on one side only a type which shows through on the reverse, began to be produced in Thuringia and Lower Saxony. The designs—the figure of the king seated facing, the half-figures of king and queen side by side, the emperor on horseback, the figures of saints, often in an architectural setting, and the like—are a not unworthy reflection of the greater art of the Romanesque period. The style reaches its zenith in the second half of the 12th century under Frederick Barbarossa and Henry VI, when the coins sometimes attain a diameter of 50 mm. It was, however, in the middle of the 13th century that the real revival began.

A similar effort was made by the little republic of Ragusa in the same century. But other states, though they wisely did not attempt to attain high relief, did begin to play with the idea of making their coins interesting or significant. Florence placed on the gold coins, which were to become norld-famous as florins, its graceful lily and the figure of St. John the Baptist (in 1252). Venice started its equally famous gold sequins or ducats in 1280 with the interesting types of the figure of Christ blessing in a border of stars, and of the doge receiving the gonfalon from St. Mark. These types were not entirely new; they had been already used in a less elaborate form on silver.

It must have been the florin that suggested to Henry III, that enlightened patron of art, the introduction of his beautiful gold "penny" in 1257. His example was followed by St. Louis in his *denier d'or* in 1266—an admirably executed coin of heraldic design. St. Louis must also be credited with a far-reaching innovation in the shape of the large silver piece or gros of 12 deniers, the forerunner of the English groat or fourpence, though that coin did not come into regular use until 1351. The enlarged size eventually made possible the introduction of more interesting designs, though France continued to cling to conventional patterns, and England to the conventional facing head and cross.

In the grossi of Wenceslas II of Bohemia (1278–1305) the opportunity afforded by the larger flan was seized for a fine heraldic design.

The 14th Century.— But the time of Edward III and his contemporaries is the golden age of European coinage. There is no distinction in style between the Anglo-French coins and those of the French kings, and foreign workmen were employed at the English mint. At this period there is no evidence of an independent English art. The fine period of the Anglo-French coinage closes about 1368; the gold coin of the Black Prince issued at that time is a distinct attempt at portraiture on a small scale. In England we have the beautiful, but abortive first issue by Edward III in 1343 of the gold florin and smaller denominations: the most beautiful coins in the whole English series, but demonstrably the work of two Florentines, Giorgio Chierichino and Lotto Nicolini. These coins are followed by the gold noble, the obverse bearing the king in his ship as type. In 1465 Edward IV introduced a type of rude strength, the angel, in which there is something peculiarly English, especially in contrast with the St. Michael on the French coins of a century and a quarter earlier (Philip VI) and the angelot of Louis XI.

Toward the end of the 15th century the Tudor coinage makes its appearance with a flourish; the sumptuous "sovereign" of Henry VII, first struck in 1489, is still Gothic, but effete: it mistakes restlessness and over-decoration for strength. As in England, the art of coinage in the Low Countries in the 14th and 15th centuries presents no essential difference from what is to be seen in France; Germany during the same period lags far behind the west, its coinage being monotonous and crude.

Italian Influence.— It was from Italy that the new revival was to come; and the splendour of its coinage in the last quarter of the 15th century was directly due to the sister art of the medal.

The portrait-medal founded by Vittore Pisano, with his incomparable series of portraits made between 1438 and 1449, showed the possibilities of the profile relief. After a few artists, like Enzola of Parma, had in the '60s and '70s made groping experiments in die-cut portraits on small medals, others. notably in Milan—though the attribution of the Sforza series to the Milanese Caradosso may be baseless—succeeded toward the end of the century in producing pieces which, as we have said, reached the high-nater mark of portraiture in coinage. Early in the 16th century the influence made itself felt outside Italy.

It was a German, Alexander of Bruchsal in Baden, who was employed by Henry VII from 1494 to 1509, but the beautiful profile portraits by which, from 1503 onward, he left his mark on the English coinage are obviously inspired by the Italian fashion. His work sealed the doom of the facing-head on English coins although examples lingered on to the reign of Edward VI.

The **Thaler.**—Meanwhile Germany had taken an important step in the invention of the thaler, again the size giving greater scope to the designer. The Tyrolese guldengroschen of 1484—the earliest of the class afterward generally known as thalers—was evidently inspired, clumsy though it be, by an Italian model. It was the ancestor of all the large silver coins, thalers, dalers, dollars, scudi and cronns, of the 16th and 17th centuries. It did not add greatly to the art of coinage, which attains its highest perfection on a field of not more than an inch and a quarter. For a larger field, the medallic art, unrestricted in relief by its nonuse as currency, is proper.

Portraiture.— The development of portraiture on coins, as seen in the second half of the 1jth century, must be traced to the Italian medal. Pisano's first medal, representing the emperor John VII Palaeologus, was made in 1438. It revealed the possibilities of profile portraiture on a small scale, suitable for coinage. What the medallists showed was that modern portraits, and not mere imitations of the antique, could find a place on modern coinage.

In the '60s and '70s engravers in Milan, Parma and Venice were producing both small medals and portrait-coins from dies. By the beginning of the 16th century the technical difficulties had been overcome; and soon the facility afforded by striking for the mass production of medals began to have a reaction on the medallic art. The art of coinage had reached its culmination; all future developments added nothing to its artistic content, and were due merely to increased technical dexterity.

But the medal had still a course to run. The best medallists continued throughout the 16th century to use the casting process for their most important work, even when they were also die-engravers by profession. But official patronage favoured the struck medal, satisfied with number rather than quality. The technical dexterity of the modeller continued nevertheless to increase.

In Germany especially, where the art of the medal culminated in the period from 1520 to 1540, a series of portraits was produced unsurpassed in the realism of their presentation and technique of casting. In Italy after about 1530 the cast medal continued to develop as an art that had lost its inspiration; facile, graceful but superficial, the elegant portraits of Pastorino of Siena are typical of the school.

The modeller begins to lose the sense of material; the original wax model is all he cares about and the final product in metal is merely a means of perpetuating it. By the end of the 16th century the Italian vein was worked out. Italian influence. however, had passed across the Alps. German lands, especially Austria, France and Flanders had all felt it, though none of them in the 16th century produced medallists who marked an epoch. It remained for France in the first half of the 17th century to do for the art of the medal what Italy through Bernini did for sculpture. As masters of the baroque portrait Guillaume Dupré Jean and Claude Warin should be mentioned beside Bernini, though they too had his excessive virtuosity, as well as his brilliance. In England Thomas and Abraham Simon are almost on the same level. In Holland a native school is distinguished by hardy vigour. These developments are the last flowering of the medallic art before the dead period of the 18th century.

The 19th Century.— In the last quarter of the 19th century the monotonous academic tradition which had reigned for nearly two centuries began to break down. The French revival took its rise in F. J. H. Ponscarme (1827–1903). By the study of character in portraiture, the search for a dignified realism, and for a harmonious relation of type to background, and by such external reforms as the abolition of the raised border which had so long been the fashion, he inaugurated a return to the true principles of the art. The French school reached its zenith under J. C. Chaplain (1839–1909), but unfortunately, thanks to modern machinery, exploited with immense skill by Oscar Roly and his school, the medal in French hands became a merely pretty art, lacking virility and sincerity.

In Germany native vigour interposed, and the portraiture by such artists as the Viennese Anton Scharff (1845–1903) is of a fine seriousness.

In England Alphonse Legros (1837–1911), with a true instinct rejecting the machine-made medal, produced a remarkable series of cast portraits; but he found no successor.

Later developments are not sufficiently important to require detailed mention. We are still in the age of experiment. The immense output of medals, especially in Germany, during World War I should have revealed original artists if there were any, but the only one to rise above a journalistic level was Ludwig Gies and he often trespassed beyond the limits of his art.

There is at the present moment no lack of fine and accomplished portraiture, and although for the purposes of mass production the use of machinery is unavoidable, the better medallists, such as Theodore Spicer-Simpson, are content to produce their works by the nobler method of casting in limited editions of two or three specimens.

See SEALS; GREEK ART; ROMAN ART.

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(G. F. H.)

TOKENS FOR WAR SERVICE

From the earliest times service of all kinds has been rewarded by honours and distinctions. We learn from Josephus ("Antiquities of the Jews") that in the 3rd century B.C. Jonathan, the high priest, successfully led the Jews in battle thereby aiding Alexander, who "sent to Jonathan, and gave testimony of his worth, and gave him *honorary rewards,* as a *golden button,* which it is the custom to give King's kinsmen." Later Jonathan received another golden button for similar service. These honorary rewards of golden buttons are the earliest form of medal to commemorate war service.

BRITISH MEDALS

War Medals.—The earliest medal in existence struck for an Englishman for war service is that awarded to John Kendal in 1480. Kendal was prior of the English Knights of St. John of Jerusalem and in 1480, relieved Rhodes. His medal is now in the British Museum.

Although decorative medals were common before her reign, Queen Elizabeth appears to have been the first sovereign to bestow a medal for particular military service to the Crown, this being the "ark in flood" medal (so called from its design) to commemorate the victory over the Armada in 1588. James I. (1603–1625) issued a medal "in reward for naval achievements" on which the design was repeated.

Under a royal warrant, dated May 18, 1643, Charles I. authorized the issue of "Badges of silver, containing our Royal image and that of our dearest son, to be achieved to wear on the breast of *every man* who shall be certified under the hands of their Commander-in-Chief to have done us faithful service in the Forlorn-Hope" (*i.e.,* the tactical advanced guard of those days and not a hopeless adventure).

During the Commonwealth, statutory provision was made for the bestowal of medals as naval awards under a minute of the council of State, Nov. 15, 1649. There was also a "Medal of the Parliament" for land service, one being awarded to Col. Mackworth, governor of Shrewsbury, as a mark of the parliament's favour. This medal was given with "a chain of gold to the value of one hundred pounds." The first English campaign medal is that issued by the Commonwealth to commemorate Dunbar, Sept. 3, 1650. A week after the battle the House of Commons authorized the medal "both for officers and men." Cromwell protested against his effigy appearing on the medal, but this was overruled, and his effigy placed thereon. The finest medals of this period are those granted to Blake, Monk, Penn and Lawson for their victory over Van Tromp, July 31, 1653. The medals are in gold, with gold chains.

One interesting medal granted by James II. was to Bishop Mew, for his services as commander of the king's artillery at Sedgemoor, 1685. Before entering the church Mew had been an able soldier, and his ecclesiastical duties had not interfered with his continued study of the military art. Almost all writers on the subject classify the "Cumberland" medal (sometimes called the "Culloden" medal) as a commemorative war medal. This is incorrect. The battle was fought on April 16, 1746, the English being commanded by the young duke of Cumberland. To commemorate his success a number of admirers formed the Cumberland Society, a rule of which was that each member on joining was to be presented with a medal. No evidence has been found to show that the victory was *officially* commemorated by the grant of a medal.

Only one medal was issued for the American War of Independence, this being awarded to a Captain Ewing who distinguished himself at Bunker Hill.

Credit is due to the Honourable East India Company for instituting the regular practice of making the grant of medals a "general distribution" and not solely to officers. Some of their early grants include the "Deccan" medal for service during 1778–84, the "Mysore" medal (1791–92) and the "Seringapatam" medal (1799), and they continued this practice until the Crown assumed the Government of India after the Indian Mutiny. The lack of medallic recognition to the rank and file prompted Davison, Nelson's prize agent, to present a medal to every man who took part in the battle of the Nile (1798). His example was followed in 1805 by Boulton, of the Soho Mint, Birmingham, who presented medals to all ranks who had taken part in the battle of Trafalgar (1805). But, it is stated, that as the medals for the men were only made of pewter they deemed them of no value and the majority threw them away. These are the only instances of medals being awarded to service men by private individuals.

British war medals enter upon a new era with those awarded to admirals and captains for Lord Howe's victory over the French on "the Glorious 1st of June" (1794), generally known as the *Navy Gold Medals,* in that the first official reference is made to *medal ribbon* in connection with them.

The Peninsula Campaign was two years old before any medals were authorized to commemorate the successful major operations therein. The battles of *Roleia* (Roliça), *Vimiera, Corunna* and *Talavern* had all been fought before the *Army Gold Medals* were instituted under general order, Sept. g, 1810. In addition to the foregoing the *Army Gold Medal* was authorized for officers, not below the rank of battalion commander, for the following operations: *Sahagun, Benevente, Bzisaco, Barossa, Fuentes d'Onor, Albuhera, Ciudad Rodrigo, Badajoz, Salamanca, Vittoria, Pyrenees, St. Sebastian, Nivelle, Nive, Orthes* and *Toulouse.* Originally a separate medal was awarded for each separate operation and many officers became entitled to several medals. This, however, caused inconvenience to the recipients and a new system was instituted in 1813 under which only one medal was to be borne by each officer entitled thereto. For the second and third occasions gold clasps, the first ever sanctioned, were added to the medal ribbon, and on becoming entitled to a fourth mark of distinction the medal was surrendered and a *Gold Cross* issued in its place, on the four arms of which were inscribed the four battles for which marks of distinction had been awarded. On becoming entitled to a fifth or further marks of distinction, gold bars inscribed with the name of each battle were added to the *Gold Cross* ribbon. The substitution of a cross for a medal was never repeated.

Of the 20 operations in the Peninsula Campaign for which medals, crosses and clasps were awarded, the Duke of Wellington had distinctions for 14, viz. *(a)* inscribed on the *Gold Cross:*—*Roleia* and *Vimiera, Talavera, Busaco, Fuentes d'Onor, (b)* clasps to the *Gold Cross: Ciudad Rodrigo, Badajoz, Salamanca, Vittoria, Pyrenees, Nivelle, Nive, Orthes* and *Toulouse.*

The first war medal to be issued to all ranks, alike in all respects, was the *Waterloo* Medal—this, at the suggestion of the Duke of Wellington.

The fact that the *Waterloo Medal,* the *China Medal* (1840–42) and the *Jellalabad Medal* (1842) were given to all ranks alike without discrimination, appears to have started an agitation amongst those who had taken part in operations for which the *Army Gold Medal* and *Gold Cross* had been awarded but for which they were not eligible, owing to their rank. In this case, the Duke of Wellington opposed granting such a medal but it was adopted as the *Army General Service Medal.* The *Military Ribband* was worn with the medal. It was usually referred to as the *Peninsula Medal,* colour being lent to the idea by Wellington's figure appearing thereon, but it included campaigns in which Wellington had no military concern. Clasps were added.

The grant of the Army G.S.M. naturally led to a similar medal being authorized for the Navy, the *Navy General Service Medal* which covered operations from 1793 to those off the coast of Syria in 1840 Clasps included: *Howe's Victory* (June 1, 1794), *Camperdown* (Oct. 11, 1797), *Nile* (Aug. 1, 1798), *Copenhagen* (April 2, 1801), *Trafalgar* (Oct. 21, 1805), *Navarino* (Oct. 20, 1827).

Later medals commemorate service in the Crimea, the Indian Mutiny, New Zealand campaigns and those in Egypt.

The Honourable East India Company followed the example of the home Government and instituted the "India 1851" medal. Four further India general service medals have been granted to cover operations from 1849–95, 1895–98, 1901–02, and from 1908 to 1928. For the late Lord Roberts' march from Kabul to Kandahar in 1880 there is a bronze, known as *Roberts' Star.* For minor campaigns, the *General Service Medal* is granted.

Gallantry Medals, Crosses or Orders.—The most famous of this class is the *Victoria Cross* instituted in 1856. All ranks and civilians are eligible for the award, to qualify for which the recipient must have performed some conspicuous act of bravery in the presence of the enemy. The ribbon now is red (claret) for all recipients, but was previously blue for the Royal Navy. Recipients who are granted a second distinction are awarded a bar. The award carries a pension. The V.C. takes precedence of all other orders and medals.

Other awards of lesser degree in this class are: *Distinguished Service Order,* instituted in 1886 and the *Military Cross* (1914); only officers are eligible for the award. *Distinguished Conduct Medal* instituted in 1854, also the *Military Medal* (1916); only "other ranks" are eligible for the award. *Meritoriozis Service Medal,* instituted in 1845, awarded to sergeants as a reward for distinguished or meritorious service; it carries a gratuity *Conspicuous Gallantry Medal,* originally sanctioned for Crimean War only, reinstituted 1874 and now available for any war; only "other ranks" of Royal Navy and Royal Marines are eligible for the award. *Indian Distinguished Service Medal,* instituted 1907, only Indian officers and "other ranks" are eligible. The Royal Air Force has medals, etc., comparable to the foregoing. See also on next page under *Other Medals and Decorations.*

Good Conduct Medals.—There are a number of medals granted for good conduct combined with a prescribed number of years' service, the conditions of eligibility varying according to the service, and whether Regular, Auxiliary, Colonial, etc. The first of these medals was the *Long Service and Good Conduct Medal* instituted in 1830.

UNITED STATES MEDALS

The premier decoration of the United States is the *Medal of Honor* which is comparable to the *Victoria Cross.* It was instituted in 1862 as a reward for conspicuous acts of bravery during the Civil War. In the course of time the details of the design have changed; the present description of the Army medal is a five-pointed star superimposed on a wreath, in the centre of the star the head of *Minerva,* surrounding which is a circle inscribed "UNITED STATES OF AMERICA." The star is suspended from a bar attached to the two top points, and on the bar is inscribed "VALOR," above which is the American Eagle. Attached to the eagle's head is a ring through which passes the ribbon. The ribbon is light blue with stars embroidered thereon, and the medal is worn round the neck. The Navy medal differs in a few details from the Army pattern. This medal takes precedence of all other United States decorations. "Medal of Honor" lapel buttons are optional for wear in civilian clothes; they are hexagonal rosettes made of light blue silk with 13 white stars. There was a *Merit Medal,* awarded with the "Certificate of Merit" for which only enlisted men were eligible, but this was abolished in 1918.

War commemorative medals follow the British practice. An interesting example is the *Civil War Medal,* on the obverse of which is a portrait of Lincoln, surrounded by an inscription taken from his famous Second Inaugural: "WITH MALICE TOWARDS NONE, WITH CHARITY FOR ALL." On the reverse is inscribed "THE CIVIL WAR, 1861–1865." The "Indian Wars" Medal is also interesting from the fact that the reverse was copied for reverses of many other campaign medals.

MEDALS OF OTHER COUNTRIES

France.—Before 1802 gallantry in the field was awarded by grants of swords of honour, muskets of honour and other weapons but in that year Napoleon instituted the *Legion d'Honour.* The original cross of the Legion of Honour was a white enamel gold badge, with five rays of double points, each point tipped with a silver ball, the whole on a wreath of oak and laurel: in the centre of the obverse, Napoleon's effigy with "NAPOLEON" inscribed around it. The present badge is much the same in appearance but instead of Napoleon's effigy on the obverse there is a female head, and inscribed round it, "REPUBLIQUE FRANÇAISE, 1870." The order is divided into five grades: Grands Croix, Grands Officiers, Commandeurs, Officiers and Chevaliers. The Legion of Honour is the premier order of France and is only conferred for gallantry in action or for 20 years' distinguished military or civil service in peace. The *Médaille Militaire,* instituted in 1852, is comparable with the British D.C.M. It is only conferred upon general officers in command of armies and to N.C.Os. and men of the Navy and Army for distinguished service in action. It was awarded to the late Field-Marshal Lord French. As regards commemorative war medals the first is interesting, viz., *St. Helena Medal,* instituted in 1857 for operations between 1792 and 1815. The medal is bronze and bears on one side the effigy of Napoleon, and on the other, in French, "Campaigns of 1792 to 1815. To his comrades in glory, his last thought. St. Helena, May 5, 1821." Another interesting war medal is the *Pontifical Cross,* instituted in 1867, by Pope Pius IX., and granted to all members of the French forces who took part in the defence of Rome in 1867.

Germany.—A renowned German decoration was the *Iron Cross,* instituted in 1813, as a reward for distinguished service in the War of Liberation. It was revived for the Franco-Prussian War of 1870 and was again issued for service in the World War. The cross is a Maltese Cross of cast iron edged with silver. On the upper link is a crown, on the lower link the date of the campaign, that for the World War being "1914," in the centre the initial or initials of the sovereign at the date of issue. There are three classes of the Order of the *Iron Cross.* The Grand Cross, double the size of the ordinary cross, is worn round the neck, and is awarded solely for the winning of an important battle, or equivalent exploit. With the rank and file the cross carries with it a gratuity. The Order of Military Merit (Prussia), founded in 166j, was bestowed for conspicuous war service.

Belgium. — The Order *of Leopold II.* was instituted in 1900. There are six classes. It is awarded to N.C.Os. and men and "ranker" officers for exemplary service after a number of years (20–30). The Ordre de la *Couronne,* instituted in 1897, was originally the premier order of the Independent Congo State but was transferred to the Ministry of Foreign Affairs in 1910. It is awarded to officers after a number of years' exemplary service (20–32) and to N.C.Os. after 38 years' exemplary service. The Military Medal, instituted in 1902, is comparable with the British Military Medal.

Japan. — The Order of *the* Rising *Sun,* instituted in 1875, is awarded to all ranks of Army and Navy for gallant service in war or distinguished service in peace. The Order of the Sacred Treasure, instituted in 1888, is awarded to both military and naval officers for meritorious service. The Order of the Golden Kite was instituted in 1891. There are several classes, the higher for officers and the lower for N.C.Os. and men. It therefore corresponds approximately to the British D.S.O., D.S.C., M.C. and D.C M. The medal to commemorate the Russo-Japanese War of 1904–05 is made of light bronze.

Italy. — The Order of Saint Maurice and Saint *Lazarus* was founded in 1434, and revised in 1831, 1837 and 1855. The *Military* Order of Savoy, founded in 1815, is awarded for special distinguished war service. Medals for military valour are awarded for acts of bravery in much the same manner as British gallantry medals. The *Messina* Medal was awarded by the King of Italy to officers and men of the British men-of-war and to certain others who assisted in succouring the injured after the terrible earthquake at Messina and Reggio in Dec. 1908. The ribbon is green with white edges.

Serbia. — The Order of the *White* Eagle, instituted in 1883, consists of five classes. The badge consists of a double-headed eagle in gold, ensigned with a crown. The Star of Kara George, instituted in 1904, consists of four classes.

WORLD WAR MEDALS AND DECORATIONS

By resolutions passed by a committee of the Peace Conference in Paris in March 1919, it was decided that the victorious Allies and associated Powers (*i.e.,* Great Britain and her dominions, France, Belgium, Italy. Spain, United States of America, Japan, etc.) should have a medal common to the Powers in general design. The medal was to be called the Victory *Medal* and was to be round, made in bronze (36mm. wide), the colour, surface, thickness and attachment to be similar to the French Medal of the 1870 war, on the obverse a winged figure of Victory full length in the middle, on reverse the inscription, "The Great War for Civilization," in the language of the country granting the medal, the rim plain. The ribbon to be identical for all countries and to consist of two rainbows joined by the red in the centre.

One of the objects of issuing a medal similar in design in all countries was to obviate the interchange of Allied commemorative war medals. No clasps have been issued with the medal except in the U.S. The exact conditions under which the medal was awarded varied in each country, but generally it was issued to all who went into a theatre of war in any capacity between the first declaration of war in 1914 and the date of the Armistice, Nov. 11, 1918. In the British service it was also granted for post-Armistice operations in North Russia and Siberia, ending on Oct. 12, 1919, and in Trans-Caspia, concluding on April 17, 1919. Also in the British service an emblem in the form of an oak leaf in bronze was placed on the Victory Medal to indicate that the recipient had been mentioned in despatches during the World War.

OTHER MEDALS AND DECORATIONS

Great Britain. — (a) *1914* Star (commonly known as the Mons Star), instituted in 1917, and awarded to all ranks, including nursing staffs, who actually served in France or Belgium on the establishment of a unit between Aug. 5, 1914, and Nov. 22–23, 1914. (b) *1914–15* Star, instituted in 1918, similar in design to the *1914* Star. (c) British *War Medal,* instituted in 1919. In general terms it was granted to all personnel of the Army who served overseas in a theatre of operations in any capacity during the war, and to the Navy for one month's service during the war. (d) *Mercantile* Marine War *Medal,* granted to members of the Mercantile Marine for service during the World War; (e) Territorial Force War Medal, instituted in 1920, granted to members of the T.F. and T.F. nursing service for service outside the United Kingdom during the war subject to certain conditioris (those awarded the *1914* Star or *1914–15* Star were ineligible for the T.F.W.M.); (f) Military Cross, instituted in 1914, an army decoration for which only captains, junior officers and warrant officers are eligible; (g) *Distinguished* Service Cross (established as Conspicuous Service Cross in 1901) re-named in 1914 and its award extended to all naval and marine officers below the relative rank of lieutenant-commander; *(h) Distinguished Service* Medal, instituted in Oct. 1914 for other ranks of Royal Navy and Royal Marines; (i) Order of the British *Empire,* instituted in June 1917, as a reward for war service in any capacity; (j) *Military Medal,* instituted in 1916; all other ranks are eligible for the award; (k) *Silver War* Badge, instituted in 1916, issued to all ranks who served at home or abroad during the World War and who on account of age, or physical infirmity arising from wounds or sickness caused by military service, had been compelled to leave the forces; (*l*) Royal Air Force. The following decorations were instituted under a royal warrant dated June 3, 1919, and have been awarded: Distinguished Flying Cross, Air Force Cross, *Distinguished* Flying Medal and Air Force *Medal.*

United States of **America.**—(*a*) *Distinguished* Service Cross, Army, instituted Jan. 12, 1918, awarded to those who since April 6, 1917, have distinguished themselves in connection with military operations in circumstances which do not justify the award of the Medal of Honour. (b) Distinguished Service Medal, Army and Navy, instituted Jan. 12, 1918, awarded for exceptionally meritorious service. (c) *Navy* Cross, terms of award similar to *Distinguished* Service Cross, Army. The United States Victory Medal has battle clasps.

France.—*Médaille* de la *Reconnaissance Française,* instituted in 1917, is awarded to persons who performed acts of devotion in the public service. The following war medals were also issued: *Médaille Commémorative d'Orient* and *Médaille Commémorative Française* de la *Grande Guerre.*

Turkey. — For the Gallipoli campaign Turkey issued a white metal five-pointed star, in the centre of which is the Sultan's cypher, and the characters representing "El Ghazi" (The Victorious), below the date "333" (*i.e.,* 1915). The ribbon is scarlet moire with a white stripe towards the edges.

Japan. — This medal is similar to that granted for the Russo-Japanese War. The ribbon is dark blue with a broad white stripe.

Egypt. — The Military Star of the Sultan *Fouad* was instituted in 1919 for officers of the Egyptian Army who are mentioned in despatches for post-Armistice operations.

Belgium. — Croix de *Guerre,* instituted in 1915, awarded for exceptional acts of bravery. Medal De la *Reine* Elisabeflz, instituted in 1916, and awarded to ladies, without distinction of rank, who assisted Belgians during the war. Other medals are *Médaille du* Roi Albert; Croix *Militaire; Décoration Militaire; Médaille* de *l'Yser.* Three medals for the general campaigns on the Continent and in Africa were also struck: *Médaille Commémorative* de la *Campagne 1914–1918, Médaille Commémorative* de la *Campagne d'Afrique 1914–18,* and *Étoile* de Service du Congo.

Rumania. — Order of St. *Michael The* Brave, instituted in 1916, solely for service in the field.

Portugal. — Victory *Medal* and *Medalha commemorativa* das *campanhas* do Excrcito *Portugues* (to which were added clasps) were issued for the general campaign.

Germany. — Several medals were issued in Germany of which the following are the most important: (a) a silver medal was struck for the March on Paris. On the obverse is the bust of Gen. von Kluck and "1914–1915"; reverse, a naked fury on horseback carrying two blazing torches and "Nach Paris, 1914"; (b) a bronze medal was struck for the anticipated German entry into Paris. Obverse the Arc de Triomphe; among rays spreading from the top "1871–1914"; in the background the Eiffel Tower, and inscribed round the whole, "Entry of the German Troops into Paris." Reverse, the 1914 Iron Cross and "Nach aussen entschlossen. Nach innen geschlossen" (Resolute in the face of the enemy, united on the home front). An attempt was made to suppress it when the German hopes were not realized, but a few specimens are in existence, one being in the British Museum; (*c*) the Failure Before Paris is commemorated by a cast-iron medal. Von Kluck's bust with "1914–1915" on the obverse, with an eagle perched on a gun-emplacement, gazing at distant "Paris" on the reverse; (d) the new Triple Alliance is commemorated by a bronze medal, bearing on the obverse the busts of Kaiser Wilhelm II., Kaiser Franz Josef and the sultan of Turkey, and the inscription "Glory to God alone" Reverse, eagle perched on an oak branch, with the inscription "Brotherhood in arms, 1915, Germany. Austria-Hungary, Turkey"; (e) Russian defeat at Tannenberg: medal cast in iron and bronze. Obverse, bust of Hindenburg; reverse, "Tannenberg-Ortelsburg 1914" and "Queller of the Russians, liberator of East Prussia"; (f) the battle of the Falkland isles, Dec. 8, 1914, is commemorated by a bronze medal; (g) the Submarine War medal is cast in bronze Obverse, bust of Admiral von Tirpitz. Reverse, Neptune with trident, seated on conning-tower of a submarine, shaking his fist at the distance where are two British sailing ships, one sinking; in middle distance, another submarine, inscription, "Gott strafe England, 18 Februar, 1915"; (h) the sinking of the "Lusitania." Obverse, ticket office of the Cunard company in New York, with Death issuing tickets to a crowd of passengers, motto "Business First." Reverse, the Lusitania (showing guns, aeroplanes, etc., on board) sinking. Inscriution, "No contraband" and "The liner Lusitania sunk by a German Submarine, May j, 1915." The liner was sunk on May 7 not May 5. "The authenticity of this medal has sometimes been denied, but the fact that it was issued has been frequently admitted by responsible German authorities as well as by the artist (K Goetz) himself" (vide Historical Medals in the British *Museum*) ; (i) the Zeppelin attack on London on the night Aug. 17–18, 1915, was commemorated by a medal cast in iron; (*j*) the failure of the Allies Dardanelles Expedition was commemorated by a satirical medal in bronze. (T. J. E.)

NUMMULITE: *see* PROTOZOA.

NUN, a member of a community of women, living under vows a life of religious observance. *See* MONASTICISM; MONK.

NUNATAK, a hill or mountain peak appearing above the surface of a glacier. Greenland is for the most part covered by an icecap which moves slowly downward to the sea. It will rise upward and pass over a barrier if there is no outlet, but will flow between and around mountain peaks leaving them standing as hills (nunataks) above the general surface of the icecap. There are also nunataks in Antarctica but they are less numerous and more widely scattered. The term is an Eskimo loanword.

NUNCIO, the resident representative of the pope in major countries, diplomatically accredited to the government (since the congress of Vienna, dean in some countries of the diplomatic corps), and also endowed with certain papal rights of jurisdiction over the Catholic faithful. The office is historically related to that of the apocrisiary at the Byzantine and Frankish courts (5th and 6th centuries) and to that of later papal fiscal officials. Angelo Leonini, sent to Venice in 1500, is usually regarded as the first official nuncio. A nuncio differs from a legate, whose office is temporary. Internuncio is the title used in some countries of nonambassadorial status. Apostolic delegate (equivalent to minister plenipotentiary) is the title used in some countries An apostolic delegate differs from a nuncio in that he lacks diplomatic status. In the late 1950s there were 31 nuncios, 9 internuncios and 15 apostolic delegates. *See* also LEGATE; VATICAN, THE: *External Relations.* (J. C. MY.)

NUNEATON, a municipal borough (1907) in the Nuneaton parliamentary division of Warwickshire, Eng., on the Anker river and the Coventry canal. 19 mi. N.N.E. of Warwick. Pop. (1951) 54,407. The prefix "Nun" was added to its name when a Benedictine nunnery was founded there between 11jj and 1159. Situated near a coal field and granite quarries, Nuneaton has big engineering and brick works and a flourishing textile industry. Other trades are leather dressing, boxmaking, fellmongering and the manufacture of needles. In 1819 Mary Ann Evans, who wrote under the name of George Eliot (*q.v.*), was born at South farm, Arbury. now within the borough.

NUNES, PEDRO (PETRUS NONIUS) (1492–1j77), Portuguese mathematician and geographer, the peak figure in Portuguese nautical science, was born at Alcacer do Sal in 1492. He was professor of mathematics at Lisbon and Coimbra, and was made royal cosmographer in 1529 when Spain was disputing the position of the .Spice Islands and maps did not agree in their longitude. He devoted himself to such problems, to maps and map projections. He was the first to show that a loxodrome course gives a spiral route, and published studies of the sphere and of the oceans. In 1538 he went to Spain, but returned to Portugal in 1544, when he was the best informed man in the world on the new discoveries of Spain and Portugal. He died at Coimbra in 1577.

See A. Cortesao, Cartografia e Cartografos Portugueses, 2 vol. (1935). (A Ds)

NÚÑEZ, RAFAEL (1825–1894), leading Colombian political figure of the late 19th century, was born Sept. 28, 1825, in Cartagena. He entered politics in the Liberal party mhile in law school, and moved to the national political scene in 1853. Holder of many high government offices, pre-eminent political figure from 1880, three times president of Colombia (1880–82, 1884–86, 1886–92), he was leader of the independent faction of Liberals. A Radical Liberal rebellion in 1884 forced Núñez into alliance with the Conservatives and enabled him to institute a series of reforms called the Regeneration, including the concordat of 1888 ending religious conflict (1850–85) and the existing centralized constitution of 1886 terminating federalist anarchy (1858–86). Regarded as the leading intellect of his time, an active publicist and journalist, Núñez wrote on politics and economic policy and composed volumes of poetry. Domineering, able, opportunistic, he was during his long public career on both sides of every national controversy. He died in El Cabrero, on Sept. 12, 1894. (R. L. GE.)

NUÑEZ CABEZA DE VACA, ALVAR (*c.* 1490–*c.* 1560), Spanish explorer, was treasurer of the ill-fated expedition of Panfilo de Narvaez to Florida in 1527–28. Of 300 men who disembarked, only four, including Cabeza de Vaca, ever returned to civilization. For eight years they wandered among the Indians of the Gulf coast and northern Mexico though their exact route has long been debated. Cabeza de Vaca's adventures (which he related upon his return) probably led to the De Soto expedition of 1538, and without question inspired the Coronado enterprise of 1540, both of which probed deeply into areas which later formed part of the United States.

Returning to Spain to seek recompense for his services, he was appointed governor of the province of Rio de la Plata. He reached Brazil in March 1541, and from November of that year to March 1542, he traveled 1,000 mi. to Asunción. the provincial capital. Intrigue and rebellion led by Domingo Martinez de Irala resulted in his seizure, confinement and (in 1545) deportation to Spain. The council of the Indies, finding him guilty of malfeasance in office,sentenced him to banishment from the Indies and to military service in Africa. Upon his appeal, the council reduced the sentence but never reversed the judgment. Cabeza de Vaca died in obscurity and poverty.

See Morris Bishop, The Odyssey of Cabeza de Vaca (1933); for sources, Cabeza de Vaca, "The Narrative" in Spanish Explorers in the *Southern* United States (1907). (K. M. S.)

NÚÑEZ DE ARCE, GASPAR (1832–1903), Spanish poet and statesman, once regarded as the great poet of doubt and disillusionment, though his rhetoric is no longer found moving. He was born in Valladolid on Aug. 4, 1832, became a journalist and Liberal deputy, took part in the 1868 revolution and was colonial minister for a time after the Restoration. He died in Madrid on June 9, 1903. As a dramatist he had some success, his best play being the historical El *haz de leña* (1872), but he attained celebrity with *Gritos del combate* (1875). This volume of verse sought to give poetic utterance to religious questionings and the current political problems of freedom and order. His longer poems include *Última lamentacidn de Lord Byron* (1879) ; the allegorical *La selva oscura* (1879); a study of Luther, *La visidn de Fray Martín* (1880); and the sentimental narratives *La pesca* (1884) and *Maruja* (1886). (H. B. HL.)

NÜRNBERG (NUREMBERG), the Second largest town in the *Land* of Bavaria, Germany, and administrative centre of the province of Middle Franconia, is situated on a sandy plain at the foot of the Franconian Jura, on both banks of the Pegnitz river. The Pegnitz flows into the Regnitz at the town of Fiirth. 6 mi. to the northwest, and the Regnitz joins the Main at Bamberg (so connecting Niirnberg with the Rhine valley) and also makes possible communication eastward with Czechoslovakia. Nürnberg's wealth as a trading centre in the 12th and 13th centuries was devoted to building and to patronage of the arts. Its industrialization in the 19th century and its use as a centre by the Nazis led to severe bombing during World War II. It was; however, reconstructed according to the original ground plan, and many of its damaged buildings were carefully restored. Its importance as a commercial and industrial centre has not destroyed its medieval character. Pop. (1950) 364,717.

The older. central part of the city, the Altstadt, is still enclosed by the medieval walls (completed 1452), with their 128 towers and four main gates. It is divided by the Pegnitz river into the Lorenzer Seite (named after the Gothic St. Lorenzkirche) on the south and the older Sebalder Seite (named after the Roman-Gothic St. Sebalduskirche) on the north. The Sebalder Seite slopes up to the red sandstone castle rock on the northwest from which the grey-walled castle: with its five-cornered 11th-century tower and 11th–16th-century Kaiserburg (imperial castle), dominates the town. Just below is a perfectly preserved medieval square, near which is Albrecht Diirer's house (c. 1450). St. Sebalduskirche (1225–73) contains a magnificent brass shrine by Peter Vischer (1508–19). Also on the Sebalder Seite are the Marktplatz. where stands the 14th-century Schoner Brunnen and the Frauenkirche (Church of Our Lady. 1352–61) on the west front of which is the Mannleinlaufen. a mechanical clock made in about 1 jog to commemorate the Golden Bull, showing the seven electors moving round Charles IV; the gabled Fembohaus (1591–160j), the only surviving example of a burgher's house, which is now the old town's historical museum (founded 1953); and the Hospital of the Holy Ghost (1487–1527).

The two halves of the town are connected by the Konigstrasse, a busy street containing modern shops as well as old buildings. It leads up to the St. Lorenzkirche (c. 1260–1360), containing the famous Engelsgruss (Annunciation) carved out of linden wood by Veit Stoss (1517–18), the stone sanctuary by Adam Krafft or Kraft (1493–1500) and a beautiful rose window over the west door (13jo). Also in the Konigstrasse are the gabled market hall (built as the city granary. *c.* 1500) and the small churches of St. Klara (Gothic. 12 73) and St. Martha (1360).

Among modern buildings worthy of mention (many built or rebuilt after World War II) are the school of economics and sociology, the school of music and the academy of art. The Germanic National museum (founded 1852) contains exhibits illustrating German art and culture from prehistoric times to the early 19th century. There are an industrial institute; a transport museum and an excellent municipal library, containing 3,000 mss. and 2.000 incunabula, in a modern building on the city's outskirts.

To the southeast of the city is Dutzendteich, which from 1933 through 1938 was used by the Nazis for their annual rallies. Some of its buildings have been dismantled. There is also a sports stadium (1923–28), and a national park on the slopes of the Schmausenbuck (1.276 ft.).

Nürnberg is a big railway junction. although the division of Germany cuts some of its lines of communication. It lies on the Munich–Berlin *Autobahn,* and on the line of the proposed Rhineland *Autobahn.* Completion of the Rhine–Main–Danube waterway would improve its economy. The airport, opened in 1955, is 6 mi. northwest of the city, at Fiirth.

Nürnberg is the centre of the north Bavarian economic area. Its chief industries are iron and metal production and manufacture, the making of electric machines and other machinery and machine tools. and the motor industry. After World War II, the holding of the German Toy fair at Niirnberg encouraged the development of the toy industry. Other products are pencils. gingerbread, chocolate, shoes and paper goods. There are big breweries and the city's hopmarket is a centre for the export of Bavarian hops.

History. — Founded about 1040 as a stronghold by Henry III. the duke of Bavaria and emperor of Germany, Niirnberg developed rapidly as a community of traders and artisans clustered round the castle. Destroyed in 1127. it was rapidly rebuilt. and in 1140–50 spread from the north to the south bank of the river. Its popularity with pilgrims because of miracles attributed to the tomb of St. Sebald. its position as a trading centre on the important trade route linking Germany with the Mediterranean and the patronage of the emperors caused it to flourish in the 12th and 13th centuries. In 1219 it received its great charter from Frederick II and after the middle of the century became a free imperial city, owning considerable land and ruled by a council of 42. most of whom belonged to wealthy patrician families Alongside the development of wealth and influence went the development of learning and of crafts of all kinds The names of the artists Michael Wohlgemuth and Albrecht Durer, the sculptors Adam Krafft and Veit Stoss. the brass founder Peter Vischer and his sons and the scholars Martin Behaim, Regiomontanus and Willibald Pirkheimer testify to the quality of the city's artistic and academic life in the 16th century. The *Gymnasium Aegidianum,* founded in 1526 by Philipp Melancthon. was among the first in Germany. The city also achieved fame as the nursery of German *Meistergesang* and home of Hans Sachs (*see* MEISTERSINGER). In 1525 it was the first imperial city to adhere to the Reformation.

As a result of the change of direction of the great European trade routes after the discovery of the Americas and of the sea route to India, of the devastation of the Thirty Years' War during which Gustavus Adolphus was besieged there, and of the customs policy of the great powers in the 17th century, Nurnberg gradually declined in importance In 1806 it, and its lands, were absorbed into the kingdom of Bavaria Its industrialization in the 19th century gradually re-established its position. In the 1930s it became a centre of the National Socialist party, which held its annual September rallies there from 1933–38, and in 1935 it gave its name to the anti-Semitic "Nurnberg decrees." It was severely damaged in air raids in Jan –Feb 1945; 6.716 people lost their lives. It was also the scene of the Allied trials of German war criminals.

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NURSERY: *see* ARBORICULTURE.

NURSERY SCHOOLS: *see* KINDERGARTEN; SCHOOL AND CURRICULUM; INFANT SCHOOLS

NURSING. Because of basic differences in eastern and western cultures the evolution of nursing has been extremely uneven. Historically it may be said to fall into five fairly well-defined periods. These are (1) pre-Nightingale; (2) the pioneer Nightingale period 1860–1900; (3) the period of professional self-development 1900–20; (4) the period of rising internationalism between the two World Wars; and (j) nursing in the Atomic Age.

To 1860. — From the time of Phoebe (AD 60), nursing has been recognized as one of the works of mercy of the Christian church. With the rise of monasticism. the care of the sick became a function of many religious orders. It was one of the services performed by communities organized under the rule laid down by St. Benedict in the 6th century. The mother house, an organizational pattern developed by the orders, was adopted by later Catholic and Protestant nursing orders and. in parts of Europe. by the Red Cross. Among the earliest nursing records are those of the Hôtel-Dieu, Paris (A.D. 606), where, since the 12th century, Augustinian sisters have been in charge. From the military nursing orders, such as the Knights Hospitaller of St. John of Jerusalem, nursing inherited a tradition of rigorous discipline. A trend toward the modernization of nursing began when Mlle. de Gras (Louise de Marillac) took a vow in 1634 to work under the direction of St. Vincent de Paul. The principles he laid down for the guidance of the Sisters of Charity, now one of the largest and most widely distributed nursing orders in the world. had lasting influence. Pastor Theodor Fliedner and his wife, whose work influenced the later development of nursing, laid the foundations of the modern deaconess movement at Kaiserswerth, Ger., in 1836. The Sisters of Mercy and the Sisters of Charity, established in Ireland at about the same time, began the reform of nursing in that country. The Reformation left England without a system of hospital nursing. Nursing, therefore, had no distinctive part in the colonial development of the United States.

Hospitals built by the Spaniards in Latin America antedated public hospitals in the United States by about 300 years. Publication in France of the Jesuit "Relations," the reports of missionaries to "New France," aroused interest in the needs of Canada's colonists. Augustinian Hospitallers from Dieppe, the first nursing sisters to cross the Atlantic. established the Hôtel-Dieu, Quebec, in 1639. Jeanne Mance (1606–73), the first white woman to arrive at Montreal, there established the Hôtel-Dieu (1664) and secured the assistance of the Sisters of St. Joseph—the Hospitallers of La Fleche—while herself remaining outside the order. Visiting nursing was introduced into Canada by Mme. d'Youville, who organized the Soeurs Grises or Grey nuns of Montreal (1755). Charity hospital in New Orleans was staffed by Ursuline sisters from 1737 until Louisiana became part of the U.S. Beginning in 1834, Sisters of Charity conducted the nursing service.

The earliest indigenous order in the U.S. was organized by Elizabeth Ann Seton in 1809 and incorporated in 1917 as the Sisters of Charity of St. Vincent de Paul. These sisters undertook hospital nursing at the Baltimore infirmary (later University of Maryland hospital) in 1923. By 1870, 17 sisterhoods and the Alexian brothers were providing the nursing service in 70 Catholic hospitals.

Four German deaconesses (Lutheran) arrived in Pittsburgh in 1849. By 1880, mother houses under Lutheran, Evangelical and Methodist auspices had been established in Philadelphia, Pittsburgh, Chicago, Milwaukee and other middlewestern cities. Anglican sisterhoods, similar to the new orders in England, provided nursing service for St. Luke's hospital, New York city (1858); St. Mary's Free Hospital for Children, also in New York (1870); and the Children's hospital, Boston, Mass. (1871).

Florence Nightingale.— Miss Kightingale made outstanding contributions to the fields of sanitation, statistics, military medicine and hospital administration but is most widely known as the founder of modern nursing. Born to luxury but dissatisfied with a life of leisure, she was endowed with the intelligence of a scientist and the emotional drive of a reformer. She observed and studied nursing as practised by the Augustinians and numerous other orders. She spent three months with the Fliedners at Kaiserswerth where she found the spirit more impressive than the practice of nursing. Convinced of the need for reform in nursing, she had just opened an institution for the care of the sick in London when, in 1854, England's secretary at war asked her to undertake the nursing of soldiers in the Crimea. The staff she recruited was made up of Catholic and Anglican sisters and practical or "experienced" nurses. The effect of her energetic and well-directed attack on the shocking results of disinterest and military red tape was spectacular. The death rate dropped from more than 400 to 22 per 1,000. The fame of that achievement spread throughout the civilized world.

Miss Kightingale used the fund raised by popular subscription in her honour to establish and endow a school of nursing at St. Thomas' hospital in London. With the admission of 15 probationers, June 15, 1860, the modern era in nursing was begun. The primary characteristics of what came to be known as the Nightingale system of nursing education, although never adopted in its entirety by any country, were (1) a qualified nurse in command of the school; (2) a planned course of instruction; (3) careful selection of students; (4) a home for students with provision for recreational and cultural activities; (5) access to the wards of a well-organized hospital where students could be given direct instruction in the care of patients; and (6) funds for the educational program. The aims of the Nightingale school were to train (1) hospital nurses; (2) nurses (instructors) to train others; and (3) nurses to care for the sick poor (visiting nursing). A supplementary period of three months was required for the third objective. Miss Nightingale insisted that health nursing is as important as sick nursing and incorporated her ideas about hygiene in her widely read Notes on *Nursing*. The new profession (Miss Nightingale preferred the term "calling") was rooted in Christian ideals and imbued with a crusading spirit. It inherited the traditions of military discipline and mother house subservience. It opened a door to opportunity for educated women.

By the latter part of the 19th century the general principles laid down by Miss Kightingale had been adopted by schools connected with both voluntary and tax-supported hospitals in the English-speaking countries and were having some influence in continental Europe. The demonstrable value to hospitals of nursing service by students plus lack of endowments for the schools led to a type of apprenticeship which prepared nurses for institutional service but seriously limited their preparation for community services. Graduates of pioneer schools in the British empire and the U.S. began at an early date to establish mission schools in China, Japan and India and, a little later, in the middle east. The deaconess movement gained momentum in northern and central Europe and the mother-house idea was also adopted by Red Cross nursing schools, especially in Sweden, Germany and Austria. District nursing, the pioneer type of public health nursing by lay nurses, was inaugurated in England in 1859. In 1875, the Metropolitan and National Nursing association in London established the principle, later adopted and expanded in the U.S., that district nurses should have hospital training followed by special experience under supervision. Midwifery was developed as a separate service for which nurses might, or might not, prepare. In the U.S. two hospitals which were established for the primary purpose of providing facilities for the practice of medicine by women physicians set up courses for nurses in 1869 and 1872 at the Women's hospital in Philadelphia, Pa., and the New England Hospital for Women and Children in Boston. The first "Nightingale" school of nursing in the U.S. was established, with advice from Miss Nightingale, at Bellevue hospital, New York city, in May 1873. By the end of that year two other schools which were destined to become famous had been established at the Massachusetts General hospital in Boston and in New Haven, Conn., and Dr. Mack's school at St. Catherines, Ont., had engaged three graduate nurses from England. The schools brought order out of the chaotic and debasing conditions surrounding hospitalized patients. The first schools under religious auspices were established in the mid-1880s; the earliest visiting nurse associations were organized in the same decade.

By 1900, 422 schools with widely varying educational standards and resources had been established. Modern nursing was facilitating the advancement of surgery and a wave of hospital construction swept across the country. Many of them established schools for the sole purpose of securing student service for the care of patients.

Period of Self-organization, 1900–20.—The evolution of modern nursing can most readily be traced by following the history of the national nursing organizations. In its struggles to overcome inertia, antifeminism, political and other opposition, the nursing profession had developed a marked trend toward self-organization before the end of the 19th century. Leaders in this movement believed that legal standards of education and practice were needed for the dual purpose of protecting those in need of nursing care and those who endeavoured to secure adequate preparation for practice. When Mrs. Bedford Fenwick effected the establishment of the British Nurses association in 1887, a few alumnae associations had been established in the United States. Mrs. Fenwick became the founder of the International Council of Nurses (I.C.N.) in 1899 which antedated the international organization of other health professions by a quarter of a century. Nurses from Great Britain, Canada, the U.S., Australia, New Zealand, South Africa and Denmark, in all of which the Nightingale influence was ,at work, attended the preliminary conference.

Miss Nightingale opposed the movement for state registration believing it to be premature. As a result British nurses were divided and did not secure a nurse practice act until after World War I. But the movement quickly gained momentum in other countries. In North America two organizations composed of American and Canadian nurses had been organized before 1900. With the British association they provided a nucleus for the International Council of Nurses. Later (1908) Canadian nurses formed their own association. The American Nurses' association (organized 1896) became the I.C.N.'s official affiliate in the U.S. The organizations of the Finnish (1896) and Danish (1899) nurses, which were to become notably efficient in elevating the standards of nursing in their respective countries, became influential members of the I.C.N. at a somewhat later date. The Australasian Nurses association (1899) for some years included the nurses of New Zealand who, in 1901, with remarkable farsightedness secured the first nurse practice act in the world and established a firm co-operative relationship with the national government. The official publications of the national oiganizations became effective instruments for promoting the development of nursing. The pioneers were the *British Journal* of *Nursing* (1887) and the *American Journal* of *Nursing* (1900).

The second nurse practice act was secured in Cuba (1902) when nurses from the U.S. had an extraordinary opportunity to modernize nursing under the military government following the Spanish-American War. In the U.S., four state legislatures passed such acts in 1903—North Carolina, New Jersey, h'ew York and Virginia. When the U.S. entered World War I the initial task was virtually complete; 47 nurse practice acts were in effect.

Other early organizations which made notable contributions to the advancement of nursing in the U.S. were the National League of Nursing Education (N.L.N.E.; 1893) and the National Organization for Public Health Nursing (1912). In Great Britain the College of Nursing (after 1939 entitled to the prefix Royal), which was later established in London (1916), quickly became the dominant force in British nursing. In the U.S. the N.L.N.E. continued to work for the improvement of basic nursing education after it had persuaded Teachers college, Columbia university (1899) to undertake a program for the preparation of graduate nurses for teaching in schools of nursing. This famous division of nursing education began modestly with funds laboriously raised by the nursing organizations and an enrolment of two students. M. Adelaide Nutting, appointed to direct the expanding program in 1907, was the first nurse to hold professorial rank in any university. She retired in 1925. An endowment in 1909 ensured stability and adaptation of programs to changing social and health needs. From its earliest days the division was a Mecca for international leaders of nursing thought.

Nurses of the British empire became interested in postdiploma education at a later date. When the Royal College of Nursing, a membership organization, received its charter, its department of education was empowered to institute and conduct examinations in all branches of women's work conducive to the efficient conduct of the nursing profession and to grant certificates and diplomas to those who pass prescribed examinations. As in the U.S., the first courses offered were for the preparation of nurse teachers.

By 1912, in the U.S., Great Britain, New Zealand and a few other countries, visiting nurses, organized originally to give nursing care in homes, were participating in a variety of specialized health programs such as child welfare. tuberculosis and school nursing. The direction of nursing services by governmental health agencies was still in its infancy. In the U.S. the National Organization for Public Health Nursing (N.O.P.H.N.; 1912) was organized by members of the older organizations to provide standards of preparation and practice and consultative services in connection with the public health movement and the development of public health nursing services. The N.O.P.H.N. began at once to urge those responsible for the basic education of nurses to provide a sound foundation for ali types of nursing and to establish the requirement of one year of collegiate postdiploma preparation for public health nursing.

Wars expedite the evolution of nursing. Military needs, by depleting civilian services, force adaptations. The evolution of military services follows a fairly definite pattern. In the U.S. hospital conditions during the American Civil War were quite as shocking as those encountered by Miss Nightingale in the Crimea. The appointment of Dorothea Dix as superintendent of nurses for the federal military establishment did little to ameliorate the situation. The army nurse corps (1902) was not organized until the Spanish-American War had again demonstrated need for a permanently organized service. The navy nurse corps was organized in 1908.

In Great Britain. Queen Alexandra's imperial military nursing service superseded less formally organized services after the South African War (1899–1901). The territorial army nursing service was organized in 1907. Members of these corps were commissioned in 1941. The officers of Queen Alexandra's royal naval nursing service (organized 1902) have relative rank. Canada, however, was the first country (1904) to make provision for commissions for nurses in military service. In the U.S., army nurses were granted relative rank after World War I; both army and navy nurses were given temporary commissions in World War II. In the military reorganization of 1947, members of both corps were permanently commissioned as were those of the new air force nurse corps organized in 1949. The chiefs of the army and air corps have the rank of colonel; the highest ranking navy nurse is a captain. Members of all three corps served in the Korean war, 1950–1953, as did nurses of Australia. Canada. Denmark, France, Great Britain, the Netherlands, Norway, Sweden and Thailand.

After World Wars I and 11.—Relationships between the Red Cross and military nursing require explanation. The International Red Cross was organized, in accordance with the principles laid down by the Treaty of Geneva (1864), as a politically neutral agency which would provide needed voluntary services in time of war. The League of Red Cross Societies (L.O.R.C.S.; 1919) was an outcome of experience in meeting civilian needs during World War I. Both work through the national Red Cross societies.

The preparation of nonprofessional volunteers for nursing service in wartime was actively promoted by the older organization; and a few national Red Cross societies, especially those of Japan, Germany. Austria and Scandinavia, established nursing schools. The division of nursing of the L.O.R.C.S. was helpful in clarifying issues in relation to the preparation, assignment and interrelationship of professional nurses and of nonprofessional volunteers such as nurses' aides. It actively promoted the teaching. by professional nurses. of courses for nurses' aides and also in home nursing and related subjects for use by nonprofessionals in their own homes.

From 1909 to 1947 the relationship between the American Red Cross (A.R.C.) and professional nursing had no counterpart. The nursing service of the A.R.C.. in addition to providing nurses for disaster service and for teaching home nursing and other courses, provided a reserve of "enrolled Red Cross nurses" for the army and navy nurse corps. It spearheaded the recruitment of the 25,000 nurses who entered military service in World War I and the 59,000 who served in World War II.

The health section of the League of Nations (1922), which gave powerful impetus to the development of health programs by national governments, had no division of nursing. But the Rockefeller foundation. through its international health program, was already promoting the organization of nursing schools which would graduate nurses equipped to participate in health programs. Its influence has been felt throughout the world. The earliest of the foundation-assisted schools were that of the Pekin Union Medical college, Pekin, China, and the Ana Nery school in Rio de Janeiro, Braz. (1922). In the U.S., the Yale school, established with foundation support in 1923 as an educational experiment, was subsequently endowed by it. The foundation sponsored and assisted with the organization of the first university school of nursing in Europe, established in connection with the University of Brussels, Belg. (1936). By mid-century it had sponsored or given developmental aid to schools in other European countries, in South America, the far east, South Asia and in the South Pacific. The A.R.C. followed up its work for civilians in Europe by sponsoring the organization of modern schools in Prague, Czech.; Posnan and Warsaw, Pol.; Sofia. Bulg.; and Constantinople, Turk.

The League of Red Cross Societies established a postdiploma program in public health nursing in connection with the College of Nursing (London) at Bedford college. The scope of the program had been broadened when, in 1934, the L O.R.C.S., in co-operation with the International Council of Nursing (I.C.N.), transferred its program to the jurisdiction of the newly organized Florence Nightingale International foundation as the nucleus of an educational memorial to the founder of modern nursing.

In countries where nursing was already well established, the period between World Wars I and II was characterized by continuous effort to adapt the basic preparation of nurses to changing social and health demands upon the profession. As a basis for action objective studies of nursing were made, under a variety of auspices. in the U.S., Canada and Great Britain. The first of them, *Nursing and Nursing Education in the United States* (1922), was followed by the experiment at Yale and the subsequent endowment of that school. Concurrently the Frances Payne Bolton school was endowed and established at Western Reserve university, Cleveland, O. The organization on a collegiate level and endowment of the Vanderbilt University school, Nashville, Tenn., followed a few years later. Reports from these schools stimulated interest in efforts to utilize the resources of institutions of higher education for the education of nurses. Other state universities began to accept responsibility for educating nurses as the University of Minnesota had been doing since 1909. The organization of the Association of Collegiate Schools of Nursing in 1932 accelerated this movement. Between 1928 and 1934 the Committee on the Grading of Nursing Schools issued a series of reports which encouraged the upgrading of many hospital schools and hastened the closing of feeble ones.

In Canada, the Cniversity of British Columbia, Vancouver, was the first (1919) in the British empire to offer a basic program leading to a degree. Other Canadian universities followed its example. The University of Toronto, Ont. (1933), developed a basic collegiate program which prepared nurses for positions in all types of nursing, including public health nursing. This program and the postgraduate offerings of the university attracted nurses from many countries. The *Survey of Nursing in Canada* (1932), sponsored by the national medical and nursing organizations, provided a well-balanced guide to further developments. In Great Britain the report of the Lancet Commission on Nursing (1932) revealed the sharp conflict which had arisen between those who clung to the methods of the past and those who were concerned with current problems and future needs. The report was the forerunner of more searching investigations sponsored by the College of Nursing and philanthropic and health agencies. As in the U.S. and Canada, the control of nursing schools by hospitals in the interest of their own, rather than community service. obscured the basic issue—the need for independence and financial support for nursing schools.

Internationally, the most important publication of the period was the *Educational Program for Schools of Nursing*, published in three languages by the I.C.X. and promptly adopted by the L.O.R.C.S.

In World War II every country which called on nurses for military service was confronted with the fundamental problems of equitable adjustment of nursing resources to military and civilian needs, and need to develop methods for augmenting the peacetime supply of nursing service. The problem was effectively handled in Great Britain where all types of nursing personnel were required to register. Data thus obtained provided a sound basis for the recruitment of student nurses. the distribution of graduate nurses and the provision of supplementary services. War accelerated action in relation to a need which was already apparent in many countries, *i.e.,* preparation of workers to supplement the services of professional nurses. In Great Britain legislation (1943) set standards for the preparation of assistant nurses and provided for a register of them. In the U.S. the preparation of practical nurses was retarded by uneven progress in securing state legislation.

In the U.S., one-fourth of all active professional nurses volunteered for military service. The profession resisted a proposed drait but the American Nurses' association later went on record as favouring a draft of nurses which would ensure a register of all nursing personnel should there again be massive military need for nursing service.

I'rior to World War II, in countries where modern nursing had been longest established, national governments had shown little evidence of continuous interest in the preparation of nurses in relation to total national need. In the U.S. the Army School of Nursing (1919–1931) was organized and controlled by the military establishment. Social legislation in the '30s had made provision for the preparation of graduate nurses for public health nursing but nursing schools had never received governmental assistance.

With the beginning of World War II nursing leadership in the U.S. was delegated by the several national nursing organizations to a Kational Nursing Council for War Service which undertook the co-ordination of the programs of the voluntary agencies and provided liaison with the American Red Cross and the several federal agencies concerned with the supply of military and civilian nursing service. The council initiated a modest program of federal aid to nursing education for which congress appropriated $4,700,000 during the period 1941–43. The few thousand additional students enrolled in nursing schools fell far short of the growing need. Concurrently with the withdrawal of nurses for military service, civilian use of hospital facilities increased at a phenomenal rate, and industries also required unprecedented numbers of nurses. An extensive program of assistance was provided by the Nurse Practice act of 1943 under which the U.S. public health service (PHS) set up a department of nursing education to administer the U.S. cadet nurse corps (July 1, 1943). When enrolment was discontinued Oct. 15, 1945, 84.5% of the 139,000 students in the schools had received federal assistance, *i.e.,* they were members of the U.S. cadet nurse corps. In contrast, there had been only 87.500 students in all schools in 1941, the year before federal aid was made available. The cadet corps effectively met the wartime emergency. Its methods also contributed to the advancement of nursing education. Following the war the essentiality of nursing as a national resource was recognized by the appointment of Lucile Petry Leone, who had directed the corps program, as chief nurse officer of the PHS with the rank of assistant surgeon general (equivalent to army rank of brigadier generalj. A division of nursing resources was created which conducts and promotes research and disseminates information about nursing.

The termination of World War II brought no end to the demand for nurses, so swiftly did social forces already in action create new or expanded demands for nursing services. Among them were the continuing growth of various types of hospital and health insurance, the adaptation of nursing to rapid changes in medical practice due to chemotherapy, advances in surgical procedure, anaesthesia and the like and to the broadening functions of medicine. especially in relation to prevention, rehabilitation and psychiatry. and the expansion of national health programs. The World Health organization became a stimulating and co-ordinating agency.

In the U.S. the Hospital Construction and Survey act (194;) set in motion a program which is rapidly expanding the capacity of hospitals and health centres but there is no federal program which helps to finance the preparation of the additional nurses and other personnel required by these facilities.

Publication of *Nursing for the Future,* the report of a study it had sponsored to facilitate the postwar adjustment of nursing, terminated the program of the National Nursing council. Out of a study of the structure and functions of the national nursing organizations, emerged in 1952 the new Kational League for Nursing (N.L.N.) and an expanded American Nurses' association (A.N.A.). The N.L.N., which superseded the National League of Nursing Education, Kational Organization for Public Health Nursing. and Association of Collegiate Schools of Nursing, set up an accreditation program as recommended by the study of nursing education. In Great Britain the passage of the National Health Service act (1946) was followed by a comprehensive nationally sponsored study of recruitment in preparation for nursing. The recommendations. directed toward improving the conditions which were causing serious "wastage" of students during training. were similar to policies generally accepted in the U.S. and Canada. Chief among them was recognition of student nurses as enrollees in schools as distinguished from service personnel. The study was followed by a job analysis (1953). An earlier study had called attention to the preparation of nurses, including midwifery training, for work in the colonies.

Need for experimentation and studies of nursing functions, in order that the services of proiessionallp prepared personnel be utilized at the highest level of efficiency, was everywhere apparent. The Canadian Nurses association courageously led off with a major research project. With financial support from the Canadian Red Cross, it set up an experimental school which attracted international attention and stimulated further experimentation in Canada. In a period of sharp competition for the services of young women it was believed that shortening the basic period of education would tend to attract larger numbers of desirable candidates to nursing schools. At the end of the four-year experiment it was concluded that when a school has complete control of students' time, nurses can be prepared at least as well in two years as in three (the 50-year-old standard) hut their education must be paid for in money and not in service.

Number of Active Graduate Nurses per 100,000 Population, Selected Years (U.S.A.) 1900–51

Year	Number of active graduate nurses	Population (thousands)	Graduate nurses per 100,000 population
1900	11,804	76,094	16
1910	82,327	92,407	89
1920	103,878	106,466	98
1930	214,292	123,077	174
1940	284,159	131,936	216
1951	366,134	154,369	237

In the U.S. individuals and both official and voluntary agencies were increasingly interested in research. The A.N.A. in 1950 set up a five-year research program in the functions of nursing and a clearing bureau by means of which work in progress might be co-ordinated.

The World Health organization became the directing and co-ordinating agency in the health field. Missionary groups had been at work constructively in some of the underdeveloped areas for generations. By 1950 Catholic and Protestant groups had each established more than 1,100 hospitals and at least double that number of dispensaries. The total number of nurses employed by these agencies is not knomn. Emphasis by both groups has usually been on remedial therapy.

In addition to participation in W.H.O. programs, U.S. nurses were also assigned to the health missions included in the programs of the Technical Cooperation administration (Point Four) and the Mutual Security agency of the U.S. Nurses were sent to such countries as Iran, Thailand, Burma and Lebanon.

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See also MONASTICISM. (M. M. R.)

NUSKU, personification of the new moon, the name of the light and fire god in Sumer, Babylonia and Assyria, who is hardly to be distinguished from a god Gibil. Nusku-Gibil is the symbol of the heavenly as well as of the terrestrial fire. As the former he is the son of hnu, the god of heaven, but he is likewise associated with Enlil of Nippur, the earth god, and regarded as his messenger. A centre of his cult in Assyria was in Harran, where, because of the predominating character of the moon cult, he is viewed as the son of the moon god Sin (*q.v.*). He is often called upon to cleanse the sick and suffering in the magic fire rituals.

The fire god is also viewed as the patron of the arts and the god of civilization in general, because of the natural association of all human progress with the discovery and use of fire, and as the protector of the family. He becomes the mediator between humanity and the gods, since it is through the fire on the altar that the offering is brought into the presence of the gods.

While temples and sanctuaries to Nusku-Gibil are found in Babylonia and Assyria, he is worshipped more in symbolism than the other gods. Nusku and Gibil are symbolized by the lamp.

See A. Deimel, *Pantheon Babylonicum,* Nos. 598 and 2367. H. Zimmern, *Keilinschriften und das Alte Testament,* 416–420.

NUT, a term applied to that class of fruit which consists generally of a single kernel enclosed in a hard shell. Botanically speaking, nuts are one-celled fruits with hardened endocarps, sometimes enveloped in a cupule or cup, formed by the aggregation of bracts as in the hazel and acorn. A great number of nuts enter commerce for various purposes, principally as articles of food or sources of oil and for several ornamental and otherwise useful purposes. Certain of the edible species such as pecan, hickorynut, Brazilnut, sapucaianut, butternut, Persian walnut, coconut, pistachionut, and others are especially rich in fat, while such others as the lychee, chestnut, chufanut and the waterchestnut are notably rich in carbohydrates. Some nuts yield oils hardly fit for human consumption, yet very valuable in soapmaking, while still others furnish oils used in making paints, varnishes and many other products. Some nuts are used only in making buttons, cigarette holders and other similar products of turnery.

While most nuts of leading importance are discussed separately elsewhere in alphabetical order, there is here included a list of many plant products commonly knomn under this name, together with an indication of their original source and the principal uses of either the nut or the plant, or both. Following are brief comments concerning a few that are of special interest.

The sweet almond is one of the world's best-known and best-liked nuts of the market. While of greatest importance as a crop in the Mediterranean basin, it is also of great importance in California and ,Australia. The bitter almond is grown chiefly in northern Africa. It is an important source of almond flavouring extract and prussic (hydrocyanic) acid.

Beechnuts are of little importance for human food, in parts of Europe they are used as the source of a pleasing salad oil. The trees are of chief value for timber and ornamental planting.

The betelnut is chewed in the Philippines and other eastern tropics in much the same manner as tobacco.

Brazilnuts and sapucaianuts are close relatives from the Amazon region and elsewhere in northern South America. The former are well-known and much prized. The latter are not well known but are among the choicest nuts obtainable from any source.

The breadnut, a relative of the true breadfruit (*Artocarpus altilis*) is about an inch in diameter and contains a single seed, which when roasted or boiled is pleasant and nutritious.

The true butternut is the seed of a member of the walnut family which grows in northeastern United States and Canada. It is considerably hardier than is the Eastern black walnut but of less value for timber. Its kernels are preferred by some to those of any other *Juglans.*

The cashewnut is a native of the American tropics but is grown to greatest extent in southern India, Ceylon and East Africa. Marketed little except in the shelled and roasted condition, it is one of the cheapest and most pleasing of the world's nuts.

The castanopsis is a warm-country evergreen which produces a nut resembling the chestnut in bur and an oak in seed. It is eaten to a considerable extent although in flavour it is intermediate between an acorn and a chestnut.

The chestnuts were originally important as food and timber producers in Europe, Asia and North America. Between 1900 and 1940, the American and European trees, which were abundant in the eastern part of the United States, were practically destroyed there by chestnut blight. By 1943, much headway had been made toward reestablishing orchards with resistant strains and varieties of Chinese origin.

Common names in order of preference	Latin name	Original source	Principal use of nut or plant
Xllegany oilnut; Elknut; Buffalonut	*Pyrularia pubera*	Eastern U. S.	Botanical interest
Almond (sweet)	*Prunus amygdalus*	Mediterraneanbasin.	Food
Almond (bitter)	*P. amygdalus*, var. *amara*	Mediterranean basin	Flavouring extract; Prussic acid
hraucarian pinenut; Piñon; Pinyonie	*Araucaria araucana*	Chile	Food; Ornamental tree
Arnut; Yer-nut; Earth chestnut; Hawknut; Lousy-nut	*Bunium* spp.	Western Europe to Caucasus	Food
Babassu nut	*Orbignya oleifera*	Brazil	Food; Fuel oil; etc.
Bambarra-nut; Groundnut	*Voandzeia subterranea*	Tropical Africa	Food
Barbadosnut; Physic nut	*Jatropha curcas*	Tropical America	Medicine
Beechnut, American	*Fagus grandifolia*	Eastern U. S.	Mast; Timber
Beechnut, European	*Fagus sylvatica*	Central Europe; S.W. Asia	Salad-oil; Mast and timber
Ben-nut	*Moringa oleifera*	India and West Indies	Artists' oil
Betelnut; Arecanut; Pinang	*Areca catechu*	Eastern Pacific islands	Masticatory
Bladderriut, American	*Staphylea trifolia*	Temperate North Xmerica	Ornamental plant
Bladdernut, European	*Staphylea pinnata*	Southern Europe; S. Asia	Necklaces
Bomah-nut; Bome N.; Boomah N.	*Pycnocoma macrophylla*	Africa	Tanning; Poison plant
Bonduc nut	*Caesalpinia bonduc*	Tropics	Medicine; Beads
Brazilnut; Castanea; Creamnut; Paranut; Butternut; Niggertoe; Castana	*Bertholletia excelsa*	Northern South America	Food; Timber. *See* BRAZILNUT
Breadnut	*Brosimum alicastrum*	Tropical America	Food
Butternut; Long or White walnut	*Juglans cinerea*	Eastern U.S.; S.E. Canada.	Food; Timber. *See* BUTTERNUT
Candlenut; Lumbang; Kukui; Varnish tree	*Aleurites moluccana.*	Tropical Pacific islands	Manufacturing oil. *See* ALEURITES
Capechestnut	*Calodendrum capense*	Southern Africa	Ornamental plant
Cashewnut; Acajou; Caja; Cajou	*Anacardium occidentale*	West Indies and Tropical America	Food. *See* CASHEW
Castanopsis nut	*Castanopsis* spp.	S.E. Asia; California	Food; Ornamental evergreens
Chestnut, American	*Castanea dentata*	Eastern U. S.	Food; Timber; Tannin. *See* CHESTNUT
Chestnut, Chinese	*Castanea mollissima*	Northern China; 'Chosen	Food; Timber
Chestnut, European; Spanish, French, Italian C.; Marron	*Castanea sativa.*	Southern Europe; N.Africa; S.W. Asia	Food; Timber
Chestnut, Japanese	*Castanea crenata*	Japan; Chosen	Food; Timber
Chilehazel	*Gevuina avellana*	Chile	Food; Ornamental plant
Chinkapin, Alabama	*Castanea alabamensis*	Southeastern U. S.	Food; Timber. *See* CHESTNUT
Chinkapin, Allegany; Dwarf chestnut	*Castanea pumila*	Southeastern U. S.	Food
Chinkapin, Ashe	*Castanea ashei*	Southeastern U. S.	Food; Tannin
Chinkapin, Florida	*Castenea floridana*	Southeastern U. S.	Foo'd; Tannin
Chinkapin, Henry	*Castanea henryi*	China	Food; Timber
Chinkapin, Ozark	*Castanea ozarkensis*	Arkansas	Food; Timber
Chinkapin, Trailing; Creeping Chinkapin	*Castanea alnifolia*	Southeastern U. S.	Botanical interest
Chocolate nut; Cacao (Cocoa)	*Theobroma cacao*	Central and South America	Food and beverage
Chufa; Rush nut; Earthnut; Ground almond	*Cyperus esculentus*	Southern Europe	Food
Cohnut. See *Hazelnut* and *Filbert*, below			
Cobnut of Jamaica	*Ophalea triandra*	West Indies and Tropical America	Food
Coconut; Cocoanut	*Cocos nucifera*	Tropics generally	Food
Cohunenut; Cahoun nut	*Attalea cohune*	Honduras	Soap oil
Colanut; Kolanut; Ombene; Temperance nut; Bissy-bissy nut; Guru nut	*Cola acuminata*	West Africa	Food; Beverage
Coquilla nut	*Attalea funifera*	Brazil	Turnery
Coquits-nut; Monkey's coconut; Dwarf coconut; Cokcr-nut	*Jubaea spectabilis*	Chile	Soap oil
Cumaranut (Tonka or Tonquin bean)	*Dipteryx odorata*	Tropical South America	Perfume
Dika-nut	*Irvingia gabonensis*	\Test Africa	Food; Oil
Filbert, American (Hazelnut)	*Corylus americana*	Eastern North America	Food. *See* FILBERT
Filbert, Beaked	*Corylus cornuta*	Eastern North America	Food
Filbert, California	*Corylus californica*	West Coast of U. S.	Food
Filbert, Chinese	*Corylus chinensis*	Central and West China	Food; Timber
Filbert, European; Cobnut; Hazelnut	*Corylus avellana*	Europe	Food
Filbert, Giant	*Corylus maxima*	Europe	Food
Filbert, Himalaya	*Corylus ferox*	Himalayas	Food
Filbert, Japanese.	*Corylus sieboldiana*	Japan	Food
Filbert, Mildred	*C. americana* x *avellana*	United States	Food
Filbert, Siberian	*C. heterophylla*	China; Siberia; Japan	Food
Filbert, Turkish; Constantinople hazel	*Corylus colurna*	Turkey; Southern U.S.S.R.; Himalayas	Food; Timber; Ornamental tree
Ginkgonut	*Ginkgo biloba*	China; Japan	Food; Timber; Ornamental tree
Goatnut. See *Jojoba*, below.			
Crugru nut; Corozo nut	*Acrocomia aculeata*	Tropical South Xmerica	Beads
Hazclnut. Synonym for Filbert			*See* FILBERT
Heartnut; Japanese walnut; Cordate W.	*Juglans sieboldiuna cordiformis*	Japan	Food. *See* WALNUT
Hican (Pecan x shellbark hybrid)	*Carya illinoensis* x *laciniosa*	Indiana; Illinois; Iowa	Novelty trees and nuts. *See* HICKORY
Hickorynut, Bitter	*Carya cordiformis*	Eastern U.S.; Ontario	Timber; Nut inedible
Hickorynut, Black; Buckley hickory	*Carya texana*	Texas; Okla.; Arkansas	Food; Fuel
Hickorynut, Carolina; Southern Shag	*Carya carolinae-septentrionalis*	Southeastern U.S.	Food; Timber
Hickorynut, Cathay	*Carya cathayensis*	China	Food; Timber
Hickorynut, Fernow	*Carya fernowiana*	Southwestern U.S.	Food; Timber
Hickorynut, Hammock	*Carya ashei*	Southeastern U.S.	Timber: Fuel
Hickorynut, Mockernut; Bigbud H.; Bullnut	*Carya tomentosa*	Eastern U.S.; Ontario	Food; Timber
Hickorynut, Nutmeg	*Carya myristicaeformis*	Southwestern U.S.	Food; Timber
Hickorynut, Pig or Hognut	*Carya glabra*	Eastern U.S.; Ontario	Mast; Timber

Common names in order of preference	Latin name	Original source	Principal use of nut or plant
Hickorynut, Red; False shagbark	*Carya ovalis*	Eastern U.S.; Ontario	Food; Timber
Hickorynut, Sand; Paleleaf hickory	*Carya pallida*	Southeastern U.S.	Mast; Timber
Hickorynut, Scrub; Florida hickory	*Carya floridana*	Florida	Fuel
Hickorynut, Shagbark; Little scalybark; Tuscatine	*Carya ovata*	Eastern U.S.; S.E. Canada	Food; Timber
Hickorynut, Shellbark; Bigleaf H.; Bottom H.; Big scalybark	*Carya laciniosa*	Central, Eastern U.S.	Food; Timber
Hickorynut, Swamp	*Carya leiodermis*	Louisiana; Mississippi	Food; Fuel
Hickorynut, Tonkin	*Carya tonkinensis*	Southern China; Indo-China	Food; Timber
Hickorynut, Water; Bitter Pecan	*Carya aquatica*	Southern U.S.	Fuel; Inedible
Horsechestnut	*Aesculus hippocastanum*	Europe	Starch; Ornamental tree
Hyphaene-nut; Doum-nut; Dom-nut	*Hyphaene crinita*	South Africa	Turnery
Indiannut. Synonym for various North American edible pinenuts			
Javaalmond; Luzon-nut; Philippine N.	*Canarium commune*	Pacific Tropics	Food
Jojoba nut; Goatnut	*Simmondsia chinensis (californica)*	California and Mexico	Food and hair oil
Lychee; Chinese nut	*Litchi chinensis*	South China	Food
Macadamia. Synonym for Queenslandnut			
Markingnut; Marany; Marsh nut	*Semecarpus anacardium*	India	Ink; Varnish
Marron. French name for large chestnuts			
Moretonbaychestnut; Black Bean	*Castanospermum australe*	Australia	Food
Mu-yu-oil-nut; Mu-yu-shu	*Aleurites montana*	South China	Manufacturing oil. *See* ALEURITES
Nittanut; Nuttanut	*Parkia africana*	Africana	Food
Nutmeg	*Myristica fragrans*	East Indies	Spice
Nut Pine. Synonym for North American edible pinenut			
Olive-nut	*Elaeocarpus ganitrus*	India	Beads and turnery
Oysternut; Tabui	*Telfairia occidentalis*	Africa	Food
Palm nut	*Elaeis guineensis*	W. Africa	Oil. *See* PALM
Pascualito nut; Pinonchillo	*Garcia nutans*	Mexico to Venezuela	Hard, quick-drying oil
Peanut; Goober; Pindar; Groundnut	*Arachis hypogaea*	Brazil	Food. *See* PEANUT
Pecan; Illinois-nut	*Carya illinoensis*	Southern U.S.	Food; Ornamental tree. *See* HICKORY
Pekeanut. Synonym for Sawarrinut			
Pilinut	*Canarium ovatum*	Pacific tropics	Food
Pinenut; Indiannut	*Pinus* spp.		
Pinenut, Aleppo	*Pinus halepensis*	Southern Europe; W. Asia	Food
Pinenut, Colorado Pinyon	*Pinus cembroides edulis*	Southern Wyoming; Colo.; N. Mex.; Ariz.	Food
Pinenut, Coulter	*Pinus coulteri*	California	Food
Pinenut, Digger	*Pinus sabiniana*	California	Food
Pinenut, Italian Stone (Pignolia)	*Pinus pinea*	Mediterranean region	Food
Pinenut, Jeffrey	*Pinus jeffreyi*	California; Oregon	Food
Pinenut, Korean	*Pinus koraiensis*	Chosen; Japan	Food
Pinenut, Lacebark	*Pinus bungeana*	Northwestern China	Food
Pinenut, Limber	*Pinus flexilis*	Alberta to Texas	Food
Pinenut, Mexican Pinyon	*Pinus cembroides*	Southwestern U.S., Mexico	Food
Pinenut, Parry Pinyon	*Pinus cembroides parryana*	California	Food
Pinenut, Ponderosa	*Pinus ponderosa*	Western U.S.	Food
Pinenut, Singleleaf Pinyon	*Pinus cembroides monophylla*	Southwestern U.S.	Food
Pinenut, Sugar	*Pinus lambertiana*	Oregon to Lower California	Food
Pinenut, Swiss Stone (Pignolia)	*Pinus cembra*	Central Europe to Siberia	Food
Pinenut, Torrey; Soledad Pinenut	*Pinus torreyana*	Southern California	Food
Pinenut, Western White	*Pinus monticola*	Northwestern U.S.; B.C.	Food
Pinenut, Whitebark	*Pinus albicaulis*	Northwestern U.S.; B.C.	Food
Piñon. Synonym for Pinenut			
Pistachionut; Pistache; Green almond	*Pistacia vera*	Mediterranean basin to Southwestern Asia	Food. *See* PISTACHIONUT
Poisonnut	*Strychnos nuxvomica*	India	Medicine
Quandongnut	*Fusanus acuminatus*	Australia	Food
Queenslandnut; Australian nut; Macadamia; Australianhazel	*Macadamia ternifolia*	Australia	Food
Ravensara nut or clove nutmeg	*Ravensara aromatica*	Madagascar	Spice
Sapucaianut; Paradise nut	*Lecythis zabucajo*	Tropical South America	Food
Sassafras nut	*Ocotea* spp.	South America	Aromatic
Sawarrinut; Pekeanut; Peruvian almond; Butternut; Piki	*Caryocar nuciferum*	Peru; Brazil	Food
Sheanut	*Butyrospermum parki*	British Africa	Food; Soap oil
Snakenut	*Ophiocaryon paradoxum*	Guiana	Charm for snakebite
Soapnut	*Sapindus saponaria*	Southern Florida to Northern S. America	Washing; Ornament
Taguanut; Ivorynut; Vegetable ivory	*Phytelephas macrocarpa*	Central America	Buttons, etc.
Tahiti-chestnut; South Sea chestnut	*Inocarpus fagiferus*	South Seas	Food
Tallownut, Chinese	*Sapium sebiferum*	China	Wax for soap and candles
Tropical-almond; Myrobalan; Tavolanut; Demerara almond	*Terminalia catappa*	Southwestern Asia	Food; Street tree
Tungnut; Wood-oil tree	*Aleurites fordii*	South China	Paint and varnish. *See* ALEURITES
Tungnut, Japanese	*Aleurites cordata*	Japan to Formosa	Oil. *See* ALEURITES
Walnut, American	*Juglans nigra*	Eastern U.S.	Trade name for lumber of this sp.
Walnut, Ancona	*Juglans regia*	Persia	Trade name indicating streaked figure in Persian Walnut
Walnut, Argentine	*Juglans australis*	Argentina	*See* WALNUT
Walnut, Arizona Black	*Juglans major*	Southwestern U.S.	Food; Lumber

Common names in order of preference	Latin name	Original source	Principal use of nut or plant
Walnut, Bixby	*J. cinerea* x *sieboldiana*	U.S.	Food; Kovelty tree
Walnut, Bolivian Black	*Juglans boliviana*	South America	Food; Lumber
Walnut, California (S. Calif.) Black	*Juglans californica*	Southern California	Food; Lumber
Walnut, Cathay	*Juglans cathayensis.*	China	Food; Fuel
Walnut, Circassian	*Juglans regia*	Persia	Trade name for lumber of Persian W.
Walnut, Claro		California	Trade name for lumber of California and Hinds Walnuts; also California hybrid walnuts
Walnut, Colombian	*Juglans columbiensis*		
Walnut, Cuban	*Juglans insularis*	Cuba	Lumber; Food
Walnut, Eastern Black	*Juglans nigra*	Eastern U.S.; Ontario.	Lumber; Food
Walnut, Ecuador.	*Juglans honorei*	Ecuador	Lumber; Food
Walnut, Guatemalan	*Juglans mollis*	Guatemala	Lumber; Food
Walnut, Hinds; N. California Black W.	*Juglans hindsii*	Northern California	Food, Shade; Lumber
Walnut, Intermediate	*J. nigra* x *regia*	U.S.	Hardy ornamental
Walnut, Manchu; Manchurian W.	*Juglans mandshurica*	N. China; Manchuria; Chosen	Food; Fuel
Walnut, Nigornica	*J. californica* x *nigra*	California	Vigorous ornamental
Walnut, Nigrind	*J. hindsii* x *nigra* (Paradox in part)	California	Vigorous ornamental
Walnut, Nigroldiana	*J. nigra* x *sieboldiana*	U.S.	Ornamental tree
Walnut, Notha	*J. regia* x *sieboldiana*	U.S.	Ornamental tree
Walnut, Perbut	*J. cinerea* x *regia*	U.S.	Ornamentaltree
Walnut, Persian; English; French; Turkish; Italian; Roumania; Common *et al.*	*Juglans regia*	Persia	Food; Lumber; Ornamental tree
Walnut, Regifornica	*J. californica* x *regia* (Paradox in part)	California	Vigorous ornamental tree
Walnut, Siebold; Japanese walnut	*Juglans sieboldiana*	Japan	Food; Ornamental tree; Fuel
Walnut, Texas	*Juglans rupestris*	Texas, Oklahoma; N. Mex.	Food; Ornamental tree; Fuel
Waterchestnut	*Trapa natans*	South China.	Food; Conservatory plant
Waternut	*Eleocharis tuberosa*	South China.	Food
Wingnut; Caucasian walnut; False walnut	*Pterocarya fraxinifolia*	Southwestern Asia	Ornamental tree

The chinkapins are closely related to the chestnuts, but are generally inferior in size of nuts and in timber values.

The chocolate nut is the source of the well-known material used in making candies and cocoa. It is extensively cultivated in many tropical regions.

The chufa is a small sedge plant producing a nut-like tuber underground which is an important hog food in the tropics and subtropics. While edible, it is rarely used as human food.

The coconut is the fruit of a palm grown in practically all tropical regions, where it furnishes food, healthful drinks, intoxicants, fibre and coconut oil.

Colanuts, now much cultivated in the American tropics, are the source of an important article of commerce used in making mildly stimulating drinks.

Coquilla nuts, or "coquilhos" as known in Portuguese, are the small coconut-like seeds of the piassava palm of Brazil. They are a by-product from the tree; the main product is fibre. They are elongated oval and 3 or 4 in. long and much used in turnery.

Coquita-nuts are the small, roundish seeds of the Syrup palm from Chile which is much prized as a conservatory plant. The seeds furnish an oil used in making soap.

The filberts are seeds of a number of temperate zone species, some of which are low shrubs while others become large trees. The nuts are roundish or oblong, yellowish brown, usually with gray tomentum over the apical end, a medium thin shell and a single kernel, which is usually slightly hollow at the centre. The filbert is one of the half-dozen or so most important nut-bearing plants of the north temperate zone.

The ginkgonut is the small, whitish, smooth-shelled seed of the Oriental ginkgo tree, also known as Maidenhair tree and as Kew tree It forms within a fruit greatly like the American persimmon in its mushiness, but exceeding it in foul odour. The seed is roasted by Chinese, who are said to regard it as a great delicacy.

The several hickorynuts, including the pecan, are important food crops grown in the eastern and southern United States. Of these the pecan is the choicest and far the most important. Several others are of great value for their timber.

The javaalmond and the pilinut are close relatives from the eastern Pacific islands, including in particular the Philippines. The shells are very hard and thick, yet the kernels are regarded by many as being fully equal to any other nuts on the world's market.

The lychee is a brownish, roundish, thin, papery and pimpled-shell product containing a raisin-like pulp surrounding a hard, smooth-shelled seed. The edible portion is the pulp. This nut is common in most Chinese stores. It is considered a great delicacy.

The markingnut is closely related to the cashew and is equally poisonous in its effects upon the skin of susceptible persons. The immature juice of the nut is mixed with quicklime and used as an ink. When dry, the juice is the basis of a valuable caulking material and varnish. The seed is edible and is the source of a useful oil.

The pinenuts are seeds of a considerable number of species, native to remote and often more or less arid parts of the earth. The nuts are borne in the axils of the cone scales. The stone pines of Europe and Asia, the pinyon pines of North America, and the Araucarian pine of the Andean region of South America are the most important. With the exception of the Italian stone pine, the seeds of which are sold as "pignolia" and exported, pinenuts are largely consumed in the general regions where they are produced. They are fairly rich in oil and are very pleasing to the taste.

The pistachionut is the small, whitish, thin, but bony-shelled seed of a medium or small-sized tree native to the region including the Mediterranean basin and extending to southwestern Asia. The kernel is of fine texture and of pale green colour throughout; it is much used in colouring and flavouring confections. It is fairly rich in fat.

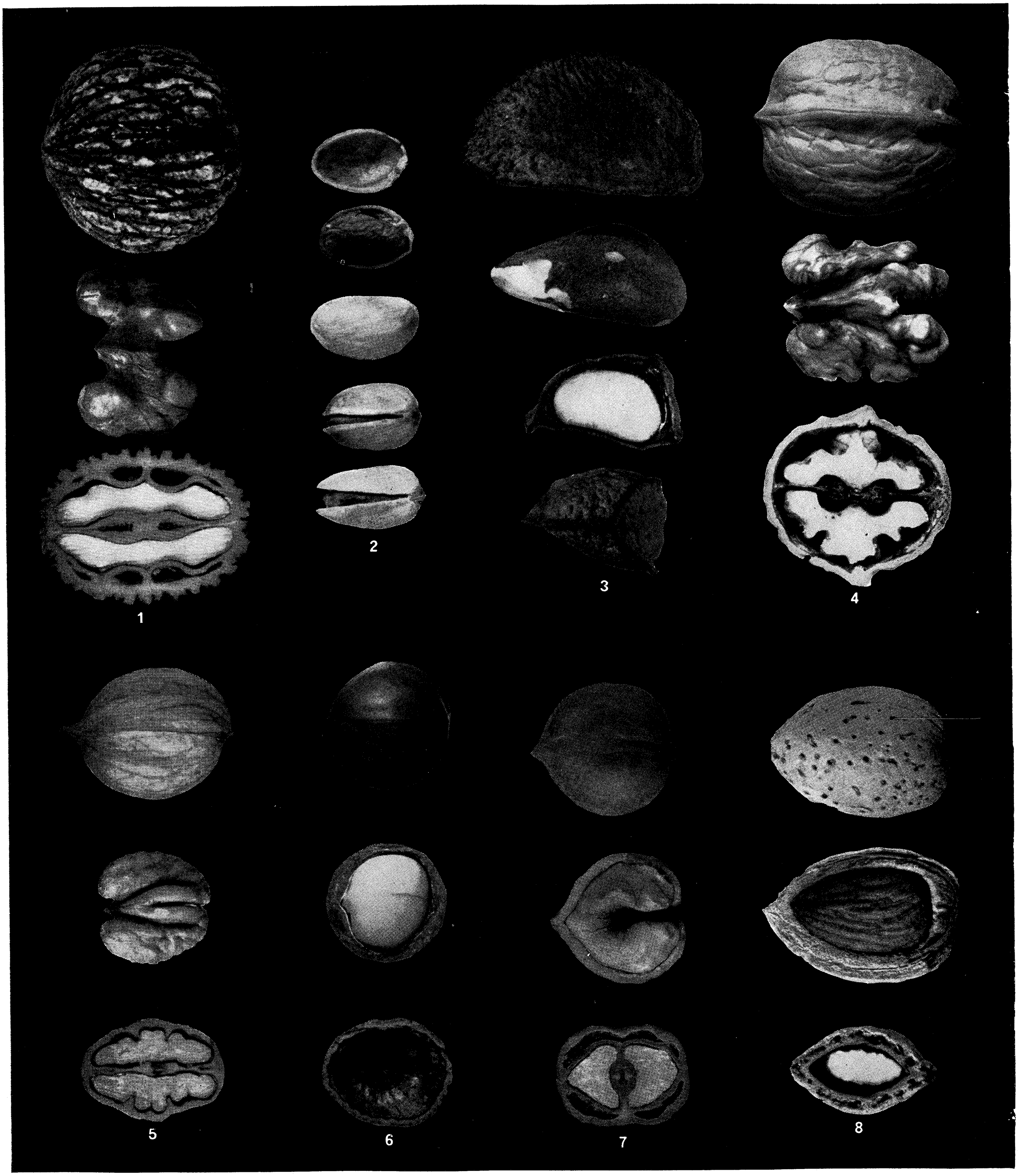
The quandong is a small, roundish, thick-shelled seed of an Australian tree which is mainly used as a preserve.

The ravensara nut is a Madagascar product considerably used as a spice under the trade name of "clove nutmeg," although it is not a true nutmeg.

The sawarrinut is the fruit of a tall-growing tree, the forest timber of which is used in building ships. The trees are cultivated in the American tropics for their very fine nuts. The latter are seldom seen in the world's market, except locally.

The taguanut is the inedible seed of a palm from northern South America, which becomes exceedingly hard and is much used in making buttons. It takes a high polish, colours well and burns with intense heat.

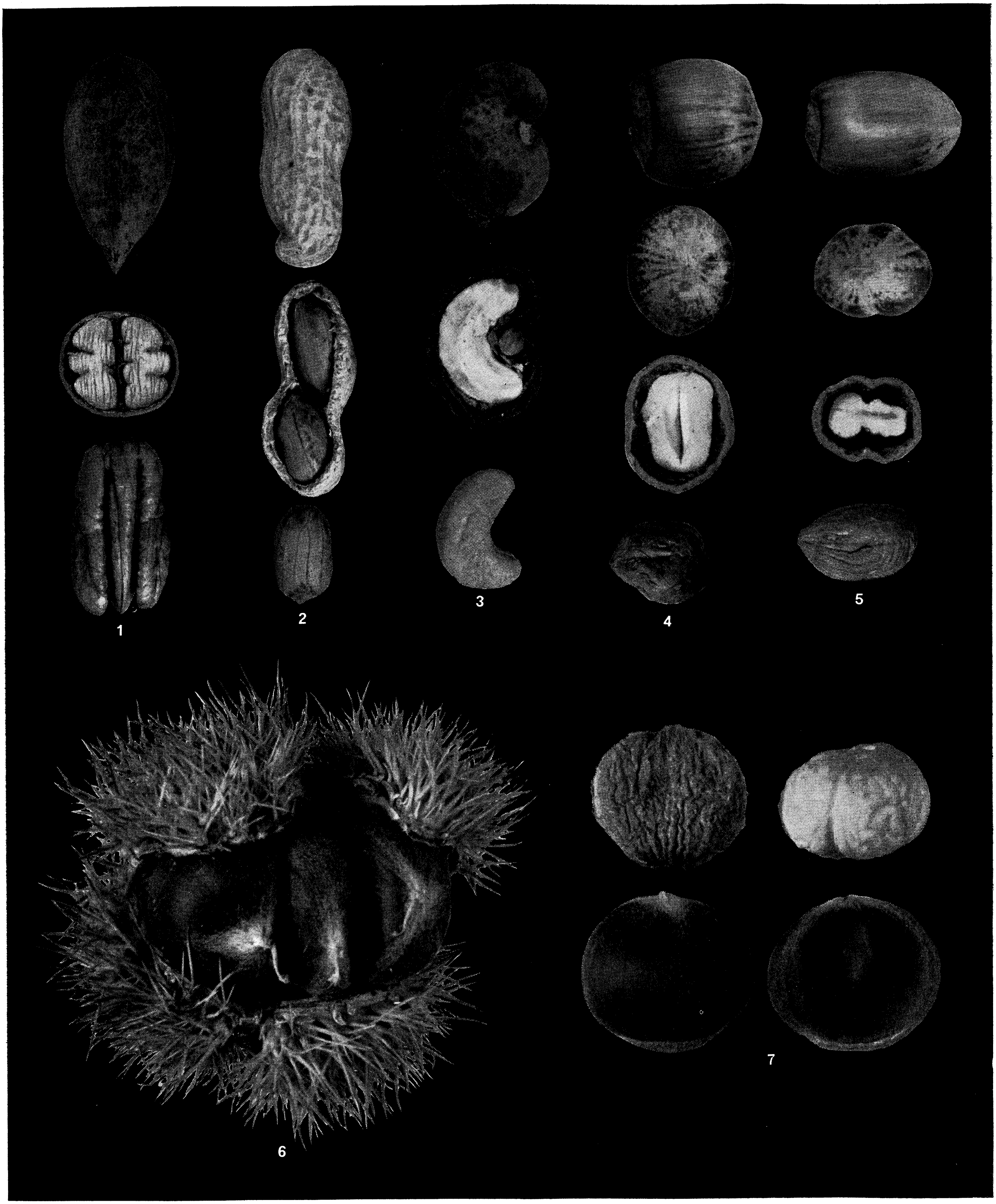
The tungnuts and their close relatives, the candlenut and the mu-yu-oil-nut, are sources of valuable oils used in many forms of manufacture. (See ALEURITES.)



PHOTOGRAPHS, ROBERT TAYLOR

VARIOUS KINDS OF COMMERCIAL AND EDIBLE NUTS

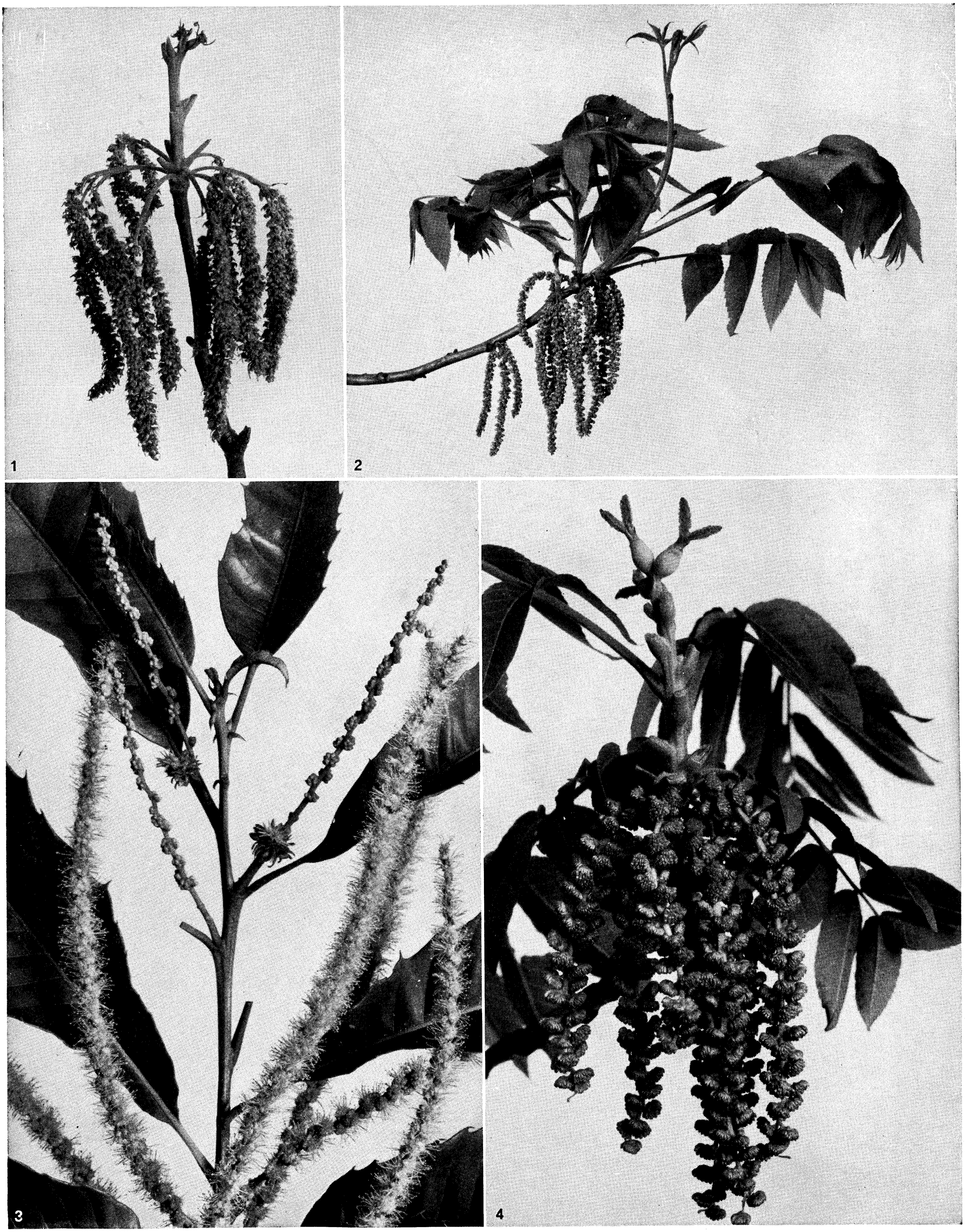
1. Eastern black walnut, *Juglans* nigra, Thomas variety
2. Pistachionut, *Pistacia vera*. Top, nut with shell removed; below, three nuts in shell
3. **Brazilnut,** Bertholletia excelsa
4. Persian (English) walnut, *Juglans* regia, Placentia variety
5. **Shagbark** hickory, Carya ovata, **Lingenfelter** variety
6. Queensland nut, Macadamia *ternifolia*. Top, whole nut; middle, **kernel** with half of shell removed; bottom, empty half shell
7. Heartnut, *Juglans* sieboldiana cordiformis, Lancaster variety
8. Sweet almond, *Prunus amygdalus*, Peerless variety



PHOTOGRAPHS, ROBERT TAYLOR

VARIOUS KINDS OF COMMERCIAL AND EDIBLE NUTS

1. Pecan, *Carya illinoensis,* variety Schley (Sly)
2. Peanut, *Arachis hypogaea*
3. Cashewnut, *Anacardium occidentale*
4. European filbert, *Corylus avellana,* Barcelona variety
5. European filbert, *Corylus avellana,* Du Chilly variety, said by some to be identical with Kentish cob
6. Chinese chestnut, *Castanea mollissima,* nuts in bur at ripening time
7. Chinese chestnut, *Castanea mollissima.* TOP: left, kernel with pellicle still attached; right, pellicle removed. Below, outer and inner views of end nuts



PHOTOGRAPHS, CLARENCE A. REED

FLOWERS AND LEAVES OF VARIOUS NUT PLANTS

1. Shagbark hickory, *Carya ovata*. Pistillate and staminate flowers
2. Pecan, *Carya illinoensis*. Staminate flowers on branch
3. American chestnut, *Castanea dentata*. Flowers and leaves
4. Eastern black walnut, *Juglans nigra*. Staminate and pistillate flowers

The waterchestnut and its close relative, the singharanut, are important sources of human food. rich in starch. Both are annuals extensively grown in the Asiatic subtropics. The former is very abundant in the slow-moving or stagnant waters in the vicinity of the Yangtze river. It multiplies rapidly and may easily get beyond control, as it has in alcoves of the Potomac river below Washington, where it forms a practically impassable blockade at many points near the shore.

The waternut *(nzatai* in Chinese) is the edible corm of a sedge plant grown under irrigation in southern China. It is much used in making chop suey and is well suited to occidental cookery. The wingnut is the winged seed of a highly ornamental tree from western China. The nut is too small to be of value. (C. A. RD.)

Nut Culture in the U.S.—Numerous varieties of the pecan are planted for commercial production in southern states. Hardy strains have been grown, however, in Missouri and Illinois.

The commercial production of almonds is restricted to various forms of the sweet variety (var. *dulcis*), with increasing preference for those having thinner walls in the stone, as in the papershell almonds. The climatically suitable districts are comparatively limited, being confined chiefly to the Pacific states.

The commercial production of the old world or Persian walnut, in the United States often called English walnut, has attained its greatest development in specially selected and prepared soils under irrigation in California. However, hardy strains have been grown with success in the eastern states from Massachusetts westward and southward to Arkansas.

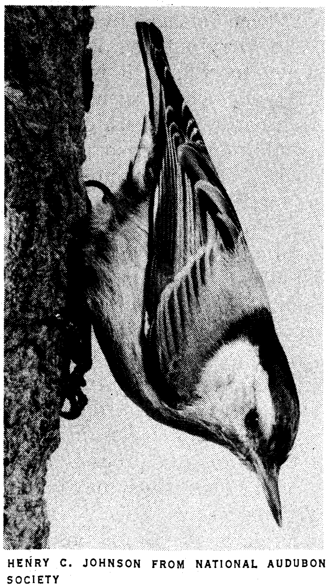
NUT (Engineering): *see* BOLT.

NUTCRACKER (*Nucifraga caryocatactes*), a European bird of the crow family (Corvidae). The plumage is mottled and the tail feathers have conspicuous white tips. The beak is long and the flight undulating. The nutcracker feeds mainly on conifer seeds, but also takes fruits, insects and young birds. The nest is built on the bough of a tree, about 20 ft. from the ground, and is a large structure of sticks lined with grass. The eggs are of a very pale bluish-green, freckled with pale olive or ash colour. Another species *(N. columbiana)* is found in America.

The Siberian nutcracker migrates into western Europe in large flocks at intervals of approximately 11 years. *See* also CROW.

NUTHATCH, a small bird, so called from its habit of hacking or chipping nuts, which it cleverly fixes, as though in a vise, in a chink or crevice of the bark of a tree, and then hammers with the point of its bill till the shell is broken. The common nuthatch, *Sitta europaea,* is widely distributed through Europe and Asia, about 24 local races being recognized. Without being very plentiful anywhere, it is generally distributed in suitable localities throughout its range, those localities being such as afford it a sufficient food supply.

During most of the year the nuthatch feeds on insects, which it diligently seeks on the boles and larger limbs of old trees, but in autumn and winter it feeds on nuts, beech mast: the stones of yew berries and hard seeds. Its bold disposition and the fact that trees favouring its mode of life often grow near houses make it quite tame and it will become familiar with humans on slight encouragement.



HENRY C. JOHNSON FROM NATIONAL AUDUBON SOCIETY

WHITE-BREASTED NUTHATCH (SITTA CAROLINENSIS) DESCENDING TREE TRUNK

The nuthatch's feathers are ash gray and warm buff and its manner is sprightly. It generally makes its nest in a hollow branch, plastering up the opening with clay and leaving only a circular hole, just large enough to afford entrance and exit. The interior contains a bed of dry leaves or the filmy flakes of the inner bark of a fir or cedar, on which the eggs are laid.

The rock nuthatches, *S. neumayeri* and its races and close relatives, nest and hunt among rocks rather than trees; they range from southeast Europe to Palestine. Iran and Turkestan. Four other little-known species of *Sitta* occur in various parts of Asia. Four familiar species, using no mud in the nest, are found in North America: red-breasted nuthatch, *S. canadensis,* mostly in Canada but southward in mountains to North Carolina and to California and New Mexico; white-breasted nuthatch. S. *carolinensis,* southeast Canada to South Carolina and northern Texas, with six races, two in Lower California. one in the Panamint and White mountains of California, southeastern U.S.. Rockies from Canada into Mexico. and the Pacific coast and its ranges; brown-headed nuthatch. *S. pusilla,* of the southeastern U.S., with a local race in Florida; and pygmy nuthatch. S. *pygmaea,* of the middle California coast. with one local race from southern California into Lower California and another along the Rockies from British Columbia to the Mexican border. No nuthatches are found in South America, Africa from the Sahara southward or New Zealand.

A peculiar genus with a single species, *Hypositta corallirostris,* is confined to Madagascar; several genera are found in Australia, India and the East Indies.

NUTLEY, a town of New Jersey. U.S.. 5 mi. N. of Newark on the Passaic river. 13 mi. W. of New York city. adjoining Bloomfield and Belleville. Founded in 1680 by the Dutch as part of Newark. it was detached in 1812 to become part of Bloomfield. In 1874 it was separated as an independent township and renamed Franklin in honour of William, son of Benjamin Franklin. last royal governor of New Jersey. In 1902 it was renamed Nutley and incorporated as a town. Primarily residential. with many old colonial style homes. it has various industries: textiles, insulators, chemicals, pharmaceuticals, paints, machine tools, radar, telephone and electrical equipment and paper. In the late 19th century it was an authors' and artists' settlement: living there were Frank R. Stockton. author of "The Lady or the Tiger?" and *Rudder Grange,* and Henry C. Brunner. For comparative population figures ,,, table in NEW JERSEY: *Population.*

See E. S. Brown, *History of Nutley (1907).* (*D. N.* A.; M. P. M.)

NUTMEG, the commercial name of a spice representing the kernel of the seed of *Myristica fragrans*, a dioecious evergreen tree about 50 to 60 ft. high found wild in the Molucca Islands and extending to New Guinea. Nutmeg and mace are mostly obtained from the Moluccas and the West Indies. although cultivation has been attempted with varying success elsewhere. The trees yield fruit in 8 years after sowing, reach their prime in 25 years and bear for 60 years or longer. The ripe fruit is about two inches in diameter. of a rounded pear shape, and when mature splits into two, exposing a crimson aril surrounding a single seed. When the fruit is collected the pericarp is first removed: then the aril is carefully stripped off and dried. in which state it forms the mace of commerce. The seed consists of a thin. hard shell, enclosing a wrinkled kernel, which. when dried, is the nutmeg. To prepare the nutmegs for use, the seed enclosing the kernel is dried at a gentle heat in a drying house over a smoldering fire, the seeds being turned every second or third day. When thoroughly dried the shells are broken and the nutmegs picked out and sorted. the smaller and inferior ones being reserved for the expression of the fixed "oil of mace" which they contain. Oil of mace, or nutmeg butter, is a solid fatty substance of a reddish-brown colour. obtained by grinding the refuse nutmegs to a fine powder which is steamed and compressed while still warm. the brownish fluid which flows out being afterward allowed to solidify. Nutmegs yield about one-fourth of their weight of this substance. It is partly dissolved by cold alcohol. the remainder being soluble in ether. The latter portion. about 10% of the weight of the nutmegs, consists chiefly of myristin, which is a compound of myristic acid with glycerin. Nutmegs, maces and their oils are used as condiments and carminatives. A liniment or ointment made of nutmeg butter has been used as a counterirritant and in treatment of rheumatism.

The name nutmeg is also applied to other fruits or seeds in different countries. The Jamaica or calabash nutmeg is derived from *Monodora myristica*, the Brazilian from *Cryfocarya nzoschata,* the Peruvian from *Laurelia aromatica,* Madagascar or clove nutmeg from *Ravensara avomatica* and the California or stinking nutmeg from *Torreya californica.*

NUTRIA (COYPU), *Myocastor coypus,* a large aquatic rodent native to South America. Features that distinguish it from other members of the family Capromyidae are: size (up to 25 lb.); reddish-brown fur: long, round-tipped tail; partially webbed hind toes; short. round ears; and smooth. broad. orange-coloured incisor teeth. These traits have given it the misnomer "South American beaver," but it more closely resembles a guinea pig or an agouti. The mammary glands are peculiarly placed along the sides of the back. an arrangement thought to be an advantage in permitting the young to suckle while the mother is surface swimming. The nutria lives in shallow burrows along the banks of rivers and edges of ponds; it subsists largely on aquatic plants. coming ashore to feed. especially in the evening. It is prolific. producing from two to eight young at a birth, and having as many as three litters a year.

Prime nutria pelts are of some commercial value, but require expensive processing. In the late 19th century a high demand for pelts led to the near extermination of the species in Argentina. Raising nutiias in captivity in South America began in 1922 and spread to niany other countries. High prices were paid for breeding stock, but the pelts from ranch-raised stock were generally inferior. and these ventures were disappointing. Some nutrias were turned loose, others escaped, and populations became established in the wild. In many countries to which they were imported. France. for example, nutrias became a distinct liability. feeding on cultivated crops. damaging dikes and irrigation ditches. destroying habitats of and competing with other wildlife. They are established in several other European countries and in Canada. and are a problem in parts of the southern U.S. (R. H. MA.)

NUTRITION. All forms of life. plant and animal alike. from simple single-cell organisms to complex mammals, require certain food materials in certain minimum amounts and proportions to ensure an active life and successful reproduction. Nutrition is concerned with what these materials are, how they function. what effects they have when absent or in too plentiful supply, what happens to them when ingested and other related problems. Nutrition might be defined as the science of food and the nutrients in food and their relation to health. Because of this wide scope there has been increasing overlapping with such sciences as biochemistry, enzymology and physiology. In spite of the enormous diversity of living things, each can be said to have two major nutritional requirements: (1) compounds n-hich are sources of energy; and (2) substances whose primary purpose is to fill a structural or functional need. Some of course fulfill both needs. Often what is an absolute dietary essential for one species is without effect in another, for the latter may be able to synthesize it from other materials. In many instances knowledge of the nutrition of one species aids immeasurably in gaining nutritional information about another. For example, the requirement of a microorganism for a given nutrient may make possible the analysis of this compound in foods which are to be consumed by other living organisms.

General **Requirements.**—All living cells, whether existing as separate entities or as part of a complex tissue, require one or more inorganic substances and some form of carbon and nitrogen. On the other hand. the need for complex exogenous organic compounds is quite different for the various forms of life. Whereas vitamins and proteins are essential for many animal species, plants are without this requirement for they are able to make these out of simpler chemicals such as carbon dioxide. water and ammonia. This difference between forms of life has a tremendous importance, for continuous cycles exist in nature whereby simple compounds of the elements such as carbon and nitrogen are converted into complex molecules by some species; these in turn are used by higher forms where they are again eventually converted to simple compounds. Thus, in the long run. only energy has been expended. Were these cycles to he interrupted for long. life on earth as we know it would cease.

Plants.— Much is known of the requirements of plants for minerals. carbon and nitrogen. As is the case with animals. certain of the elements are required in extremely minute amounts for normal growth and reproduction. These are knon-n as trace elements. a term not to be confused with the word tracers, which refers to isotopes incorporated into compounds to facilitate the tracing of a biochemical pathway. Boron and silicon are examples of trace elements which are needed by some plants but have not been shown to be required by animals. The nutrition of plants has a very important bearing upon nutrition of animals because the latter consume the plants and thereby gain proportionately to the nutritional status of the plants. The importance of this is shown by the fact that the analysis of plants for important nutrients is a constant facet of nutritional research. Furthermore, agricultural research is engaged in improving the food value of crops through plant breeding and nutrition.

Microorganisms.— .I fascinating phase of nutritional investigation has been that dealing with the requirements of microorganisms: bacteria. molds and yeasts. As might be expected. the diversity of microorganisms makes for a diversity of nutritional requirements which is reflected among species and also among strains within a given species. Some. like the plants, require no complex organic material whatsoever. Nitrogen (usually as an ammonium salt), carbon (as a simple salt such as carbonate) and minerals are sufficient to provide optimum growth and reproduction in such organisms. Others, however, have almost as complex requirements as human beings do. In these cases amino acids, vitamins. carbohydrates and minerals must be made available in chemical forms readily utilized by the organism. So exacting are the requirements of many organisms for certain nutrients that in the absence of any particular one there will be no growth. If inadequate amounts are provided, the growth will often be proportional to the amount present. This forms the basis of several important tools for biochemical and nutritional research. One of these is the inicrobiological assay developed by E. Snell and F. Strong. In this procedure all but one of the essential nutrients necessary for rapid growth are provided an organism such as *Lactobacillus casei,* found in cheese. When the missing factor is furnished in some suitably prepared extract of a natural product, the increased growth that results is a measure of the amount of the compound present in a readily available form. Comparison of this response with that obtained when known amounts of the iactor are present give a fairly exact estimate of the amount of the substance in the natural product. Such assays came to have widespread use because of their simplicity, accuracy and rapidity.

Microorganisms also aid in the understanding of the nutrition and biochemistry of higher animals in another way. They readily lend themselves to investigations which deal with theactual pathways of synthesis and degradation of important nutrients and biologically important compounds. Extensive studies, notably by E. L. Tatum and coworkers. have been made on organisms which have been damaged by X-rays. Such organisms have lost the ability to carry out one particular step in a series of reactions. By proper techniques it is possible to isolate the affected ones and determine where such a metabolic lesion occurs and what its exact nature is. Such damage is usually reflected in the need for an additional nutrient not ordinarily required. In a sense an almost unlimited number of mutants of a given organism can be produced which differ only in that each has a special "dietary" requirement.

Although it is usual to think of higher animals in terms of the individual. such is not strictly possible frorn a nutritional standpoint. The reason is that the intestinal tract supports a flourishing population of microorganisms which have their own nutritional requirements, produce various important nutrients themselves and also degrade other nutrients. It is difficult to assess the importance of these uninvited guests on the nutritional status of the host. however. except in certain instances. For example. the use of antibiotics and sulfa drugs is known to have definite effects on the intestinal flora which may influence the amount of certain vitamins available to the patient. In studies with animals born and raised under germ-free conditions, J. A. Reyniers and coworkers shon-ed that good gronth and reproduction are not dependent upon the intestinal flora.

Human and Animal Nutrition.— The nutrition of the more complex forms of life, the higher animals and humans, differs from

*Recommended Daily Dietary Allowances**
(for persons normally vigorous and living in temperate climate)

Person	Age years	Weight kg. (lb.)	Height cm. (in.)	Calories	Protein g.	Calcium g.	Iron mg.	Vitamin A I.U.	Thiamine mg.	Ribo-flavin mg.	Niacin mg.	Ascorbic acid mg.	Vitamin D I.U.
Men	25	65 (143)	170 (67)	3,200†	65	0.8	12	5,000	1.6	1.6	16	7 5	
	45	65 (143)	170 (67)	2,900	65	0.8	12	5,000	1.5	1.6	15	75	
	65	65 (143)	170 (67)	2,600	65	0.8	12	5,000	1.3	1.6	13	75	
Women	25	55 (121)	157 (62)	2,300†	55	0.8	12	5,000	1.2	1.4	12	70	
	45	55 (121)	157 (62)	2,100	55	0.8	12	5,000	1.1	1.4	11	70	
	65	55 (121)	157 (62)	1,800	55	0.8	12	5,000	1.0	1.4	10	70	
	pregnant (3rd trimester)			Add 400	80	1.5	15	6,000	1.5	2.0	15	100	400
	lactating (850 ml. daily)			Add 1000	100	2.0	15	8,000	1.5	2.5	15	150	400
Infants‡	0–1/12§												
	1/12–3/12	6 (13)	60 (24)	kg. x 120	kg. x 3.5‡	0.6	6	1,500	0.3	0.4	3	30	400
	4/12–9/12	9 (20)	70 (28)	kg. x 110	kg. x 3.5‡	0.8	6	1,500	0.4	0.7	4	30	400
	10/12–1	10 (22)	75 (30)	kg. x 100	kg. x 3.5‡	1.0	6	1,500	0.5	0.9	5	30	400
Children	1–3	12 (27)	87 (34)	1,200	40	1.0	7	2,000	0.6	1.0	6	35	400
	4–6	18 (40)	109 (43)	1,600	50	1.0	8	2,500	0.8	1.2	8	50	400
	7–9	27 (59)	129 (51)	2,000	60	1.0	10	3,500	1.0	1.5	10	60	400
Boys	10–12	35 (78)	144 (57)	2,500	70	1.2	12	4,500	1.3	1.8	13	75	400
	13–15	49 (108)	163 (64)	3,200	85	1.4	15	5,000	1.6	2.1	16	90	400
	16–20	63 (139)	175 (69)	3,800	100	1.4	15	5,000	1.9	2.j	19	100	400
Girls	10–12	36 (79)	144 (57)	2,300	70	1.2	12	4,500	1.2	1.8	12	75	400
	13–15	49 (108)	160 (63)	2,500	80	1.3	15	5,000	1.3	2.0	13	80	400
	16–20	54 (120)	162 (64)	2,400	75	1.3	15	5,000	1.2	1.9	12	Xo	400

*In planning practical dietaries, the recommended allowances can be attained with a variety of common foods which will also provide other nutrient requirements less well known; the allowance levels are considered to cover individual variations among normal persons as they live in the United States subjected to ordinary environmental stresses.

†These calorie recommendations apply to a certain degree of activity. For the urban white-collar worker they are probably excessive. In any case, the calorie allowance must be adjusted to the actual needs of the individual as required to achieve and maintain his desirable weight.

‡The recommendations for infants pertain to nutrients derived primarily from cow's milk. If the milk from which the protein is derived is human milk or has been treated to render it more digestible, the allowance may be in the ranee of 2–3 g. per kilogram. There should be no question that human milk is a desirable source of nutrients for infants even though it may not provide the levels recommended for certain nutrients.

§During the first month of life, desirable allowances for many nutrients are dependent upon maturation of excretory and endocrine functions. Therefore no specific recommendations are given.

Source: Food and Nutrition Board, National Research Council.

that of the plants and microorganisms in several important aspects: First., all higher animals require a number of preformed complex organic compounds in their diet for bare survival, let alone optimum development and reproduction. Second, not only must the requirements of a diversity of cells be met, but those of complicated tissues as well. Third. there is absolute dependency upon plants and microorganisms for satisfying dietary requirements. Fourth. higher animals have a greatly added caloric requirement to meet the needs imposed by muscular activity. In addition to these and other differences. the higher animals possess such additional traits as appetite. habits and idiosyncrasies that influence not so much their requirements as the problems of meeting those requirements adequately.

Caloric Requirements.— The fundamental requirement of the cell, and therefore of the animal as a whole, is for calories. Without a source of energy, the capacity to do work even on a cellular basis would be lacking and the process of life would stop. Ordinarily, this need is satisfied by the consumption of sufficient caloric foodstuffs. In conditions such as starvation, the need for calories continues but the source now is the body's own reserves of fats, carbohydrates and, to some extent, proteins. Obviously, there comes a time when these sources are exhausted and death ensues. During the period prior to death. it is found that the animal becomes progressively less active in order to economize on the expenditure of calories.

Energy must be provided to satisfy a number of different needs. In the adult the most basic one is for maintenance of the *status* quo of the body exclusive of voluntary muscular work and other additional energy-consuming functions. Many of the processes which contribute to this basic need are easily overlooked. for they include the maintenance of body temperature, breathing, heart ac-

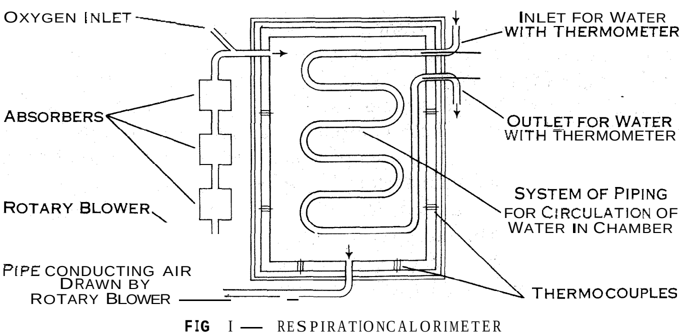


FIG I — RESPIRATION CALORIMETER

Devised by W. O. Atwater, F. B. Rosa and F. G. Benedict (schematic drawing)

tion. gastrointestinal activity, muscle tone and many reactions nhich are involved in the chemical syntheses and degradations constantly going on in the tissues Over and above this required caloric intake are a number of functions demanding calories whose needs must be satisfied. One of the most important is that of voluntary muscular work This is governed by the activity of the individual. Energy must also be supplied for gronth in children and for women during pregnancy and lactation The recommended caloric intakes for men. women and children under various conditions and the recommended intakes of certain other nutrients have been tabulated by the Food and Sutrition board of the National Research council (*see* Table).

In order to determine either the caloric requirement or the amount of food necessary to meet these needs, it is essential to know the caloric value of the energy-yielding components of food. This can be done by completely burning a pure sample of fat, carbohydrate or protein in a device knonn as a bomb calorimeter. During this process all organic matter is converted to carbon dioxide, water and nitrogen oxides, and the energy liberated is calculated from the amount of heat evolved. The number of calories per gram of material obtained by this method. however, is above that available to the animal because of incomplete absorption of the compounds from the intestine and also because of incomplete metabolism of the protein nhich results in the loss of calories through the urinary excretion of urea. uric acid and related compounds. The losses can be measured and subtracted from the values derived in the bomb calorimeter. When this is done it is found that the caloric values of fat. carbohydrate and protein are nine. four and four calories per gram respectively. To calculate the caloric content of a food it is only necessary to multiply the per cent of each of the proximate principles (fat. carbohydrate and protein; by its respective caloric value and add the products together

The use of a direct animal calorimeter enables the determination of not only the caloric values of foods, but the extent and degree of metabolic activity of the subject as well. The subject is enclosed in a special chamber or calorimeter so devised that all the heat given off by the subject can be directly collected and measured (*see* fig 1) In order that there be no escape of the body heat to the environment the double copper walls of the chamber are fitted up nith elaborate electricai equipment that permits so delicate a balance that heat can neither pass out of nor into the chamber In order to measure the heat given off by the subject. a current of cold water is circulated within the box in continuous piping If the temperature of the incoming and outgoing nater is carefully measured and if the quantity of water passing through also is known, the heat lost by radiation and conduction by the subject in a given time can be determined. As part of the heat lost, amounting to about one-fourth of the whole, is eliminated by the subject in the form of water vapour, this must be and is also determined by absorbing the water lost in sulfuric acid and subsequently weighing the acid container.

This method of direct calorimetry is very accurate and reliable. but the method is difficult and the apparatus is very liable to get out of order. In addition to this direct measurement of the heat output, the metabolic activity of the subject can be calculated from a determination of the amount of carbon dioxide given off and the amount of oxygen utilized by the subject in a given period. This method of indirect calorimetry can be carried out simultaneously with the direct method and serve as a check upon it. The calorimeter chamber in which the subject is enclosed is gastight and the air is circulated through a gastight absorbing system by means of a rotary blower. The carbon dioxide given off is absorbed by means of soda lime, the amount absorbed being determined by weighing the soda lime container at the beginning and the end of the experiment. The carbon dioxide-free air is returned to the chamber after the deficiency in oxygen, which is approximately determined by reduction in volume. has been made good from a cylinder of pure oxygen. The amount of oxygen used during the experiment is determined either by measuring by a meter the amount of oxygen passed in or by weighing the cylinder before and after the experiment. The heat lost by the subject can be determined from the amount of oxygen used. The caloric value of a litre of oxygen used in the tissue combustion has been determined. This value varies with the carbon dioxide-oxygen ratio, called also the respiratory quotient (R.Q.), from 4.795 cal. with an R.Q. of .713 which is held to represent the combustion of fat alone to 5.058 cal. with an R.Q. of 1.00, which is accepted as representing the combustion of pure carbohydrate by the tissues. The two methods of direct and indirect calorimetry have been found to give almost identical results.

To enable measurement of energy expenditure of subjects engaged in actual work, a portable apparatus was first designed by N. Zuntz and later much simplified by C. Douglas. In this last form the subject, wearing either a mask or special mouthpiece, with nose clip, fitted uith two one-way valves, breathes into a gastight bag carried on his back. At the end of the experiment the air collected in the bag is measured by passage through a meter. a sample of the expired air is analyzed in the Haldane gas analysis apparatus, and the amount of carbon dioxide and oxygen present is determined. As the composition of the atmospheric air is known it is readily calculated how much carbon dioxide the subject excreted and how much oxygen is utilized in a given time and the caloric values can be determined as above. In order to relate the carbon dioxide output and oxygen utilization to the nonprotein moiety of the food the protein metabolized during the period of the experiment is determined from the nitrogen output in the urine. For every gram of urinary nitrogen derived from protein 8.45 g. of oxygen are required and 9.35 g. of carbon dioxide are given off. Hence, to determine the nonprotein utilization the appropriate amounts of carbon dioxide and oxygen are deducted from the total amounts. As the amount of nitrogen excreted during the period of examination is minute, in practice it is usually ignored.

When the alterations of the gaseous metabolism are considered they are commonly referred to variations from the so-called basal metabolism. The basal metabolism may be defined as that of a subject lying comfortably at rest in a warm bed and in the postabsorptive condition; i e., about 12 to 1j hours after the last meal. With the subject in such a condition the metabolism reaches its lowest level. It has been estimated that functional activities of the various organs may account for about 25% of the resting metabolism (thus the activity of the heart for about 3.6%, respiratory movements for about 10% and the kidneys for about 5%).

It is obvious, in view of the fact that humanity is of varying sex and size, that if a universally applicable standard is to be obtained there must be some fundamental unit on which to base assessments. It has been shown that body weight is not satisfactory. The modern unit selected is the surface area of the body. A very useful formula for the determination of this area based on height X weight × a constant was worked out by E. F. and D. Du Bois. As a result of their work it is common practice to take as the fundamental unit the calorie output per square metre of surface area.

This basal metabolism is shown to be high in childhood: as adolescence is reached it falls to a level which is more or less uniformly maintained until about the age of 50. Thereafter the decline is steady although small. The basal metabolism is also influenced by the sex of the subject, the nature of the food consumed and environmental conditions like temperature, climate, etc.

COMPONENTS OF NUTRITION

Carbohydrates, fat and proteins form the major portion of the diet, while minerals and vitamins are present in smaller quantities. All are important and many have special functions as will be seen below. (See CARBOHYDRATES; OILS, FATS AND WAXES; PROTEINS.)

Until R. Schoenheimer and D. Rittenberg demonstrated otherwise, most of the body constituents such as proteins and fat were considered to be stable in the sense that they were not in equilibrium with ingested food components. The latter were thought either to undergo degradation or, if incorporated in body constituents. to remain there indefinitely. There was no adequate way to study this problem before the advent of isotopes. because there was no way of distinguishing an ingested compound or its parts from like ones already present in the body. By synthesizing compounds which contained an isotope of one of the atoms in the molecule, it was possible to follow the exact fate of the compound by making suitable isotope measurements. Such experiments have shown beyond doubt that in reality there is a constant equilibrium between ingested substances and identical ones which have been incorporated into the body. This concept of a "dynamic state of body constituents" had profound effects on the understanding of biochemistry and nutrition.

Enzymes. — Many enzymes are involved in reactions which are concerned with the removal or addition of water between molecules while others are concerned with the joining together or splitting of the bonds between atoms within a molecule. (See ENZYMES; PEPSIN.) The process of digestion, for example, involves the addition of water to complex molecules with the formation of their simple integral parts. On the other hand, the actual metabolism of these simpler molecules may involve either their reincorporation into other complex compounds as such or their conversion to other simple molecules. It is believed that almost every reaction in the body is mediated by an enzyme which is specific for that particular reaction. Many of the enzymes had been isolated by the 1950s and in many cases had also been crystallized. One of the most interesting properties of enzymes is their high degree of activity under very mild conditions. Similar reactions carried out by chemical means alone would require in many instances drastic conditions and long reaction times. All enzymes discovered had been found to contain mainly protein, and it was also shown that they are not immune from the "dynamic status" referred to previously. Many toxic materials are known to inactivate enzymes, and this action is believed to be the basis of their toxicity. Numerous modern drugs also function by virtue of some effect on one or more enzyme systems. Indeed, such sought-for activity forms the basis of research in many fields such as cancer where the arrest of specific processes is essential.

Carbohydrates. — These compounds are present in most foods in the form of sugars known as disaccharides. such as cane sugar, and polysaccharides, such as starch. When ingested, they must be converted into monosaccharides, or simple sugars, before they can be absorbed. Ptyalin, an enzyme found in saliva, is able to affect some hydrolysis of starches, but the main agents which cause the hydrolytic breakdown of the carbohydrates are amylase, maltase, sucrase and lactase, which attack starches, maltose, sucrose and lactose (milk sugar) respectively. The nutritionally important simple sugars — fructose, glucose and galactose — which are thereby formed are absorbed and are made available via the blood stream to the cells of the various tissues. Here the first step in their utilization involves enzymatic reactions nhich result in the formation of phosphorylated sugar. The sugar phosphates are then either converted to glycogen or undergo a series of reactions which lead eventually to the formation of carbon dioxide and water. The elucidation of these reactions by such workers as A. Harden and W. Young, C. F. Corie. G. Embden, O. Meyerhof, H. Krebs and A. Szent-Gyorgyi was of tremendous importance to the fields of biochemistry and nutrition. It was absolutely established through the use of isotope studies that some of the carbon present in the sugars can be recovered in the fat, protein and other important compounds in the body as a result of enzymatic action.

The proper utilization of carbohydrate is essential for health. Insulin (*q.v.*) is necessary to carry out the initial phosphorylation of glucose. When not in adequate supply. as in diabetes mellitus. the glucose concentration in the blood rises and some of the sugar is lost in the urine. Another hormone, adrenaline, which is produced by the adrenals. causes the breakdown of carbohydrate stored in the liver and muscles as glycogen (see ADRENALINE AND NORADRENALINE). It is this source of energy which is called upon for immediate needs. About 100 g. of carbohydrate per day are necessary for the prevention of ketosis in human adults.

Fats.—When fats are eaten. relatively little happens until they reach the intestine There they are emulsified and undergo extensive enzymatic hydrolysis by lipase to form mono- and diglycerides and fatty acids. The precise manner in which these products are absorbed mas still unknown in the late 1950s. Ordinarily most of the fat upon being absorbed enters the lymphatic system and is present as an extremely fine emulsion known as chyle, which enters the blood stream through the thoracic duct. The small droplets of fat (*chylomicrons*) then appear to undergo a process of partial dissolution brought about by the action of an enzyme. lipoprotein lipase, found in blood and tissues. Further metabolism occurs within the cells.

Since the early studies of F. Knoop the mechanism by which fatty acids are degraded had been postulated to proceed by removal of two carbons at a time, but definitive proof of this was not obtained until much later Through the research of A L Lehninger. F. A. Lipmann, F. Lynen. D. Green and others it became known that the fatty acids react to form phosphate esters which in turn react with coenzyme A (a derivative of the vitamin pantothenic acid) to form coenzyme A derivatives. In this form they undergo a series of enzymatic transformations to yield at intervals the coenzyme A derivatives of the next lower fatty acid and of acetic acid. This continues until the acid is degraded. The acetic acid-coenzyme A molecules may react with a carbohydrate derivative, oxaloacetate, and be converted to carbon dioxide and water, or form "ketone bodies" The latter are greatly increased in diabetes. By means of fats labeled with radioactive carbon it was definitely shown that fats can be converted to carbohydrates and proteins. Aside from serving as a source of energy, fats act as insulating material against cold and mechanical shock. They also serve as carriers for fat-soluble vitamins. The normal adult human male consumes about 150 g. of fat per day. As far as is known this amount is not necessary; however, it is easier to obtain part of the daily caloric requirement in the form of fat because of its higher caloric value per gram.

Essential Fatty Acids.—This group of nutrients is comprised of linoleic. linolenic and arachidonic acids, all of which are polyunsaturated. George O. Burr and M. M. Burr first demonstrated that without at least one of these acids in the diet the rat failed to grow, developed scaly skin and necrosis of the tail, and eventually died. Although no comparable disease has been proved to occur in man, considerable study has shown that these acids may be of importance in atherosclerosis because they are effective in lowering the cholesterol concentration of the serum of man and animals Such an effect often can be achieved by the inclusion in the diet of liberal quantities of maize. safflower or similar vegetable oils that are rich in essential fatty acids. mainly linoleic. An appreciable portion of the cholesterol of blood serum occurs as the ester of this acid.

Proteins.—Although available as a source of calories, the main function of dietary protein is to furnish amino acids for the maintenance and synthesis of body proteins. When ingested, protein as such is not absorbed but is first converted to peptides and then amino acids. This conversion begins in the stomach through the action of the enzyme pepsin, which is effective under the acidic condition found there. The rest of this degradation is carried out in the intestine by the enzyme trypsin. Both of these enzymes also occur in an inactive form or zymogen and are converted to the active form when the need arises. Once the amino acids are formed they are absorbed and transported via the blood stream to the various tissues. Here they may be incorporated into tissue protein or undergo various metabolic degradations. Since the structures of the different amino acids are on the whole dissimilar, these reactions are multifold and usually quite specific. The amino group of the acid may be transferred to a nonamino acid by means of an enzyme of the class known as transaminases. One of the B-complex vitamins. pyridoxine, plays a role in this type of transformation. The ultimate fate of the amino acids is metabolism to water, carbon dioxide, ammonia, urea, uric acid and related compounds. In species which have access to an abundant water supply, urea is the chief urinary nitrogenous excretory product, while in those with limited water supplies. uric acid is more important. When the amount of nitrogen excreted in the urine, feces and other excretory products such as perspiration equals the amount of nitrogen ingested, the subject is in nitrogen equilibrium. Growth makes for a smaller output of nitrogen than input, although the reverse is true in starvation; however, the actual amount of protein ingested has an important bearing on the nitrogen balance.

Not all proteins are adequate for normal nutrition. This stems from the fact, as found notably by W. C. Rose, that of the approximately two dozen naturally occurring amino acids, about nine are necessary in the diet while the others can be synthesized by the body. This means that if a protein contains the essential amino acids in adequate amounts it is a complete protein and can satisfy the needs of the body when consumed in normal quantities. Incomplete proteins may be used to fortify one another in such proportions that they supply sufficient quantities of the amino acids. For optimum utilization of the amino acids H. Borsook found that they should be ingested simultaneously. An interesting interrelationship between tryptophane, one of the essential amino acids, and nicotinic acid, the pellagra-preventing vitamin, was uncovered. Many of the details were known by the late 1950s, and it was definitely established that an interconversion between these compounds can take place in the body and as a result the intake of one can affect the apparent effectiveness of the other when the latter is in short supply.

Salts.—The body requires a constant replenishing of the minerals and electrolytes that are excreted from the body in various forms. Among those that are needed by most species are calcium, magnesium, iron. iodine. phosphorus, sodium, potassium and chlorine. Whereas it is recommended that the adult human take in 1 g. of calcium per day, 15 mg. of iron are sufficient. In many instances with animals the need for trace elements has been shown. These include zinc, copper, cobalt and manganese, and the amounts required per day when calculated on the basis of humans is far below that of iron. Of interest is the fact that less than 0.0001 mg, of cobalt in the form of vitamin B_{12} is necessary to keep pernicious anemia patients normal. This vitamin is the only one known to have a metal as part of its molecule. On the other hand. many instances are known where metals play a role in enzyme reactions. Copper, for example, is necessary for the oxidation of ascorbic acid (vitamin C) by the enzyme ascorbic acid oxidase, while magnesium is essential for several enzymatic steps in the metabolism of carbohydrate. Phosphorus plays an important role in the metabolism of many compounds. In addition it is a major constituent of bone and teeth.

As the result of the different metabolic processes which take place in the tissues there is a constant production of acid. chiefly from sulfur and phosphorus, which must be neutralized by basic elements like sodium and potassium and probably also calcium and magnesium. The kidney for the most part regulates in a very selective fashion the output of these various inorganic constituents. It must not be imagined, however, that the body can completely protect itself from excessive salt loss, a loss so great that it may give rise to symptoms of a serious character. Thus it has been shown that men who. in the course of their work, are exposed to high environmental temperatures with consequently much sweating are very liable to a form of cramp. Further the cramp is frequently exacerbated where the men drink freely of water to allay their thirst. It has been found that the condition is due to an excessive loss of sodium chloride from the body carried away in the sweat and that the condition may be cured or prevented by giving the men saline fluid to drink.

Although five-sixths of the total mineral matter of the body is found in bone, and in spite of the fact that bone has all the appearance of being firm and resistant, the evidence available goes to show that the bony structures must be regarded as active storehouses of mineral matter. When the need arises the body as a whole can draw upon the bones for constituents such as lime and phosphates. Under certain conditions the bones indeed may give up so much of their mineral matter that they become soft and can no longer function as an effective framework.

The other one-sixth of the mineral constituents found in the body are not distributed uniformly throughout the remainder of the tissues. As regards this varying distribution of salts in the tissues and the blood, A. B. Macallum, in his study of paleochemistry, produced some interesting evidence in favour of his view that the present composition of the blood plasma, insofar as its inorganic constituents are concerned, is probably identical with that of the sea water just before the Cambrian period and that the salt concentration in protoplasm represents conceivably the salt concentration of the primeval ocean in which life first appeared. At any rate the curious ratio of potassium and calcium to sodium, that is characteristic of protoplasm, is reflected in the salt relationship in water drawn from pre-Cambrian formations.

Water. — Because water forms about 60% of the body weight of man, it is obvious that the part it plays in metabolism must be an important one. The whole series of chemical actions that are intimately related to the life of the living organism, animal or vegetable, are ultimately referable to changes that take place in solution. It has been conclusively shown that the younger the animal the richer it is in water. It has also been found that the fatter the animal the smaller the percentage amount of water present.

By means of heavy and radioactive water the exchange that occurs between ingested water and the metabolically derived water in the cells has not only been shown, but much information concerning its extent and rate has been gained. Some water in cells is tightly associated with proteins and other cellular constituents and is referred to as bound water. Although some forms of life require little water, none can exist without any. It is common practice to remove much of the moisture in many bacteria, for instance, by the process of freeze drying, in which conditions viability remains for years. However, for active growth and metabolism, water must be furnished.

Vitamins. — These specific organic compounds widely distributed in foods and needed by the body in small amounts are also important nutrients and hence components of nutrition. *See* VITAMINS. *See* also BIOCHEMISTRY; DIGESTION; OILS, FATS AND WAXES; PROTEINS. Daily food allowances and diet planning are discussed in DIET AND DIETETICS. Deficiency diseases and other problems are discussed in MALNUTRITION. *See* also Index references under "Nutrition" in the Index volume.

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(E. P. C.; F. J. SE.; R. P. G.)

NUTTALL, GEORGE HENRY FALKINER (1862–1937), biologist and founder of the Molteno institute for research in parasitology at Cambridge, Eng, was born in San Francisco. Calif., on July 5, 1862. Graduating M.D at the University of California, Berkeley, in 1884, he joined Johns Hopkins university, Baltimore, Md., in 1885. During 1886–99 he studied zoology, botany and hygiene, mostly in Germany, developing his eventual interest in parasitology. He was appointed lecturer in bacteriology and preventive medicine at Cambridge university in 1900, and elected in 1906 to the newly founded Quick professorship of biology, holding this until 1931. He founded the *Journal of Hygiene* in 1901 and remained editor until his death; in 1908 he founded *Parasitology* and was chief editor until 1933. In 1919 he raised funds for the erection of an institute of parasitological research in Cambridge — the Molteno institute. Nuttall's work covered a very wide field; he wrote almost 200 papers on bacteriology, serology, hygiene, tropical medicine and parasitology. He made pioneer experiments on life under aseptic conditions, founded the study of humoral immunity and work on precipitin reactions. He acquired British nationality on going to Cambridge.

His classical monograph, *Blood Immunity and Blood Relationship,* appeared in 1904. Later he studied diseases transmitted by ticks and with W. R. Hadwen discovered the curative properties of trypan blue for piroplasmosis. *Ticks, a Monograph of the Ixodoidea* (with C. Warburton and L. Robinson) appeared in parts from 1908. He died in London Dec. 16, 1937. (ED HE)

NUTTALL, THOMAS (1786–1859), British-U.S. naturalist, was an expert on North American flora and described many new genera and species of plants. He was born on Jan. 5, 1786, at Long Preston, Yorkshire. After serving seven years as an apprentice printer, he emigrated to the United States in 1808. Benjamin S. Barton (*q.v.*) encouraged and assisted him in his scientific career. Nuttall's expeditions included those to the Missouri river (1810–11), Arkansas territory (1818–20), and the Columbia river and Hawaii (1834–36). He was lecturer on natural history and curator of the botanic garden at Harvard university from 1825 to 1834. His publications include *Genera of North American Plants, and a Catalogue of the Species, to the Year 1817* (1818), describing genera and enumerating species; and The *North American Sylva* (1842–49). Nuttall's *A Manual of the Ornithology of the United States and of Canada* (1832–34; further editions in 1840, 1891, 1896 and 1903) was the first work of moderate size and price on American birds. In 1842 Nuttall returned to England. On Sept. 10, 1859, he died at Nut Grove hall, Lancashire.

See biography and list of works in *Leaflets of Western Botany,* vol. ix, pp. 32–42 (1959). (J. W. TT.)

NUX VOMICA, a poisonous drug, consisting of the dried ripe seed of *Strychnos nux-vomica,* a tree (family Loganiaceae) indigenous to most parts of India and found also in Burma, Thailand, Indochina and north Australia. The tree is of moderate size, with a short, thick, often crooked stem and ovate entire leaves, marked with three to five veins radiating from the base of the leaf. The flowers are small, greenish-white, tubular and arranged in terminal corymbs. The fruit is the size of a small orange and has a thin hard shell, enclosing a bitter, gelatinous white pulp in which from one to five seeds are vertically embedded. The seed is disk shaped, about one inch in diameter. and one-fourth inch thick, slightly depressed toward the centre, and in some varieties furnished with an acute keellike ridge at the margin. Externally, it is grayish-green and satiny from a coating of appressed silky hairs. Internally it consists chiefly of horny albumen, which is easily divided along its outer edge into halves by a fissure, in which lies the embryo. The latter is about three-tenths inch long and has a pair of heart-shaped membranous cotyledons.

The chief constituents of the seeds are the alkaloids strychnine (*q.v.*) and brucine, each of which constitutes from 1% to 2% of the dried seeds. The two have similar pharmacological actions, though brucine is much less active.

NYASA, the third largest of the great central African lakes, lies in the trough of the Great Rift valley south of the confluence of its eastern and western branches. It extends from 9° 29' S to 14° 25' S. and is 360 mi. long from north to south, varying in breadth from 10 to jo mi. The total area of the lake is 11.630 sq.mi. The country on either side (Nyasaland on the west. Tanganyika territory to the north and northeast and Mozambique to the southeast) consists of high plateaus. The Livingstone mountains in the northeast, formerly the stronghold of Arab slave traders, are clothed with dense forests. On the Nyasaland side, the altitude varies between 3,300 and 5,000 ft., with uplands rising to 8,000 ft. Except in the northwest, mountains descend steeply to the shores. which lie at an altitude of 1,550 ft. The slopes continue to the bottom of the lake which, at its deepest part in the north. is 1.226 ft. deep. In the south a plain separates the shores from the mountains.

The fresh waters of the lake are derived mainly from streams descending from mountains to the north. The only outlet is the Shirk river in the south. Nyasa is subject to seasonal variations in level, amounting to about 4 ft.. with greater variations occurring in cycles of about 11 years. The Shirk Valley scheme, approved by the federal government in 1955, promised to stabilize the level of the lake and enable wheat, sugar and coiton to be grown on reclaimed land formerly subject to flooding. The scheme planned also to provide hydroelectric power and envisaged the construction of harbours and jetties.

About halfway up the lake, near its eastern shore, is the island of Likoma on which stands a cathedral. The lake is treacherous, being subject to sudden and frequent storms. The first steamer to sail the lake (1875) was carried in pieces over the Murchison falls on the Shiré river and reassembled. The fishing industry in Lake Nyasa is important. The fish (mainly *Tilapia*) are caught in huge ring nets and gill nets and are sun-dried for African consumption. At Nkata bay in the west is a fishery research station, while Kota Kota farther south is the centre of the African fishing industry.

Lake Nyasa was first reported by Caspar Boccaro in 1616; another Portuguese, Cardoso. claimed to have seen it in 1846. David Livingstone with John Kirk reached it from the south in 18jo and charted its shores. The Yao people told him its name was "Nyasa," which means "lake" or "broad water." Livingstone returned alone in 1866 and the following year E. D. Young was sent to look for him and reached the northern shores. The first shot of World War I between British and German forces was fired on Lake Nyasa on Aug. 6, 1914, when the S.S. "Gwendolen" engaged and captured the German gunboat "Hermann von Wissmann" at Sphinxhaven (Mbamba bay). (S. M. C.)

NYASALAND PROTECTORATE. A British central African country forming part of the Federation of Rhodesia and Nyasaland (see RHODESIA AND NYASALAND. FEDERATION OF). Nyasaland covers 46.066 sq.mi., of which 36.686 are land. The country is situated between 9° 45′ and 17° 16′ S., and between 33° and 36° E.

Its length from north to south is about 520 mi.. while its width varies from 50 to 100 mi. It is bounded on the west by Northern Rhodesia and Mozambique, on the northeast by Tanganyika territory and on the east and south by Mozambique. The northern half of its eastern boundary is formed by Lake Nyasa (*q.v.*).

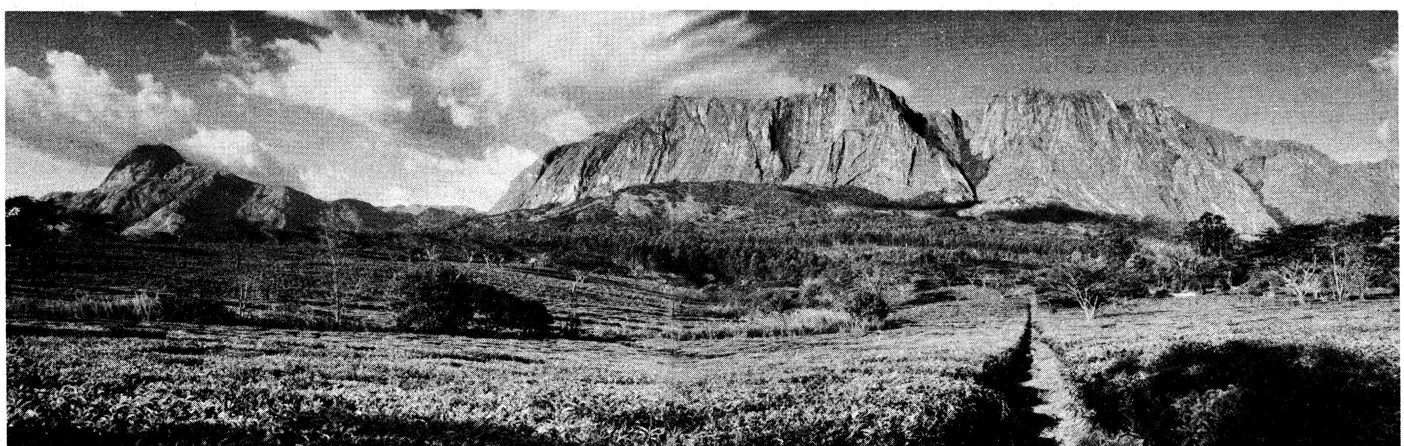
Physical **Features.**—Nyasaland consists of elevated plateaus, sometimes separated by low-lying ground. The most important of these are the Nyika plateau, 8.550 ft., and the Angoniland plateau, between 5,000 and 6,000 ft.. both of these being on the western side of the lake; the Mlanje massif, in the extreme southeast, mostly more than 6,000 ft., with one peak attaining 9.848 ft.. and the Shiré highlands between Lake Chilwa and the Shiré river, reaching 7,000 ft.

Besides Nyasa, other large lakes are Lake Chilwa and Lake Chiuta which is situated north of Lake Chilwa, and being 6 mi. long and 2 mi. broad. The water of Lake Chiuta is fresh.

Climate. — Three distinct climatic zones may be distinguished. In the Ion--lying Shiré valley the climate is hot. temperatures rising to 115° F. in October and November. In the highlands. at an altitude of 3.000 ft. and above, extreme heat is unknown. The dry season lasts from May to September, the weather being comparatively dry and cool. In higher mountain regions occasional frost may even occur during the night. The first rains set in after the middle of October and continue periodically until the end of December. when the season of heavy rains begins, lasting from January through March. The annual rainfall is about 50 in. in the highlands. 35 in. in the lowlands.

Vegetation. — Large tracts of the country are still covered with forests of little economic value, apart from their effect in checking rapid runoff and soil erosion. Most of the trees are small, but timber trees are found in damp ravines on the mountainsides and along the banks of the rivers. The most important of these are the patches of Mlanje cypress (Widdringtonia *whytei*), which yields a soft: durable wood. immune from the attacks of termites. These trees grow on the higher slopes of Mlanje mountain. Two species of *Brachystegia—mombo* and nchengn — provide the natives with material for bark cloth and ropes. Tree planting is encouraged. and seeds are easily procurable of the Mlanje cypress, and of several kinds of eucalyptus.

History. — The first European who visited southern Nyasaland was Caspar Boccaro, who in 1616 carried samples of Zambezi silver from the vicinity of Tete to Malindi near Mombasa. During the next century Jesuit missionaries traveled through many sections of the country and brought back rumours of the existence of Lake Nyasa. The Lacerda expedition which penetrated as far as Lake Mweru in 1798 made the watershed of Lake Nyasa known, but the lake itself was not effectively discovered nor the country opened to Europeans until David Livingstone (Q.V.) reached it on Sept. 16, 1859. Two years later the first attempt to establish missions was made, but it failed when a small group led by Bishop Charles Frederick Mackenzie of the Universities' Mission to Central Africa was overcome by fever and Yao hostility in the vicinity of Zomba. The region was, therefore, left to itself until the Livingstonia Free Church mission and the Church of Scotland mission were established in 1875–76. Since the missions



BY COURTESY OF FEDERAL INFORMATION DEPARTMENT

MLANJE MASSIF. SOUTHEAST NYASALAND

found themselves unable to cope with the problems of supplying food and transport, the African Lakes company was formed in 1878. This company, nicknamed *mandala* ("glass") by the natives because its founder, John Moir, wore spectacles, was the most important factor in opening Nyasaland.

The clashes between the missionaries and Arab slave traders brought the first British consuls into the country in 1883, and the African Lakes company enlisted volunteers in its unofficial war. placed in 1888 under the command of Capt. Frederick (later Lordi Lugard. At this time, the British government hesitated to interfere officially because Tyasaland was surrounded by Portuguese territory and remained inaccessible. A change in British attitude occurred in 1889, when D. J. Rankin discovered the navigable Chinde mouth of the Zambezi river. the status of which as an international waterway had been recognized in 1884. In the same year Cecil Rhodes' British South Africa company obtained a charter to develop Xyasaland. These developments inspired the British government to send H. H. (later Sir Harry) Johnston into Nyasaland to negotiate treaties with the native chiefs and to thwart a Portuguese expedition under Alexandre Serpa Pinto designed to link together the Portuguese territories of Mozambique and Angola. Between 1889 and 1891 British influence was consolidated, and as the result of the Anglo-German convention of 1890 and the Anglo-Portuguese convention of 1891, the Nyasaland protectorate was established and was formally proclaimed in 1891. Johnston was put in charge of it as commissioner and consul general responsible to the British foreign office. For five years he combined this post with that of administrator of the British South Africa company's trans-Zambezi territories which became Northern Rhodesia. With the aid of gunboats and Indian troops he suppressed slave raiding, forced Arabs and Tao into submission and subdued the Angoni. who had harassed the non-Angoni natives. The country was finally pacified in 1897. There were then about 150 European settlers, nearly all in the vicinity of Blantyre and Zomba.

Sir Harry Johnston was succeeded as commissioner in 1897 by A. (later Sir Alfred) Sharpe, whose intimate knowledge of the country was valuable in the work of development. In 1904 the protectorate was transferred from foreign office control to the colonial office. In 1907 the title of the chief official was changed from commissioner to governor and in the same year executive and legislative councils were established. Called at first the Kyasaland protectorate, the name was changed in 1893 to the British Central Africa protectorate, but in 1907 the old name was revived. When in 1910 Sir Alired Sharpe retired, the urgent problems awaiting solution were economic; the chief concern was Nyasaland's communications with the sea, the river route having proved unsatisfactory. When World War I began, northern Nyasaland was invaded by Germans from East Africa. The governor, Sir George Smith, received the full support of both Europeans and Africans.

There were 18,920 Africans recruited for service with the king's African rifles, and 191.200 rendered seasonal service as carriers and noncombatants. The Germans were repelled and later Nyasaland became a base for operations against them. There was, however! during the war, a disquieting incident. Among the natives were a number of professed Christians who claimed freedom from white control. One of these men, John Chilembwe, who had been educated in the United States, on his return built a church and preached the independence of Africans. With about 500 followers he rose in revolt in Jan. 1915. Three white settlers were murdered, but the revolt was speedily suppressed by a small force of British and Africans. (H. A. WF.; F. R. C.)

After World War I, which brought German East Africa (renamed Tanganyika) within the British orbit, several attempts were made to amalgamate Nyasaland with adjacent British territories. While during the 1920s and 1930s Nyasaland's ties appeared to have been with Kenya and Tanganyika, after 1938 there was a movement to unite it with Northern Rhodesia. In 1939 the governor became a member of the East African Governors' conference as well as of the Inter-territorial conference at Salisbury. an assembly of the governors of Southern Rhodesia, Northern Rhodesia and Xyasaland. (During World War II nearly 30,000 Nyasalanders served in the forces, some in action in Abyssinia. Madagascar and Burma.) On Oct. 18, 1944, the British colonial office formally established a standing Central Xfrican committee to promote the closest contact and co-operation between the governments of the three territories. A conference was held in London in 1953 on central African federation and the leaders of the delegations from the three territories concerned agreed that close political and economic association was essential. An order in council established the central African Federation of Rhodesia and Nyasaland. Each territory was to continue to have its own territorial legislature but there would also be a federal legislature. Lord Llewellin was appointed the first governor general of the federation.

Population. — In 1954 the estimated population consisted of 2,501,010 Africans. 6,178 Asians and 4,387 Europeans. Almost half of the Europeans live in Blantyre and Zomba. The remainder are scattered widely in various parts of the protectorate. The area is one of the most thickly populated in Africa and has an average density of jj.66 persons per square mile. The native Africans belong to the Bantu and are composed of many ethnic groups of which the Nyanja, Nguru, Yao (*q.v.*) and Ngoni (*q.v.;* or Angoni) are numerically the strongest.

Government and Administration. — Theprotectorate is administered by a governor appointed by the crown. He is assisted by an executive council comprising three ex officio, one official and one unofficial members. There is a legislative council consisting of the governor as president. On Sept. j. 19jj, the Nyasaland legislative council passed a bill providing for increased representation of Africans in the council and for free elections to be held in the protectorate to fill the council seats for non-Africans. The bill provided for Africans to have five instead of three seats in the legislative chamber. Non-Africans were to have six seats and the members to fill these seats were to be chosen for the first time by free elections. Previously Europeans had five seats in the council and Asians one. The European and Xfrican members are appointed to the council by the governor on the recommendalion of the European and Asian representative bodies. The first elections under the territory's changed constitution were held in April 1956.

The principal departments of administration are in Zomba. The protectorate is divided into three provinces — northern, central and southern — in charge of provincial commissioners. There are 19 districts in the provinces in charge of district commissioners and each district contains one or more native authorities constituted as such under the Native Authority ordinance. 1933. There are councils of chiefs and several subordinate councils, including group and village councils. The council system has been developed in order to provide a ladder of councils from the village level up to the legislative council. The townships of Blantyre. Limbe, Zomba, Lilongwe and Salima are administered by town councils. Blantyre and Limbe have elected councils; the other three have nominated councils.

Religion and Education. — The majority of the Africans are pagans; only 11% are classified as Christians and 10% as Moslems. Missionary activities are of long standing; the first mission opened near Zomba in 1861. Among missions represented are the Universities' mission. the Livingstonia Mission of the Church of Scotland, the Church of Scotland mission. the Dutch Reformed Church mission and the White Fathers. Primary education is predominantly in the hands of the missionaries, but a few primary schools are conducted by native authorities with grants-in-aid. Schools have also been opened by local communities with government help and managed by local committees. In 1951 the total school population was about 144,000 boys and 97,000 girls. In 1953 there were three Xfrican secondary schools attended by 250 pupils. There were five primary schools for European children with an attendance of 46j and ten for Asians with an enrolment of 685. There was also a Eurafrican school located near Blantyre with 117 pupils.

Besides a number of technical schools, teacher training is undertaken by both missions and government. The chief centre is the Government Teacher Training centre at Domasi.

Agriculture.— Agriculture is the chief occupation in Nyasaland. Besides maize and millet, which are the staple foods of the African, both European settlers and Africans grow tobacco, cotton and tea for export. The total tobacco production in 1951 was 33,152,570 lb., in 1953, 36,074,143 lb. Most of the tea is grown on European estates in the Mlanje district, but there are some plantations in the Cholo district. According to the international tea agreement (1938), Nyasaland agreed not to plant more than 17,700 ac. or produce more than 18,750,000 lb. for sale in the world's markets. The 1953–54 export was 15,034,419 lb. Cotton production has been steadily developing, but unfavourable rainfall resulted in 3,977 bales of 400 lb. each being produced in 1951, as compared with 9,927 in 1950. By 1954 the production had risen to 11,488. Interest in tung production has been declining and acreage under tung was reduced to 17.780 in 1953 compared with 18.13; in 1952. Livestock supplies the needs for local markets. Several thousand Africans are engaged in fishing in Lake Nyasa and Lake Chilwa to supply the local markets. Although the African is primarily an agriculturist working on his own farm, many have taken to wage earning on European estates or in the Union of South Africa and Southern Rhodesia.

In 1951 the number of Africans working outside the protectorate was 148,000. The protection of the contracted worker and the interests of his family are secured by a system of carefully controlled recruitment.

The value of exports in 1953 was £7,328,040; tobacco and tea accounted for £2,877,700 and £1,570,417 respectively. Imports, including provisions, cotton piece goods and manufactured articles, were valued at £7,697,895 in 1953. Nyasaland, under the Congo Basin treaties of 1885, cannot give a preference in its customs tariff to any state.

Monthly wage rates for Africans are from *22s.* to *30s.* for unskilled labour, *30s.* to *100s.* for overseers and shop assistants, *17s.* to *60s.* for domestic servants and 68s. to *220s.* for drivers.

Communications.—The Nyasaland, Central Africa and Trans-Zambesia railways provide communication with the sea at Beira and thence with Southern Rhodesia and the Union of South Africa. The companies operate a 3 ft. 6 in. gauge line. The line passes over the Lower Zambesi bridge (12,064 ft.). The principal station is at Limbe and the railhead is at Salima. At Chipoka trains connect with the vessels operating on Lake Nyasa. In 1954 a diesel passenger train was introduced. The total road mileage was 4.852 in 1954, many of the secondary roads, however, being only serviceable during the dry season. There is a regular service of ships on Lake Nyasa and the Central African Airways corporation provides air services to Northern Rhodesia and the outlying districts of Nyasaland.

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NYBORG, a seaport of Denmark on the island of Fyn, in the *amt* (county) of Svendborg. Pop. (1955) 11,316. The town was founded in the 12th century and a castle erected on Knudshoved ("Canute's head"). From the 13th to the 15th century Nyborg was one of the most important places in Denmark. In 1658 it was held by the Swedes for about a year. The fortress, built by Christian IV and Frederick III, was dismantled in 1869, and the ruins of the castle are used as a prison.

NYE, EDGAR WILSON (Bill Nye) (1850–1896), U.S. journalist, humorist and lecturer, was born in Shirley, Me., on Aug. 25, 1850. In 1852 the family moved to Wisconsin, where Nye attended River Falls academy, taught school and read law. Settling in Laramie, Wyo., in 1876, he served as postmaster and justice of the peace, and contributed to the *Denver Tribune* and *Cheyenne* Sun. His humorous squibs and tales in the *Laramie Boomerang,* which he helped found in 1881, were widely read and reprinted. Collected, they form the substance of several published volumes. Later Nye returned to Wisconsin, and for several years wrote for the *New York World*. In 1886 he lectured with James Whitcomb Riley, the combination of Nye's wit and Riley's sentiment proving extremely popular. He continued writing, but he suffered from poor health, and spent his last days in Arden, N.C., where he died on Feb. 22. 1896.

Nye is associated with Charles F. Browne ("Artemus Ward" [*q.v.*]), David R. Locke ("Petroleum V. Nasby" [*q.v.*]), Henry W. Shaw ([*q.v.*] "Josh Billings") and other professional humorists who flourished after the Civil War. But he avoids their political satire and their tricks of faulty spelling. grammar and diction. Writing in his own person, rather than in the guise of a foolish character, Nye reveals his own kindly but droll nature. Possibly for these reasons he has worn better than some of his humorous contemporaries.

See F. W. Nye, *Bill Nye: His Own Life Story* (1926). (L. T. D.)

NYIKA. This Swahili word means "forest and thorn bush country" and is used by the Swahili to designate a set of Eastern Bantu tribes, who during the 16th century under pressure from the Galla migrated down the coast from the steppes on the left bank of the Tana river. It does not include the Taita, Pokomo, Segeju and Akamba, though these are ethnically connected with the tribes to whom it is applied. The nine tribes included in the term Nyika are the Giryama, now living about 3° south of the Equator, the Rabai, the Duruma and the Digo—all upper Nyika tribes and the most important of the group: the other five are the lower Nyika—the Kauwa, Chonyi, Dzihana, Kambe and the Rihe or Ribe.

Generally speaking they are tall, muscular, well set up and broad-headed The Digo, however, though well built are slender and have refined oval faces. There are evident affinities with the Northern Hamites, and their general colour is dark brown, becoming paler the nearer Mt. Kilimanjaro is approached. Waist clothes are worn by the men, and women wear many-pleated kilts, but are nude from the waist up, though now the tendency is to dress like Swahili women.

The *kaya* or fortified village was fundamental to their clan organization, but now that war is no longer anticipated, and villages are built outside the fortification, it has lost some of its significance, though still used for the assemblies of elders. The *kaya* is always situated on a hill or in a dense forest and is strongly palisaded. The Pokomo build circular huts like the Galla, but this group generally is characterized by rectangular huts, with a ridge-pole and a thatched roof extending to the ground and thus dispensing with walls. The houses are either gable- or hip-ended.

The Nyika tribes are divided into exogamous clans, which observe certain prohibitions and avoidances and share a general veneration for the hyaena in which all the cognate tribes join except the Pokomo: but now at any rate there is no trace of totemism. The clans of the Digo and Duruma are matrilineal; the rest are patrilineal with the exception of the Rabai, who are in a transitional stage. The Rabai have two sets of clans, male and female, and every man inherits the clan of his father and of his mother, but for all practical purposes he is reckoned as a member of his father's clan; a woman, on the other hand, while she similarly inherits both clans, stresses the mother's. Every clan has its own clubhouse (*lwanda*) and there is also the *moro* or council house, which is the general inter-clan meeting place for men, and houses the friction drum used for convening the council.

The Digo, probably under Arab influence, have hereditary sultans, but otherwise there are no paramount chiefs The government is in the hands of elders, who wear an ivory armlet as a badge of office. Every 13 years males have to be initiated at circumcision into an association analogous to Masai age-grades and after passing through the preliminary degrees they eventually reach the status of elders, among whom there is an inner circle called the Hyaena, which alone knows all the magical spells and consequently inspires great terror. From this circle are selected the "owners of the land," who carry on the government during the space of a *rika* or circumcision cycle.

The bow is the most usual weapon and the arrows are often poisoned. They also carry swords which are, however, as much implements as weapons. The Giryama have a parrying stick unique in the eastern area. Agriculture is carried on by women who grow maize, millet, vegetables and sweet potatoes. They have sheep and goats but few cattle, and like most of the coastal tribes are careful not to take the cattle out till the heavy dew has dried from the grass, a precaution which does not seem to be necessary to the Bantu and Kilo-Hamitics living at higher altitudes.

The Nyika worship the typical Eastern Bantu deity mulungu, a vague abstraction of the sky combined with ancestor-worship with the main emphasis on the latter, the spirits of the dead (koma) surviving mortality and taking the world of the living under their charge. *Mulungu* is the dispenser and creator and from his union with the earth have sprung all things in the world including human beings, who are *mulungu's* hens and chickens. There are no professional rainmakers.

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NYIREGYHAZA, capital of the county of Szabolcs-Szatmar, Hung., is situated on the sandy loess Nyirseg plateau. It is an agricultural centre, specializing in the intensive cultivation of fruit and vines. There are also small manufactures, *e.g.,* of soda, soap and agricultural machinery. Pop. (1957 est.) 56,000 (mun.).

NYKOPING, a seaport of Sweden, chief town of the county (lan) of Sodermanland, 98 mi. S.W. of Stockholm by a branch from the Stockholm-Malmo railway. Pop. (1950) 20,427.

Nykoping (*i.e.,* New-Market, Latinized as *Nicopia*) begins to appear as a town early in the 13th century. Its castle was the seat of the kings of Sodermanland, and after those of Stockholm and Kalmar was the strongest in Sweden. It was burned by Albert of Mecklenburg's party in 1389, by an accidental conflagration in 1665, and by the Russians in 1719. Nykoping lies at the head of the Byfjord, an inlet of the Baltic. The ruins of its once famous castle, the town hall (1662), and the district governor's residence, are notable buildings.

NYMPH, in zoology, is the name given to the immature stages through which all insects with incomplete metamorphosis pass after leaving the egg. At its last moult the nymph gives rise to the perfect insect. (See INSECT.)

NYMPHAEUM, a monument consecrated to the nymphs (*q.v.*), especially those of springs. These monuments were originally natural grottoes, which were traditionally considered the habitations of the nymphs. They were arranged to furnish a supply of water. Subsequently, artificial grottoes took the place of natural. The nymphaea of the Roman period were borrowed from the Hellenistic east (*e.g.,* the Great Nymphaeum of Ephesus). The majority were rotundas, adorned with statues and paintings. They served the threefold purpose of sanctuaries, reservoirs and assembly rooms. A special feature was their use for the celebration of marriages. Such nymphaea existed at Corinth, Antioch and Constantinople; the remains of about 20 have been found at Rome and of many in Asia Minor, Syria and Africa. The term nymphaeum was also applied to the fountain in the atrium of the Christian basilica. See FOUNTAIN.

NYMPHS, in Greek mythology, the generic name of a large number of female divinities of inferior rank. The word, the etymology of which is uncertain, seems to mean simply a marriageable woman; this is appropriate, as they are mostly associated with fertile, growing things (as trees), or with water. They are frequently associated with the superior divinities, as Artemis, Apollo, Dionysus, Pan and Hermes (*q.v.*).

The nymphs were distinguished according to the different spheres of nature with which they were connected. Sea nymphs were Ocearzids or Nereids, daughters of Oceanus or Nereus. Naiades (from Gr. νάειν, flow, cf. νᾶμα, stream) presided over springs, rivers and lakes. Oreades (ὄρος, mountain) were nymphs of mountains and grottoes, one of the most famous of whom was Echo. *Napaeae* (νάπη, dell) and *Alseïdes* (ἄλσος, grove) were nymphs of glens and groves. Dryades (*q.v.*) or *Hamadryades* were nymphs of forests and trees.

In Italy they tended to be identified with native divinities of springs and streams (Iuturna, Egeria, Carmentis, Fons), while the Lymphae (originally Lumpae), Italian water-goddesses, owing to the accidental similarity of name, were identified with the Greek Nymphae.

O THIS letter, the fourth vowel of the modern alphabet, corresponds to the Semitic ayin, which represented a breathing and not a vowel. The Semitic form may derive from an earlier sign representing an eye. The Greeks in adapting the Semitic alphabet to their own use used this letter (omicron) to express the vowel O, as the letters aleph, he, cheth and yodh were used to express vowels. Vowels were not expressed alphabetically in Semitic. The form of the letter on the Moabite stone was small O, and this small form appears in early Greek inscriptions from Thera and Corinth, In Corinth and in the inscriptions from Abu-Simbel in Egypt there is a form ◇. A form with a dot in the centre occurs in Thera ⊙, and this is paralleled in the large Etruscan O. At Miletus a form ∩ occurs. The Latin form, taken from the Chalcidic or Etruscan, was O. The minuscule form retains the shape of the majuscule letter

The Greeks at first used the letter to represent not only the short close vowel ŏ but also the long open ō and certain other

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	B.C 1.200	⊙
CRETAN	1.100-900	⊙ ◎
THERAEAN	700-600	o
ARCHAIC LATIN	700-500	⊙
ATTIC	600	⊙
CORINTHIAN	600	O
CHALCIDIAN	600	O
IONIC	403	⊙
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	◇ ∩
URBAN ROMAN		⊙
FALISCAN		⊙
OSCAN		Y V
UMBRIAN		V
CLASSICAL LATIN AND ONWARDS		O

THE DEVELOPMENT OF THE LETTER "O" FROM THE EARLIEST TIMES TO THE PRESENT DAY

long vowels of o-colour resulting from contraction or compensatory lengthening. The use of Ω or omega, in origin apparently a variant form of O with the value of a long vowel, gradually spread with the spread of the Ionic alphabet throughout the Greek-speaking world. In Latin the letter O stood for the same vowel without distinction of length, and the sound has partly passed into the Romance languages unchanged, partly with certain alterations, among the more striking of which is the Spanish change of short o to ue (*e.g.*, puerto from Latin portum).

In modern English the vowel has undergone changes. The long ō has become a diphthong (ou) as in the words "bone," "rose." Short ŏ has become more open and lower, as in "rob." Before the consonant r the sound is rounded and pronounced very far back in the mouth, *e.g.*, "glory," "north." In the word "do" the single letter is used where a more usual orthography would require its doubling. Again in the word "son" one would expect the vowel *u*. In words such as "word," "work," "world" the sound has been affected by the preceding bilabial. The short sound is the descendant of Middle English short 6 in which both the close and open short ŏ, which were distinguished in Old English, met. The long 6, now a diphthong, descends from Middle English long 6, an open sound, which was derived from Old English long ā. In Middle English this was a rounded back vowel akin to the modern vowel in "shore," "north." Old English close long ō became in Middle English oo (ū). See also ALPHABET. (B. F. C. A.; J. W. P.)

OAK is the common name for more than 300 species of trees and a few shrubs belonging to the genus *Quercus* of the beech family, the Fagaceae. As a group the oaks are characterized by alternately disposed, simple, deciduous or evergreen leaves with lobed, toothed or entire margins and a featherlike arrangement of their principal veins. Their small inconspicuous unisexual flowers are borne in separate inflorescences on the same plant (monoecious). The male or staminate flowers are borne in many-flowered, sulfurous-yellow, pendent catkins that appear with or after the leaves, each being comprised of a 4- to 7-lobed calyx and 4 to 12 (mostly 6) stamens. The female or pistillate flowers, by contrast, appear in few-flowered spikes or are solitary. Each flower consists of a 6-lobed calyx and 3- to 5-celled pistil, the whole partially enveloped by many involucral bracts. The fruit of the oak is the distinctive acorn, a nut that is partially (rarely wholly) encased in a "cup" composed of the greatly enlarged involucral bracts that attended the pistillate flower. The bark pattern of oak trees varies greatly not only among species, but often within a species of different age classes. The bole of several species features transverse and longitudinal fissures resulting in a blocklike configuration reminiscent of alligator leather. Barks of other trees are often smooth, superficially scaly, plated or irregularly ridged between deep longitudinal and often anastomosing furrows.

Distribution. — Oaks are widely distributed throughout the temperate regions of the northern hemisphere and are quite abundant at high elevations in many parts of the tropics. A few are found below the equator, in the new world as far south as Colombia and in the old to the Indian archipelago. Their greatest concentration occurs in the highlands of Mexico, especially in the Sierra Madre range where they are the principal components of vast mixed hard ood forests. Several of the oaks indigenous to the eastern United States are productive of some of the world's finest cabinet and structural timbers. The forests of Japan, India, the U.S.S.R., Czechoslovakia and Poland also include valuable timber-producing species.

Subgeneric Groups. — On the basis of certain common botanical features, the genus *Quercus* is readily divided into three very distinctive subgeneric groups known as the Cyclobalanus, *Leucobalanus* and *Erythrobalanus* oaks. Cyclobalanus oaks feature fruits in which the involucral bracts of the acorn cups are fused together into several concentric rings. In the other two groups the bracts are spirally arranged. *Leucobalanus* oaks, commonly known as the white oaks, feature leaves with smooth or occasionally glandular margins but are never bristle tipped. Their acorns, which mature at the end of a single growing season, are usually sweet meated, and germinate within a few days following their fall. Erythrobalanus oaks, the red or black oaks of commerce, in contrast, are characterized by leaves with bristle-tipped lobes and apices, and astringent fruits that not only mature at the end of two growing seasons but also winter over and germinate the following spring. The term "live" oak is applied to any of the oaks that feature persistent, evergreen foliage.

Of the more than 85 species of *Quercus* indigenous to the United States, more than 50 attain the stature of large trees, and fully half of these are of primary importance in the timber industry. Many of them attain heights in excess of 100 ft., and diameters of from 4 to 7 ft. are not at all uncommon. While oaks are found in every forested region in the United States, the chief centres of oak lumber production lie in the southeast.

Among the most valuable of the eastern leucobalanus oaks are the white oak *(Q. alba),* a tree 80 to 100 ft. tall with a trunk 3 to 5 ft. in diameter, productive of some of the world's finest white oak lumber; the massive bur oak *(Q. macrocarpa),* often 150 to 170 ft. high and 4 to 7 ft. in diameter, easily recognized by its corky twigs, obovate leaves with deep central sinuses and large fruits, the fringed cups of which nearly enclose the nut; the post oak *(Q. stellata)* with its leaves in the form of a cross; the chestnut oak *(Q. prinus)* and swamp chestnut oak *(Q. michauxii),* two species with chestnutlike leaves, the former an upland form, the latter largely restricted to permanently wet sites on the coastal plains; and the overcup oak *(Q. lyrata)*, another denizen of southern coastal swamps, readily recognized by its irregularly lobed leaves and large nuts completely enclosed in thin scaly cups. The eastern red oaks of primary importance to the lumber industry include the northern red oak *(Q. rubra),* the fastest growing of the eastern oaks which at maturity often attain a height of 150 ft.; the black oak *(Q. velutina)* another equally large tree, whose bark is the source of a yellow dye principle, quercitron *(see* QUERCITRON BARK); the Shumard oak *(Q. shumardii)*; the scarlet oak *(Q. coccinea)*; and the willow oak *(Q. phellos)* a large tree of the southern coastal plains with willowlike leaves, commonly used as a street and shade tree throughout many of the southern states. The live oak *(Q. virginiana)*, the only evergreen oak in eastern United States, was once highly prized by both British and American shipbuilders.

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LEAVES AND ACORNS OF THE WHITE OAK (QUERCUS ALBA)

The oaks of the Rocky mountain region are mostly small trees that at high elevations are little more than shrubs. The Gambel oak *(Q. gambelii).* rarely 45 ft. tall, is the largest oak in Colorado, and the somewhat larger Arizona white oak *(Q. arizonica)*, is the principal oak of Arizona and New Mexico.

A number of deciduous and evergreen oaks are indigenous to the Pacific slope. The most important of these is the Oregon white oak *(Q. garryana),* found from British Columbia to San Francisco bay. commonly used locally in the production of furniture and flooring. Two other deciduous species. the California white oak *(Q. lobata),* a massive tree with a crown spread of 150 or more feet, and California black oak *(Q. kelloggii).* are trees of secondary importance. Among the evergreen species are the interior live oak *(Q. wislizenii)* with hollylike leaves; canyon live oak *(Q. chrysolepis)* with small. thick, unlobed leaves and woolly twigs, the California live oak *(Q. agrifolia)* and the small shrublike California scrub oak (Q. *dumosa*).

The timber of both the American red and white oaks is put to many diverse uses. The better grades of lumber are used for flooring, furniture, paneling and millwork. The white oaks are admirably suited for staves and headings for tight cooperage. Large quantities are also consumed in the production of crossties, structural timbers and mine props, stulls and sills.

Among other important oaks of the world particular mention should be made of Q. *suber,* a small to medium-sized tree of the Mediterranean basin, the bark of which is the principal source of the world's supply of commercial cork (*q.v.*). The cork oak forests, which comprise an area of about 5,000,000 ac., yield about 200,000 metric tons annually, essentially half of which is produced in Portugal.

Brown oak (Q. *robur),* the only oak indigenous to England. is a cosmopolitan tree of wide distribution through most of the milder parts of Europe and the Caucasus mountains in Asia. At least 40 varieties are known in cultivation. Long noted for its heavy, fine-grained, rich brown heartwood, it was once used in the construction of British merchant shipping. At one time it was also a favourite of wood carvers, and the shrine of Edward the Confessor in the abbey at Westminster was fabricated of this handsome wood. This species, also known as English oak, attains great longevity, and many of the largest trees still standing in the British Isles are believed to date from Saxon times. One venerable old forest giant, the celebrated Newland oak in Gloucestershire, known for centuries as "the great oak," was 47.5 ft. in diameter 5 ft. from the ground at the time of its destruction.

Q. cerris, the Turkey oak, abounds over the Taurus ranges along the Turkish peninsula and in many other parts of southern Europe. It is also a common ornamental plant in England and in several of the older cities of eastern United States.

The evergreen holly oak, *Q. ilex,* is indigenous to southern Europe and northern Africa. In its native lands it attains great age. Pliny attributed to several trees growing in Rome a greater antiquity than the city itself.

While the oaks are principally known for the many fine timbers they produce, several of them are also important sources of other valuable forest products. Kermes oak *(Q. eoccifera),* a small bushy tree of the Mediterranean basin, is heavily preyed upon by kermes, small insects whose body juices are bright red and which are used as a source of dye. Tannin (*q.v.*), a chemical complex used in converting raw hides to leather. is obtained in commercial quantities from the barks of several oaks. Valonia tannin is traceable to the acorn cups of *Q. aegilops,* a small tree indigenous to Greece and the coasts of the Levant, while Aleppo tannin is derived from insect galls commonly found on the twigs of the Aleppo oak *(Q. infectoria)*, a Turkish tree. The acorns of several oaks are a common article of diet of small game, and because of their high nutritive value have been used to fatten swine.

Leaf-eating organisms (tent caterpillars; larvae of gypsy, Luna, browntail, Cecropia and buck moths; striped oak, American silk and canker worms) commonly denude several species of oak, but seldom bring about their death. Other insects cause unsightly twig and leaf galls. Oak wilt fungus causes severe loss in several areas, threatening extinction of some species.

Other Trees Bearing the Name of Oak.--Several other unrelated groups of trees, the timbers of which also display large prominent wood rays that on the quarter section of boards give rise to a spangled figure, are likewise known in the lumber trade as oaks. Notable among these are the Australian silky and satin oaks. a group of highly prized ornamental woods traceable to the genera *Cardwellia, Grevillea, Embothrium* and *Orites* of the Proteaceae. The tulip oaks, another group of Australian trees. belong to the genus *Tarrietia* of the cocoa family (Sterculiaceae). The she (or shee) oaks, including beef oak and flame oak, are members of the genus *Casuarina* of the Casuariniaceae, a monotypic family widely distributed through the southern hemisphere. but most abundant in Australia. African oak timber is the product of two unrelated species from the Ivory Coast, *Oldfieldia africana* and *Lophira alata.* Wood of the former has been used in marine construction by the British navy but is virtually unknown in the United States.

Tanoaks belong to the genus *Lithocarpus,* also a member of the Fagaceae and may be distinguished from true oaks on the basis of their unisexual flowers which appear in bisexual catkins.

See also TREE; FAGACEAE; TIMBER; PLANTS AND PLANT SCIENCE.

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OAKHAM, a market town and urban district in the Rutland and Stamford parliamentary division, and the county town of Rutland, Eng.. 93 mi. N N.W. of London by road. Pop. (1951) 3,539. Area 3.5 sq.mi. It is an ancient market town in the fertile Vale of Catmose and in the country hunted by the Cottesmore, and has also some light industries. Around the market place, where the old octagonal Butter cross is, stand the Norman castle, originally a fortified manor house, which has a banqueting hall hung with a collection of the horseshoes presented to the lord of the manor by every passing peer since the days of Elizabeth I; All Saints parish church, dating from c. 1190 but mainly Perpendicular; and the main buildings of the grammar school founded in 1584.

OAKLAND, a city of California, U.S., is the county seat of Alameda county and part of a metropolitan area surrounding San Francisco bay in central California. The city land area covers 53 sq mi. in the centre of a continuously built up plain between the east shore of the bay and parallel ranges of hills. The east bay also includes the cities of Richmond and Berkeley on the north, Alameda across a narrow estuary to the west and San Leandro and Hayward (*qq.v.*) to the south, together with the smaller communities of Albany, El Cerrito, Emeryville and Piedmont. Residential areas rise into the hills, and extend beyond them where the Broadway tunnel opens a way into the valleys of Contra Costa county.

The population in 1950 was 384,575 and in 1960, 367,548 by federal census. The population of the San Francisco-Oakland standard metropolitan statistical area, which includes Alameda. Contra Costa, Marin, San Francisco, San Mateo and Solano counties, was 2,783,359 in 1960. (For comparative city population figures see table in CALIFORNIA: *Population.*)

History. — The east bay was settled by the Spanish in 1820, when Luis Maria Peralta received a royal grant of about 48,000 ac. and established the Rancho San Antonio. In 1849 Moses Chase leased land for farming and laid out a town named Clinton in the area of east Oakland. In 1851 Horace W. Carpentier gained control of a large section of waterfront and started a ferry to San Francisco. The following year he secured a town site and named it Oakland after the live oaks on the grassy plain. In 1854 Carpentier and his associates extended the area and reincorporated it as a city. In spite of bitter competition, Carpentier and the railroads which later took over his interests maintained control of access to San Francisco through the old waterfront claims. By 1885 the Southern Pacific railroad had established its western terminus on the Oakland mole and was operating numerous ferries. In 1903 the Key system, formed out of a small railroad and local electric lines, began another system of ferries. The 1906 earthquake and fire in San Francisco caused a shift of population to Oakland, and regular commuter traffic across the bay increased rapidly.

Under Frank K. Mott, mayor from 1906 to 1915, a new city hall and auditorium were constructed, large areas to the south annexed and a new charter adopted. Most important of all, the city secured court decisions breaking the railroad monopoly on the waterfront and gained control of the tidelands in 1911.

Thereafter the commercial and industrial growth of the east bay was rapid, and it ceased to be primarily a "bedroom" for San Francisco. World War II brought tremendous military and naval activity, and the construction of extensive shipyards. This expansion continued in the postwar years, until the whole area from the refineries of Richmond to the orchards of Hayward became a continuous urban complex.

Administration.—Oakland is governed under a charter adopted in 1911 and amended in 1931 and 1951 to provide for a council elected by a city-wide vote, a city manager appointed by the council and a popularly elected mayor. The council appoints commissioners for the port. the parks, recreation. city planning and civil service.

Since 1923 water has been supplied through the East Bay Municipal Utility district. which received rights to the water of the Mokelumne river in the Sierra Nevada. Construction of the Pardee dam and aqueducts across the San Joaquin valley provided enough water to expand the district to include 225 sqmi. of the east bay. In 1944 Oakland and six neighbouring municipalities placed their common problems of sewage treatment and disposal in the hands of the district.

The state of California bridge authority operates all toll bridges crossing the bay. It built the tremendous double-deck bay bridge from Oakland to San Francisco, which is $8\frac{1}{4}$ mi. long, including the approaches. The bridge was an immediate success when it was opened in 1936, but was already inadequate ten years later. Controversies regarding the location of a second bridge to San Francisco were not resolved, but a new bridge from Richmond across the northern arm of the bay was completed in 1956. In 1957 a San Francisco Bay Area Rapid Transit district was created by the state to plan an integrated system of public transportation for the region. The same procedure of creating special districts in the bay area has been used to deal with the problems of water pollution and smog control.

Commerce and Industry. — The port of Oakland covers 19 mi. of waterfront in the outer, middle and inner harbours. Including the Alameda side of the inner harbour, it handles 4,000,000 tons of cargo annually. There are large terminals and warehouses, ship building and repair yards, dry docks, small boat harbours, various industries, an international airport and Jack London square, a restaurant area developed by the port commissioners. The Oakland army base, the Oakland naval supply centre, and the naval air station in Alameda across the estuary are tremendous installations, covering over 3,000 ac. of filled land. Large areas in the north harbour and around San Leandro bay are held by the port for further development. as well as 8,000 ac. of submerged land annexed in 1955 to provide for the expanding airport.

The principal industries of Oakland and the east bay include food processing and milling, oil refining, manufacture of automobiles, calculating machines, electrical equipment, containers of all kinds, steel fabrication, chemicals and drugs. Oakland is headquarters for Kaiser Industries Corp. and the related Kaiser enterprises, which have built a large and strikingly beautiful office building overlooking Lake Merritt.

Education. — Public education is in the hands of an elected school board, which maintains a junior college and 5 senior high schools as well as more than 75 junior high schools and elementary schools. Mills college, founded in 1852, the oldest college for women in the far west, occupies a 136 ac. campus in east Oakland. The College of the Holy Names (for women) and the California College of Arts and Crafts are inside the city. and St. Mary's college (for men) is in the Moraga valley to the east. The University of California is in Berkeley, about a mile from the city line.

Oakland maintains a public library system, an art gallery, a public museum, the Woodminster outdoor theatre and the Chabot observatory.

Parks. — The park system includes Lake Merritt, a large salt water inlet from the estuary near the heart of the city. In the park around its shores are the children's fairyland and the waterfowl sanctuary. established in 1867, the first public wild fowl refuge in the Cnited States.

Oakland includes the Knowland state park and arboretum, and is adjacent to large areas in the Contra Costa hills maintained by a regional park district. (F. H. HK.)

OAK MOSS, a lichen (Evernia *prunastri*) containing an oleoresin valued in perfumery both for its own fragrance of heavy, oriental type and as a fixative base. Another species (E. furfuracea) having similar properties is often included under the same common name, which is a translation of the French Mousse de *chêne*. Oak moss grows on the trunks and branches of trees, also on poles and rails, in mountainous country throughout much of the northern hemisphere. in pale, greenish-gray tufts two or three inches long, extending or drooping, made up of flattened strands which fork repeatedly, ending in pointed tips. The upper or outer surface of these strands is minutely warty and dusted with pale gray soredia, particles which reproduce the plant in the absence of the rare, disk-shaped, sexual fruit bodies (apothecia). The under surface is whitish, channeled in a faint, netlike pattern.

RUTHERFORD PLATT

OAK MOSS (EVERNIA PRUNASTRI) GROWING ON THE BRANCH OF AN INCENSE CEDAR TREE

Other lichens of the genera *Usnea, Ramalina, Parmelia,* etc., which grow intermingled with the *Evernia,* frequently gathered with it in the commercial product, have little fragrance, but may contribute to the value of the oleoresin as a base. Chief sources of oak moss from about 1900, when the perfume first came into general use, until 1940, were Yugoslavia and France, large quantities being shipped for distillation in northern Europe. After the disruption of trade by World War II, investigation showed the lichens to exist in Canada and northern United States. and thev have been distilled in America to a limited extent.

Oak moss was used in perfumery as early as the 16th century and later forgotten. Baskets filled with it have been found in the ancient royal tombs of Egypt, but whether intended for perfume or, as some suggest, for making bread, is not known. It contains a starchy edible substance.

OAK PARK, a village of Illinois, U.S., in Cook county, west of and adjacent to Chicago. Oak Park was first settled in 1833 and served as a stopping place for farmers taking their produce into Chicago. In 1871 after the Chicago fire the population grew rapidly, and in 1901 the village was incorporated. Primarily a residential community, Oak Park has an extensive retail trade, little light industry and no heavy industry. Oak Park is unusual in possessing 24 homes designed by Frank Lloyd Wright. It has a number of public and parochial schools and a Catholic military academy. In 1953 Oak Park adopted a village manager-council form of government. For comparative population figures *see* table in ILLINOIS: *Population.* (J. ZA.)

OAK RIDGE, a city of Tennessee, U.S., is about 20 mi. N.W. of Knoxville, at the eastern end of a remote 58.800-ac. tract selected in 1942 as headquarters site for the U.S. wartime atomic energy program, the Manhattan project. Originally known as the Clinton Engineer works, Oak Ridge was picked for the vital government installation because it was isolated, yet accessible to power, water, transportation and manpower. Army engineers began work in early 1943 on the community to house project personnel. The town, built in 29 years behind security fences, reached a peak population of 75,000 in 1945. Maximum wartime employment was 82,000. After World War II, Oak Ridge's population declined, so that in 1960 the population was 27,169. For comparative population figures *see* table in TENNESSEE: *Population.*

In the latter 1950s the internationally known community, by then headquarters for a major Atomic Energy commission field office, was still centred about a single industry, atomic energy. The government investment at Oak Ridge totaled $1,500,000,000 in two huge uranium processing plants and Oak Ridge National laboratory.

Oak Ridge bears slight resemblance to the temporary wartime boom town. In 1949 fences were removed from the community area. In 1953, roads through the plant areas were opened, and for the first time land was leased for private construction. New churches and schools were built as were many homes.

In 1955 congress provided for the sale of property in Oak Ridge, and in Sept. 1956, the first government-owned house was sold. In less than a year, Oak Ridge became the city with the largest percentage of individual home ownership in the U.S. The resulting renovation and remodeling effected a major face lifting in the community.

Oak Ridge has many active business groups and several shopping areas serve the community. From its inception Oak Ridge depended upon the federal government for services normally rendered by municipal government, but in 1959 it was incorporated. (J. A. Hs.)

OANNES (also IANNES, EUAHANES), in Babylonian mythology, the name given by Berossus to a mythical being who taught mankind wisdom. He is identical with the god Ea (*q.v.*), although there may not be any direct connection between the two names: Berossus describes Oannes as having the body of a fish but underneath the figure of a man. He is described as dwelling in the Persian gulf (Erythraean sea) and rising out of the waters in the daytime and furnishing mankind instruction in writing, the arts and the various sciences.

Other epithets of Oannes are Annedotus, Odakon, Euedokus, Eneugamos, Eneuboulos, Anementos. This antediluvian myth of a fishlike monster is based on the water god Enki of Eridu, patron of wisdom, symbolized as a "goat fish," and identified with Capricorn. (S. L.)

OARFISH, an oceanic fish, *Regalecus,* characterized by the long, compressed body, short head, large eye and long dorsal fin forming a crest on the top of the head. The oarfish is distinguished from its allies, the dealfishes (*q.v.*), by the long filamentous pelvic fins ending in a spatulate expansion (hence their name). These fish reach a length of nearly 40 ft.

OASIS, a fertile spot surrounded by desert. On the desert Libyan plateau immediately west of the Nile between Aswan and Cairo are areas where the water comes to the surface or is found in shallow wells; *e.g.,* Oases of Khârga, Dbkhla and Farbfra. The water may come to the surface in springs, upon the artesian principle, or it may collect and remain in mountain hollows. These areas vary considerably in extent; they are always intensively cultivated and support thick growths of date palms; and all kinds of tropical vegetables, grains and small fruits are grown. Some oases have a large population with substantial dwellings; others are merely halting places.

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TYPICAL WADI. A RIVER BED THAT IS DRY EXCEPT IN THE RAINY SEASON. IN AN OASIS IN BOU-SAADA. SOUTHERN ALGERIA

OASTLER, RICHARD (1789–1861), English factory reformer, one of the instigators of the Ten Hours bill (1847), was born at Leeds on Dec. 20, 1789. In 1820 he became steward of Thomas Thornhill's estate at Fixby, near Huddersfield, Yorkshire. A Wesleyan family background and a Moravian schooling directed Oastler's attention to practical philanthropy as well as business. In 1830 John Wood, a Bradford worsted manufacturer, revealed to him some of the evils of child employment in the local factories. Oastler was shocked and wrote a vigorous letter, entitled "Yorkshire Slavery," to the *Leeds Mercury,* thereby starting an agitation which soon passed from philanthropy to politics. Edward Baines, the Liberal editor of the *Leeds Mercury*, backed by millowners. condemned the "undue warmth" of Oastler's charges, but Oastler was supported by "factory operative" or "short-time committees," which appealed to Tories as well as Radicals.

During the next ten years Oastler was the most prominent of a band of Tory-Radicals who attacked the "factory system" and the poor law of 1834 and pleaded for a stable social order, based on the principle that "every man born in England has a natural right to live well." Although not a Chartist, he mas just as prepared as the Chartists were to agitate when parliament seemed insensitive to operatives' pressure. For his efforts in the West Riding he began to be called the "Factory King," and at last, after many rebuffs, in 1847 a Ten Hours bill was passed by parliament. which appeared to secure the objectives he and his parliamentary colleagues, particularly Lord Shaftesbury, had demanded. A further act of 1850 was necessary to enforce ten-hour working. by uhich time the factory reform movement mas divided into hostile sections and Oastler was still dissatisfied with results.

Although when he died at Harrogate on Aug. 22, 1861. his name according to the *Leeds Mercury* was "a household word in every working man's abode throughout Yorkshire and Lancashire," the mid-Victorian social order was very different from that for which he had struggled and made great sacrifices. His opposition to the poor law of 1834 had led to his dismissal from his stewardship, and being unable to pay an outstanding debt to Thornhill he was sent in 1840 to the Fleet prison where he spent more than three years.

From prison he published the *Fleet Papers* which summarize his philosophy. In 1844 his friends paid his debt, and after his release he was given a triumphal entry into Huddersfield.

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OATES, TITUS (1648–1705), professional English perjurer, was born on Sept. 1j. 1648. at Oakham. Rutland, the second son of Samuel Oates, an Anabaptist preacher, who was for some time chaplain in Col. Thomas Pride's regiment of foot. From his earliest years he seemed destined to a career of villainy. Expelled from Merchant Taylors' school, London, within a year of his admission, and sent down from both Caius and St. John's colleges, Cambridge, he yet secured admission to orders in the established church, and became successively vicar of Bobbing. Kent, in 1673, and curate to his father, who had conformed after the Restoration, at All Saints, Hastings, in 1674 While serving in the latter position he made his first serious essay in the art of perjury by uniting with his father to bring scandalous and quite unfounded charges against a local schoolmaster whose place he coveted He sought refuge from prosecution in the navy, and in the summer of 1675 visited Tangier as chaplain to the "Adventure" man-of-war. From this post also he was dismissed on the return of the "Adventure" to England, yet early in 1677 he contrived to secure appointment to the position of chaplain to the Protestants in the household of the Roman Catholic duke of Norfolk.

There for the first time he came into intimate and extensive contact with Catholic circles, and was inspired by the association he had formed mith Israel Tonge, a fanatical anti-Jesuit, to see what profit could be derived from them. On March 3, 1677, he joined the Roman Catholic Church. and in the summer of the same year was sent to study for the priesthood at the English college at Valladolid. during his stay at nhich he later claimed to have received the degree of D.D. from the University of Salamanca. His stay was short, however, for he was expelled within five months, only to secure admission instead to the English seminary at St. Omer, from nhich in turn he was expelled on June 23. 1678. Making his way back to London with a mass of miscellaneous information about the Catholics, he rejoined his ally Tonge, and on the basis of that information and Tonge's imagination the pair proceeded to draw up their account of a vast Jesuit conspiracy to assassinate the king, place the duke of York on the throne and recover England for the Roman Catholic Church. On Aug. 12, 1678. Tonge, with the utmost affectation of secrecy, took the first step toward making a disclosure of these designs to Charles II and the government; and on Sept. 28 Oates. dissatisfied with the progress that had been made, deposited a written account of the plot with a prominent justice of the peace. Sir Edmund Berry Godfrey, and swore to the truth of its contents.

To any one with real knowledge of the Catholics it was obvious that the tale told by Oates was a clumsy fabrication Unfortunately it contained just sufficient truth to enlist the support of the ignorant; it was welcomed by several of the contending factions at court, who imagined they could turn it to their own advantage; and it received immediate apparent confirmation mith the discovery of Godfrey's dead body under circumstances never satisfactorily explained. A wave of terror swept over England which carried Oates to the summit of power. Hailed as the saviour of his country, rewarded with a pension, and provided with a guard, he found himself in a position to send to the scaffold almost anyone whom he cared to accuse, and did in actual fact bring about the death of some 35 more or less innocent persons. But as the frenzy died down, and too many imitators came forward with additions to his story, discrepancies became apparent which even his brazen assurance could scarcely brush aside, and his credit steadily declined. On July 18, 1679. the queen's physician, Sir George Wakeman, against whom he had given evidence. was acquitted. In the folloning October he was refused the degree of D.D. by the University of Oxford. During the years 1681 and 1682 his pension was first reduced and then withdrawn altogether. In June 1684 damages to the enormous amount of £100,000 were awarded against him at the suit of the duke of York Finally in May 1685 he was convicted of perjury, subjected to a flogging from which he barely escaped alive and committed to prison for the remainder of his life.

After the Revolution of 1688. Oates was released and once more granted a pension; but the refusal of the house of lords to reverse the sentence passed upon him precluded him from giving evidence in a court of law, and so deprived him of his former means of livelihood. His efforts to train others to follow in his footsteps proved unsuccessful, and his marriage on Aug. 17, 1693, to Rebeccah Weld, daughter of a wealthy draper, folloned shortly afterward by his admission to and expulsion from the Baptist Church. provoked little but mirth. By the accession of Anne he had been practically forgotten, and his death (in London) on July 12 or 13, 170j, passed almost unnoticed

BIBLIOGRAPHY.—Contemporary accounts of Titus Oates are largely the product of party passion, and cannot be relied upon. The only full-scale modern account is Jane Lane, *Titus Oates* (London, Toronto, 1949), which combines much painstaking accuracy in detail with a less satisfactory presentation of the general background against which Oates's career has to be considered. A good short life, by Thomas Seccombe, is included in the *Dictionary of National Biography*. *See* also John Pollock, *The Popish Plot* (London, 1903). (A. BG.)

OATH AND AFFIDAVIT. An oath is a statement or assertion made under penalty of divine retribution for intentional falsity; an affidavit is a formal written statement executed under oath. Both are widely employed throughout the Anglo-American world.

Oath.— Fealty to a sovereign, the obligations of public office and the ethical obligations of learned professions are all assumed by oath. The most frequent use, however, occurs when a witness in an authorized inquiry states his intention to give his pertinent knowledge and to tell only the truth in relating that knonledge. The precise formula varies, usually being prescribed by statute. A common formulation of the witness oath is: "I do solemnly swear that the testimony I am about to give will be the truth, the whole truth, and nothing but the truth. So help me God." In Anglo-American legal practice testimony will not be received unless the witness is subject to some sanction for falsity, the oath being the usual form. Civil-law nations use it more sparingly; they generally do not permit parties to the case to testify under oath and they make the oath voluntary with many others. In these countries the oath is often administered after rather than before the testimony is given.

Moral consequences may not vary with the manner of assuming the oath but temporal consequences do turn upon whether the administering officer was validly empowered and whether the proceeding was properly authorized. Judges, court attachés and some other public officers have statutory power to administer oaths; normally consular officials and commissioned officers of the armed forces have the same power. One of the principal functions of the notary public is administering the oath. The low estate of that office in the United States, contrasted with its dignity in Europe, is a product of indiscriminate resort to the oath. Although so cheapened that it gives little assurance against false testimony, the law nevertheless provides that false testimony under oath constitutes the crime of perjury (*q.v.*).

Affirmation.——The principal alternative to the oath as a safeguard against false testimony is the affirmation—the witness declares his intention to tell the truth, under the pains and penalties of perjury. Affirmation was originally a concession to those whose religious scruples prevented the swearing of oaths. It has been extended in Great Britain and in many states of the United States to nonbelievers as well. Members of nonmonotheistic religions are frequently sworn according to the forms of their own faith. Persons of immature understanding may testify without either oath or affirmation if they display understanding of the duty to tell the truth.

Affidavit.—An affidavit is used in judicial proceedings and in perfecting records of factual events. It recites the place in which it is made; that the affiant (or, commonly, deponentj, having been first duly sworn, "deposes and says" certain facts; and, in appropriate cases! that he knows nothing further of the matter—"further deponent sayeth not.'! It must then be signed by the deponent in the presence of the administering official, who executes thereon his jurat. In the jurat he recites that the instrument was executed before him, under oath, giving the date thereof; he states his authority to administer oaths; and he impresses thereon the seal of his office. The purposes are two: the formalities give some assurance that the instrument is genuine; and the oath gives some assurance that the statement is true as well as genuine. Because not made subject to cross-examination, however! the lam courts regard it as hearsay and decline to receive it in lieu of oral testimony. Were the affidavit made subject to cross-examination, however, it would be called a deposition and would, although still technically hearsay, be more freely receivable. Depositions are now freely used in court when the deponent is unavailable.

See H. Silving, "The Oath," Yale *Law* Journal, 68:1329–1390 and 1527–1577 (June and July 1959). (R. E. De.)

OATS. The oat plant belongs to the genus *Avena* and is one of the important cereal crops. The grain is used largely as feed for livestock, although some is processed directly into food for human beings.

Origin.—Wild oats were first found growing in different regions of western Europe. Early writers stated that oats were found as a weed mixed with barley and therefore may have been distributed as a mixture in barley. From western Europe oats spread to other temperate parts of the world and are produced under a wide range of conditions. It was previously thought that cultivated oats were derived chiefly from two species. the common wild oat (*Avena fatua*) and the wild red oat (*A. sterilis*). Some cereal workers held that common white oats (*A. sativa*) were derived from A. *fatua* with a spreading panicle and that red oats (*A. byzantina*) came from *A. sterilis*. Later some workers believed that *A. sterilis* was the progenitor of both the red oats and white oats.

Botanical Description.—The flowering and fruiting structure of the oat is a terminal panicle that is usually lax or spreading. In some rare types, the panicle is reduced so that it approaches the spikes or heads of other small grains. The panicles may be either approximately symmetrical or with a preponderance of branches and their terminal spikelets hanging to one side. producing what is called side oats. The panicle is made up of numerous branches and spikelets, which in turn are composed of two papery glumes and usually two florets. The primary and secondary florets are held together by a short, thin rachilla. The individual floret has a lemma and palea that enclose three stamens, a pistil and two lodicules.

After fertilization the pistil develops into a one-seeded fruit called a caryopsis. The fruit, also called the groat, is closely clasped by the lemma and palea except in hull-less types where it is freed upon threshing. In *Avena nuda*, a naked species, spikelets may have five to ten florets, borne on long rachillas.

The lemma and palea, the covering or hulls containing the groat, are usually without hairs in most cultivated oats (*Avena sativn*). In a large number of the wild forms. however, the lemma is covered with numerous hairs. The lemma has a weak awn in many cultivated varieties and sometimes a large and twisted awn in wild types. The hull colour at maturity may vary considerably from yellow to white; black. brown or red. In some wild species of oats. empty glumes remain attached to the panicle branches after the kernels have fallen to the ground. In cultivated species, however, most of the kernels remain attached until threshed. The basal articulation of the spikelet is useful in species classification. Sometimes the secondary kernel is tightly clasped by the lemma of the primary kernel; this is known as doubling or bosom kernels. Sometimes the first flower may be sterile and yet not doubled. The caryopsis or groat weighs about 20 mg. and the lemma and palea about 6 mg. in cultivated oats. The oat panicle usually is from 4 to 21 in. long and may have as few as 8 to 10 kernels or as many as 200, and averages about 45 kernels.

The leaves of the oat plant are thin. narrow and long. They are very prominent in the early phases of growth. but become less prominent upon maturity. at which time the culms elongate and produce the stalk or culm of the plant. The base of the leaf blade has no auricle, this being in contrast to other small grains. The stems are usually hollow except at the nodes. Culms are from two to five feet tall and the number per plant depends largely upon the rate of sowing, the fertility of the soil and growth conditions. Roots are fibrous and numerous, and penetrate the soil to various depths.

PANICLES OF OATS

Classification.—The genus *Avena* is composed of a polyploid series. as is true of *Triticum* (wheat), the haploid chromosomes numbering 7, 14 and 21, or 14, 28 and 42 in the vegetative cells. There are several recognized species in the seven-chromosome group, several being wild types. There are at least two species recognized as being in the 14-chromosome group. In the third group with 21 chromosomes are found the commonly cultivated varieties, including *Avena byzantina,* red oats. Hull-less and wild forms are in this series.

The common wild oat is a weed in many sections of the world, although in some areas it is cut for hay or grazed. Because the seeds may lie dormant for long periods it is difficult to eradicate. Kernels at the top of the panicle mature sooner and drop to the ground as they ripen, even though the culm may still be green. The panicle of the wild oat is usually longer and more lax than that of the ordinary cultivated sorts.

Fatuoids or false wild oats have been observed in nearly all cultivated varieties. Fatuoid kernels also drop to the ground as do wild oats. However, false wild types do not constitute a weed hazard.

The various common oats are grown in cooler and more temperate regions of the world. Side and late-maturing common oats occur in northwestern Europe, northern sections of the United States and southern Canada. The smaller yellow-kerneled varieties occur in southwestern U.S.S.R. and in the corn belt of the United States. Red oats are grown principally in warmer climates, including the southern sections of the United States, the Mediterranean region and areas of South America and Australia. These are considerably more heat-tolerant than are the common types. Hull-less *(A. nuda)* forms are found in the highlands of Tibet, northern India, Turkestan and western China.

Some of the more important older agricultural varieties of oats in North America are Kherson, Silvermine, Victory, Fulghum, Red Rustproof, Markton, Columbia, Ajax, the "Victoria-Richland" group and "Bond" varieties including Clinton, Cherokee and Nemaha. Some of the newer varieties are Alamo, Beedee, Burnett, Clintland, Garry, Mo. o–zoj, Sauk and Victorgrain 48–93. Varieties from other sections of the world are Algerian, Astra, Ballidu, Belar, Blenda, Eagle, Flamingstreue, Gelbhafer. Golden Rain II, Landhafer, La Prevision, Lyallpur No. 1, Maldwyn, Marne, Mauerner Weiss, Minor, Orion III, Red Algerian, Rex, Santa Fe, S. 147, S. 172, Sisu, Sun II, Victoria and Victory.

Cultivation and Use.—A large part of the oats produced in the United States are sown in the spring. There are three groups of spring-sown oats: those that are midseason to late in maturity; early white and yellow types; and the spring-sown red types that are grown principally in the Great Plains of the United States. There is also a large area of fall-sown oats in the southern section of the United States. Seeding is done in practically all months of the year in various areas of the world.

Oats are less exacting in their soil requirements than are other cereals with the exception of rye. They seem to be able to extract nutrients from the soil that would not be available for wheat and barley. In the presence of sufficient moisture, oats do comparatively well on soils that are sandy and low in fertility and on soils high in acidity, but will also do well under fertile conditions. Rye. however, will produce crops on soils that are too poor for satisfactory oat production. In the corn belt of the U.S. oats are grown widely in rotation with corn and forage crops. Oats are used as a nurse crop with grasses and legumes that are to be used later for forage purposes. Since oat culture is relatively simple, a good crop may be obtained by either disking or plowing in the fall or spring, followed by sowing seed with a grain drill or with a broadcast seeder. The rate of seeding is about ten pecks to the acre.

Production in the spring-sown area is usually greater when seed is sown soon after frost has left the ground. The combine is widely used for harvesting the crop. Another method is the use of a binder followed by shocking the bundles and then threshing by means of a separator. In some countries harvesting is done by more primitive means.

In the late 1950s about 93% of the U.S. oat crop was used for feed. It is fed to all classes of livestock as grain in pure form or in feed mixtures. The straw is used for animal feed and is excellent for animal bedding. Oats are also used for pasturing in various sections of the world, and the crop is also cut for hay. Oats have long been a favourite source of breakfast food. Rolled oats or oatmeal is used mostly for porridge, although other kinds of breakfast foods are manufactured from the groats. Oat flour is also used in cookies, breads and puddings.

The oat grain is high in protein and fat content. It is also a very good source of vitamin B_1 and has an appreciable amount of vitamin E. The grain has as much riboflavin as other cereals, but much less niacin than wheat. It is practically devoid of vitamins C and D. Leaves of growing young plants are high in a large number of nutritional elements, including the "grass juice factor," which is in commercial usage.

The oat crop enters industrial usage to a small extent. One of the principal industrial products is the liquid aldehyde called furfural. This is made by the destructive distillation of oat hulls in the presence of acid and steam under regulated conditions. Furfural is used in selective solvents for various purification purposes, in paint remover, lacquer solvents and in adiponitrile, which in turn is used in developing nylon. Limited medical products come from oats.

In most regions of the world, oat culture faces the hazards of rust, smut, *Septoria* and other diseases that may greatly reduce yield and quality. Plant breeders try to develop oats that are resistant to these major diseases and that are high in quality and yield. In certain areas drought resistance and the survival of fall-sown varieties are much-needed characteristics sought by the plant breeder. Inasmuch as oats are self-pollinated and breed true after pure lining, improvements are easily utilized in production increase. The development of new varieties by means of hybridization followed by purification and testing has commanded considerable attention from oat breeders the world over for many years.

One of the main problems in breeding is the selection of plant progenies in early generations that will resist disease and have high productive capacity. Specialized races of pathogenic fungi complicate the problem of breeding for disease resistance. Lodging resistance is much needed where oats are grown on highly fertile soil. In the years between 1930 and 1956 much progress was made in oat breeding in the United States. During those years hybridization and selection were used to develop smut- and rust-resistant varieties. Starting in 1950, breeders experimented with several types of irradiation and chemicals with the hope of inducing desirable gene mutations.

Production. — For several years, as of the late 1950s, world production had averaged about 4,300,000,000 bu. on about 130,-000,000 ac. European and Asian production was a bit low immediately after World War II. For the ten-year period 1945–54, the United States averaged 1,327,496,000 bu., or 34.1 bu. per acre. In 1945, 1946, 1954 and 1955, its production was nearly 1,500,000,-000 bu. The predominant varieties were the "Victoria" group, Vicland. Tama, etc., in 1945 and 1946. Because of susceptibility to *Helminthosporium victoriae,* the fungus that causes Victoria blight, these varieties were replaced by the "Bond" group, Clinton, Bonda, etc. These proved susceptible to leaf rust and race 7 of stem rust and in turn were replaced by still newer varieties. A high acre-yield of 38.3 bu. was reached in 1955. Other principal producing nations, with approximate annual averages 1952–54, were: U.S.S.R., 720,000,000 bu.; Canada, 426,000,000; France, 243,000,000; Federal Republic of Germany, 175,000,000; United Kingdom, 187,000,000. (H. L. Ss.)

OAXACA, a southern state of Mexico that includes the greater part of the Isthmus of Tehuantepec (*q.v.*) on its Pacific side. Pop. (1960) 1,675,926, the majority of whom are Indians divided into more than 1j major tribes. Area 36,375 sq.mi. The capital city, also named Oaxaca (*q.v.*), is near the centre of the state on a high plateau surrounded by mountains. The Sierra Madre del Sur ends at the Isthmus of Tehuantepec, which is low, hot and arid. The Atlantic lowlands near Veracruz are hot and humid, but most of the state enjoys mild, healthful conditions in its broad valleys and fertile uplands. The Pan-American highway from Mexico City traverses the state southeasterly, while rail lines from Coatzacoalcos on the Gulf of Mexico to the Pacific port of Salina Cruz and trunk lines from Puebla and Veracruz form an incomplete rail net within the state. There are good air connections, and the free port of Salina Cruz has large dry docks.

Oaxaca is an agricultural and mining area, with a broad range of products, chief among which are maize, wheat, coffee. sugar, tobacco, fibres and tropical fruits. It manufactures for local consumption cigarettes, soap and famous Indian blankets, or serapes, from wool. Its mountains are veined with gold, silver, uranium, diamonds, onyx and other deposits.

In colonial times Oaxaca was a fabulous producer of silk and of cochineal for dyestuffs.

In pre-Columbian times the Zapotecas and Mixtecas constructed stone edifices, the remains of which are found at Mitla and Monte

Albán; their descendants form the majority of the population. (J. A. Cw.)

OAXACA (Oaxaca de Juárez), capital city of the state of the same name in Mexico, stands in the fertile valley of Oaxaca at an altitude of 5,070 ft. Pop. (1960) 68,545. The Pan-American highway, continuing south from Mexico City, passes through Oaxaca on the route to Guatemala. A beautiful colonial city, Oaxaca is noted for its 16th-century art and architecture as well as for the delicately coloured green stone used in many buildings. Nearby are the Mixtec ruins of Mitla and the Zapotec ruins of Monte Albán. Oaxaca has one of the most colourful handicraft markets in Mexico, selling multicoloured glazed pottery. black pottery ware, leather goods, fine steel knives, gold filigree jewelry and hand-woven wool and cotton textiles. Founded in 1486 as an Aztec garrison post and conquered by the Spanish in 1521, Oaxaca has played an important part in Mexican history and was the home of two of Mexico's most famous presidents, Benito Juárez and Porfirio Díaz. (H. R. Hy.)

OB or Obi, river of Russian Soviet Federated Socialist Republic, known to the Ostiaks as the As, Yag, Kolta and Yema; to the Samoyedes as the Kolta or Kuay; and to the Tatars as the Omar or Umar. Its length is 3,459 mi.; the area of its basin is more than 1,131,273 sq.mi. and the navigable waters in its basin total more than 17,000 mi. Its source is in the Altai mountains and its course is through hilly country to the Kirghiz steppe and thence it flows to its delta in the Gulf of Ob, an inlet of the Arctic ocean 600 mi. in length. In its middle course, south of its junction with the Irtish, and extending between the two streams, are the Vasuigan swamps, named from the Vasuiga, a left bank tributary of the Ob.

The swamps extend for 100,000 sq.mi. and in summer are impassable marshes, with dense thickets of cedars, larches and pines. In spring they are flooded and are then known as the Vasuigan sea. In winter they become icebound and may be crossed. When drained the land proves fertile.

North of the swamps the river flows through coniferous forest to Berezov, and passes Obdorsk. where there is a Veterinary institute for the help of the reindeer breeders and to which small sea-going vessels can penetrate.

After receiving its largest tributary, the Irtish, the Ob divides into more than one arm and is of little use for navigation except for barges bringing fish from the delta in the autumn. Above the junction of the Irtish, steamers and barges ply upon the Ob and its tributaries the Irtish, the Tobol, the Tavda and the Tura in summer. The east-west river traffic was giving place to railway communication in modern times, but the north-south route continued to be important. The river is frozen from November to May or June; floods, ice and floating timber impede navigation for some time after the thaw.

The fact that in its southern parts the Ob approaches so close to the Yenisei that short and easy portages link them made the penetration of Siberia by the Cossacks an easy task. The Chulim, a tributary of the Ob, in its upper course is at one point only 6 mi. from the Yenisei. but a canal link is impossible because of the great difference in level, while the Ket river. another right bank tributary of the Ob, has canal communication with the Kas, a tributary of the Yenisei.

The Irtish, which is as important as the Ob. rises as the Black Irtish, south of the Mongolian border. and flows through the Dzungarian gate into the U.S.S.R., where it expands into Lake Zaisan, and then cuts its way across a spur of the Altai into the plains. There are lakes. many of which are salt and are rapidly drying; flourishing villages stand on the site of what formerly was Lake Chany.

OBADIAH, the fourth of the "minor prophets." the otherwise unknown author of the shortest book in the Old Testament. Its 21 verses show evidence of the expansion or addition of which a manuscript, as distinct from a printed book, so easily admits. While the first 14 verses address Edom in the second person singular. with apparent reference to recent disasters that have befallen that people. the last 6 address Israel in the second person plural, promising judgment on the nations, including Edom, and proclaiming the eschatological "Day of Yahweh." when the lost territories shall be recovered. (The "join" is made in verse 1j, of which a belongs to the latter, and b to the former, prophecy.)

The Edomites (identified with "Esau," verse 6; cf. Gen. xxxvi, 1) occupied the mountainous country south of the Dead sea. on both sides of the Arabah; hence the reference to their rock dwellings (verse 3). The aid which they gave to the Babylonians against Jerusalem in 586 (Ps. cxxxvii. 7, etc.) was never forgiven, and its remembrance inspires the present prophecy (verses 11ff.). The actual disaster that befell the Edomites was probably some invasion by the neighbouring nomads; *e.g.*, the Nabatean Arabs (verse 7). The opening paragraph of Malachi may refer to the same event; if so. the prophecy of Obadiah may be supposed in its earlier part to belong to the first half of the jth century B.C. The dominant thought of it is that at last Edom has received its deserts at the hand of Yahweh. It is not known at what date this earlier portion was continued and incorporated into the more general prophecy concerning the future vindication of Judah, with which the book now closes. The original prophecy has elsewhere been reproduced, as well as expanded. Its first five verses occur in almost the same form in Jer. xlix. 14–16 and 9 (cf. also Joel ii. 32), a passage probably later than Obadiah.

See Edom. (H. W. R.)

OBAN, a small burgh, seaport and yachting centre of Argyllshire, Scot.. 49 mi. S.S.W. of Fort William by road. Pop. (1951) 6,226. Its bay is screened by the Island of Kerrera and by hills to the north and east and it is the port for Mull and other Hebridean islands. Tourism is the main industry, but there are extensive fisheries, a tweed mill and a distillery. There is a Roman Catholic cathedral.

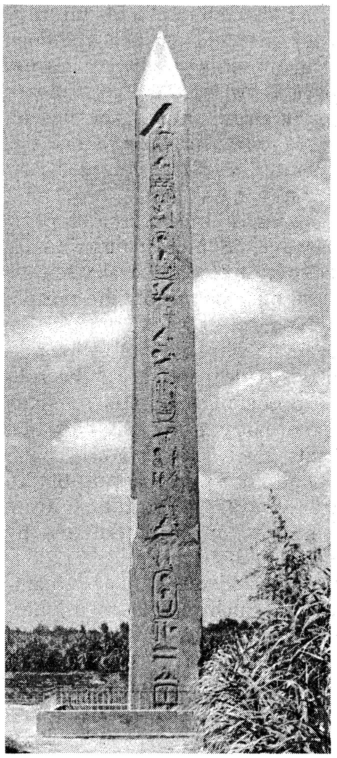
Surmounting the town is "McCaig's Folly," a colosseumlike building of the late 19th century built to relieve unemployment. At the northern end of the bay stands the ruin of Dunollie castle, old stronghold of the Macdougalls of Lorne, whose modern mansion adjoins it. In the grounds is a huge rock. called the Dog stone (*Clach* a' *Choin*) from the legend that Fingal used to fasten his dog Bran to it. About 3 mi. N.E. are the ruins of Dunstaffnage castle. It was there that the "Stone of Destiny," now in Westminster abbey, was kept before its removal to Scone.

OBEDIENT PLANT (Physostegia *virginiana*), a North American herb of the mint family (Labiatae). called also false dragonhead and lion's-heart, native to moist soil from Quebec to Ontario and Minnesota and south to Florida and Texas. It is an erect. usually unbranched perennial, one to four feet high, bearing oblong or lance-shaped. sharply toothed, pointed leaves and dense terminal clusters (spikes) of pale-purple, rose-coloured or sometimes white flowers, about one inch long. The flower displays the characteristic of remaining temporarily at whatever angle it may be placed with reference to the stem.

OBELISK, an Egyptian stone pillar, square in section. tapering upward to an offset pyramidal top. Obelisks seem to have originated in the Egyptian Old Kingdom as grave monuments. In the 6th dynasty a pair was placed at the entrance of the tomb of Sabui at Elephantine and in the 11th dynasty single examples marked the graves of kings at Thebes. These earliest obelisks, which were also used in gardens and in front of palaces, were short (about ten feet at Thebes) and tapered little. The earliest surviving obelisk still in its original position is that of Senusret I (12th dynasty) at Al-Matariyah, ancient Heliopolis. It is 68 ft. high and does not taper sharply as do later examples. It commemorates a jubilee of Senusret's accession.

Cnder the New Kingdom. obelisks occupied an important position in temple planning. The 18th-dynasty temple was composed of three main elements: pylon. portico yard and shrine. Such was the plan of the Temple of Amon at Karnak, in which the largest surviving obelisks still stand. The earliest pair was placed in front of the pylon built by Thutmose I. Of these, one remains in place, over SO ft. high, 6 ft. square at the base and weighing 143 tons. It celebrates the 30th anniversary of his accession. Queen Hatshepsut added a second, larger pylon and two obelisks 96 it. high. 5 ft. 4 in. square at the base and weighing 325 tons.

While the majority of obelisks were erected to commemorate jubilees. their real purpose seems to have been connected with sun worship. In a sun temple discovered at Abousir near Giza, the central shrine consisted of a raised platform in the form of a truncated pyramid surmounted by an obelisk. Such obelisks were not monolithic but built up of limestone blocks, and they had sacrificial altars placed in front of them. The Egyptian word for obelisk, *téhen,* is philologically connected with the word for sunbeam. It is known that the pyramidal summits were covered with sun-reflecting electrum (an alloy of silver and gold), and the hieroglyphic sign for obelisk suggests that a golden ball was placed on top of them. A considerable number of small obelisks found at Elephantine originated in the temple of the god Khnum, who by his assimilation as Khnum-Ra to the sun-god could display obelisks as symbols of solar religion. Other obelisk dedications are to sun-assimilated gods—Harakhti (at Heliopolis), Amon (at Thebes)—and an obelisk erected by Augustus in Rome bore the dedication "*Soli donum* dedit."



A. F. KERSTING

OBELISK AT AL-MATARIYAH, EGYPT

The sole material for making larger obelisks was the granite of Aswan, where the quarries still hold a large unfinished example. Lesser obelisks were made of basalt or quartzite. Special boats were built for their transport down the Nile.

Close relations between Egypt (*q.v.*) and Canaan in the 12th dynasty led to the adoption of obelisks by Canaanites and Phoenicians. A ron of them was found in the temple at Byblos (ancient Gebal). Lebanon, of the early 2nd millennium B.C., and Theophrastus states that at a later date an obelisk of solid turquoise was set up in the temple at Tyre. Obelisks in use by the Assyrians were short and step-topped and designed to bear horizontal reliefs of historical content around the four sides. The most complete example is the "Black Obelisk" of Shalmaneser III (British museum), showing the submission of Ring Jehu of Israel in the 9th century, B.C. (*See* also EGYPTIAN ARCHITECTURE.)

In Greco-Roman Egypt obelisks (*obeliskos,* a "peg" or "needle") were still made. Many were transported to Italy in imperial times and one to Constantinople by Theodosius I. Caligula imported the obelisk of Thutmose III, now in the Piazza S. Pietro. Rome, while Domitian and Hadrian made copies. Two large obelisks of Thutmose III mere brought by Constantine to Rome from Heliopolis. Tno other examples were imported by Domitian to Beneventum for the temple of Isis. Copies of obelisks inserted into architectural schemes were already popular in Britain and France in the 18th century. In the 19th century obelisks were taken to London and New York (the two "Cleopatra's Xeedles," *q.v.*), Paris, Arles, Vincennes and Fontainebleau. The latest obelisks to be constructed in the ancient world were fan-topped monuments at Aksum in Ethiopia. Their purpose is obscure, but evidence of sacrificial ritual connected with them suggests that they antedated the adoption of Christianity in the 6th century.

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OBERAMMERGAU, a village in Bavaria, Germany, 42 mi. S.S.W. of Munich. Pop. (1950) 5,325. The village is famous for its wood-carving industry and the performance of the Passion play every ten years.

The Passion Play.—In 1633 Oberammergau was stricken by the plague. As an expression of their gratitude for the end of the scourge the villagers vowed to enact the Passion of Christ every ten years. In 1634 the first performance of the Passion play took place. After 1674 the dates nere changed so as to fall on decimal years. From 1680 on, the play was given regularly every ten years. In the 1770s a crisis arose when the performance of religious plays was forbidden throughout the electorate. An appeal of the players to the elector Karl Theodor brought about the lifting of the ban. After World War I the production that should have been mounted in 1920 was postponed until 1922. During World War II no performances could take place: most of the villagers were in the German army, and the Nazi regime frowned upon the staging of religious plays. Performances were resumed in 1950.

It takes almost eight hours to perform the play, which is divided into episodes. After a prologue the action begins with Christ's entry into Jerusalem. After Christ's capture on the Mount of Olives falls the intermission. The second part begins with Christ's appearance before the high priest Annas and ends with the Resurrection. Each episode is introduced by a song of the Passion chorus of 50 singers. Moreover, a pantomime tableau presenting the Old Testament prefigurations precedes each episode. Thus the scene with Christ before Pilate is introduced by a tableau showing Daniel before King Darius.

The text of the original Passion play as it was produced in 1634 seems to have been a conflation of two earlier versions of the sacred story, of the so-called Augsburg Passion and of the Passion written by the Augsburg Meistersinger Sebastian Wild. In 1680, honever, the text was altered by Johann Aelbl. A new version made by Father Ferdinand Rosner was used in 1750 and 1760. For 1780 Magnus Kipfelberger made alterations. In 1811 a new version was ready, this time prepared by Othmar Weiss. For the performance of 1860 Alois Daisenberger served as play doctor. The text as it stands today has no traceable relation to any authentic medieval text and may well be lacking in literary merits.

Nor is medievalism a feature pronounced in any of the productional aspects. The vast forestage is an open-air platform on which permanent architectural elements are set up. In central position rises a curtained picture-frame stage with wings and backdrops. Next to this inner stage of shifting scenes there are, on either side, gates through which the spectator looks into the streets of Jerusalem. Both gates are flanked by palaces, that of Annas at stage left, and Pilate's at stage right. In extreme downstage position there are smaller gates for side entrances on either side. An orchestra pit accommodates the musicians. The audience is seated in a roofed auditorium nhich holds 5,200 spectators.

Both the text and the stage are hybrid forms and far removed from medieval prototypes But the spirit in nhich the Passion of Oberammergau is presented is still in the medieval tradition nhich demands that an entire community become involved in the undertaking for the glory of God and the edification of the faithful A Passion play committee supervises the preparations for the production. The amateur actors are chosen from among the inhabitants of the village, and it is a task of some magnitude to select suitable performers for the 124 speaking parts. Hundreds of villagers are employed in the crowd scenes nhich are staged in the spirit of the Meininger troupe.

The most famous interpreters of Christ were Josef Mayr, from 1870 to 1890; Anton Lang. in 1900, 1910 and 1922; and Alois Lang (no relation to Anton) in 1930 and 1934. (A. M. N.)

OBERHAUSEN, a tonn in North Rhine-Westphalia. Ger., 5 mi E of the Rhine. 20 mi N E. of Dusseldorf. on the main railway line to Hanover and Berlin, and at the centre of an important netn ork of lines radiating hence into the Westphalian coal and iron fields Pop. (1950) 202,808 The first houses of Oberhausen were built in 1845, and it received its municipal charter in 1874. The tonn has large ironworks, coal mines, rolling mills, zinc smelting works, dye works, railway workshops and manufactures of wire rope, glass. chemicals, sugar, porcelain and soap. It was bombed in World War II.

OBERLIN, a city of Lorain county, O., U S , is located 34 mi. W S.W. of Cleveland; the seat of Oberlin college. The community was founded in 1833 by the Rev. John Jay Shipherd. a Presbyterian minister, and Philo Penfield Stewart, a former missionary to the Choctan Indians. In 1834 they also established the Oberlin Collegiate institute to educate ministers and schoolteachers for the west; the name was taken from John Frederick Oberlin (d. 1826), the Alsatian pastor and philanthropist. In the antislavery agitation then current in the Korth a group of students at the Lane Theological seminary in Cincinnati left that institution in protest against its lack of support of antislavery; the Tappan brothers, merchants in New York. promised to finance their later education under the instruction of Charles G. Finney (*q.v.*), by that time a well-known evangelist, in a college which would appoint him to its faculty. He was given a professorship at Oberlin in 1835 and also served as president from 1851 to 1866. The institute (officially designated a college after 1850) was identified with various innovations: it was coeducational, it admitted Negroes on an equal footing with whites and it became a station on the Underground Railroad by which fugitive slaves escaped to freedom in Canada. In 1858 students and tonnspeople rescued a Negro at Wellington, 8 mi. S.. from law officers uho were returning him to his legal owners. As a result some of the "rescuers" were imprisoned in the Cuyahoga county jail in Cleveland and the case attracted nation-wide attention. Charles Martin Hall. an alumnus who had developed a cheap method of making aluminum commercially, bequeathed to the college several million dollars for the endowment and the construction of Hall auditorium.

Oberlin college is still interracial and coeducational; it includes a college of arts and sciences, a graduate school of theology and a conservatory of music which maintains a branch in Salzburg, Aus.

The community, which continues to be primarily a home for the college, was incorporated as a village in 1846 and as a city in 1950. It has a council-manager form of government, in effect since 1926. For comparative population figures *see* table in OHIO. *Population.* (R. S. *FR.)*

OBERON, king of the elves or fairies, appearing in different guise in various legendary and literary works In the legendary history of the dynasty of Merovingians (*q.v.*) he is a magician and the brother of Merowech (Mérovée). With the name of Alberich, in the German heroic epic *Nibelungenlied* (q v.), he guards the treasure of the Nibelungen but is overcome by Siegfried. Also as Alberich in the German medieval poem *Ortnit,* he is king of the dwarfs and aids his son in his wooing. In the French romance *Huon de Bordeaux* (q *v*) Oberon is king of the fairies and fills a role similar to that of Alberich in *Ortnit,* but some elements from Celtic tradition are added, such as the magic cup that remains full for the virtuous and Oberon's parentage (he is the son of Morgan le Fay and Julius Caesar). Shakespeare used the fairy element of the story in *A Midsummer Night's Dream,* probably deriving it from popular legend and Lord Berner's translation of *Huon;* and Ben Jonson wrote a masque, *Oberon, or the Fairy Prince,* presented at court on New Year's day, 1611, and published in 1616. The libretto for Carl von Weber's opera *Oberon,* first produced at Covent Garden in 1826, was based on an English translation of Christoph Wieland's German epic *Oberon* (1780) In Richard Wagner's operas *Der Ring des Nibelungen,* Alberich is the Nibelung who steals the magic gold from the Rhine maidens. He is there the father of Hagen and has throughout the *Ring* a darker character than the Alberich of the earlier *Nibelungenlied.*

OBESITY is that physical state in which excessive fat is stored in the body. Though it is often considered primarily a cosmetic defect, making the obese person less attractive than the person of normal weight, obesity is essentially an anatomic abnormality that deserves the consideration accorded to serious disease. The disorder indicated by obesity is a prolonged positive energy balance, with resultant excess accumulation of fat and formation of superfluous adipose tissue.

In obesity there is excess deposit of fat in both normal and abnormal sites. In extreme cases the subcutaneous fat may exceed ten centimetres in thickness. Large amounts of fat may be found in the membranous tissues that enclose the abdomen (retroperitoneal space, omentum and mesentery), in the tissues surrounding the kidney, in the space between the lungs and in the pericardium (the membranous sac that contains the heart). Fatty infiltration may occur in the pancreas, in skeletal muscles and in the heart muscle. The liver may be greatly enlarged, and many of its cells may be filled with fat.

Diagnosis. — Although adiposity is usually evident from appearance alone, appearances may be deceptive. Some persons who are overweight by the usual standards have exceptionally heavy muscle development and are not fat. Others may be within the normal weight limits, but their bodies may contain excessive fat and be deficient in muscle. The diagnosis of obesity is simply the first step; it is necessary to establish also the ideal weight of the subject and the degree of obesity. Approximate optimal weights according to height, sex, age and type of body frame may be found in tables (see *Bibliography).* Weights given in such tables, however, are approximations and are not necessarily applicable to any single person; they give mean or average weights. More accurate optimal weights for each person can be determined by individual application of one or more methods:

1. Skeletal measurements of wrist circumference, knee circumference, shoulder width, hip width, etc. Such measurements permit calculations based upon the width and depth of the body and the size of the skeletal framework.
2. Densitometry, a more exact method of measuring fat storage as compared with normal, requires the determination of the specific gravity of the whole body by weighing the person under water. Since human fat has a density of 0.92 whereas the rest of the body has an average density of 1.1, the percentage of body fat may be calculated when the total body density is known, correction being made for residual air in the lungs. This is the most accurate method of calculating body fat content, but the difficulties involved limit its use to research laboratories.
3. Measurements of total body water (by dye dilution and other chemical techniques). Under normal conditions total body water maintains a constant relationship to lean body mass. When total body water is known, lean body mass can be calculated and the fat content of the body determined by subtracting lean body mass from total body weight.
4. Skin-fold thickness. Formulas have been devised for estimating body fat content by calculating from careful caliper measurements of skin-fold thickness at several specified points on the body.

Many useful data have been developed from studies utilizing these methods. In an average healthy young man, fat constitutes about 15% of the total body weight, extracellular water about 23%, cells or active tissue 58% and bone mineral 4%. In obesity of extreme degree the percentage of fat may exceed 50 and even reach 70. In extreme leanness, the percentage of body weight made up of fat may be lower than 10, even as low as 2. Normal young men of the same heights and ages as a group of young women had average body fat content of 9.8% as compared with 17% for the women. Even when weights are the same, normal middle-aged men are much fatter than normal young men if body content of fat is used as the criterion rather than height-weight-age tables. The trend for older as compared with younger females is similar, but females are fatter than males at all ages.

Computation of actual individual body fat content can be very helpful, but for practical purposes in most cases, accurate weighing of the unclothed fasting person (before breakfast), careful physical examination and comparison with ideal weight figures from the standard tables suffice to establish the diagnosis of obesity and its degree.

Tables giving average rather than desirable weights at various ages and heights are misleading, for the optimal weight of an adult remains unchanged but average weights increase in the middle decades. Even minor degrees of corpulence (*i.e.*, 10% to 15% above optimal weight) are accompanied by higher mortality rates.

Incidence.--Obesity occurs frequently even among children and adolescents, but it is commoner among adults. Moderate corpulence affects about one-fifth of the adult population of the United States, occurs most frequently between ages 30 to 50 years, and is somewhat commoner in women than in men. In the United States it is estimated that about 9% of the population is 10% overweight and 3% is 20% overweight.

Consequences. — Obese persons suffer more often from a number of illnesses than do persons of normal weight, and they also have a shorter life expectancy. The hazard of obesity increases with age. so that persons 45 to 50 years old who are 10 lb. overweight have an increase above the average death rate of 8%; those 20 lb. overweight, 18%; and so on. Analysis of the causes of death among obese persons as compared with those among persons of normal weight reveals that deaths from degenerative diseases of the heart, the arteries and the kidneys account for the greatest proportion of the higher mortality. All types of cardiovascular-renal conditions appear to occur more frequently and with greater severity among overweight persons, including, in particular, heart failure, cerebral hemorrhage and thrombosis, coronary thrombosis and nephritis. More of the obese die of accident, probably because fat people are less agile than thin people. The death rate from diabetes is almost four times as great among obese persons as compared with those of normal weight. Other diseases that occur more frequently in the obese are cirrhosis of the liver, gallstones, cancer of the liver and gall bladder, cancer of the uterus, appendicitis, complications of pregnancy and the postpartum period, diaphragmatic hernia, degenerative arthritis and flat feet. High blood pressure, varicose veins and venous thrombosis and embolism affect obese persons more severely and appear to occur more often among them. The greater the adiposity, the poorer the chances of success in and survival after surgery.

Because obesity is so common and affects health and life expectancy in such a variety of ways and in such severe and definite manifestations, it has been called the greatest single health hazard.

Causes. — Investigation of developing obesity in its early stages offers hope of discovering specific causative factors. There is of course only one ultimate cause of obesity: a caloric intake persistently exceeding the caloric output. There are, however, many ways in which the energy balance may be tilted to the positive side. Maintenance of normal body weight and of normal fat stores depends upon an outflow of heat and energy equal to the inflow provided by food. Excess food, \ hether taken as protein, carbohydrate or fat, is chiefly converted into and stored as body fat.

In children. when the body is growing and physical activity is high, protein intake and total caloric intake must be high to provide for tissue growth and muscular energy. After body growth is complete, and muscular activity diminishes (as it does in most persons in the middle decades), excess calories taken as food produce not useful body tissue but detrimental fat. Perhaps in the least complex cases of obesity the commonest causes are either simple overeating or lack of exercise or both.

Physiological Factors. — Digestion and absorption of food are not more efficient in obese than in thin persons. Lipophilia (an extraordinary ability of the body to retain fat) has not been demonstrated to be present in the usual types of obesity. Local tissue avidity for fat, however, may be of importance in conditions in nhich the adiposity has a characteristic distribution. as, for example, in lipomatosis or lipodystrophy or in the condition called Cushing's syndrome. Obese persons do not conserve calories by accomplishing work with less effort and storing the difference. On the contrary, the total metabolism of obese persons is higher than normal. not lower.

It once was thought that the majority of obese persons might have endocrine defects, but this has not proved to be true. In only a minority of cases (perhaps about 5% of all obese persons) disorders of glands of internal secretion are demonstrable, among them hypothyroidism, hypogonadism, hyperadrenocorticism and hyperinsulinism. Cnderfunctioning of the thyroid gland is rarely the cause of obesity. The thyroid gland function and the basal metabolic rate are normal in the great majority of obese persons. When the sex glands (ovaries or testes) are absent or deficient in function, the subject may become more placid and less active physically and there is a predisposition to obesity, with fat deposits in certain areas: breasts, buttocks, hips and thighs. Formerly hypopituitarism was considered a cause of obesity, but pituitary disorders are not associated with adiposity unless the area at the base of the brain called the hypothalamus (*q.v.*) is impaired. In the hypothalamus are groups of nerve cells concerned with the regulation of appetite. When certain of these centres are damaged in experimental animals appetite is increased and obesity is a consequence unless increased muscular activity is enforced. Frohlich's syndrome and other types of adiposogenital dystrophy characterized by adiposity and hypogonadism are due to hypothalamic disturbance plus pituitary disturba ce, he gonadal deficiency being secondary to pituitary malfunc ıor. Cushing's syndrome and disorders associated with excess secretio of the steroid hormones of the adrenal cortex are characterized by development of a striking "central" type of obesity in which the ex tremities tend to be spared. Similar adiposity may result from therapy with steroid hormones. Excess secretion of insulin by the pancreas may cause recurrent periods of low blood sugar and hunger and thus lead to obesity. (See also METABOLIC DISEASES.)

Limitation of energy output from any cause may predispose to obesity. Laziness due to psychogenic factors is a common influence, but obesity also may develop if eating habits persist during periods of enforced inactivity for medical or surgical treatment.

Psychological Factors. — Improper childhood training, frustrations, nervous tensions and dissatisfactions may be expressed in increased food intake or decreased physical activity, and frequently both. Pleasure in eating may become a dominant personality trait, serving as a substitute for other satisfactions (social, business, sexual, etc.) that are unfulfilled. Problem children often become obese and use the condition to demand special attention.

In the great majority of cases psychological factors are important, but in many instances both psychological and physiological influences favouring a positive energy balance may be discovered. In certain families may be seen hereditary factors that favour the development of obesity. Multiple causative factors are the rule, not the exception.

Symptoms. — Physical symptoms of obesity are fatigue and shortness of breath. and there may be aching in back, knees and feet. Later symptoms may be those of high blood pressure, heart failure, diabetes or other conditions to which obesity predisposes. Psychological results of obesity range from shyness and withdrawal to overly bold self-assertion. Often there are accompanying neuroses or even more severe psychological disorders.

Treatment. — It is better to prevent obesity than to attack the condition after it has reached considerable proportions. Proper eating habits should be established and, unless contraindicated, moderate regular exercise should be encouraged. When obesity is mild and uncomplicated, treatment with a low caloric diet and exercise should be sufficient. When obesity is more severe and causes are multiple or complex, treatment may include diet, physical therapy, drug and hormone treatment and psychotherapy.

Treatment has two aims: removal of causative factors and removal of excess stored fat. Removal of causative factors is relatively easy in rare cases only; for example, when a pancreatic islet tumour can be discovered to be responsible and can be removed surgically. Since, however, in the common types of obesity a disorder of appetite control is present, or there is a neurosis of which obesity is only a symptom, attempts to correct causative influences may prove difficult.

Whatever the cause of obesity, restriction of caloric intake in the diet is necessary to induce weight loss. Use of certain drugs under careful medical supervision may help to reduce appetite and ensure better observance of prescribed diets. The diet should allow about 10 calories per kilogram of ideal body weight if the subject is relatively inactive, or 15 to 20 calories per kilogram per day for moderate muscular exercise. Such a diet mould allow 700, 1.000 or 1,400 calories per day for persons with ideal weight of 70 kg. (150 lb.). In reduction diets protein allowance usually should be liberal and fat minimal. The carbohydrate allowance should be supplied chiefly in the low carbohydrate bulky fruits and vegetables. Salt restriction may be advisable if fluid retention is present. Supplements of vitamin A and the B complex are advisable if dieting is to be prolonged, since foods containing these vitamins are restricted.

Regular exercise, preferably daily and preferably out-of-doors (such as walking, golf. swimming, etc.). is very helpful in increasinn caloric output, but is even more valuable to improve muscular development, general health and morale. *See* also DIET AND DIETETICS; ENDOCRINOLOGY; HEART, DISEASES OF; MALNUTRITION: *Overnutrition*; NUTRITION.

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(C. M. MACB.)

OBITER DICTUM, that which is said by the way; an incidental statement. Specifically, in law, a passage in a judicial opinion which is not necessary for the decision of the case before the court. Such statements lack the force of precedent, but may nevertheless be significant. "In order that an opinion may have the weight of a precedent . . . it must be an opinion the formation of which is necessary for the decision of a particular case; in other words, it must not be *obiter dictum*." Dicta frequently take the form of statements which are unnecessarily broad. Thus when a young man willfully murdered his grandfather to prevent his revoking a will, the court held that the beneficiary was not entitled to the legacy which the will provided for him, saying that the law will not permit one "to take advantage of his own wrong, or to found any claim upon his own iniquity, or to acquire property by his own crime."

In a subsequent case: involving a legatee who had negligently caused the testator's death in an automobile accident. the same result would not necessarily follow; the court would be free to distinguish the cases on their facts and limit the broad dictum of the earlier case.

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(B. CE.)

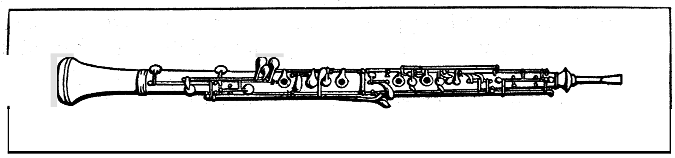
OBLATE, an ecclesiastical term for persons not professed monks, friars or nuns, who have devoted themselves or have been devoted as children by their parents to a religious life. "Oblate" is more familiar in the Roman Church as the name of a religious congregation of secular priests. the Oblate Fathers of St. Charles. This congregation was founded in 1578 under the name of Oblates of the Blessed Virgin and St. Ambrose by St. Charles Borromeo (*q.v.*), archbishop of Milan. There is a similar congregation of secular priests, the Oblates of Mary Immaculate, founded at Marseilles, France. in 1816.

See the *Catholic Etzcyclopaedia, s.v.* "Oblate."

OBOE or **HAUTBOY.** The treble member of the class of wood-wind instruments having a conical bore and a double reed mouthpiece, the oboe consists of a conical wooden tube, composed of three joints, upper, middle and bell, and of a short metal tube to which are bound by many turns of waxed silk the two thin pieces of cane that form the mouthpiece. These pieces of cane are so bevelled and thinned at the end which is taken into the mouth that the gentlest stream of compressed air suffices to set them vibrating and thereby to set up the rhythmical series of pulses which generate the sound waves in the stationary column of air within the main tube of the instrument.

The compass of the oboe is from B flat below the treble stave to F in alt, or even a note or two higher, with all chromatic semitones. Its quality of tone is thin, penetrating and even somewhat nasal. It is possible to play on it diatonic and chromatic scale and arpeggio passages, legato and staccato; leaps; cantabile passages; sustained notes, crescendo and diminuendo, grace notes and shakes (with reservations).

The first appearance of the instrument in a musical work occurs in Sebastian Virdung's *Musica getutscht und aussgezogen* (1511). It there bears the name of *Schalmey*, and is already associated with an instrument of similar construction called *Bombardt*. There exists, however, much earlier evidence, in the illuminated mss. and in the romances of the Middle Ages, of the great popularity of the instrument in all parts of Europe. The oboe was known during the early Middle Ages as *Calamus, Chalumeau* (France), *Schalmei* (Germany) and *Shawm* (England), while after the Renaissance we find instruments of this type ranged in complete families from the soprano to the bass and known respectively as the little Schalmey; the discant Schalmey; the alto Pommer; the tenor Pommer; the bass Pommer; and the great double quint Pommer.



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THE OBOE IN ITS MODERN FORM

The 17th century brought no great changes in the construction of the four smaller instruments of the family. Extensively used in France, they were there called "haulx bois" or "hault-bois," to distinguish them from the two larger instruments which were designated by the words "gros bois." Haultbois became hautbois in French, and oboe in English, German and Italian; and this word is now used to distinguish the smallest instrument of the family still in use.

The reform in the construction of the flute due to Theobald Boehm of Munich about 1840, a reform which principally consisted in the rational division of the tube by the position of the lateral holes, prompted Triebert to try to adapt the innovation to the oboes and bassoons; but he failed, because the application of the system denaturalized the timbre of the instruments, which it was necessary, before all things, to preserve. Further improvements, however, made upon the same lines by Barret and later by Rudall Carte, have transformed the oboe into the most delicate and perfect of reed instruments, as which it constitutes one of the most valuable and indispensable members of the modern orchestra.

OBRECHT, JACOB (also HOLBRECHT) (*c.* 1430–*c.* 1500), Dutch composer, was born probably at Utrecht about 1430. About 1474 Erasmus was under him as a choir boy at Utrecht, where he was chapel master, and in the same year Obrecht seems to have held an appointment at Ferrara. He was afterwards director of the Cambrai school of singing, and at some time lived in Florence, where his name is associated with Josquin, Isaac and Africola, and the musicians who clustered round Lorenzo's court. The principal records of his later years are found in Antwerp Cathedral, where he was chapel master from 1491 until his death. That he possessed immense contrapuntal skill and was considered one of the greatest masters of the age there is evidence in the praise of his contemporaries and successors, the honours bestowed upon him, and the visits received by him at Antwerp. The finest of his eight masses, *Fortuna Desperata*, was published in Amsterdam (1870) and appears in 1880 in the *Maatschappij tot Bevordering der Toonkunst (No. ix.)*. He also wrote chansons and motets. The finest of the motets is *Salve crux arbor vitae*. Great interest attaches to his *Passion*, in which the chorus impersonates all the characters in the story and the narrative is given to the tenor in recitative.

A definitive edition of his works has been published by Johannes Wolf (*Werke van Jacob Obrecht*, Amsterdam and Leipzig).

OBREGON, ALVARO (1880–1928), Mexican soldier and president, was born in the district of Alamos, Sonora, on Feb. 17, 1880. During his early life as a planter he became an advocate of land reforms to better the condition of the peons and Indians, and in 1912 he entered the services of Madero, a man of similar ideals. With Indian troops which he recruited, Obregon aided in suppressing the revolt of Orozco against Madero, and later he again took the field against Felix Diaz whose successful revolt led to the downfall of Madero and the establishment of Huerta as provisional president. Obregon then joined the counter-revolution of Carranza who had remained true to Madero. After a string of victories culminating in the successful storming of Sinaloa and Culiacan and the capture of Guadalajara, the way to Mexico City was opened, and on Aug. 15, 1914, Obregon led the Carranza troops into the capital. Huerta fled.

In the struggle which arose between Carranza and Zapata and Villa, Obregon remained loyal to Carranza. He defeated Zapata finally at Pueblo in Jan. 1915. In April he conducted a campaign against Villa for the control of central Mexico and by winning the battles of Celaya and Leon forced Villa back to his mountain fastnesses. As leader of the radical wing of Carranza's followers and chief of the army. Obregon possessed power enough to force into the new constitution of 1917, against Carranza's wishes. the famous article 27 which provided for the restoration of communal lands to the Indian villages, limited the size of individual land holdings, deprived religious organizations of the right to hold lands and reserved to the government the ownership of all mineral and petroleum resources. The new constitution also provided that no president should succeed himself, but in 1920 Carranza took steps to have himself retained in power, one of these steps being an order for the arrest of Obregon. Obregon escaped to Sonora where a revolt against Carranza was already in progress and put himself at the head of the troops. In a short time he was master of the situation and on Dec. 1, 1920, was elected president. He immediately adopted a friendly tone toward the United States and other foreign countries, and in 1923 the United States recognized his government. His administration was made notable by many labour and agrarian reforms and by a sincere effort to carry the provisions of the 1917 constitution into force. In 1924 he supported Calles, his minister of the interior, for president. His opponents under Huerta charged fraud in the election and started a revolution. Obregon once more took the field, defeated the rebels and drove Huerta into exile. Obregon was again elected president on July 1, 1928, but on July 17 before taking office he was assassinated.

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OBRENOVIC, the name of a dynasty which supplied several rulers of Serbia in the 19th century. *See* MILOŠ OBRENOVIĆ I; MICHAEL OBRENOVIĆ III; MILAN OBRENOVIĆ IV; and ALEXANDER (ALEXANDER OBRENOVICH).

O'BRIEN, WILLIAM (1852–1928), Irish patriot, was born at Mallow, Co. Cork, on Oct. 2, 1852, son of James O'Brien. a solicitor's clerk. He was educated at the Cloyne diocesan college and at Queen's college, Cork, and began journalism in 1869. In 1881 he became editor of *United Ireland,* which he conducted with such vigour (Aug.–Oct.) that it mas suppressed for the time being, and O'Brien was shut up in Kilmainham jail with Charles Parnell and others. There he drew up the famous "No Rent" manifesto, which led to the Land league's being outlawed.

Released in 1882, O'Brien resumed his campaign in *United Ireland.* He was elected M.P. for Rfallow in 1883. In 1886, O'Brien started the slogan of "no reduction. no rent." Parnell was much out of Ireland and eventually disavowed the "plan." but O'Brien had stirred up a fierce agitation. met by the British government with the Coercion act of 1887, under which O'Brien was sent to Tullamore jail. On his release he appeared in the house of commons to renew his obstructive tactics there.

After the O'Shea divorce case in which Parnell was involved he tried to mediate between the Parnellites and the anti-Parnellites, siding with the majority who rejected Parnell's claim to retain leadership. In 1900, after years of bitter strife, both sections were reunited under the Parnellite John Redmond, largely as a result of O'Brien's formation of the United Irish league. Having given active support to the Land conference. which secured agreement between the landlords and tenants' representatives and resulted in the Wyndham Land act of 1903, O'Brien became convinced that nationalists and unionists could unite for common purposes. He founded the All for Ireland league, which obtained a large following in County Cork, in opposition to Redmond's control of the United Irish league. But O'Brien's personal following did not survive the rise of the Sinn Fein agitation, and after World War I (Irish participation in which he had supported) he withdrew from public life.

He died on Feb. 25, 1928.

O'BRIEN, WILLIAM SMITH (1803–1864), leader of Young Ireland, was born in Co. Clare on Oct. 17, 1803, and educated at Harrow and at Cambridge. He used his second name of Smith on inheriting his maternal grandfather's estates in Limerick. He entered parliament in 1828 as member for Ennis and from 1835 to 1848 represented the county of Limerick. Although he actively supported Catholic emancipation he opposed Daniel O'Connell's election for County Clare in 1828 and continued to oppose repeal of the legislative union until O'Connell's imprisonment at the end of 1843.. O'Brien then joined the Repeal association and was at once appointed deputy leader while O'Connell was in prison. He became closely associated with Thomas Davis and Gavan Duffy and the brilliant group who later became the Young Ireland party; and in 1846 he led them in withdrawing from the Repeal association, when O'Connell demanded repudiation of any conceivable resort to arms. Early in 1847 they formed the Irish confederation, to press for a more active policy during the years of famine. In May 1848, after a mission to Paris to congratulate the new French republic, O'Brien was tried for sedition, but acquitted. He exercised a restraining influence while the young men urged preparations for an armed rising, but the government issued warrants to arrest all the most active leaders. O'Brien then assembled all the leaders to make a last stand in County Tipperary and appealed for a general rising. It collapsed in a short collision with the police and military at Ballingarry. O'Brien was arrested at Thurles, tried for high treason and sentenced to be hanged, drawn and quartered. The sentence was. however. commuted to exile to Tasmania for life. O'Brien obtained a full pardon in May 1856 and returned to Ireland. He died at Bangor, North Wales, on June 18, 1864.

OBSCENITY. By English common law it is an indictable misdemeanour to give an obscene exhibition or to publish any obscene matter, whether it be in writing or by pictures, effigy or otherwise. But the test of criminality as accepted in England is whether the exhibition or matter complained of tends to deprave and corrupt those whose minds are open to immoral influences and who are likely to visit the exhibition, or to see the matter published. If the exhibition or publication is calculated to have this effect, the motive of the publisher or exhibitor is immaterial. Even in the case of judicial proceedings, newspapers are not privileged to publish evidence which falls within the definition.

Besides the remedy by indictment there are statutory provisions for punishing as vagabonds persons who expose to public view in public streets or adjacent premises obscene prints, pictures or other indecent exhibitions. These are supplemented by the Indecent Advertisements act of 1889. By the Obscene Publications act of 1857 powers are given for searching premises on which obscene books, etc., are kept for sale, distribution, etc., and for ordering their destruction, and the post-office authorities have power to seize postal packets containing such matter and to prosecute the sender under the Post-Office act.

The use of obscene or indecent language in public places is punishable as a misdemeanour at common law, but it is usually dealt with summarily, under the Metropolitan Police act of 1839, or the Town Police Clauses act of 1847, or under local by-laws.

In the United States, the different states provide punishment for obscene libel, the exhibition of obscene pictures and the display or use of obscene language in public. The federal government penalizes sending of obscene matter through the mails.

Under the tariff act of 1930 (U.S. Code § 1305) the U.S. may ban the import of "any obscene book." "Obscene" is legally defined in the courts as "tending to stir the sex impulses or to lead to sexually impure thoughts." In a decision of the U.S. district court (1933) by Judge John M. Woolsey, the ban was lifted on James Joyce's modern classic *Ulysses*. Legal precedent was established in the opinion, which describes an investigation of a work of art on literary as well as juridical grounds, from the point of view of both intent and results.

Indecent acts committed with intent to insult females are punishable under the Vagrancy act of 1824 as amended by sec. 42 of the Criminal Justice act of 1925, and if committed otherwise under the acts of 1839 and 1847. (W. DE B. H.; X.)

OBSERVATORY (ASTRONOMICAL). This article covers the important observatories of the world. For a general discussion of the purpose and work of astronomical observatories and for the history and technical aspects of the telescope, see ASTRONOMY and TELESCOPE.

The erection of special buildings for astronomical research is a practice of long standing. It is said by Diodorus that the great temple of Belus at Babylon was built for astronomical purposes, and, since there is indication in the Chinese records that the gnomon was used for measuring the height of the sun in the reign of the emperor Yao (2300 B.c.), it may be said that the beginning of practical astronomy was contemporaneous in eastern and western Asia. There is no evidence of the existence of an observatory of Greek or Alexandrine origin until the time of Ptolemy Soter, who, about 300 B.C., built one at Alexandria. The earliest records from an observatory known to be extant are those of Hipparchus (c. 140 B.c.), who has left a catalogue of stars from observations made at the island of Rhodes, repeating those made earlier at Alexandria. Three hundred years later, Ptolemy (A.D. 150) compiled a star catalogue, but it is doubtful whether this was from his own observation and, therefore, whether he had an observatory beyond that at Alexandria.

The art of astronomical observation was revived several hundred years later in western Asia when observatories were established at Damascus and Baghdad and one at Mokatta by Caliph Hakim about A.D. 1000. A splendid observatory was built at Maragha in northwest Persia by Hulagu Khan about A.D. 1260, but the most productive was that of the Persian prince Ulugha Beigh, grandson of the great Timur, who, at Samarkand with his assistants, made a catalogue of stars from observations with a large quadrant in the first half of the 15th century. Later in that century, about 1471, John Miiller of Konigsberg, better known as Regioinontanus, set up an observatory at Niirnberg, with the help of Bernard Walther of that city, furnished with instruments of his own design, and after his death in 1476, clocks, then a recent invention, were added to the equipment. The first observatory, however, that may be considered a prototype of modern national observatories was that of Tycho Brahe on the island of Hveen (Ven), off the southwest coast of Sweden. To the building commenced on Aug. 8, 1576, he gave the appropriate name Uranibourg ("castle of the heavens").

Tycho **Brahe's** Observatory. — This building was of some magnificence and large enough to house Tycho and several young men who lived with him as students or observers. It was furnished with a large quadrant attached to a wall in the plane of the meridian, for to this astronomer is due the credit of appreciating the advantage of size in instruments of this type, and of the principle which is embodied in the mural circle. There Tycho Brahe with his assistants, one of whom was Longomontanus, a name well known in the science, observed the heavens and produced a catalogue of the positions of more than 1,000 stars. On the death of his patron, Frederick II, in 1588, Tycho was deprived of royal favour and income. In 1597 Tycho left Denmark, the observatory at Hveen having been already dismantled.

The invention of the telescope in 1608 opens a new chapter in the history of observatories, and the building at Padua in which Galileo discovered and made the first observations of Jupiter's satellites on Jan. 7, 1610, may be regarded as the first of a new class. Others were created as additions to universities or similar institutions during the 17th century. In 1637, King Christian IV of Denmark established a permanent observatory at Copenhagen, which was completed 20 years later and then placed under the direction of Longomontanus.

Johannes Hevelius, a member of a noble family of Danzig, built an observatory in 1641 in his own house and furnished it with an azimuthal quadrant of five-foot radius and a sextant of six feet, with which he measured the meridian altitudes of stars, sun, moon and planets, and their distances from one another in the manner of Tycho — that is, with plain sights, believing this to be superior to the newly adopted telescopic method.

Paris, Greenwich **and Others.**—Hevelius died early in 1687 and his work was not carried on, but by that date there had come into existence the two national observatories at Paris and Greenwich. The former was built in the years 1667–71, according to the plans of Claude Perrault, as an architectural monument. Under the Cassinis and others it has done much for astronomy. The Royal observatory, Greenwich, was founded in 1675 for the definite purpose of the improvement of navigation. Architectural pride again entered into the design, for Sir Christopher Wren wrote of it to Bishop Fell of Christ Church. Oxford, as built "a little for pomp," referring to the main building. The essential instruments were housed apart, and Wren's beautiful creation is merely a small item in its extensive domain.

Few establishments of the kind were erected during the next half century. Mainly because of the occurrence of the transit of Venus in 1769, George III built and furnished the King's observatory at Kew. The improvement in reflecting telescopes by James Short and the invention of the achromatic object glass in the latter part of the 18th century marked the beginning of many observatories that have since become famous. The Radcliffe observatory at Oxford was erected 1771–74 from funds bequeathed by John Radcliffe, a court physician, "for charitable purposes," the words being interpreted somewhat widely. Provost Andrews bequeathed a substantial sum for building and endowing an astronomical observatory for the University of Dublin, which was built at Dunsink in 1785, but not furnished with instruments until many years later. An observatory was established and endowed at Armagh in Ulster in 1793, in charge of Primate Richard Robinson, while the most prolific British observatory of the period was that of William Herschel at Bath, Datchet and Slough, successively.

Early Continental Observatories. — Continental observatories established during this period were those of Mannheim (1775), which was transferred to Karlsruhe in 1880, and again to Heidelberg in 1896; Lilienthal, founded by J. H. Schroter in 1779, and furnished with a reflector made by Herschel; Leipzig, where a small observatory existed on the tower of the university in the years 1787–90; Breslau (1790); also one at Seeberg near Gotha, founded by Duke Ernest II in 1788, that was made famous by F. X. von Zach and J. F. Encke. The observatory at Palerrno, Sic., where G. Piazzi made his famous catalogue of stars, was founded in 1790; and at about the same time J. Lalande and his assistants were observing transits of stars from an observatory in the École Militaire, Paris.

19TH CENTURY

British Observatories. — A full list of observatories, public and private, founded in Great Britain during the next 100 years would be large. An observatory on Calton hill, founded by a private association, the Edinburgh Astronomical institution, in 1818, was taken over by the crown as a royal observatory in 1834, and transferred to its present site on Blackford hill in the years 1889–96. Cambridge university observatory was founded in 1820 and under its noted directors, George Biddell Airy, James Challis, John Couch Adams, Robert Stawell Ball and Arthur Stanley Eddington, has done valuable work, and by the end of the century was well equipped with instruments for solar and astrophysical observations. The Radcliffe observatory at Oxford was originally in the charge of the Savilian professor of astronomy, but this arrangement lapsed and the offices of professor and Radcliffe observer became distinct about 1839. In 1875 the University observatory came into existence, largely through the liberality of Warren de la Rue, for the use of the Savilian professor. The work of this observatory has been primarily photographic. An observatory was established at Liverpool mainly for the time service of the port in 1838, and at Glasgow a small observatory attached to the university, of which Alexander Wilson had been the first director about 1760, was enlarged and transferred to a new site in 1836.

Among private observatories the reflecting telescope, with a six-foot mirror made by Lord Rosse and set up at his seat, Parsonstown, Ire., in 1845, is famous, and scarcely less so are the smaller instruments of the same type made by William Lassell, and used by him at Liverpool 1844–52.

Observatories established in England in the second half of the 19th century were those of De la Rue, a pioneer in astronomical photography, at Cranford in Middlesex; of George Knott at Cuckfield, Sussex; of William Huggins, the famous spectroscopist, at Tulse hill, the private observatory of Norman Lockyer, who afterward developed spectroscopic research at a state-supported establishment at South Kensington. Those of Edward Crossley at Halifax. Yorkshire, and Thomas Espin at Towlaw, Durham, have reputations based on double-star observations.

Colonial Observatories. — A feature of the 19th century was the establishment of British colonial observatories. Acting on the proposal of the board of longitude in 1820, the lord commissioners of the admiralty resolved to establish an observatory at the Cape of Good Hope for the improvement of practical astronomy, which came into being in the year 1829, and fulfilled its purpose as a government observatory under the directorship of Thomas Maclear, Edward James Stone, David Gill, George Washington Hough, Harold Spencer Jones, John Jackson and R. H. Stoy (from 1950). This observatory has a reversible transit of modern type and an equatorial twin telescope with a 24-in. photographic lens and 18-in. visual lens. known as the Victoria telescope for photographic and spectroscopic work. In 1834 Sir John Herschel established at the Cape a temporary observatory which is historically important. During four years he completed a survey of the southern heavens, extending the work his father had done many years earlier on the northern sky.

The first observatory on Australian soil was one on Dawes point, the headland on which stands the present Sydney observatory, established in 1786. In 1853 Robert L. Ellery was appointed to superintend an astronomical observatory at Williamstown which was moved to Melbourne in 1861–63. With the observatories of Sydney and Perth, Melbourne has taken a share in the international work of charting the heavens by photography, and in addition meridian observing, magnetism, seismology, meteorology and time service form its activities. The Adelaide observatory was not completed until 1861. The observatory of Western Australia at Perth was established 30 years later. The aim of a small observatory established at Wellington, N.Z., under Sir James Hector, in 1869 for time service was later enlarged and the institution called the Dominion observatory.

Continental Observatories. — During this period many observatories were established on the continent of Europe, two of which were made famous by the labours of Wilhelm Struve. The University of Dorpat, Livonia, Russia, possessed in 1809 an observatory of small dimensions, scantily equipped, of which Struve, a student of astronomy in the university, was given charge in 1813. His successful work attracted the attention of the Russian government, and soon the observatory was furnished with such instruments and pecuniary means as to raise it to the rank of a first-class establishment, where Struve, almost single-handed, produced results of a very high standard. Attracted by Struve's work. the emperor Nicholas in 1833 resolved to erect a central observatory for the empire of Russia, and. largely to Struve's design. an observatory was completed in 1839, at Pulkowa near St. Petersburg, which was considered to be the finest and best equipped of the time. Another observatory of the first half of the 19th century, though not on the magnificent scale of Pulkowa, but associated with the name of a distinguished astronomer. was that of Königsberg. established by the king of Prussia in 1813 and put in the charge of F. W. Bessel who had already made a reputation at the observatory at Lilienthal. The observatory at Altona near Hamburg, completed in 1823, was made famous because of its association with Heinrich Christian Schumacher, to whom is ascribed the encouragement given to astronomy by the Danish government, In 1874, this observatory was transferred to Kiel, which had then become the chief German naval station, and formed the international central bureau for distribution of astronomical information until World War I, when this useful work was transferred to Copenhagen.

The Royal observatory at Berlin had its origin in the year 1705. It was with the nine-inch refractor of this observatory that the planet Neptune was first seen. The establishment of an observatory at the University of Bonn was decided on by the king of Prussia, in 1836, and Friedrich Wilhelm Argelander, who had been director of the Abo observatory, Finland, transferred to Helsingfors in 1837, was chosen as director. Although the instruments of this observatory were not large, stupendous work in star cataloguing, its principal branch of activity, was carried out by Argelander and his successors. The University of Strasbourg has an observatory attached to it, completed by the German government in 1881, consisting of three magnificent buildings placed in a large open garden. Its largest telescope, the great equatorial, a refractor with object glass of 20-in. aperture, is said to have been the largest in Germany at the time of its erection. The University observatory, Vienna, built on a new site in the years 1874–80 to replace one that dated from the middle of the 18th century, is a large structure standing in grounds of 14 ac. in extent, with an imposing facade and surmounted by four domes designed on the model of the Berlin observatory. Basel (1874), Bordeaux (1879), Breslau (1790), Budapest (1856), Cracow (1791), Kazan and Leipzig (1790, remodeled in 1861) are other universities of Europe that have observatories attached to them. At Heidelberg (Königstuhl), a private observatory founded by Max Wolf in 1877 was merged with Grand-Ducal institute, established in 1898, which combined two sections — one an astrometric observatory that had existed successively at Schoetzingen, Mannheim and Karlsruhe since 1762, and an astrophysical observatory under the direction of Wolf.

Among the notable observatories in northern Europe established before 1800, but greatly expanded in later years, is the Stockholm observatory, founded in 1748. It is equipped with a large double equatorial telescope, a 40-in. reflecting telescope and many modern auxiliary instruments. Also notable are the observatory of the University of Uppsala founded in 1730; the Royal observatory of Lund, first established in 1670; and the University observatory of Copenhagen originally built about 1650 on the summit of the famous "round tower."

Before World War I there were ten French national observatories under the control of a consultative committee that reported annually to the government. The Paris observatory of the 17th century has been mentioned. Some that were resuscitated or created in the ten years after the war of 1870–71 have interesting histories. An observatory at Marseilles, founded by the order of Jesuits in 1702, was taken over in 1763, after the expulsion of the order, as the Royal Naval observatory and was made famous by Jean Louis Pons, Joseph Bernard, Adolphe Gambart, Jean Valz and Jean Chacornac. A new observatory was built in 1862 with which the older one was incorporated and the names of Jean Stephen, Jerome Coggia and Alphonse Louis Nicolas Borelly recall many discoveries of minor planets and comets made with its instruments. The observatory at Toulouse had a predecessor as early as 1718, but the existing establishment dates from about 1840 when it was erected and supplied with excellent instruments at the public expense, but with an inadequate staff, so that it was devoted for many years solely to meteors and meteorology.

The observatory at Bordeaux, together with those at Paris, Toulouse and Algiers, has taken a share in the international work of charting the heavens by photography. The Algiers observatory is an imposing group of buildings set up on a hill at Boudzareah, near Algiers. The observatory at Nice was bequeathed by the founder to the University of Paris in 1899 and later ranked as a national institution. Other observatories were located at Montsouris, Besançon and Lyons. The list of ten is completed by the observatory at Meudon near Versailles. For many years it has been pre-eminent in solar physics. It also has the largest refracting telescope in Europe, of 33-in. aperture, which was used extensively for study of the planet Mars.

U.S. Observatories. — The first U.S. observatory is said to have been erected at the University of North Carolina. Chapel Hill, in 1831–32. It was destroyed by fire in 1838. Projects for observatories mere started at Williams college, Williamstown, Mass., in 1836; at Hudson, O., 1836–37; and for the National observatory at Washington, D.C., which was actually established by Lieut. J. M. Gilliss of the U.S. navy in 1843–44. The movement was encouraged and in many cases observatories were created by collective financial help. By the efforts of O. M. Mitchel, money was raised for shares in a public company to build an observatory at Cincinnati, O. The first meeting of stockholders was held on May 23, 1842, and an object glass 11 in. in diameter, which was quite large for that epoch. was procured during the summer. The Litchfield observatory of Hamilton college, Clinton: N.Y., was founded by public subscription in 1852. An observatory attached to the University of Missouri, Columbia. in 1853 was afterward improved by a gift from S. S. Laws. In 1856, the Dudley observatory, Union college, Albany, N.Y., was established by gifts from local citizens, and was named for the largest donor, Mrs. Blandina Dudley. The Allegheny observatory of the University of Pittsburgh. Pa.. founded in 1860, was completed in 1867 through the liberality of W. Shand. The Dearborn observatory of The University of Chicago was built in 1864, but was moved to Northwestern university, Evanston. Ill., in 1887. The Halsted observatory, attached to Princeton university, came into existence in 1866. The Leander McCormick observatory of the University of Virginia, Charlottesville (1883), Washburn observatory of the University of Wisconsin, Madison (1878), University of Michigan observatory, Ann Arbor (1855), and other university observatories are used for both purposes of education and astronomical research.

The U.S. Naval observatory at Washington, D.C., is somewhat akin to Greenwich, since it is a nationally supported institution for the purposes of the navy. Chronometers and compasses are tested, and the staple astronomical work has been the making of star catalogues and astronomical calculations.

One of the most famous of the observatories of the 19th century was that of Harvard college; the origin is associated with William Cranch Bond! a member of a Cornish family that emigrated in 1786 and settled in Portland, Me.. where he was born in 1789. Bond had great aptitude for scientific research, especially astronomy. and when, in 1837. it was decided to build an observatory for Harvard, he, though engaged in a profitable manufacturing business, accepted the invitation to take charge. No salary was attached to the office until 1846. The original Harvard observatory (Dana house, 1839) and the new observatory (1843–47) were established by public subscription. Under the direction of E. C. Pickering, the work of this observatory was mainly photometric and spectroscopic. Harvard had no telescope of size until the new observatory was furnished with a 15-in. equatorial telescope, one of the two largest made up to then. Later a photographic telescope of 24-in. aperture was added, the gift of Miss Catherine Bruce. Harvard had a branch observatory in Arequipa, Peru, at a high elevation in the Andes, built and largely supported by a sum of money bequeathed for the purpose by Uriah Boyden, but this branch was in 1928 transferred to South Africa.

Yale university has an observatory. founded in 1882, which is known for its work on the determination of stellar parallaxes and theoretical astronomy. The private observatory of Percival Lowell of Flagstaff, Ariz., has attracted attention because of the observations of the surfaces of the planets made there, for which it was founded in 1894. The outermost planet, Pluto, was discovered there in 1930.

In South America, there had been an observatory at Buenos Aires. Arg, in 1822, whose period of activity was short, so that the National observatory at Santiago, Chile, may be regarded as the first permanently founded (1856) on the continent. The National observatory of the Argentine republic established at Córdoba in 1870, did good service in cataloguing the stars of the southern hemisphere. It acquired a 60-in. reflecting telescope. The other major South American observatory, also in Argentina, was founded at La Plata in 1882.

The last quarter of the 19th century may be said to have seen the beginning of the era of the large telescope, though the large specula of Parsonstown (6 ft.) and Melbourne (4 ft.) were earlier. The 26-in. refractor at Washington, D.C., dates from 1873, but a few years later a telescope was made on a considerably larger scale through the beneficence of James Lick. This telescope, with object glass 36 in. in diameter, is set up in an observatory on Mt. Hamilton. Calif. In 1895 a reflector with a silver-on-glass mirror of 36-in. diameter, that had been used by A. A. Common, was presented by Edward Crossley of Halifax, Eng., and with these two instruments and others, the Lick observatory attached to the University of California, Berkeley, has done much photographic and spectroscopic observation. The size of the larger instrument mas surpassed ten years later when, in Oct. 1897. through the efforts of George Ellery Hale, C. T. Yerkes presented a refracting telescope with object glass of 40-in. aperture, together with a large observatory building containing it on the shore of Lake Geneva, Wis., to The University of Chicago. From that date the Yerkes observatory has been pre-eminent in spectroscopy and astrophysics, and has contributed much to our knowledge of double stars, planets, satellites and comets.

20TH CENTURY

Modern Observatories. — The names and locations of active and inactive observatories are printed yearly in the *American Ephemeris and Nautical Almanac.* The progress of astronomy and the changes in the aim of celestial research have brought changes in the characteristics of observatories. At the beginning of the 19th century the equipment of an observatory may be said to have consisted of a meridian instrument with an equatorial as subsidiary; in the latter half of the 20th century the latter mas generally the more important instrument, usually supplemented by photographic equipment, spectrographs and other instruments. The routine determination of the positions of sun, moon, the planets and stars, however. continues as standard work at Greenwich, Washington, D.C., and other national observatories, since such records are necessary for the maintenance of fundamental astronomy.

Outstanding trends of the 20th century have been the making of large telescopes, in some cases of novel design for special researches, and the establishment of branches to existing observatories in places considered more suitable meteorologically than those of their parents. One important example is the observatory set up in 1904–05 on Mt. Wilson, 5,700 ft. above sea level, near Pasadena, Calif. This observatory was established by George Ellery Hale as a department of the Carnegie institution of Washington, D.C. The telescopes are on Mt. Wilson where the observations are made. The library, laboratory, administrative offices and machine shop are in the valley below. For solar observations two tower telescopes — one 150 ft. high and one 60 ft. high — are used. A revolving mirror, known as a coelostat, and a fixed mirror on the top of the tower reflect the sun's light through an object glass downward. In each of the towers the spectrograph is mounted in a well under the tower, the depth of the well being one-half the height of the tower. With these instruments a continuous photographic record of the sun's surface is maintained day after day. This observatory has two large reflecting telescopes, one having a mirror 60 in. in diameter and one with a mirror 100 in. in diameter. The 100-in. telescope has been used with an interferometer for measuring the diameters of stars and has served for a great variety of researches. Optical arrangements for both telescopes provide for the use of different focal lengths in the Newtonian, Cassegrain or coudé form, and include powerful spectrographs. Additional instruments are a horizontal solar telescope, a 50-ft. interferometer, and 10-in. and 5-in. photographic refractors.

Another large U.S. observatory is the McDonald observatory of the University of Texas, Austin. Established in 1939 on Mt. Locke, 6.828 ft. above sea level. in the Davis mountains of Texas, it was organized under a co-operative agreement between two universities, the University of Texas building the observatory and The University of Chicago providing the scientific staff. The mirror is 82 in. in diameter and is mounted in a telescope of the cross-axis type, with the tube situated on the side of the polar axis. There is a prime-focus camera used for direct photography at the focus of the 82-in. mirror, without other reflections such as are common in a Newtonian telescope. A second camera provides for direct photography at the Cassegrain focus. Spectrographic equipment includes a slitless spectrograph for low-dispersion spectra, a spectrograph for use at the Cassegrain focus and a coudé focus spectrograph for high-dispersion spectra. The program at McDonald has been mainly spectrographic. The Perkins observatory was founded at Ohio Wesleyan university, Delaware. O., in 1924. It is equipped with a 69-in. reflecting telescope and is operated jointly with Ohio State university, Columbus.

Palomar Observatory.— This observatory was built by the California Institute of Technology to which the General Education board of the Rockefeller foundation made a grant in 1928 for the construction of a 200-in. reflecting telescope. Its operation is under a joint co-operative plan between the California institute and the Mt. Wilson observatory of the Carnegie institution. It is located at an elevation of 5,600 ft. on Palomar mountain, which is about 100 mi. from Mt. Wilson. The combined institutions are officially named Mt. Wilson and Palomar observatories.

The dome and building for the great telescope were erected in 1938. The dome, which is 137 ft. high and of about the same diameter, is insulated throughout to protect the telescope from change of temperature when not in operation. The building which supports the dome has three floor levels on which are offices, photographic rooms, air-conditioning units, electrical switchboards and motors, and a large vacuum chamber for aluminizing the 200-in. mirror.

In the centre of the building, rising to the height of the third or operating floor, is the heavy structural steel framework which supports the two pedestals carrying the telescope. The frame or yoke in which the tube rests is rectangular in shape with tubular side members 10 ft. in diameter. A unique feature is the horseshoelike form of the north member of the yoke which permits the telescope to be turned northward as far as the north pole. The lower surface of this member is accurately faced and serves as the north-bearing surface of the telescope mounting. The tube and frame, weighing a total of about 500 tons, are carried on a system of bearings employing high-pressure oil pads which nearly eliminate friction and provide remarkable ease of motion.

The tube, 22 ft. in diameter, is designed to avoid angular deflections at its ends and thus to reduce injurious effects of flexure. Uniform driving of the telescope is accomplished by a synchronous motor fed by current generated by a vibrating string standard and suitably amplified.

The disk for the zoo-in. mirror is a single block of Pyrex glass cast by the Corning Glass works. It consists of a surface plate about 6 in. thick supported by a network of deep ribs. An opening 40 in. in diameter is cast in the centre of the disk. The finished mirror weighs about 16 tons. In the first grinding to spherical form in 1938, more than five tons of glass were removed. The slow and difficult work of parabolizing the surface was interrupted by World War II. The mirror was completed and installed in 1948. This instrument, named the Hale telescope, is used in two forms: primary focus with focal length of 55 ft.; and coudé combination, equivalent focal length 500 ft. In addition to the Hale telescope, the Palomar observatory put in operation a 48-in. telescope of the Schmidt type, working at ratio F/2.5 and utilizing a 72-in. concave spherical mirror. Smaller instruments include an 18-in. Schmidt telescope and a 20-in, reflector.

Other Observatories.— Canada has a 72-in. reflector at the Dominion Astrophysical observatory established in 1916 at Victoria, B.C., as a branch of the Dominion observatory at Ottawa, which itself had grown from a modest establishment used by the survey department. The telescope has been devoted chiefly to astrophysical work. In 1935 this size was surpassed by the 74-in. Pyrex mirror at the David Dunlap observatory of the University of Toronto. In spite of a rigorous climate this reflector has performed admirably.

In the eastern hemisphere an observatory specially adapted for solar investigation was established in Canberra, N.S.W., by the federal government of Australia as a link in the chain' of such institutions around the world, of which the Solar Physics observatory at Cambridge, Eng. (moved from South Kensington in 1911), and that at Kodaikanal, southern India (which was established as a government institution about 1900 and replaced, in part, the observatory of the government of Madras founded in 1792), are others. The D. O. Mills expedition from Lick observatory established a 37-in. reflecting telescope at Santiago, Chile, in 1903 for spectroscopic study of southern stars. This station was discontinued in 1929. The former Harvard southern station, located near Bloemfontein, U. of S. Af.. is known as the Boyden observatory and is operated jointly by six northern institutions: Armagh, Dunsink, Hamburg, Harvard. Stockholm and Uccle. It has a 32-in. reflecting telescope of the Baker-Schmidt type and a 60-in. reflector, one of two in the southern hemisphere. The other is at the National observatory, Córdoba, Arg. Yale university set up a southern branch in 1925 at Johannesburg, U. of S. Af., where a 26-in. photographic refractor was used for measuring stellar parallaxes. It was transferred in 1955 to Mt. Stromlo, Austr., to be used jointly with Columbia university. The University of Michigan established a branch at Bloemfontein in 1927, primarily for the study of double stars. The principal instrument is a 27-in. refractor. From 1954 to 1958 it was used by the Lowell observatory for the study of Mars. The observatory of the Union of South Africa at Johannesburg has a 26-in. refractor. The largest instrument in the southern hemisphere is the 74-in. reflector of the Radcliffe observatory at Pretoria, U. of S. Af., in operation from 1948. A telescope of equal dimensions was placed in operation in 1955 at the Commonwealth observatory, Mt. Stromlo. In 1942 the National Astrophysical observatory in Tonanzintla, Mex., was dedicated. Its principal instrument is a 22-in. reflecting telescope of the Schmidt type.

Some notable additions were made to the observatories of Europe in the first quarter of the 20th century. Since the climate of Pulkowa, U.S.S.R., was considered to be unfavourable for observation, three branch establishments were founded through the influence of Oscar Backlund, its director: at Odessa (1898) and Nikolayev (1912), for astronomy of position, and at Simeis in the Crimea for astrophysical work. Backlund died in 1916, but in his last years the Russian government sanctioned the expenditure of large sums of money for equipment for the new observatories, and during 1926 a reflecting telescope with a mirror 1 m. in diameter and a photographic refractor with an objective of 41-in. aperture were supplied to the Simeis observatory by a British firm. The observatory of Geneva, Switz., which is of very early foundation (1772), possesses a reflector with mirror 1 m. in diameter, the gift of a member of the staff. The Astrophysical observatory at Potsdam, Ger., which dates from 1878, was enriched by the addition of a 32-in. photographic refractor in 1899, and in 1921 a tower telescope was erected in its grounds as a tribute to Albert Einstein.

A tower telescope was set up at the Royal Astrophysical observatory at Arcetri (Florence) designed for solar observation. A new object glass was supplied to this institution in 1925 by the German government, by way of war reparation. The Italian Royal observatory at Milan, with which the name of Giovanni Virginio Schiaparelli is associated, was removed and improved by the help of resources similarly supplied. The observatory at Bergedorf, Ger., 5 mi. S. of Hamburg, developed out of a local school of navigation in the city of Hamburg. Contributions by the citizens for instruments enabled the school to grow into the Hamburg municipal observatory. In 1906 it was transferred to Bergedorf and the new establishment was completed in 1909. In addition to instruments used for time service, there is a reflector, 1 m. in aperture, and a large twin telescope for photography. This observatory has been especially successful in the discovery of comets.

In Great Britain, transfer of the Royal Greenwich observatory to Herstmonceux castle in Sussex began after World War II and was completed in 1958. The original site at Greenwich, now surrounded by the city of London, is a park, but the main building designed by Wren has been preserved. The Norman Lockyer observatory, originally the Hill observatory, is on the top of Salcombe hill near Sidmouth, Devon. It contains instruments from the observatory of Frank McClean at Rusthall, near Tunbridge Wells, and others used at the government establishment formerly at South Kensington. The spectroscopic classification of stars and the determination of their parallaxes from examination of their spectra were covered in its program.

In 1914 at the Allegheny observatory, Pittsburgh, a go-in. long-focus photographic refractor was completed. This instrument, at mid-20th century still the largest of its kind, has been used almost wholly for measurement of stellar parallaxes. A 37-in. reflecting telescope was installed at the University of Michigan in 1911. At the Lick observatory, a 120-in. reflecting telescope was completed in 1958. Schmidt-type telescopes of 24-in. aperture were placed in operation at Warner and Swasey observatory, Case Institute of Technology, Cleveland, O. (1941), and at the University of Michigan (1950). The McMath-Hulbert observatory, also a part of the latter institution, has been devoted primarily to the study of the sun. It has two tower telescopes (40-ft. and 70-it.), the larger equipped with a vacuum spectrograph.

Funds granted by the National Science foundation will be used to establish a U.S. National observatory. The site, at Kitt Peak, Ariz., was selected early in 1958. The first instruments planned were 36-in. and 80-in. reflecting telescopes. An observatory of an unusual type was established in France in 1930 by Bernard Ferdinand Lyot of Meudon, who set up his apparatus on the Pic du Midi in the Pyrenees mountains at an elevation of 9,300 ft. There, with a special refracting telescope and optical system of his own design, he obtained remarkable results in the photography of the solar corona. prominences and spectrum of the corona in full sunlight. Using a cinematograph, he was able to record the movements of the prominences by means of motion pictures. A station of the Harvard observatory using equipment of a type similar to that of Lyot was established at Climax, Colo., in 1940. This became the high altitude station of the University of Colorado. A still more elaborate solar observatory of similar type was established by the U.S. air force in 1951 at Sacramento Peak, N.M.

In World War II many observatories in continental Europe and some in England were damaged. Two great Russian observatories, Pulkowa and Simeis, were almost totally destroyed. Restoration of the Pulkowa observatory was completed in 1954. New and modern equipment has been added to the larger observatories in the U.S.S.R. since World War II. The Crimean Astrophysical observatory has a jo-in. reflecting telescope, and construction of a reflector of 104-in. aperture was begun in the late 1950s. The Sternberg Astronomical institute at Moscow and the Byurakan observatory in Armenia are the other major institutions. Noteworthy solar installations are operated at the universities of Leningrad, Lwow and Kharkov.

Radio Observatories. — Radio waves from space were first recorded in 1931 by Karl Jansky of Bell Telephone laboratories, using a directional antenna. Additional pioneering work was done a few years later by Grote Reber, who employed a 30-ft. parabolic reflector of his own construction, at Wheaton, Ill. These installations, though only temporary, deserve recognition as the first radio observatories. Immediately after World War II, great activity in astronomical radio observations began simultaneously in Australia and in England. Most of this early work was done with instruments adapted from the equipment of installations for radar experimentation. After the first successes, design and construction of new "radio telescopes" specifically for astronomical research were begun. This development has proceeded with extraordinary rapidity and recalls the burgeoning of astronomical spectroscopy in the later years of the 19th century.

A radio observatory departs considerably from the traditional plan of an astronomical institution. Instead of a main large building surmounted by domes housing the instruments, the radio observatory consists primarily of the bulky instruments themselves, sometimes spread over many acres, in addition to a comparatively small building to house the recording equipment and a workshop. The offices of the observatory may be located a number of miles from the observing station. Because a radio observatory is not hampered by cloudy weather, continuous automatic recording is possible. However, electrical disturbances can be a serious handicap, and the site for a radio observatory must be chosen at a sufficient distance from industrial establishments.

The largest radio -observatories were developed independently of already existing astronomical institutions. One of the foremost is the Radiophysics laboratory at Sydney, Austr., whose two "Mills cross" antenna arrays have dimensions of 1,joo and 3,500 ft. At the Jodrell Bank experiment station of the University of Manchester, the largest paraboloidal radio telescope, with a diameter of 250 ft.. began operation in 1957. The Cavendish laboratory, Cambridge, Eng., operates an interferometer-type system of four large paraboloids. On the European continent. the most extensive installation is that of the Leiden University observatory, whose large paraboloids have been used to map the distribution of hydrogen in the structure of the Milky Way.

In the United States, the Naval Research laboratory, Washington, D.C., completed a jo-ft. precision paraboloid in 1952, and one 84 ft. in diameter in 1958. The Harvard observatory has a 60-ft. instrument of the same type. The operation of a large array of helical antennas was begun at Ohio State university in the mid-1950s. An 85-ft. paraboloid at the University of Michigan observatory was completed in 1959. The largest such establishment is that of the National Radio observatory at Greenbank, W.Va. Paraboloids 85 and 140 ft. in diameter were scheduled for completion in 1959 and 1960, respectively, and larger instruments were planned.

International Geophysical Year. — This extensive co-operative scientific effort extended over 18 months, beginning July 1, 1957. The primary purpose was the improvement of knowledge of the earth and its atmosphere. However, because of the intimate relation between activity of the sun and conditions in the upper atmosphere, intensive observations of solar activity formed a necessary part of the program. The solar observations were carried out in part by already existing, well-equipped solar observatories (such as Mount Wilson, Sacramento Peak and McMath-Hulbert). In addition, a number of special stations were established. A total of 120 stations in 31 countries maintained an essentially continuous patrol for recording solar flares and other phenomena. New equipment of special design was constructed for this purpose.

Tracking of the artificial satellites was another astronomical program of the IGY. The Smithsonian Astrophysical observatory, with headquarters at Cambridge, Mass., established several observing stations at widely separated places. These were equipped with specially designed cameras for taking precisely timed photographs of the satellites.

A number of observatories also co-operated in precise determination of latitudes and longitudes by observing the moon's position referred to the stars. Specially constructed cameras were used for this purpose. See also INTERNATIONAL GEOPHYSICAL YEAR.

Possible Future Developments. — In the mid-20th century the radio telescope was the most spectacular example of the way in which important fields had been opened up by new types of instruments. Another example that foreshadowed possible future standard practice was "Project Stratoscope" of the Princeton University observatory. In Sept. 19j7 a 12-in. reflecting telescope was carried by an unmanned balloon to a height of over 80,000 ft. Photographs of the sun were taken automatically and the equipment dropped by parachute.

The successful launching of artificial satellites by the Soviet Union and the United States indicated the possibility of carrying considerable weights of equipment above the atmosphere. It was clear that such satellites would eventually be used, at least to a limited extent, for certain types of astronomical observation that were impossible at the earth's surface. This was a far cry from the traditional observatory with its fixed instruments.

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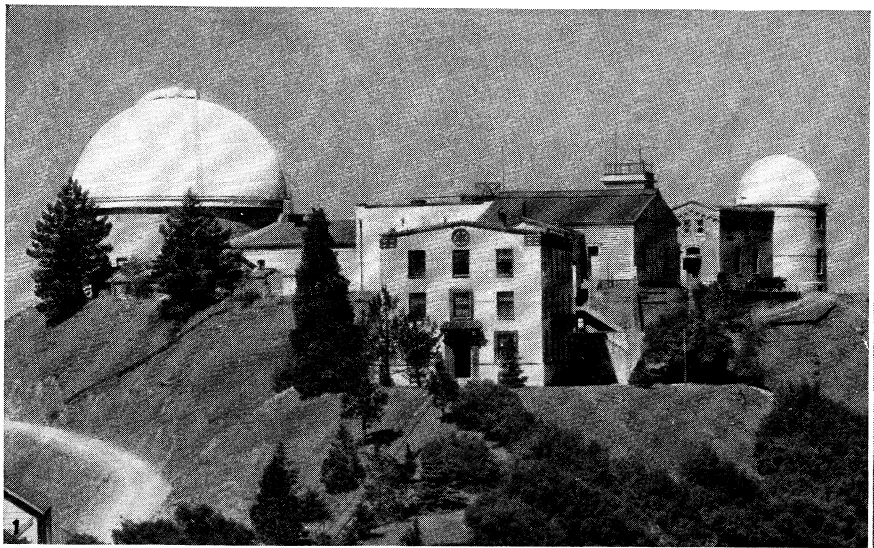
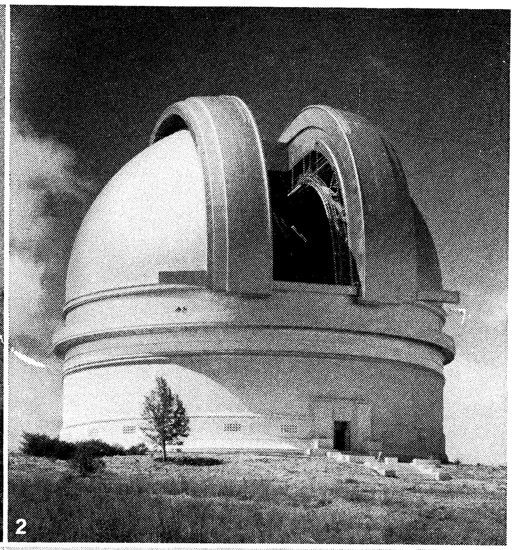
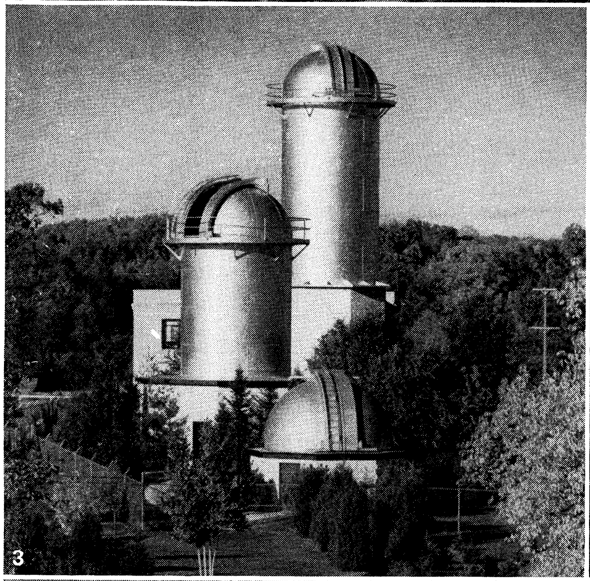
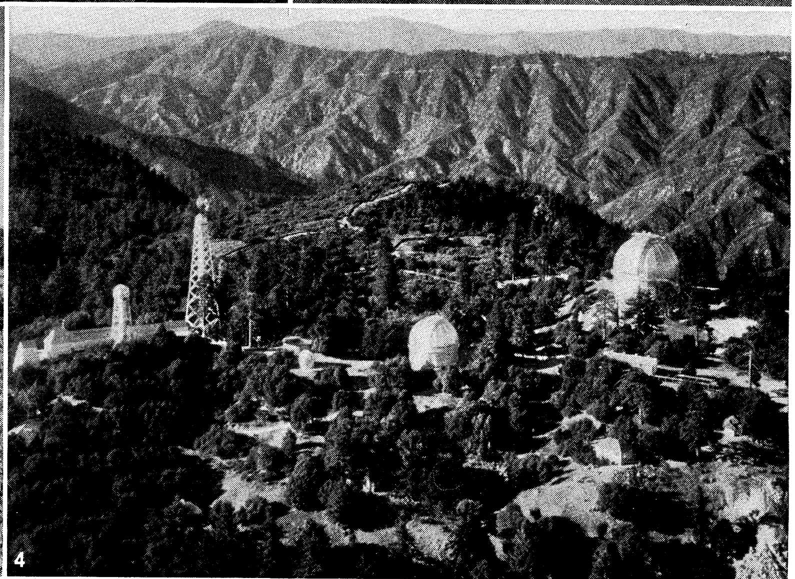
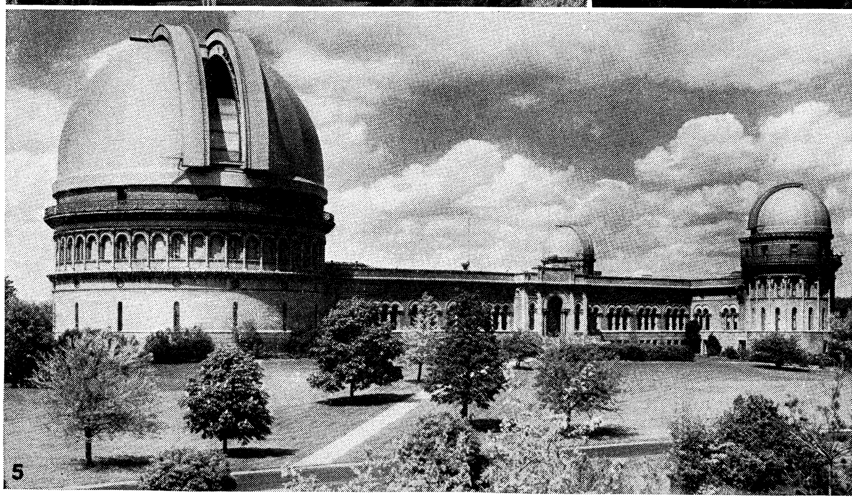
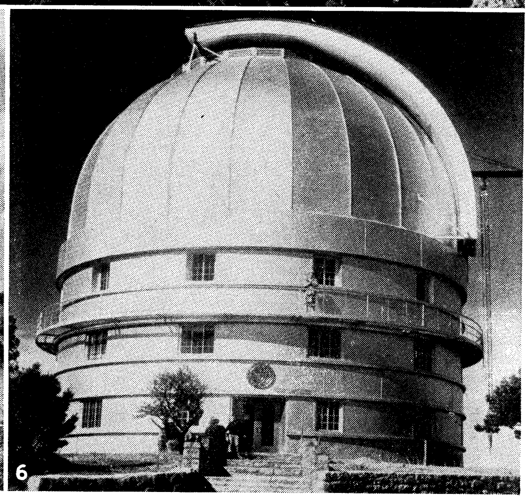








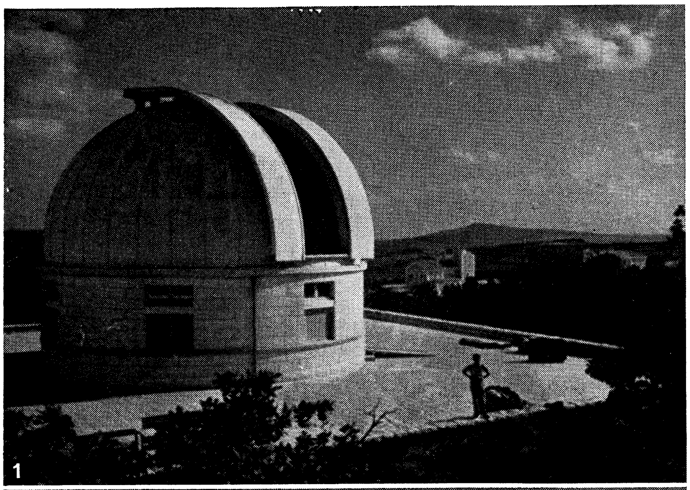


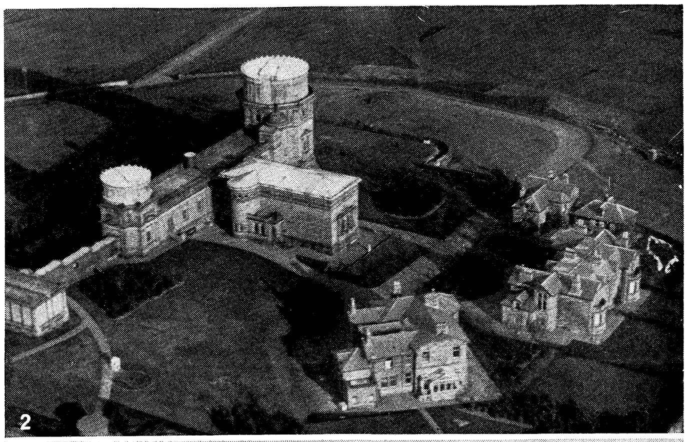


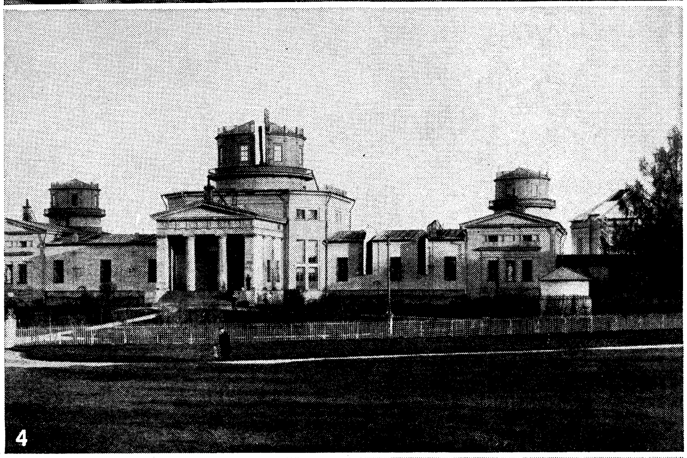
BY COURTESY OF (1) LICK OBSERVATORY, (2) EDISON R. HOGE, (3) THE DIRECTOR, MC MATH-HULBERT OBSERVATORY, (4) FAIRCHILD AERIAL SURVEYS, (5) YERKES OBSERVATORY, (6) ELWOOD M. PAYNE

AMERICAN OBSERVATORIES

1. The Lick observatory on Mt. Hamilton. Calif., completed in 1887–88. The domes on main buildings covering the 36-in. and 12-in, refractors are shown
2. The dome of the 200-in. Hale reflecting telescope, at Mt. Palomar, California
3. The McMath-Hulbert observatory of the University of Michigan. located near Pontiac, Mich., and devoted to solar work. The smallest dome houses a 24-in. reflecting telescope. The middle tower contains a coelostat and the tower-type solar telescope with a 30-ft. spectrograph. The highest tower also houses a coelostat and tower-type solar telescope with vacuum snectrograph
4. Mt. Wilson observatory, near Pasadena, Calif., established in 1904–05. its largest reflecting telescope, completed in 1917, has a mirror 100 in. in diameter
5. Yerkes observatory of the University of Chicago, at Williams Bay, Wis., completed in 1897. View from the southwest
6. The W. J. McDonald observatory. Dome of the S2-in. refiecting telescope of Mt. Locke, Texas. Founded in 1939 jointly by the University of Texas and The University of Chicago







BY COURTESY OF (1), (3), (4) YERKES OBSERVATORY. (2) THE ASTRONOMER ROYAL FOR SCOTLAND, (5) THE DIRECTOR LA PLATA OBSERVATORY

OBSERVATORIES OVER THE WORLD

1. Dome of the 48-in. reflecting telescope of the Astrophysical observatory near St. Michel, 60 mi. northeast of Marseille, France
2. Royal observatory, Edinburgh, Scotland. On Blackford hill. Established in 1896 in place of an observatory on Calton hill, Edinburgh
3. Office building of the Astrophysical observatory near St. Michel, France
4. General view of the historic building of the Pulkowa observatory in the U.S.S.R., destroyed during the siege of Leningrad in World War II. The Russian government reconstructed the building on the original plans with instruments of modern type
5. General view of the La Plata observatory at La Plata, Argentina

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OBSERVER CORPS IN AIR DEFENSE. World War I, England.—At the beginning of world war hostilities in 1914, the necessity of an air-raid warning service was hardly envisioned, but it was not long before the importance and desirability of such an observer system to transmit intelligence of enemy aircraft activity became evident in the British Isles. Flash warnings, it was obvious, would prove invaluable for air defense as well as to centres about to be attacked.

At first in Great Britain the defenses were limited to telephone reports to the admiralty from police within 60 mi. of London. In 1915 the system was extended to cover England and Wales, with reports telegraphed by local chief constables to the admiralty, which then informed the war office.

In 1916 the war office took charge, a more efficient system of observers was introduced with cordons of 30 mi. outside vulnerable areas, while London was provided with two cordons and coastal posts were established. In the autumn of 1917 the London air defenses were reorganized under General Ashmore. The aeroplane patrol improved steadily, but information from the observers as to enemy aircraft operations was not yet quick enough or reliable enough to aid the defensive pilots. German activity early in 1918 being confined to London and its south and east, a new system was devised: the attacked areas were covered with the various units of the defense, coastal posts, squadrons, guns, searchlights and balloon aprons. These units reported activity of the enemy aircraft, the information filtered through certain centres and then was added to a big map in headquarters. All report message lines were open during operations and no connections were necessary. Extensive telephone construction work was not completed until after May 19, 1918, the date of the last air raid.

Air defense revival early in 1924 found large vulnerable areas without observers; despite the simplicity of demands by the service, intelligence reports would be lacking on enemy aircraft movements over Great Britain. Therefore the country was covered by watchers in series of observation posts, six to eight miles apart, equipped with complete telephone service. The year 1924 saw the first experimental operation around Cranbrook, the reporting centre It proved the system feasible, and valuable experience was gained.

In 1925 the system was extended to two zones covering the whole of Kent and Sussex, each zone consisting of a network of observer posts with lines to a local centre and then to the headquarters of the air defense. Chief constables and special constables manned the equipment, and the R.A.F. tested the layout by day and night operations. As a result the organization received the official sanction of the home office and the war office, and by 1927 the system embraced Hampshire, Sussex, part of Surrey, Kent, Essex and half of Suffolk. Observers, without pay, were efficient and alert.

World War 11.—Air raid defense or the protection of the civilian population caused both Allied and axis governments grave concern, so much so that in 1938 German, Swedish and British civil defense personnel were working together in and around the dockyard towns on the Medway in England and witnessing exercises carried out with a view to saving life and dealing with casualties. The Germans provided much better shelter than the British, but Britain was *facile princeps* in its fire-fighting organization.

Before World War II, Sir John Anderson (later home secretary and minister of home security in Great Britain, 1939–40) lectured to the Imperial Defense college and to the staff colleges on air raid precautions. People with foresight began to think of the future safety of Great Britain and the commonwealth, and passive defense, air raid precautions or civil defense, the new baby of national defense services, was born. It was not at first a popular step and roused little public interest; during the first year of World War II, before the heavy bombing attacks on Great Britain began, quite a large percentage of citizens almost suggested scrapping the carefully built civil defense organization. The cabinet and the home office meanwhile had deputed to a dozen regional commissioners the duty of co-ordinating civil defense, and these chosen deputies used that time as one of valuable training for fire fighters, rescue and decontamination squads, stretcher bearers, ambulance drivers and attendants, air raid wardens, repair parties, control and reporting personnel, etc. Preparation was made for dealing with the damage to water mains, gas, sewerage and electric light installations.

The shelter problem necessitated the appointment of a special regional commissioner in London. Generally speaking, adequate shelter was provided by local authorities, but some of the boroughs failed to provide proper shelter and since the deep-shelter policy was turned down by the government as too costly to provide or, for a variety of reasons, an impossible undertaking, basements, surface shelters, underground tube station shelters, etc., were put under central control. Bunks were constructed and made available for distribution, priority of supply being given to the crowded East End boroughs. In recasting the shelter problem, the community was impressed with the need for dispersal as opposed to crowding thousands together in large communal shelters. Some of the bigger shelters were hit, and the casualties were heavy.

Civil defense in Britain was a community business on a territorial basis. Local government was mainly responsible for recruiting its members, acquiring its vehicles, establishing its depots and control centres and, largely, for its training and administration. Usually the town clerk, the chief local government official, was appointed official civil defense controller. In some cities and towns this duty was taken over by the chief constable.

Air raid defense from the civil viewpoint was concerned firstly with saving life, limb and suffering. Property generally came second, but industries, utility services and food supplies had high protection priorities, and it was the duty of the regional commissioners to ensure the minimum interference with production, war effort, health, morale and the education and upbringing of youth. Civil defense, when faced squarely, became a matter of common sense. Expert opinion helped in matters of shelter construction, protection against blast and splinter effect, fire fighting and the strengthening of buildings and special protection of such key points as power stations, pumping stations and communication centres. Water supplies for fire fighting during large-scale attacks were not at first up to requirements. The defect was overcome later by the building of an elaborate system of static water tanks and reservoirs.

British National Fire Service.—The National Fire service, built to start with on the peacetime fire brigade system, was enlarged by what was first called the Auxiliary Fire service, comprising thousands of men and women. The National Fire service built up a vast network of controls which extended and co-operated throughout Britain, and developed a new, highly disciplined fire organization that was visited by the fire services of the United States, Canada and other Allied countries, whose representatives worked with the National Fire service for weeks at a time before going back to their own lands armed with experience of wartime fire fighting.

There were 1,725 fires in the city of London on Dec. 8–9, 1940, and 780 serious fires on Dec. 29, 1940, when the Guildhall was damaged and eight Wren churches were destroyed.

On March 19, 1941, there were 1,880 fires within the London region. The heaviest "fire blitz" occurred on the night of April 16, 1941, when there were no fewer than 2,251 fires, mainly in Chelsea, Westminster and Lambeth. On May 10 there were 2,154 fires in the centre and West End of London. The fire blitz then began in Liverpool. Following the London fire blitz of Dec. 1940, the government ordered compulsory fire fighting by civilians. Ellen Wilkinson (parliamentary secretary for the ministry of home security 1940–45) took over the general direction of the fire guard, and between the National Fire service and the wardens' service millions of men and women were trained and exercised until fire watching and fire fighting became part of air raid defense.

Civil Defense Services in Britain.—More than 1,000,000 people were enrolled in civil defense in Great Britain. In London alone, excluding the fire guard, nearly 250,000 people were enrolled to man the different services. The air raid wardens were the "front line soldiers" of the blitz; a very great proportion of them were volunteers or "part-timers." Wardens' work included a greater variety of duties than fell to the lot of any other civil defense service. The control room staff—operators, messengers, teleprinter girls, tally board and plotting clerks and the representatives of the heads of services—were in the charge of a selected deputy who supervised the reports from the wardens; the staff dissected them and dispatched the requisite aid. Members of the rescue party services were mainly builders' workmen, trained to lift steel girders and shift masonry and concrete blocks. They tunnelled under the debris of demolished buildings and cleared a way for the stretcher bearers. The rescue parties had their trucks fitted with standard equipment: jacks, levers. pulleys and tackle, u-ire and hemp rope, acetylene cutting plant, shores, sheer-legs, picks, shovels, axes and tools enough to satisfy most lifesaving and demolition requirements. The ambulance service was mostly run by womsn in civil defense. In London alone this ambulance service conveyed 93.524 casualties to hospitals and 609,783 inter-hospital patients. Other uses were made of this form of transport, and nearly 1,000,000 repair workers were carried for first aid to bombed buildings.

Closely associated with the ambulance service were the mobile hospital units of the field hospital type, usually with a crew of eight: medical officer, qualified hospital nurse, five assistants and man driver. Included in the casualty services were first-aid posts situated in places selected according to density of population and distance from hospitals. Hospitals, their size and capabilities were all worked into the civil defense plan, as were rest centres and mobile supporting columns, consisting of rescue parties and casualty units equipped to be rushed to any area which, through concentrated bombing, found its resources inadequate. An organization for housing the homeless was included in air raid defense and whether the bombed-out people were to be accommodated for a very short time or permanently proved a very heavy commitment, especially in London, where well over 1,000,000 homes were hit and more than 250,000 destroyed. (E R. G R. E.)

The Royal Observer corps was reorganized in 1946, and by 1950 it had a strength of 13,000 men and 2.000 women. (X.)

United States.—In the United States no effort toward creating aircraft warning systems had been made until about 1933. Following the great earthquake in Long Beach. Calif., in 1933, when the sheriff of Los Angeles county, Eugene W. Biscailuz, found he was without communications to the stricken area 20 mi away, an organization for communications in event of disaster was formed. From this evolved the civilian aircraft warning service. utilizing networks of observations and detection of possible enemy aircraft over areas 250 mi. from a central point. These points were known as information centres.

The war beginning in Europe in 1939 intensified the study of this subject in the United States. In total war any object in enemy territory is a military target. The army air corps and allied services conducted several blackouts and enemy air raids, simulating as nearly as possible actual warfare.

These exercises were carried out from 1937 to Jan. 1941. The locations covered were southern California. North Carolina, Alabama and the New England area including the metropolitan area of New York. The first air warning exercise to be conducted in the United States was over 9,000 sq mi. in southern California and central California in 1937; utilizing the Los Angeles county plan, the tests nere carried out by the First Wing G H Q air force and the 63rd antiaircraft artillery for two ueeks. March field, corps area headquarters, was the theoretical objective of the enemy.

The information centre for southern California was equipped with every means of communication, including telephone, telegraph, county forestry circuit. Edison poner and light telephone circuit, teletypewriter circuits, Santa Fe railroad and Southern Pacific railroad telephone and telegraph circuits, commercial radio and amateur wave lenghts in addition to the county short-wave, two-way portable radios under control of the sheriff's office and the army radio network.

A second exercise covering 80.000 sq.mi., comparable to the area of the British Isles and Ireland, was held in 1938. In 1939 the most extensive effort of this type ever attempted in practice involved the entire Pacific coast. Four information centres were set up. two in California, one in Oregon and one in Washington. Army intelligence reported briefly that the service "worked"

From this trial came opportunity to expand further the service. The civil advisory system was inaugurated. operating directly out of the centres, by which information about approaching enemy aircraft was sent directly from communications centre by the sheriff's office to defense industries, aircraft plants. oil, electric and nater systems. During exercises, every vital industry within a radius of 250 mi. was given the warning within a few minutes.

In collaboration with the U.S. army, the Los Angeles county system, known as the aircraft warning system, proved so efficient that it was adopted, with slight modifications, by other large concentrations of population in the United States.

For a large-scale national emergency, the nation was divided into four general areas, with communication centres as follows: northeast, Mitchel field. N.Y.; southeast, Tampa, Fla.; southwest, Los Angeles and March field. Calif.; northwest. Spokane, Wash. It was planned to have the intelligence from observation post spotters flow into the centres after first having been directed through filtering stations in each local area.

Under the general plan of the aircraft warning service, the southern California sector information centre was established at Alhambra, a suburb of Los Angeles, with all incoming circuits terminating at this point. There were four outgoing channels of communication, tno radio, one telephone and one teletypewriter circuit from Alhambra to March field, U.S. air corps defense headquarters. To inform all officers in the Alhambra information centre simultaneously of the contents of a received "flash message," a translux projector was employed, projecting each message on a moving tape which in turn was reflected on a screen above the operating map. The map itself was a relief scale map horizontally placed and surrounded by a gallery for personnel. It was operated by a control board of 300 individual push buttons for lighting up the courses of invading aircraft.

The purposes of the test were to co-ordinate the communication systems of the various agencies comprising the aircraft warning service and train the observers in the proper procedure for transmission of messages, identification of aircraft, etc.

An aircraft warning experiment was held in the New York-New England region from Jan. 21 to 24, 1941, under the direction of the G H.Q. air force. A corps of civilian observers, organized under the auspices of the American Legion, worked with the army. The communications network was operated by the American Telephone and Telegraph company and its affiliated companies

The test was excellently co-ordinated and proved the feasibility of the plan which the army was formulating. As a result of the test an orientation and indoctrination course was held at Mitchel field, L I., from March 2; to April 13, 1941, during which all knouledge on the subject was weighed and explored with a view to setting up a fixed and standardized aircraft warning service. (H. E. Hy.)

In Sept. 1939 the governor of New Jersey appointed an emergency defense committee. In May 1940 Tennessee and Virginia organized the first state defense councils. By May 1, 1941, defense councils had been established in most of the states and in more than 1,000 communities. On May 20, 1941, the president, by executive order, established the Office of Civilian Defense. The interest of the U. S. public in air raid defense followed the course of the war. At the time of Pearl Harbor, civilian defense had 3,516,600 volunteers and 7,031 defense committees. Two years later there were more than 12,000,000 registered, of whom 5,534,000 were assigned to duty in the protective services. By then the United States had the largest force of civilian volunteers ever formed for war service Air raid defense included the army, the air force, Civil Air Patrol, state guards, state police, Red Cross and community welfare services. Each had a role and uas prepared to carry out its part.

When war was declared, the framework was well under way.

The pattern was that set up in England as a result of experiences there in 1940 and 1941. These demonstrated that the armed forces and the peacetime services of fire, police and medicine were not capable of meeting the impact of the new strategy of total war; that the existing services should be expanded with added equipment and personnel; new services should be added and the individual schooled to take care of himself and his home; and the nation should be mobilized to protect itself.

The OCD (headed by a director appointed by the president), with nine regional offices, was the national organization. Each state had its state defense council and many local councils, of which there were, at the peak, more than 12,000. Every community likely to be attacked organized one. The national government had no authority over the state or local councils. The OCD was a planning and co-ordinating body. The state and local defense councils were the operating units.

OCD set up the Civil Air Patrol, Forest Fire Fighters service, Facility Security program and civilian protection schools. Its training manuals and guidance on gas defense, blackout, dimout, shelters, camouflage, organization, communications, safety measures and the many other problems of civilian defense were followed by state and local councils. It became the research and advisory centre.

The army air force operated the Aircraft Warning service, with about 600,000 volunteers to warn communities of impending attack. To ensure necessary uniformity, the army promulgated an air raid warning system and controlled practice blackouts. The local units had the true responsibility. Operating through a staff, air raid warden, auxiliary police. auxiliary fire, utility repair, road repair, emergency medical and related services and headed by a commander—the mayor, a well-known citizen. or the head of the police department—these people took their task seriously. They knew that if they failed in their mission there was little hope for their community. Each local unit was expected to be strong enough to handle any anticipated attack.

Every community was far short of the fire equipment necessary to handle effectively the fires resulting from even a small attack. To meet this, in Feb. 1942, congress appropriated $57,000,000 for pumpers, hose and other equipment for communities in critical zones. and $43,000,000 for gas masks, helmets, arm bands, medical supplies and miscellaneous equipment for the individuals of the defense corps.

Neither Germany nor Japan was capable of bombing the United States during World War II. How well the civilian defense organization would have kept down the effect of any air raid attack was unknown. Some units performed creditably in local emergencies, which were, in some sense: tests of their efficiency. Experiences elsewhere pointed to many ways in which it might have been improved, yet it accomplished much. It stood out as the greatest example of U.S. mass mobilization, organization and training ever undertaken by volunteers. Communities found a way to unite by themselves for their own welfare. It gathered the people behind the war effort.

After World War II civilian volunteers, serving without pay, were organized as members of the Ground Observer corps, established to supplement coverage provided by radar networks. The civil authorities were made responsible for the administration of the corps, including recruitment, assigning duties, etc., and the air force supervised the tactical operation, including training. The air force headquarters was established at Ent Air Force base. Colorado Springs, Colo. A number of filtre centres were organized as central points to gather information from observers, plot the course of aircraft, pass on the information to the military air defense authorities. etc.

The U.S. Ground Observer corps was discontinued in Jan. 1959 because of the rapid development of electronic means of detection. See AIR DEFENSE.

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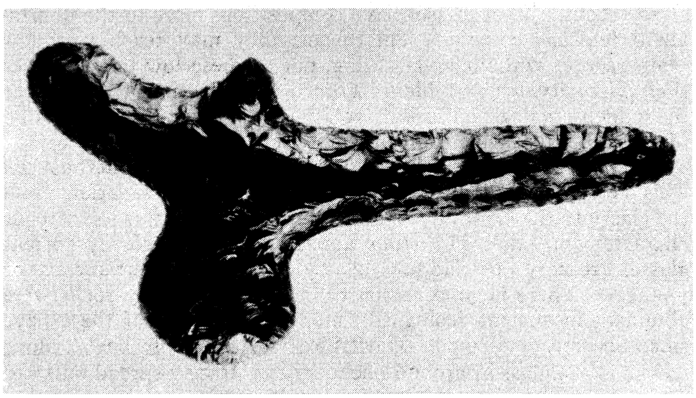
OBSIDIAN, a natural glass of volcanic origin, usually black and of a chemical composition equivalent to granite. Obsidian which has a vitreous lustre, was used by American Indians and many other primitive peoples for weapons, implements, tools and ornaments. Due to its fracture, like glass, conchoidal. with smooth curved surfaces and sharp edges, the sharpest stone artifacts were fashioned from obsidian. Centuries ago the Mayas used obsidian for mirrors. Obsidian in attractive and variegated colours is used as a semiprecious stone.

It forms by rapid cooling of viscous lava, has a vitreous lustre and is slightly harder than window glass. or about 5.5 on the Mohs' scale (*q.v.*). The typically jet black colour is due to abundant closely spaced crystallites (microscopic embryonic crystal growths). So numerous are these tiny inclusions that the glass is opaque except on thin edges. Red and brown obsidian receives its colour from included iron oxide dust; whereas light gray shades may be due to abundant tiny gas bubbles or finely crystallized patches.

Variegated types with banding or mottling in black and red or black and gray are common.

Most obsidian is associated with volcanic rocks and forms the upper portion of rhyolitic lava flows. Less abundantly it occurs as thin selvages of dikes and sills. Well known are the obsidians



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

MONOLITHIC AX CHIPPED FROM OBSIDIAN FOUND IN BRITISH HONDURAS. MAYAN, LATE CLASSIC (600–900 A.D.)

of Mt. Hekla in Iceland; the Lipari Isles, off Italy; and Obsidian cliff in Yellowstone National park, Wyo.

Composition and Characters.—Most obsidians are extremely rich in silica and are roughly compositional equivalents of granite and rhyolite (*qq.v.*). Others correspond to trachyte. dacite, andesite and latite. Glassy rocks equivalent to basalt are rare and go by the name tachylyte instead of obsidian. The composition of natural glass may be approximated from its index of refraction (see also MINERALOGY).

Average index values for volcanic glass are: rhyolitic—1.495; trachytic—1.505; dacitic and andesitic—1.515; and basaltic—1.57. Glassy rocks are roughly 6% lighter than their crystallized equivalents, and their densities increase with index of refraction. Average density values for volcanic glass are: rhyolitic—2.37; trachytic—2.45; dacitic and andesitic—2.50; and basaltic—2.77.

In addition to the crystallites, which are too small to show polarizing effects under the microscope, obsidian may carry abundant microlites (tiny polarizing crystals) many of which are large enough to be identified as feldspar. Both crystallites and microlites, however, are more magnificently and abundantly displayed in pitchstone (*q.v.*).

Some obsidians carry numerous large, well-formed crystals (phenocrysts) of quartz. alkali feldspar and plagioclase, many of which contain abundant inclusions of glass. Less common are phenocrysts of biotite. hornblende or augite. With increase in number of phenocrysts these porphyritic glasses pass into a glassy rock called vitrophyre.

Many obsidians contain spherical aggregates (spherulites) up to several inches across but generally a small fraction of an inch in diameter and composed of radially arranged needlelike crystals (see SPHERULITE). Some of these spherulites consist of concentric shells separated by annular (ring-shaped) interspaces. Such structures are known as stone bubbles or lithophysae.

Characteristic of many natural glasses is a streaked or swirly structure consisting of bands or trains of phenocrysts, microlites, crystallites or spherulites and believed to have formed by flowage of viscous lava. Some flow structures consist of alternating bands of different coloured obsidian. In others layers of bubble-free glass alternate with highly visicular glass (pumice, *q.v.*).

Obsidian is relatively poor in water, generally containing less than 1% by weight. This water represents only part of that contained in the original melt, most having escaped as steam when the lava poured out on the surface. A small chip of obsidian heated under a blowpipe will fuse readily and lose its water by volatilization. A second heating, however, will show the material to be highly infusible. This experiment demonstrates the fluxing action of water in rock melts. Cnder high pressure at depth rhyolitic lavas may contain up to 10% water which helps to keep them fluid even at a low temperature. Eruption to the surface, where pressure is low, permits rapid escape of this volatile water and increases the viscosity of the melt. Increased viscosity impedes crystallization and the lava solidifies as a glass.

Chemical composition controls in large part the formation of glassy rocks. Most glasses have compositions close to the quartz-alkali feldspar cotectic. This means they may reach very low temperatures without crystallizing, but at these low temperatures their viscosity may be high. Forced solidification at this stage by sudden cooling and loss of volatiles will favour the formation of glass, because high viscosity inhibits crystallization.

Volcanic glass is unstable and tends to change spontaneously. This change (devitrification) involves the transformation from the glassy to the crystalline state and the material loses its vitreous character and takes on a stony appearance. Geologically ancient glasses are very rare and most glassy rocks are of Tertiary age or younger. There is good reason to believe that glassy rocks were abundant in ancient geological time, but nearly all of these have since become devitrified. Devitrification commonly begins along cracks in the glass or around phenocrysts. It may spread outward until eventually the entire mass has been converted to a finely crystalline aggregate composed mostly of quartz, tridymite and alkali feldspar. If no glass remains, it may be difficult to demonstrate that a particular rock was ever glassy. The presence of spherulites, lithophysae and perlitic cracks (see PERLITE) is generally considered good evidence for the former existence of glass.

Closely related to obsidian are perlite, pitchstone and pumice. It is believed that under favourable conditions obsidian may be converted to perlite by adding water. Often in such cases the only remnants of the original obsidian are found in the cores of the glassy perlite beads. For chemical analyses of obsidian and related glassy rocks see PITCHSTONE. (C. A. CN.)

OBSTETRICS. Obstetrics is the branch of medical science dealing with childbirth, and is concerned with the care of women from conception through pregnancy and labour, and to the completion of the lying-in period, when the reproductive organs have returned to their normal nonpregnant condition. The word itself is derived from the Latin ob ("against," "in front of") and stare ("to stand"), indicative of the accoucheur in the middle ages, when the attendant stood before the obstetrical chair to receive the child as it was extruded. With gynaecology (*q.v.*), which treats of the diseases peculiar to women, it provides for the care of conditions in, and related to, the female reproductive function. The two subjects are generally taught and practised as a single discipline since their fields are so interdependent and overlapping. There is a growing tendency to begin obstetrical supervision even before conception. In the United States many states make statutory provision for premarital examinations directed particularly at the control of congenital syphilis by preventing the marriage of infected individuals. A more thorough evaluation of reproductive capacity was being demanded by many women before marriage. Such examinations include study of the bony pelvis, the pelvic organs and the organism as a whole for evidence of disease or deformity that might make childbearing unusually hazardous. The old idea that the obstetrician is concerned only with confinement had given way to a newer concept that his duties include all types of supervision necessary to ensure the delivery of a healthy child from a healthy mother.

Pregnancy.—The gestation period in humans averages 280 days from the beginning of the last normal menstrual period, or 266 days from the ovulation which led to conception, assuming that ovulation occurred 14 days before the anticipated period which was missed. Pregnancy is accompanied by significant alterations in the physical economy of the body and by definite mental changes so that the whole body participates. These variations from the nonpregnant normal impose additional stresses which are likely to overload any organ or system that is not completely normal, and may thus lead to serious complications. Not only must the organism provide materials for the growth of the reproductive organs, especially the uterus and breasts, but it must supply the growing conceptus with the elements essential for its growth. These demands become greater as pregnancy advances and the rate of foetal growth increases, and lead to an increasing metabolic strain. The last two or three months constitute the period when these stresses and strains are most likely to disturb the normal body functions. These facts finally forced recognition of the necessity for professional supervision during the greater part of pregnancy; and the development of a program for such prenatal care constituted an outstanding contribution in the field of preventive medicine.

Ante-Partum (Prenatal) Care.—Early in the 20th century there developed an increasing awareness of the need for, and the practical advantages of, medical supervision during pregnancy. This program calls for an initial visit to a physician as soon as pregnancy seems probable, and repeat visits at stated intervals. At the first visit a general physical examination is made with special attention to the pelvic organs and the bony pelvis to determine their integrity and adequacy. In many communities blood is taken for a test for syphilis, for determination of the Rh factor and for routine studies of the haemoglobin and blood cell content. Any apparent inadequacy is subjected to further study. At subsequent visits (every four weeks in the early months to every week in the last month), the weight is recorded. the blood pressure tested, the urine examined and the course of the pregnancy evaluated. The woman comes to know her attendant who assumes the responsibility for advising diet, for regulating physical activity, for treating complaints as they arise and for general supervision aimed at avoiding serious complications and assuring a successful outcome of the pregnancy,. Competent authorities ascribe a considerable share of the marked reduction in maternal mortality after 1930 to the beneficial results of ante-partum care, in that it tends to prevent untoward pregnancy manifestations or to detect them in an early stage when they are amenable to treatment.

The pregnant woman is subject to all the diseases and accidents of the average adult and, in addition, is exposed to certain risks inherent in the pregnant state. Among the latter, the most common is abortion (or miscarriage), the expulsion of the conceptus before the period of viability (generally taken as 28 weeks). This may result from causes operative in the mother or the conceptus—spontaneous abortion; from malicious interference with the pregnancy—criminal abortion; or from medical intervention designed to protect the mother's health or life—therapeutic abortion. It is estimated that 10% to 20% of all pregnancies terminate themselves (spontaneous abortion) in the first few months. The most common cause is the failure of some portion of the conceptus to develop properly, its expulsion representing a form of biological economy. The incidence of criminal abortion is not determinable because of the secrecy surrounding its performance, but it has been estimated that 500,000 to 700,000 such illegal procedures were being carried out at mid-20th century in the United States annually. Therapeutic abortion is generally limited to women with chronic diseases that tend to be aggravated by pregnancy; as the medical treatment of these conditions improves, the reasons for therapeutic abortion become less common. The chief risks in any type of abortion are infection of the uterus and haemorrhage from incomplete separation of the placenta. Under the influence of therapy with antibiotics and blood transfusions, these conditions became much less likely to prove fatal than was formerly the case.

Another inherent pregnancy danger is the possibility of the development of toxaemia of pregnancy, one of several related but seemingly different conditions characterized by hypertension, albuminuria and oedema, which may terminate in generalized convulsions (eclampsia). Toxaemia at mid-century was still one of the three major causes of mortality, but ante-partum supervision had considerably reduced its severity and its death rate. Its Cause was still unknown in spite of years of work by many investigators.

Labour. — Labour, the period of parturition, appears approximately 280 days after the onset of the last normal menstruation; variations of two or three weeks in either direction are not uncommon and are usually of no significance. At the appointed time the uterus begins to contract to expel its contents and the contractions are called "labour pains." The process is divided into three (or four) stages depending upon the events transpiring in the birth canal. The first stage, which involves the dilatation of the cervix, the mouth of the womb, is the longest and may last many hours; the second lasts from complete dilatation of the cervix to birth of the child; and the third from then until the expulsion of the placenta (afterbirth). Some authorities include a fourth stage which lasts for an hour or more after birth of the placenta, or until the uterus is thoroughly contracted and the danger of haemorrhage from relaxation of that organ is passed. The entire process may take days, but is generally completed in 12 to 18 hrs. First labours are generally longer than succeeding ones. The primary motive power in all stages of labour is the strong intermittent contractions of the uterine muscle, aided in the second and third stages by reflex or voluntary efforts of the abdominal muscles.

In the first stage the uterine contractions slowly dilate the cervix by pulling it up over the foetal part which is the lowest. Normally this part is covered by the bag of waters, or amniotic sac, in which the child lies. When this sac breaks early, permitting escape of some of the fluid. there is a dry labour. This latter condition mas formerly thought to produce long, difficult labours, but it is now recognized that premature rupture of the bag of waters does not materially alter the birth process provided other conditions are normal. In fact. artificial rupture of the sac is widely employed to induce labour when some condition makes it advisable. The child usually descends little during the first stage, especially if the sac remains intact. In the second stage the force of the uterine and abdominal muscular contractions drives the child down, through and out of the birth canal according to certain patterns, the mechanism of labour depending upon the way the child is lying. As the child leaves the uterus, this organ contracts to accommodate to the reduction in the volume of its contents until at the end of the stage its cavity contains only the placenta. The contractions of the third stage separate the afterbirth from its attachment to the uterine wall and then expel it from the canal. In the fourth stage the muscle fibres contract and retract to close off the vessels torn through by separation of the placenta and thus prevent excessive blood loss.

Usually at full term the top of the child's head, the vertex, comes first and this is thought of as the normal position for birth. Occasionally (3% to 4%), the buttocks, or breech, are lowermost, and rarely the child lies crosswise (transverse presentation). A breech presentation is more serious for the child. who may suffocate if not expelled or extracted promptly. while a transverse presentation offers an insurmountable obstacle to the birth of a normal-size child and must be treated by operative intervention. It is common practice to attempt to change a breech or transverse presentation to a vertex by external manipulation before the onset of labour. Failing that, some operative procedure may be required to effect delivery.

Twins occur about once in 80, and triplets once in 6,400 births. Quadruplets and quintuplets are correspondingly still more uncommon. In any multiple pregnancy birth is likely to occur prematurely because of overdistention of the uterus, and the children are generally smaller than normal. It is uncommon for the total weights of the children to exceed 1j to 17 lb. Single children rarely weigh more than 11 lb. (5,000 g.), and the average is about seven and one-half lb.

In the 20th century there was an increasing tendency in most areas to alleviate the pains of labour by the use of analgesic and anaesthetic drugs. Although dozens of drugs, singly and in combination, had been employed by mid-century, none had been universally accepted. The ideal medication which would relieve pain without slowing the birth process or injuring either mother or child had not been discovered. It had become possible, however, to reduce the pain safely to a point where childbearing was not the ordeal it once was.

Delay in the birth process caused either by disproportion between the child and the maternal pelvis or by ineffective pains (uterine inertia) is the most common complication of labour. With modern methods the adequacy of the pelvis can usually be determined before labour, and delivery effected by Caesarean section in those cases where normal birth seems impossible. Under the influence of improved surgical technique, the availability of blood transfusions and the protection from infection offered by the antibiotics, abdominal delivery came to be a relatively safe method of treating such complications. First-stage inertia is combated with rest under narcotics and the maintenance of fluid balance, with Caesarean section available should vaginal delivery eventually prove impossible. Second-stage inertia is managed with forceps or some other form of manipulation.

Haemorrhage during or shortly before the onset of labour is caused by early separation of the placenta which may either be normally implanted well up on the uterine mall (ablatio, or abruptio, placentae), or located over the cervix when dilatation inevitably produces bleeding (placenta praevia). These conditions are dangerous to both mother and child, but especially to the latter who suffers from asphyxia and is, moreover, generally premature.

The third and fourth stages present one of the most serious complications of childbearing — post-partum haemorrhage. Excessive bleeding after delivery of the child is usually due to incomplete separation of the placenta or to failure of the uterus to contract and retract properly after that structure has been expelled. The time-honoured remedies, removal of the afterbirth, employment of uterine massage and administration of oxytocic drugs, are supplemented by blood transfusions. The lifesaving virtues of a hospital blood bank are nowhere better illustrated than in this complication.

Puerperium.—The puerperium, or lying-in period, continues from the end of the fourth stage of labour to the restoration of the pelvic organs to the nonpregnant state.—usually six to eight weeks. The necessary anatomical changes occur with extraordinary rapidity; *e.g.*, the uterus, which weighs two pounds at the termination of labour, comes to weigh two ounces after six weeks, and its blood vessels, which carried the burden of nourishing the child for nine months, are replaced by new vessels suitable to this smaller size. Unless the child is suckled, menstruation reappears usually in about eight weeks; lactation may be accompanied by absence of the menses.

It was thought formerly that full recovery of the mother depended upon maintenance of a semi-invalid regimen, ten days or more of bed rest and several additional weeks of restricted activities. The later tendency, especially in the United States, was toward early ambulation and prompter return to normal activity by women with normal pregnancies and labours. It was believed that such a course not only ensured more rapid convalescence but also greatly reduced the incidence of "milk leg," formerly a frequent and serious puerperal complication.

The chief risk during the lying-in period is puerperal fever, caused by the growth of pathogenic bacteria in the wounded areas of the birth canal, especially the uterus. These organisms are generally introduced from without during or shortly after labour but may occasionally be resident in the birth canal where they are relatively innocuous until presented with the favourable growth conditions developing after delivery. Aseptic surgical technique during labour can largely control exogenous infections but has little effect on endogenous organisms. since it is impossible to sterilize the birth tract. However, pelvic infections can generally be controlled with antibiotic drugs and blood transfusions.

Mortality. — As late as 1933 the position of the United States among the nations of the world with respect to maternal mortality was far from enviable. The rate that year was 6.2 maternal deaths per 1,000 live births; Sweden had a rate of 3.1, the white population of New Zealand 4.4 and England and Wales 4.5.

After 1933, however, many factors became operative to reduce this largely unnecessary loss of life. Ante-partum supervision was expanded to include the majority of pregnant women; intrapartum and post-partum care was improved by the provision of more obstetrical beds in well-regulated hospitals, by the availability of physicians better trained in obstetrical care and the progressive elimination of untrained midwives and by the introduction of chemotherapeutic and antibiotic drugs and of banks for storing blood and blood substitutes. From 6.2 in 1933, the death rate fell to 4.4 in 1938, to 2.5 in 1943 and to slightly below 1.0 in 1949 for the Cnited States. In England and Wales in 1947 the rate was 1.2 maternal deaths per 1,000 live births.

(E. D. P.; X.)

History. — Among the Egyptians, Hebrews and Greeks the skilled attendants for women in labour were women. There are indications in the Hippocratic writings (400 B.C.) of his interest in the disorders of females. and his oath forswears the use of abortifacients. In the writings attributed to Hippocrates' followers. some of these subjects are dealt with more fully; but while the physician was sometimes called in to give advice in a difficult labour, he was usually called only in a case where the child was already dead, and then he told how he had to mutilate and extract it. Celsus (in the reign of Augustus) reported that surgeons could sometimes bring about the delivery by the operation of turning the infant. In the middle of the 16th century, Ambroise Paré revived the operation of podalic version and showed how the infant could often be saved instead of being broken up and extracted piecemeal. After the middle of the 17th century, medical men began to publish treatises, and parturient women began to call on men to attend them in natural labours. Heinrich van Deventer, a Dutch obstetrician, in 1701 gave a scientific description of the pelvis, and by 1716 doctors were using the "harmless forceps." In the 18th century various universities established chairs of midwifery. and two new operations—symphysiotomy and the induction of premature labour — enhanced the powers of the obstetrician. Two outstanding achievements in the 19th century were the introduction of anaesthesia and the arrest of mortality from so-called puerperal fever by antiseptic measures. (X.)

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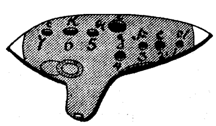
OCARINA, a wind instrument invented in Italy, which is classed with musical toys or freaks.



BY COURTESY OF CARL FISCHER INC., N.Y.

THE OCARINA, A WIND INSTRUMENT POPULAR AMONG STREET PLAYERS

It consists of a vessel in the shape of an egg with a pointed base and perforated with holes and a tube like a spout in the side, containing the mouthpiece. In America, it is sometimes called a "sweet potato."

O'CAROLAN (or CAROLAN), **TURLOGH** (1670–1738), Irish bard, son of John O'Carolan, a farmer, was born at Newtown, near Nobber, Co. Meath. At 18 he became blind from smallpox. He received special instruction in music, and used to wander with his harp round the houses of the surrounding gentry, mainly in Connaught. The number of Carolan's musical pieces, to nearly all of which he composed verses, is said to exceed 200. He died March 25, 1738, and was buried at Kilronan.

His poetical *Remains* in the original Irish, with English metrical translations by Thomas Furlong, were printed in Hardiman's *Irish Minstrelsy* (1831). Many of his songs were preserved among the Irish manuscripts in the British Museum.

OCCAM, WILLIAM OF (WILLIAM OCKHAM) (c. 1280–1349), English schoolman, known as *Venerabilis Inceptor*. Born probably at Ockham, Surrey, he joined the Franciscans around 1300. At Oxford he studied the arts prior to 1310, and theology, 1310–15; lectured on the Bible, 1315–17, and the *Sentences*, 1317–19, and prepared himself for his doctorate, 1319–23. Accused of heresy by the chancellor of Oxford in 1323, he was summoned to Avignon to account for some of his doctrines. He was confined to his convent from 1324 to 1328.

Pope John XXII ordered various theses from his works to be examined by the masters of theology in 1325–27, but his works were never actually condemned. In 1328 his championship of the Spirituals, a branch of the Franciscans, brought him into further conflict with the pope, and as a result he and Michael of Cesena. general of the Franciscan order, joined the emperor Louis of Bavaria who was at that time in contest with the papal curia. Expelled from the order in 1331, Occam came into sharper conflict with the pope, this time on theological grounds. Yet, when Michael of Cesena died in 1342, Occam received from him the official seal of the order, and was recognized as general by his party. He died at Munich in 1349, having tried to be reconciled to the Church after the death of the emperor (1347).

Occam was one of the most interesting figures in the great contest between pope and emperor, which laid the foundation of modern theories of government. In the *Opus nonaginta dierum* (written in 1330), and its successors, the *Tractatus de dogmatibus Iohannis XXII papae* (1335–38) and in the *Defensorium contra erroves Iohannis XXII papae* (1335–39), Occam only incidentally expounds his views as a publicist, the *Compendium* being of special interest because it selects four papal constitutions that involved a declaration against evangelical poverty, and insists that they are full of heresy. The *Octo quaestiones dc potestate papae* (1339–42) attacks the temporal supremacy of the pope, insists on the independence of kingly authority, which he maintains is as much an ordinance of God as is spiritual rule. and discusses what is meant by "state." His views on the independence of civil rule were even more decidedly expressed in the *Consztltatio de causa matrimoniali,* in which he contends that it belongs to the civil power to decide cases of affinity. By 1343 his great work, the *Dialogus,* was in circulation. His last political work, *De electione Caroli IV,* restates his opinions upon temporal authority.

In philosophy, Occam's most significant doctrines fall within the field of psychology. metaphysics. logic and theodicy. In the first, he contends that since singulars alone exist, the universal has an objective value only inasmuch as it is thought; that the *intellectus agens* (active intellectj and its end product and the *species intelligibiles* are superfluous because abstraction follows naturally upon perception or intuition, the fundamental forms of human knowledge; that will and not intellect is the primary faculty of the soul, and that both faculties, like memory, are identical with the substance of the soul; and that a *forma corporeitatis* (substance of the body) must be admitted if the independence of the soul is to be preserved. In metaphysics, Occam teaches that matter has its own essence apart from form; that accidents are only aspects of substance; that the problem of individuation is meaningless because each thing is singular in itself, and that between essence and existence there is no real distinction. The famous dictum—*entia non sunt multiplicanda praeter necessitatem* (beings ought not to be multiplied except out of necessity)—has become known as "Occam's razor," though it had already been stressed by other Scholastics. In logic, next to Albert of Saxony, Occam is the most powerful systematist of the Middle Ages. In theodicy, he asserts that the existence of God and His attributes, including His unity and infinity, are not provable by a strict syllogism.

In theology. Occam has been considered as a forerunner of Martin Luther and the originator of theological scepticism. Both affirmations are inexact: Occam did not make much of the philosophical arguments of earlier theologians, and applied to theology his famous "razor"; however, he was respectful of tradition and traditional understanding of the Bible. *(See* also NOMINALISM.)

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See also L. Baudry, op.cit. (Paris,1950); G. *Buescher, The Eucharistic Teaching of William Ockham (Washington, D.C., 1950);* F. *Van Steenberghen, Le Mouvement doctrinal du IXe au XIVe siècle (Paris, 1951); M. C. Menges, The Concept of Univocity Regarding the Predication of God and Creature According to William Ockham (St.* Bonaventure, N.Y., 1952); *P. Boehner, Medieval Logic (Chicago, 1952); D. Webering, Theory of Denzonstration According to William Ockham (St* Bonaventure, NY, 1953) *(E. M* BT.)

OCCASIONALISM, in philosophy, a term applied to that theory of the relation between matter and mind which postulates the intervention of God to bring about in the one a change which synchronizes with a change in the other. The theory. denying any direct interaction between matter and mind, attempts to account for their seeming interaction. *See* CARTESIANS; *see* also MALEBRANCHE, NICOLAS; GEULINCX, ARNOLD; DESCARTES, RENÉ.

OCCLEVE (or HOCCLEVE), **THOMAS** (1368–1450?), English poet, was born probably in 1368/9. What is known of Occleve's life has to be gathered mainly from his works. **At** eighteen or nineteen he obtained a clerkship in the Privy Seal Office, which he retained on and off, in spite of much grumbling, for about thirty-five years. In 1399 he received a small annuity, which was not always paid as regularly as he would have wished. "The Letter to Cupid," his first poem to which we can affix a date, was translated from *L'Epistre au Dieu d'Amours* of Christine de Pisan in 1402, evidently as a sort of antidote to the moral of *Troilus* and *Cressida,* to some mss. of which we find it attached. About 1410 he settled down to married life, and the composition of moral and religious poems. His longest work, *The Regement of Princes* or *De Regimine Principum,* written for Prince Hal shortly before his accession, is a tedious homily on the virtues and vices, imitated from Aegidius de Colonna's work of the same name, from the suppositious epistle of Aristotle, known as the *Secreta secretorum* and the work of Jacques de Cessoles (*fl.* 1300) rendered into English later by Caxton as *The Game and Playe of Chesse.*

On the accession of Henry V. Occleve turned his muse to the service of orthodoxy and the Church, and one of his poems is a remonstrance addressed to Oldcastle, calling upon him to "rise up, a manly knight, out of the slough of heresy." Then a long illness was followed for a time, as he tells us, by insanity. His "Dialog with a Friend," written after his recovery, gives a naive and pathetic picture of the poor poet, now fifty-three, with sight and mind impaired, but with hopes still left of writing a tale he owes his good patron, Humphrey of Gloucester, and of translating a small Latin treatise, *Scite Mori,* before he dies. His hopes were fulfilled in his moralized tales of "Jereslaus' Wife" and of "Jonathas," both from the *Gesta Romanorum,* which, with his "Learn to die," belong to his old age. After finally retiring from his privy seal clerkship, he was granted in 1424 sustenance for life in the priory of Southwick, Hants. on which, with his former annuity, he appears to have lived till about the middle of the century. A "Balade to my gracious Lord of Yorke" probably dates from 1448 or later.

The main interest for us in Occleve's poems is that they are characteristic of his time. They illustrate the blight that had fallen upon poetry on the death of Chaucer. The nearest approach to the realistic touch of his master is to he found in his "Male Regle," which, written about 1406, gives some interesting glimpses of his "misruly youth." But these pictures of 15th-century London are without even the occasional flash of humour that lightens up Lydgate's *London Lickpenny.*

A poem, "Ad beatam *Virginem," generally known* as *the "Mother of God," and once attributed to Chaucer, is copied among Occleve's works in* ms. *Phillipps 8151 (Cheltenham), and may thus be regarded as his* work. *Occleve found an* admirer *in the 17*th *century in* William *Browne, who included his "Jonathas" in the Shepheards Pipe (1614). Browne added a eulogy of the old poet, whose works he intended to publish in their entirety (Works, ed. W. C. Hazlitt, 1869, ii. 196–198). In 1796 George Mason printed six Poems by Thomas Hoccleve never before printed . . .; "De Regimine Principum" was printed for the Roxburghe Club in 1860, and by the Early English Text Society in 1897. See F. J. Furnivall's introduction to Hoccleve's Works; The Minor Poems, in the Phillipps MS. 8151, and the Durhanz MS. III. 9, ed. F. J. Furnivall; ii. The Minor Poems in the Ashburnhanz MS. Addit. 133, e d Israel Gollancz; iii. The Regement of Princes A.D. 1411–12, and fourteen of Hoccleve's minor poems, ed. F. J. Furnivall (Early English Text Society, 3* vols., 1892–1925).

OCCULTISM: *see* MAGIC.

OCEAN AND OCEANOGRAPHY. The ocean (also called the world ocean or the oceans) is the interconnecting body of salt water which occupies 70.8% of the surface of the earth. An ocean is one of the major subdivisions of this sheet of water, lying between the continents. Smaller partially enclosed subdivisions of the oceans are called seas.

Following an introduction which defines oceanography, traces the history of the terms "ocean" and "oceanography" and considers the general significance of the ocean and the reasons for the probable uniqueness of the earth's ocean, this article is divided into the following main sections:

I. *The Ocean Basins*
II. *Marine Sediments*
III. *Physical Properties of Sea Water*
IV. *Movement of Sea Water*
V. *Chemistry of Sea Water*
VI. *Biological Oceanography*

Oceanography is the scientific study of the ocean in all its aspects. Although it may be regarded as a separate science. it actually is a common meeting ground of four sciences. It includes the physical study of the water and wave movements, the geological study of the form of the ocean basins and the characteristics of the sediments laid down in them, the chemical study of the water and dissolved substances and the biological study of the plant and animal life in the sea. Some writers have preferred the term oceanology to embrace all these fields, and thalassography has also been employed, but the weight of usage is behind the term oceanography. The similar study of lakes and other freshwater bodies is limnology.

Together with lakes, rivers, underground water and atmospheric water vapour, the ocean makes up the major division of the earth's surface known as the hydrosphere. The other divisions are: the atmosphere, or gaseous portion; lithosphere, or solid portion; and biosphere, or living portion. Although the physical aspects of oceanography are commonly included as one of the subdivisions of geophysics, the chemical aspects more properly belong to geochemistry. the geological aspects to geology and the biological aspects to the life sciences.

The word ocean came into English from the French *océan,* which in turn was derived from the Latin *oceanus* and Greek *okeands.* The term was originally applied to the great river or outer sea that encompassed the ancient world of Eurasia and Africa, as distinguished from the Mediterranean and other inland seas. It was personified in classical mythology as the god Oceanus, son of Uranus (sky) and Gaia (earth) and husband of Tethys. a titaness. In 13th-century English the terms "sea of ocean" and "sea ocean" were often used. and later, down to 1650. the form "ocean sea" was common.

The word oceanography was first used in English by W. Dittmar in 1883; the German *Ozeanographie* (now often replaced by *Meereskunde*) is a few years older.

The ocean serves and affects mankind in many ways. So vast is it that often these ways are contradictory. The ocean stores heat and water that have a profound influence on weather and climate; yet castaways at sea may die from cold or thirst. The sea is a barrier to invasion, so that island races have developed parliaments (Iceland in 930; Britain in 1275) and other democratic institutions when their continental kindred were still in feudalism. Likewise. the breadth of the Atlantic facilitated the winning of independence by the United States and the Spanish possessions in America. and the subsequent operation of the Monroe Doctrine. On the other hand. to those who master its tech-

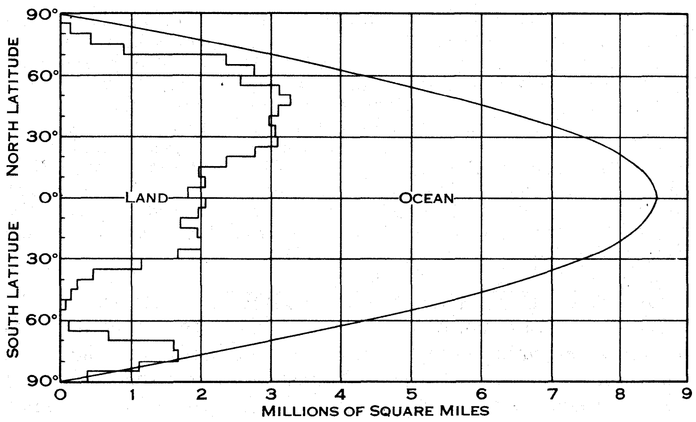


FIG. 1.—DISTRIBUTION OF LAND AND OCEAN AREAS

The smooth curve represents the total area of the earth's surface in each five-degree band of latitude

nology, the sea is a means of communication. The frontiers of the United States and Canada were pushed east from the Pacific as well as west from the Atlantic because it was easier to sail around Cape Horn than to cross the continent overland.

The sea is an important source of food, particularly of animal proteins and fats; yet into it are dumped the sewage of seaside communities and even radioactive wastes. The sea serves for recreation and for the disposal of garbage. From its animals and plants are obtained not only precious jewels but also the raw materials for such prosaic items as paint, fertilizer and glue. Land and the fertility of the soil are lost to the sea and won back from the sea. Salt and chemicals are recovered from sea water, building materials from the nearby continental shelves, and coal, petroleum, gas and sulfur from shafts and wells drilled miles offshore in shallow water.

In possessing an ocean, bordered by continents, the earth is probably unique among the planets and satellites of our solar system. To understand why this has come about, we need to ask three questions:

1. Why are there ocean basins? The answer to this question is that the rocks making up the outer portion of the earth's crust are not uniform in their properties or chemical constitution. Over large areas of the earth's surface, the rocks are characteristically light in colour and relatively light in weight. They are classed as granitic, since granite is the major rock type. Over larger areas, the rocks on the average are darker in colour and heavier in weight. These are the basaltic rocks, since among them basalt is the chief type. It is known from studies of the propagation of earthquake waves that the core of the earth at a depth of a few hundred miles below the surface has the properties of a fluid. The crustal rocks, about 50 mi. thick, in effect are floating on this liquid core. The areas of granitic rock, since they are lighter, stand higher than the surrounding areas of basaltic rock, just as a cork floats higher than a piece of wood the same size. The granitic areas thus form the continents, and the basaltic areas are the ocean basins. Were the crustal rocks of the earth uniform in composition, the earth's surface would consist of one vast ocean, more than a mile deep. Under such conditions, although an occasional volcanic island might form above the ocean surface, it probably would soon sink and disappear below the surface again, as the locally overloaded earth's crust adjusted to the strain by the process of isostasy (*q.v.*).

2. Why is there water in the ocean? Even if we have explained ocean basins, we have not yet completely accounted for the ocean. The moon, for example, though it is known to have suitable basins, has a bone-dry surface. The reason why there is water in the oceans is threefold. In the first place, molten rock, such as lava, holds much more water when liquid than when it hardens and cools. Thus, as the earth's crust has solidified during geologic time, water vapour has been given off to the atmosphere. Analyses of gases from volcanoes and fumaroles show that this process is still going on today. Something like this must have happened on the moon, yet the moon has no ocean. The explanation is that gravity is much weaker on the moon than on the earth. Gas molecules in the earth's atmosphere behave just as does any other moving body with respect to the earth's gravitational field. If the escape velocity of 7 mi. per second is exceeded, the body can escape to outer space. At the boiling point of water (212° F.), the mean speed of water molecules is only 0.4 mi. per second, and the probability that any molecule may have $17\frac{1}{2}$ times this speed at this temperature is infinitesimally small. Therefore, even if fairly high temperatures exist in the upper atmosphere, the earth does not lose water molecules. For the moon, where a temperature of 212° F. is regularly exceeded on the face presented to the sun, the escape velocity is only 1.4 mi. per second. At 212° F., one water molecule has this speed for every 60,000 having the mean speed. Thus the moon fails to hold water vapour or the other light gases that make up our atmosphere and hydrosphere, and hence it lacks an ocean. The second reason that there is water in the ocean, therefore, is that the earth's gravity keeps the water from escaping into space, just as it also retains the air we breathe. As the third reason, the pressure-temperature relationships on the earth's surface are such that the water is mainly in liquid form. Conceivably the atmosphere could be so hot that all the water existed in vapour form. A temperature of at least 705° F. (the critical temperature of water vapour) would be necessary, and the corresponding atmospheric pressure would then be of the order of 5,500 lb. per square inch. On the other hand, if the earth's temperature at sea level never exceeded 32° F., the ocean basins would be filled with solid ice. Since there still would be water vapour in the atmosphere, and snow still could fall, a vast continental glaciation might take the place of the present river drainage system. Since neither of these extreme temperature conditions exists, we have the ocean in its present form.

3. Why is the ocean salty? The salts in the ocean are one result of over 2,000,000,000 years of disintegration of the igneous rocks of the earth's crust. The soluble materials remain in the ocean; the insoluble precipitates have formed sedimentary rocks and the ocean sediments. The ocean contains all the elements originally present in the igneous rock to the extent that they are soluble, are not adsorbed on clay or are not removed by biological activity.

Suspended material and dissolved salts, extracted from the rocks of the continents, are still delivered to the sea by rivers. Much of this eroded material is from sedimentary rocks that have previously passed through the same cycle. Equivalent amounts of new sediments are being laid down at the same rate. The result is that the sea is in a steady state with regard to the composition of its salt, and it has probably maintained a close approximation to this present composition for millions of years.

When changes in drainage pattern and climate cut off lakes from their outlets to the sea, they soon become salt lakes. Great Salt lake in Utah is an example. Standing over 4,200 ft. above sea level, it never was part of the ocean. Evaporation keeps it from overflowing, the salts leached out of the surrounding mountains remain behind, and, in the approximately 100,000 years since its

TABLE I.—Percentages of Water for Each Latitude Band

Latitude band	Total area (000,000 sq.mi.)	Percentage covered by sea	
		Northern hemisphere	Southern hemisphere
0° to 5°	8.542	78.6	78.4
5° to 10°	8.479	75.7	75.4
10° to 15°	8.352	76.5	76.4
15° to 20°	8.164	70.8	79.6
20° to 25°	7.915	65.2	76.9
25° to 30°	7.606	59.6	75.9
30° to 35°	7.239	57.7	84.2
35° to 40°	6.817	56.8	93.4
40° to 45°	6.342	51.2	96.4
45° to 50°	5.818	43.8	97.5
50° to 55°	5.249	40.7	98.5
55° to 60°	4.638	45.0	99.9
60° to 65°	3.990	31.2	99.7
65° to 70°	3.310	28.7	79.5
70° to 75°	2.602	65.5	38.6
75° to 80°	1.874	77.1	10.7
80° to 85°	1.131	85.2	0.0
85° to 90°	.378	100.0	0.0
Whole hemisphere	98.446	60.6	81.0

parent Lake Bonneville became isolated, the Great Salt lake has become eight or ten times as salty as the ocean. Most of the world's other salt lakes, such as the Dead sea, Caspian sea and Aral sea, have acquired their salt in this fashion. independently of the ocean. They represent oceans in miniature.

I. THE OCEAN BASINS

Distribution of Land and Sea.—The relative distribution of land and sea in relation to latitude is of fundamental importance in understanding how the ocean behaves as a whole. Thus, the north polar region is an ocean basin which communicates chiefly with the North Atlantic and is connected to the Pacific only by the shallow Bering strait. The south pole. on the other hand, is on land, but is surrounded entirely by water, which communicates with all the other oceans. Fig. 1 illustrates the relative proportion of land and water areas of the earth, while fig. 2 shows how all the ocean connects in the Antarctic.

The percentages of aater for each latitude band are given in Table I (after Erwin Kossinna).

The Seven Oceans.—The term "seven seas" is often encountered in the uorks of medieval Arabic geographers. The Turkish hydrographer Piri Reis in the 16th century listed them as the South China sea. Bay of Bengal. Arabian sea, Persian gulf, Red sea, Mediterranean sea and Atlantic ocean. These were the waters of the Mohammedan world prior to the fall of Constantinople (1453). The phrase appeared in E. FitzGerald's translation of Omar Khayyam in 1859 and was popularized by Rudyard Kipling as the title of a book of verses in 1896.

It happens that, although there is considerable disagreement among various authorities as to the number and designations of the maior subdivisions of the ocean, a verv convenient arrangement is into seven oceans, as shown in Table II.

TABLE 11.—Major Subdivisions of the Ocean

Ocean	Area in sq mi.	Mean depth in feet
Arctic	5,440,000	3,950
North Atlantic	18,058,000	10,780
South Atlantic	14,426,000	13,420
North Pacific	31,506,000	14,050
South Pacific	32,225,000	12,660
Indian	25,298,000	12,770
Antarctic	12,451,000	12,240

In this scheme, the equator is taken as the boundary between the North and South Atlantic and North and South Pacific; the Antarctic is arbitrarily bounded by the parallel of 55° S.; and the meridians of Southeast cape, Tasmania. and Cape Agulhas. U. of S. Af., determine the limits of the Indian ocean, South Pacific and South Atlantic. The further breakdown of the ocean into seas, gulfs and straits has been the subject of careful study by the International Hydrographic bureau, whose Publication No. 23 should be consulted for details.

The total area of the ocean is 139,404,000 sq.mi., total volume 328,750,000 cu.mi. and mean depth 12,450 ft.

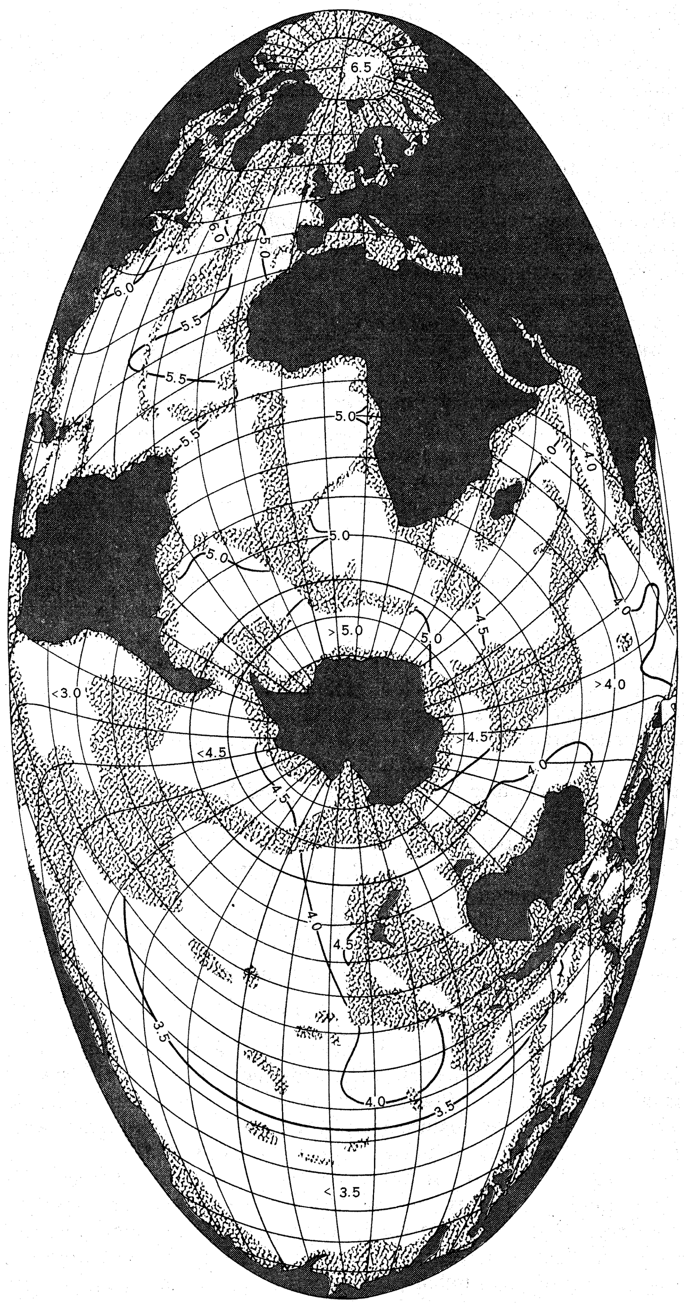
Ocean Depths.—Relative to the size of our planet, the ocean forms hardly more than a wet film over the part of the earth that it covers. To visualize the true scale of the Pacific between Panamá and Manila or Yokohama and Callao, let the thickness of an ordinary pencil mark ($\frac{1}{16}$ in.) represent the average depth of the ocean. Then to represent the distance of over 8,000 mi. on this same scale. we must continue the pencil line for 5 ft. Or, on the blackboard, if we are to represent the average depth of the Atlantic by a chalk line $\frac{3}{8}$ in. wide, to cover the distance from Jacksonville, Fla., to Southampton, Eng., we will need to make the line 56 ft. long.

We must not infer from this picture of the ocean that its bottom consists only of vast level plains. Although it is true that river drainage systems, the chief factors in shaping the land, do not exist under the sea, there are still mountain ranges and canyons, basins and ridges, and peaks and valleys as well defined as any on land. We cannot see these features with our own eyes, as we can the land features. and only the painstaking tabulation and plotting of ocean soundings make them apparent.

Fig. 3 shows that the deepest ocean is much farther below sea level than the highest mountain is above. This figure is the hypsographic curve of the earth's surface. It shows the area of the earth's solid surface above or below any given elevation or depth. The mean height of the dry land is 2.760 ft.; the mean height of the physical earth's surface is 29% of this or 800 ft.; the mean level of the crust of the solid earth is 8,000 ft. below sea level.

Sea Level.—Sea level, or more properly mean sea level, is the average height of the sea surface after all wave motion has been smoothed out. Since some of the highest waves are those of the tide, it is necessary to average observed tide levels for 19 years in order to eliminate all the astronomical influences on them (see TIDES).

Longer series of observations often show substantial changes



BY COURTESY OF E D STROOP AND H STOMMEL

FIG. 2.—THE WORLD OCEAN. SHOWING THE INTERCOMMUNICATING NATURE OF THE OCEAN BASINS

The white zones are deeper than 13,000 ft., the approximate average depth of the ocean. Contours of dissolved oxygen, in volumes per 1,000 vol. of sea water (ml./l.), are also shown in mean sea level with time. Thus along the east coast of the United States, sea level between 1930 and 1950 rose about one-fourth inch per year. or at the rate of two feet per century. This effect is generally attributed to the melting of polar icecaps, which are thereby adding more water to the ocean. In Scandinavia. on the other hand, tide gauges show that the land is rising relative to the water. and there the effect is explained as isostatic adjustment. the land formerly having sunk under the load of the Pleistocene ice sheets and now rising after removal of the load.

Depths shown on charts prepared for the use of mariners are generally measured not from mean sea level but from some level corresponding to the average low-water mark. Thus the soundings are approximately correct at low tide and provide a factor of safety at other times.

Continental Shelves. — Since, as shown above, there is no cause-and-effect relationship between the volume of the ocean basins and the amount of water in the ocean, and since, as just shown, there is nothing fixed or rigid about sea level, it is not surprising to find, as fig. 3 indicates, that the present quantity of water in the ocean is somewhat greater than the capacity of the ocean basins. We thus find virtually all the continents surrounded

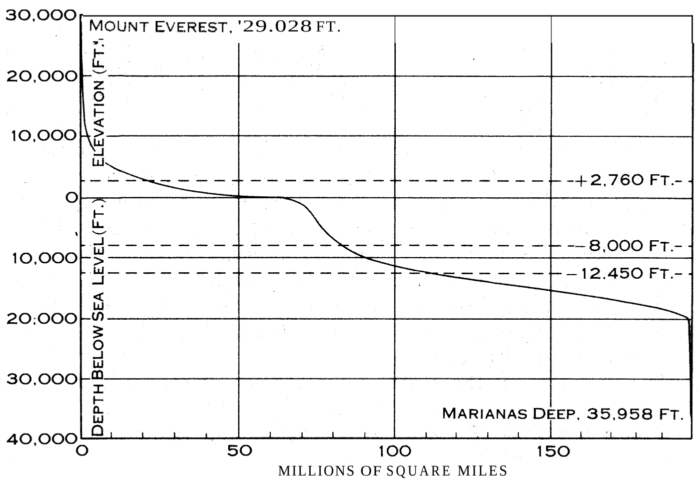


FIG. 3. — HYPSOGRAPHIC CURVE OF THE WORLD, SHOWING THE CUMULATIVE AREA HAVING AN ELEVATION LOWER THAN MT. EVEREST. SEA LEVEL FALLS AT 57,100,000 SQ. MI.

This curve should not be interpreted as giving a typical cross section from high mountain? to ocean deeps, since in nature high mountains are often near the coasts and the greatest ocean deeps are near the shore. The average height of land is 2,760 ft.; the average depth of the ocean is 12,450 ft.; and the average elevation of the crust of the solid earth is 8,000 ft. below sea level

by a shallow submerged zone called the continental shelf, a seaward continuation of the coastal plain. Characteristically, the continental shelf has a slope of only 10 ft. per mile and an average width of 42 mi., but there is great variation in these figures. Off California and Chile, the shelf may be less than a mile wide; north of Europe and Siberia the width may be as much as 750 mi. At the edge of the continental shelf, at a depth conventionally taken as 600 ft., but which averages somewhat less and actually varies from 160 to 3,000 ft., the slope of the bottom increases markedly. This region of greater slope is the continental slope, and, as shown in fig. 3, it ends at a depth of about 10,000 ft., where the floors of the ocean basins are reached. The continental shelves make up more than 7% of the area of the ocean.

Many of the world's greatest fishing banks, such as the 'North sea and the Grand Banks, are located on the continental shelves. After 1945 their economic importance increased, because the recognition that they are structurally part of the continent, and hence contain mineral deposits similar to those of the adjacent continents, has led to their exploitation for these minerals.

Submarine Canyons. — Cutting across the continental shelves and down the continental slopes in many parts of the world are prominent canyons, some on the same scale as the Grand canyon of the Colorado river. Most of these are associated with present rivers, like Hudson canyon, off New York, the deep soundings over which are used as a guide by ships making for the port of New York at the mouth of the Hudson river. It is generally accepted that the heads of these canyons were cut by rivers at a time when sea level was several hundred feet lower than today, probably during the Pleistocene when considerably more water than at present was tied up in continental ice sheets. The continuation of the canyons down the continental slopes involve depths too great to be explained by river-cutting under conditions of lowered sea level, and it is likely that these lower portions were cut and are maintained by turbidity currents (see below) or related processes involving the sudden transfer of loose sedimentary material that has collected in the upper reaches of the canyons.

Sea Mounts, Islands and Atolls. — Continental islands, which rise from the continental shelves, are hills or mountains no different in origin from the other features of continental terrain. Most of them were joined to the mainland during the period of lowered sea level of the Pleistocene.

Oceanic islands are those which rise from the deep floor of the ocean basins. Unlike the continents, the oceans lack high, folded mountain ranges, and nearly all oceanic islands are volcanic in origin. Volcanic peaks that do not reach the surface are called sea mounts Since the erosive forces that tend to obliterate continental features are lacking in the sea, such peaks are relatively more prominent and persistent in the sea than on land. Charles Darwin in 1837 suggested that coral atolls form on top of volcanic peaks that have reached the surface, the upward growth of coral proceeding at a rate that balances the downward sinking of the peak through isostatic adjustment. All of the drillings and other geophysical measurements that have been made on atolls, particularly those at Bikini in 1946 and subsequently, confirm this theory. Additional confirmation was provided by H. H. Hess in 1946, who showed that hundreds of flat-topped sea mounts are scattered over the Pacific. Hess gave these the name of guyots. E. L. Hamilton in 1956 showed that west of Hawaii these guyots are truncated Cretaceous volcanoes, whose tops were eroded by wave action near sea level and subsequently sank to depths of 3,000 to 6,600 ft. by subsidence of the sea bottom, too fast for coral accumulation to maintain them as atolls.

Island Arcs and Ocean Trenches. — The deepest known places in the ocean are all in the Pacific, and there is singular uniformity in their maximum depths. In the North Pacific, a sounding of 34,077 ft. has been obtained in the Kuril-Kamchatka trench, 34,038 ft. in the Japan trench, 34,440 ft. in the Mindanao trench and 35,958 ft. in the Marianas trench. In the South Pacific, the Kermadec trench has yielded a depth of 35.445 ft. and the Tonga trench 35,341 ft. It is characteristic of all these trenches that they are not circular basins but elongated V-shaped grooves. and also that they closely parallel lines of active volcanoes, which in most cases rise above the surface as a curved line of islands. The association of these island arcs with deep trenches has not yet been fully explained.

The deepest sounding in the h'orth Atlantic, 30.216 ft. in the Milwaukee Depth north of Puerto Rico, is in a feature similar to the Pacific trenches and points to a common cause.

II. MARINE SEDIMENTS

The materials that cover the ocean bottom are of considerable interest for several reasons. The sediments of the shallower regions are being laid down in environments similar to those in which most of the sedimentary rocks of the continents were formed. The study of present-day sedimentation therefore provides useful clues to conditions of the past, and in the case of petroleum deposits may yield results of considerable economic importance. The sediments of the deep ocean, since they are relatively unaffected by material from the continents, tell different stories. From them much can be learned about the temperatures of the ocean, and hence of the climate of the earth, in past ages.

Sediments of the Continental Shelves. — The continental shelves are not uncommonly bare of sediment in places. Such areas may have been eroded to the underlying rock during the Pleistocene lowering of sea level, or bared by glaciation, or they may consist of locally formed coral rock or lava. In any case, steep slopes, strong currents or the lack of a sufficient supply of sediment prevent the accumulation of a covering deposit.

Elsewhere, similar processes may move all deposits but large water-worn cobbles, and the bottom is stony, or. with weaker currents. gravelly. Most of the continental shelves, however. are covered with mud, sand or mixtures of the two. usually with appreciable proportions of the remains of animals, and sometimes with sufficient for the bottom to be characterized chiefly as shelly.

A boulder is defined as anything larger than 10 in. in diameter; cobbles are between 10 in. and $2\frac{1}{2}$ in.; and pebbles are from $2\frac{1}{2}$ in. down to $\frac{5}{32}$ in. Smaller particles are designated sand down to $\frac{1}{400}$ in., silt domn to $\frac{1}{6,400}$ in. and clay if still smaller. However. these distinctions can be made apparent only by laboratory analyses, and the mariner's classification of the finer sediments recognizes only sand, sandy mud and mud.

The localization of sediment types on the continental shelves depends both on the supply of sediment, and on the currents Sediments are supplied not only by rivers but by the constant attack of the sea on the coastline. Cliffs are undermined. and even the hardest of rocks are worn away by the grinding action of other pieces of the same material in the surf zone; the powerful solvent action of water and the oxidizing action of the atmosphere exert their influences; and rock-boring organisms. such as the pholad clams and certain sea urchins. contribute to the destruction of the softer strata.

Bottom areas swept by strong currents are kept bare of fine sediments. Mud will deposit only where currents are relatively weak, unless the supply of mud. as from a river, is so great that the current cannot keep it all in suspension, Mud bottom is therefore most commonly found near large river mouths, particularly on the down-current side. in sheltered bays and sounds and in depressions on the open shelves. Rock, gravel and stony bottoms are most common in narrow straits. off rocky points and cliffs and on elevations of the shelf (reefs) Sand is found outside straits, off beaches and sandy points and, in general. on the open shelves. Glaciated areas typically have sand and gravel mixed Distance from shore has relatively little to do with determination of sediment types, since tidal currents are frequently strongest on the outer edge of the continental shelf. Geophysical investigations indicate that the thickness of sediments increases seaward however, with up to 20,000 ft. of unconsolidated sediments existing at the edge of the continental shelves.

Where coral reefs exist, broken bits of coral and calcareous fragments produced by associated algae such as *Halimeda* make up most of the sediments, since reef-building corals are not able to live in the vicinity of rivers, and their growth protects the shore from direct erosion by the sea. Deposits of finely divided calcareous material are found on the Bahama banks and to a lesser extent among the Florida Keys and in Pacific lagoons; these were attributed by W. H. Dall in 1892 and by many subsequent investigators to direct chemical precipitation of calcium carbonate. Evaporites (sediments precipitated from sea water as it is concentrated through evaporation), such as gypsum. anhydrite and salt, although fairly common among sedimentary rocks, cannot be formed in the present ocean and must have been the result of special processes in the past. The other types of sedimentary rock are represented by the present continental shelf sediments. boulders and pebbles form conglomerates, sand forms sandstone; coral and shells form limestone; and mud forms shale. Petroleum is derived from the organic fractions of the sediments, when laid domn under conditions that resisted oxidation.

Sediments of the Continental Slopes.—The continental slopes, like the outer continental shelves, have been shown by geophysical investigations to overlie up to 20.000 ft. of sediments in various stages of consolidation. Their surface sediments have been computed by F. P. Shepard to be about 60% mud, 25% sand. 10% rock and gravel and 5% shells and ooze. The predominance of mud reflects the quieter water conditions, the strong tidal currents of the continental shelves being absent and the permanent currents diminishing greatly at depths below 3,000 ft. As described under turbidity currents, the deposition of the fine materials on the relatively steep slopes (3° to 5°) is thought to give rise to periodic catastrophic transfer of sediments of terrestrial origin down the slopes and into the deep ocean basins.

Sediments **of** the **Ocean** Basins.—Characteristically, the ocean floor at the foot of the continental slopes consists of level plains, except for isolated hills and sea mounts that rise above the general level. These plains slope away from the areas adjacent to sediment sources, and their sediments show material of shallow-water origin, including sand and foraminifera (single-celled animals with calcareous shells). Likewise the sediment layers are graded. that is, layers of coarse material are covered by layers of increasingly finer material. just as would be the case if an unsorted mixture of sediments and water were stirred up and then the sediments were permitted to settle out. All these circumstances lend weight to the conclusion that accumulations of sediment on the continental slopes from time to time are dislodged and travel as turbidity currents down the slopes and out across the nearby ocean floors. Additional weight is lent by the fact that farther out to sea, beyond the reach of such currents, the ocean floor is much more irregular, with both hills and valleys.

Beyond the reach of turbidity currents, material of terrestrial origin can still be transported to the floor of the ocean by a number of mechanisms. One of the best recognized is ice. Icebergs often contain morainal material from the glaciers of their origin, river ice may entrap detritus, and fast ice formed along the shore may be dislodged by tide or storm action and set adrift with beach materials embedded in it. Similarly, tree trunks can be carried aut to sea in floods with rocks and pebbles encased in the roots, and kelp and other large algae growing on rocky bottoms near shore can buoy stones gripped by their holdfasts. Many sea birds swallow gravel. just as do their barnyard cousins, and sea lions often have quarts of pebbles in their stomachs; the migrations of these creatures and the further possibility of drift of their carcasses after death provide widespread opportunities for delivery of such stone fragments to the deep sea. Floating pumice from volcanic eruptions is carried for thousands of miles by currents, the pieces continually wearing each other down when they touch as a result of wave action, and producing a rain of fine particles that sink to the bottom.

The activities of man also need to be considered. **A** century of steam navigation on the North Atlantic has marked the principal steamer lanes with a trail of coal ash and cinders. which form a substantial proportion of the material now collected from the bottom in that area, while such exotic materials as oyster shells, crockery fragments and beef bones are not uncommon. Shipwrecks offer another possibility in the accumulation of deepwater materials. It should be emphasized that the popular belief that sunken ships do not reach the bottom of the deep ocean, but instead sink to some intermediate depth at which they drift about, is without foundation. Still another agent in the transport of terrestrial material to the deep ocean is the wind, which carries dust from volcanic eruptions or from deserts far out over the oceans. Nor is the supply of material restricted to the earth itself. Occasional meteorites fall from outer space, and cosmic dust, black spherical particles of diameter up to .0092 in.. has been recovered from the deep ocean floor. However, the quantity of these extraterrestrial materials is very small and is equivalent to the coal ashes supplied by only one average-sized coal-burning steamship.

Except for the materials just enumerated. therefore, the sediments of the deep ocean basins must consist only of the very fine clay particles that can be transported from shore in suspension in sea water. together with substances absorbed on these particles, compounds precipitated from solution and the insoluble remains of the plants and animals that live in the overlying waters. Whereas a sand grain of diameter 0.02 in. sinks about 15 ft per minute, a clay particle of 0.00004-in. diameter settles at a rate of less than 7 ft. in a month. Thus, these fine clay particles take centuries to reach the bottom of the deep ocean. in the course of which time they are carried by currents to all parts of the earth. Therefore the deep ocean receives a nearly uniform supply of terrigenous clay particles. independent of location or distance from land.

Pelagic, *i.e.*, deep-sea, deposits are classified as red clay when they are mainly inorganic and ooze when they are highly organic. Pelagic sediment with less than 30% skeletal remains of organisms is classified as red clay. Its colour (which is more often brown than red, except in the Atlantic) is derived from the 8% or 9% of ferric oxide that it contains. It also typically has about 1% manganese dioxide which, along with the iron oxide and with significant quantities of the oxides of cobalt, copper and nickel, forms crusts on any exposed projection above the bottom. These manganese nodules often contain as a core a shark's tooth or the ear bone of a whale, two types of skeletal remains that prove highly resistant to decay and redissolving on the ocean floor.

The oozes, defined as pelagic sediments with over 30% skeletal remains, are subdivided first into calcareous and siliceous oozes and then again according to the predominant skeleton type. Thus the calcareous oozes include globigerina ooze, containing the tests of planktonic foraminifera, and pteropod ooze, made up chiefly of the shells of pelagic snails. The siliceous oozes include radiolarian ooze, which is essentially red clay with more than 30% of the skeletons of warm-water protozoa, and diatom ooze, containing the frustules (tiny shells) of diatoms. The siliceous oozes exist only where the rate of supply of diatoms or radiolarians is greater than the rate of solution of silica in the deep waters; thus the diatom oozes are confined to productive belts in the North Pacific and Antarctic, and the radiolarian oozes are found only under the eastern part of the Equatorial current in the North Pacific. Except near the equator, the rest of the North Pacific is covered almost entirely with red clay. The other oceans have both red clay and globigerina oozes. Pteropod ooze is found only in mid-Atlantic. Seismic measurements indicate that there is a thickness of about 1,000 to 1,200 ft. of unaltered pelagic sediments in the deep oceans.

Rates of Sedimentation and Past **Climates.**—Various calculations have shown that the average rate of deposition of red clay is about one inch every 2,500 years, and rates for the other pelagic types of deposit are not much greater. It is technically quite feasible to lower sharpened pipes to the bottom and drive them in to depths of 70 ft. or more, and thus samples can be obtained that go back in time for 2,000,000 years. Since the layers are preserved in the pipe in the order in which they were laid down, it is possible to examine the deposits with various techniques that tell of past climates and events. For example, a layer of glacial till would indicate an era of lower temperatures in the past, while pumice or ash would reveal volcanic activity. The tests of foraminifera can often be identified as predominantly cold-water or warm-water forms. Oxygen isotope analysis can be applied to the O^{18}/O^{16} ratio, which is a delicate "fossil thermometer." Providing information of this nature is but one of the many ways in which oceanography comes to the assistance of other sciences.

III. PHYSICAL PROPERTIES OF SEA WATER

Salinity and **Chlorinity.**—All the principal salts in sea water are found everywhere in the same proportions, and only the total quantity of salt in a given amount of sea water varies significantly. It is therefore possible to express this relationship as the salinity. Salinity is defined as the weight of dissolved salt in 1,000 parts of sea water, *i.e.*, grams per kilogram, when all the carbonates and organic matter have been converted to oxides, and all bromides and iodides to chlorides. The value found in accordance with this definition is about one-half of 1% lower than the actual weight of dissolved solids. Because of the accuracy required in physical oceanography, it is necessary to report salinity to four significant figures, and, as the Scandinavian countries (where physical oceanography developed) use decimal currency, it has become customary to report salinity not as per cent (%) but per mille ($^0/_{00}$). By this convention, the four-digit numbers look like amounts of money, and printing and proofreading of long columns of figures are made easier. Thus salt content of the open ocean, which ranges from 3.2% to 3.6% salt, is expressed as salinity $32^0/_{00}$ to $36^0/_{00}$.

Seas receiving extensive river drainage may have lower values. The northern Bay of Bengal, Yellow sea and Okhotsk sea all have surface salinities as low as $30^0/_{00}$; the surface water of the Black sea is about $16^0/_{00}$; and the Baltic in the spring drops as low as $1^0/_{00}$. Where evaporation is high and river drainage and rainfall low, salinities as high as $40^0/_{00}$ are encountered in the Persian gulf and $41^0/_{00}$ in the Red sea.

It is not easy to make determinations of salinity directly, so that it is usually derived from measurements of some other property, such as electrical conductivity, specific gravity, index of refraction or chlorinity. The chlorinity of sea water is the value derived from direct titration of the halides with silver nitrate. Chlorinity was originally defined as the proportion (per mille) of halides in sea water if all the bromides and iodides were replaced by chlorides. The relationship between chlorinity and salinity was found in 1902 by Martin Knudsen and collaborators to be $S = 0.03 + 1.805 \times Cl$. Many years later, it was discovered that, mainly because of changes in values for atomic weights, chlorinity as defined by this expression (which formed the basis of Knudsen's tables) was 45 parts in 100,000 lower than the value given by the original definition, and J. P. Jacobsen and Knudsen in 1940 therefore redefined chlorinity as 0.3285233 of the silver equivalent of sea water.

The constant term 0.03 in the relationship between salinity and chlorinity is of interest, because it means that water having zero chlorinity still has a salinity of $0.03^0/_{00}$. This apparent paradox results from the fact that low salinities in the ocean generally result from mixing with river water rather than rain water. River waters usually contain significant quantities of dissolved salts, invariably with much more sulfate and bicarbonate than chloride, and hence their chloride values are zero while their total salt values are still significant.

Temperature, Freezing Point and Heat Capacity.—The freezing point of ordinary sea water (salinity $34.75^0/_{00}$) is 28.7° F. Temperatures in the ocean range upward from this value to maxima of a little above 85° F. in the open tropical seas and as high as 90° in the Persian gulf in summer.

The distribution of surface temperatures in the ocean is approximately as shown in Table III.

Below the surface, the ocean almost invariably shows a de-

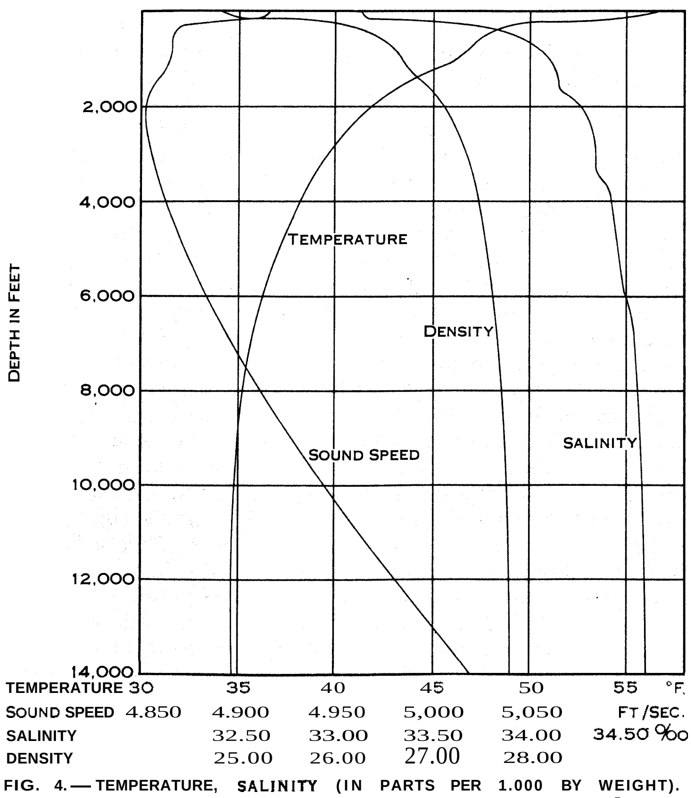


FIG. 4.—TEMPERATURE, SALINITY (IN PARTS PER 1.000 BY WEIGHT). DENSITY (IN σ UNITS. EQUAL TO 1.000 X [SPECIFIC GRAVITY—1]) AND SOUND SPEED. SHOWING TYPICAL VARIATION WITH DEPTH IN THE PACIFIC OCEAN OFF SOUTHERN CALIFORNIA

TABLE III.—*Approximate Distribution of Surface Temperatures*

Average surface temperature, ° F.	Percentage of area of ocean
35 or below	12.5
35–40	4.9
40 45	3.6
45–50	4.8
50–55	5.2
55–60	5.5
60–65	5.9
65–70	7.5
70–75	10.2
75–80	17.0
80–85	22.8
85–90	0.1

crease of temperature with depth, reflecting the fact that colder water is denser and hence sinks below warmer water. Fig. 4 shows a typical distribution of temperature with depth in the ocean. Near the surface there is generally a layer of constant temperature resulting from mixing by the action of wind and waves. This mixed layer, or isothermal layer, has a thickness ranging from 10 ft. or less in calm regions to as much as 600 ft. in trade-wind latitudes. Below it is a zone of rapid temperature decrease, the thermocline, which merges smoothly with the temperature of the deep oceans. The ocean is everywhere colder than 60° F. at a depth greater than 1,200 ft., and even at the equator the temperature in deep water is as low as 35°, since the water of the deep oceans has sunk from the surface in polar regions. The average temperature of the ocean was determined in 1957 by R. B. Montgomery and associates to be 39° F.

There is an important difference between temperatures in the sea and those encountered in deep wells or mine shafts on land. In sedimentary rock, there is a temperature increase of 1° F. for every 60 to 110 ft. of depth. In the sea, this geothermal gradient is almost entirely suppressed, and when it is encountered, in deep basins separated by ridges from the general flow of bottom water (as in the Mediterranean sea), it amounts to only 1° F. in 10,000 ft. of depth.

The specific heat of sea water is reduced only slightly below that of distilled water by the dissolved salts and amounts to about 0 93 B T.U per pound. The significance of this figure is the comparison with the specific heat of air, 0.24 B.T.U. per pound, and of rock and soil, 0.19 to 0.22. Thus the total heat capacity of the lower 10,000 ft. of the atmosphere is matched by the top 2.7 ft. of the ocean, and the heat capacity of the top 100 ft. of the dry land, which is as deep as any annual heating or cooling effect is felt. is the same as the top 40 ft. of the sea. The annual variation of surface temperature in the sea has a maximum range of 15° F. at about latitude 40° N. in the Atlantic and 18° F. in the North Pacific. It amounts to only 3° or 4° F. in the tropics and 9° or 10° F. in the south temperate zones. Annual variations are felt to a maximum depth of about 600 ft., unless the water at the surface is cooled sufficiently to cause it to sink to the bottom. This condition takes place in the winter in the Arctic and Antarctic oceans and in the eastern Mediterranean sea. In the polar regions, formation of denser water at the surface is accelerated by ice formation, which by removing part of the water makes the remaining water saltier.

Fresh water has a maximum specific gravity at 39.2° F., which means that water cooled below this temperature cannot sink to the bottom of a lake until the entire lake has reached this temperature. The addition of salt to water, however, lowers the temperature of maximum specihc gravity very rapidly, and at a salinity of $24.70^0/_{00}$ this temperature is the same as the freezing point. At higher salinities, *i* e., everywhere in the open oceans, sea water always has a higher specific gravity the lower its temperature.

The main source of heat in the ocean is radiation from the sun, most of which is absorbed in the top five feet of water. Except under unusual conditions, however, such as in sheltered bays. mixing by waves and wind distributes this heat through a much greater depth. When the air is colder than the sea surface. this heat is given off again to the atmosphere. The ocean thus exerts an ameliorating effect on climate. Since the global circulation of air is from west to east in temperate and polar latitudes, this effect is felt much more on the western edges of continents. Ireland, in the same latitude as Labrador, has a much milder climate, and the Gulf stream, though it passes close to the coasts of North Carolina and Virginia, is virtually without influence on their climate or that of the rest of the United States.

Density and Pressure.—Sea water weighs almost exactly 64 lb. per cubic foot, so that 35 cu.ft. weigh a long or shipper's ton (2,240 lb.), a relationship widely used in naval architecture. Since the density of distilled water is 62.43 lb. per cubic foot, the specific gravity of sea water, in round figures, is 1.025. For the same reason as stated under salinity, it is customary to report the density of sea water in a unit equivalent to "grams per litre excess over one kilogram," designated by the symbol σ. In this notation, the specific gravity of 1.025 is expressed as a of 25. Density increases with increasing salinity but decreases with increasing temperature. It also increases with increasing pressure, because of the slight but appreciable compressibility (about 4 parts in 100,000 per atmosphere pressure). Fig. 4 includes a typical curve of density as a function of depth. The pressure increases in the sea as depth increases, at the rate very nearly of one atmosphere for each 33 ft. Table IV gives the average pressure in the ocean as a function of depth.

TABLE IV.—*Average Pressure as a Function of Depth*

Depth in feet	Pressure in pounds per square inch
1,000	445
2,000	892
4,000	1,788
6,000	2,685
8,000	3,586
10,000	4,488
20,000	9,034
30,000	13,640
35,958	16,415

The values shown represent the pressure due to sea water alone, and for strict accuracy an additional 15 lb. per square inch should be added to include the atmospheric pressure in the total pressure at depth.

As an example of how pressure affects specific gravity. we can take the calculation of the mean density of sea water. The mean temperature of 39° F. and mean salinity of $34.75^0/_{00}$ yield a specific gravity of 1.02762 or a of 27.62 from Knudsen's tables. This value of a is designated $\sigma_{t,0}$ to indicate that it is corrected for temperature but not for pressure. The mean depth of the ocean is 12,450 ft., and the pressure at this depth is 5,600 lb. per square inch. Application of compressibility. as given in LaFond's tables, yields $\sigma_{t,p}$ of 44.90 or specific gravity of 1.04490 for this pressure.

Multiplying 62.43 by 1.04490 gives 65.23 lb. per cubic foot as the average density of sea water in the ocean. Since the volume of the ocean is 3.288×10^8 cu.mi. and there are $5{,}280^3$ or 147,197,-952,000 cu.ft. in a cubic mile, the total weight of sea water in the ocean is $65.23\times3.288\times10^8\times1.472\times10^{11}$ or 3.16×10^{21} lb.

Electrical Conductivity.— Since sea water is a fairly strong salt solution, its electrical conductivity is much greater than that of pure water. The values of electrical resistance given in Table V are for sea water of salinity $34.75^0/_{00}$.

TABLE V.—*Values of Electrical Resistance*

Item	At 39" F.	At 77° F.
Ohms per foot cube	1.01	0.69
Ohms per inch cube	12.1	8.3

Colour and Transparency.— The blue colour of sea water, like the blue of the sky, is the result of molecular scattering of light. Dissolved yellow pigments produced from the decay of plants give the green colour to coastal waters. Abundant phytoplankton and suspended sediments add a brownish tinge to estuarine waters.

In certain oceanic areas, such as the Sargasso sea, where phytoplankton is scarce, sea water is nearly as transparent as distilled water. Where phytoplankton is more abundant, the transparency is much less. The area, near the surface to which sufficient light penetrates to enable phytoplankton to carry on photosynthesis is called the euphotic zone. Its thickness ranges from a maximum of over 300 ft. in the open sea to 3 ft. or less in estuaries.

Sound in the Sea.—The speed and other characteristics of sound in the ocean are of considerable practical importance. The reception of a reflected sound signal can be used to determine the depth to the bottom (see SOUNDING) and to locate schools of fish or other submerged objects. Echo-location systems, knonn in naval parlance as asdic or sonar, have been highly developed for detecting submerged submarines.

In the operation of sonar, the refraction, scattering and absorption of sound are limiting factors. Refraction results from the variation in speed of sound. which causes bending of the sound rays. The speed of sound at one atmosphere pressure. salinity $34.75\,^{0}/_{00}$ and temperature 39° F. is 3.800 ft. per second, or about 4.5 times its speed in air. The speed increases with increasing pressure, temperature or salinity. In the thermocline, temperature decreases rapidly. but in the deeper layers it changes more slowly whereas pressure steadily increases; hence. sound speed commonly shows a minimum value at an intermediate depth, as in fig. 4. Horizontally directed sound waves tend to be refracted toward the zone of low sound speed. and thus they are trapped in the zone of minimum speed and may be transmitted for long distances with little loss in intensity.

This layer or channel is the basis of the system of sofar (sound fixing and ranging), which has been proposed as a means of long-distance communication, particularly for the location of survivors at sea. An explosive charge set to detonate at the depth of the sound channel could be detected by hydrophones placed at the proper depth thousands of miles away, and the differences in time of the arriving signals could be used to construct hyperbolas that would intersect at the detonation point.

Much of the scattering of sound in the ocean results from echoes produced by living organisms, many of which migrate upward to the surface at night from a depth of about 1,000 ft. Absorption is due mainly to the content in sea water of dissolved magnesium sulfate, which has a specific ability to absorb sound, particularly at high frequencies.

IV. MOVEMENT OF SEA WATER

Currents. — Motion of water particles in the sea is of various kinds. The molecular motion involved in the propagation of sound has been covered above. The periodic rise and fall of the surface is described in the articles TIDES; WAVES AND SHORE CURRENTS; WAVES OF THE SEA. There remain to be considered the horizontal and vertical circulation of water masses in the sea. The horizontal movement of water is called a current. In the ocean there exist both tidal currents. or tidal streams, which are associated with the tidal rise and fall of sea level and result from the same causes, and nontidal currents. The nontidal currents show considerable regularity in their general flow, although they may be modified by a persistent wind that blows for several days in the same direction. However: in temperate and boreal latitudes changes in weather tend to occur too quickly for the ocean to respond to them, so that the nontidal currents in a given season of the year are relatively stable.

Coriolis Force. — In describing the motion of any particle on the rotating earth, it is necessary to consider the rotation of the earth. To an observer in space, the motion would not appear the same as to an observer also on the rotating earth. Since a body once set in motion continues that motion relative to space. it has an apparent deflection relative to the observer on the rotating earth. The horizontal component of this deflection is proportional to the sine of the latitude, and thus it is a maximum at the poles and zero at the equator, and the direction in which this apparent deflection is exerted is opposite on opposite sides of the equator. This deflecting force is called Coriolis force, after the French engineer who first derived it mathematically in 183j. Coriolis force actually affects all motion on the earth's surface: but usually it is slight in comparison with the other forces of friction and propulsion. In the cases where a motion once initiated is proceeding against almost negligible friction, however, it must be considered. These cases include a projectile or missile in flight, a swinging pendulum (Foucault's pendulum), a moving air mass (see also BUYS BALLOT'S LAW) and an ocean currcnt.

The direction of Coriolis force is to the right (clockwise) in the northern hemisphere and to the left (counterclockwise) in the southern. Since this is the apparent direction in which the sun moves, it is convenient to describe it as *cum* sole ("with the sun"). If no other force acts on a body moving with speed V, it will be directed *cum* sole in a circle (the inertia circle), the radius r of which is given by the centrifugal force $\frac{V^2}{r}$. This will equal the Coriolis force. $2\omega v \sin\phi$, where W is the angular velocity of the earth's rotation ($.729 + 10^{-4}$ radians/second) and ϕ is the latitude. In latitude 40°, this relationship yields a radius of 3 mi. for a speed of 1 m.p.h. Obviously, therefore. ocean currents that flow in the same direction for thousands of miles at speeds of this order of magnitude cannot persist unless a force is provided to oppose Coriolis force. Just as in the atmosphere, this opposing force is supplied by the pressure gradient. In the sea, pressure is given by the product of gravity × depth × density. Gravity is of course constant at any point. so for a given depth the pressure can be varied only by varying the density. Thus if a permanent steady ocean current is found to exist, there will be found a density gradient across it. with the lightest water cum sole.

Water movement in the inertia circle has been observed in the tideless Baltic sea, under conditions where there were no density gradients in the water, but, in general, motion of this kind is unusual in the sea.

Tidal Streams and Estuaries. — In restricted channels, a tidal stream exhibits a regular pattern of ebb (seaward flow) and flood (landward flow). The duration of each corresponds generally to the time interval between high water and low water, but in the case of river mouths, the ebb is usually longer or faster than the flood, in order to accommodate the river flow. In such a river mouth. there is generally an upstream undercurrent of sea water, forming a salt wedge, which thins out upstream with a fairly sharp interface between the salt nater and the fresh aater above. Mixing takes place all along this interface, and the salt water returns to the sea mixed with the river water in the upper layers.

The uater discharged to the sea by a river is fresher and therefore lower in density than the sea water, hence it tends to turn *cum* sole along the coast. Thus, along the Atlantic coast of the United States, which has numerous rivers producing an appreciable lowering of the coastal salinity, the general inshore current sets to the south as far as Cape Hatteras. On the coast of California, where rainfall and runoff of the coastal rivers is confined chiefly to the winter months, the California current sets south in the summer. but in winter a well-defined north-setting inshore current, the Davidson current. makes its appearance.

The Amazon river is unique among the great rivers of the world in that its mouth is exactly on the equator, where Coriolis force is zero. Since there the fresh water has no tendency to be deflected either right or left, instead of hugging the coast it spreads out in a thin layer to seaward. so that the fresh waters of the Amazon can be detected for scores of miles off its mouth.

Tidal currents exist in the open sea as well as in restricted channels since they represent the motion of the mater particles in the progressive or standing waves that comprise the tide. In deep mater their effect is small and almost immeasurable, but on the continental shelves they are usually the predominant current. When not confined by coastal barriers, tidal currents generally change direction continually *cum* sole, and where the tide is mainly semidiurnal in character a drifting object completes a roughly circular path every 12 hours. A typical diameter for such a circle is 4 or 5 mi, but appropriate hydrographic publications, *e.g.,* the U S. coast and geodetic survey *Current* Tables for *United* States *Waters,* should be consulted for specific details at a given locality.

Wind-Driven **Currents.**—Whenever the wind blows over a stretch of aater for an appreciable time. the frictional drag between wind and water and betneen the layers of water will set the aater in motion. V. W. Ekman shoned in 1902, as the result of observations of the drift of pack ice made by Fridtjof Nansen in the "Fram." that in water of sufficient depth, assuming that the aater is homogeneous and that eddy viscosity does not vary with depth, the surface wind current is directed 45° *cum* sole from

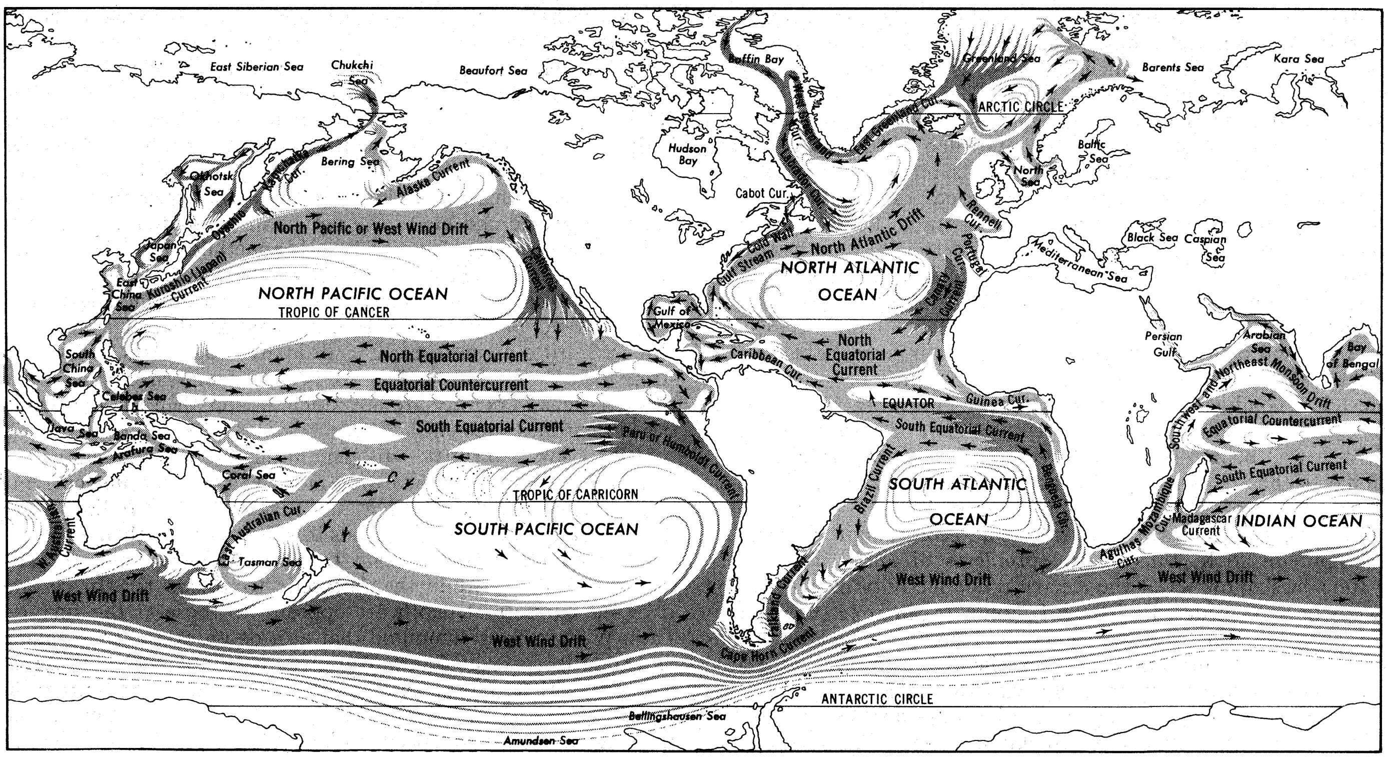


FIG. 5.— SCHEMATIC MAP OF THE PRINCIPAL OCEAN CURRENTS OF THE WORLD. LIGHT AREAS INDICATE WARM CURRENTS. DARK AREAS COLD CURRENTS

the wind direction. Each layer below the surface is deflected further *cum sole* by the layer above, but with a lower speed. so that the water on the average is carried 90° *cum* sole. There even exists a depth (equal to $7.6W\sqrt{csc\ \phi}$ where W is wind speed in feet per second) at which the current initiated by the wind flows in the direction opposite to the wind, although its speed is only $\frac{1}{23}$ that of the suriace current. The speed of the wind-driven current at the surface is $.013W\sqrt{csc\ \phi}$. It is obvious that these relationships cannot be valid near the equator.

Permanent Currents.— Fig. *j* presents the system of permanent surface currents in the ocean. Comparison with a chart of average prevailing winds shows in general good agreement with the principle that the water moves about 45° *cum* sole from the wind, but there are two notable individualities that result from other causes. The well-developed countercurrents that flow eastward just north of the equator in the Pacific and Atlantic and just south of it in the Indian ocean do not appear to agree with what would be expected from prevailing winds. However. H. U. Sverdrup in 1947 showed that the equatorial countercurrents develop in the region of minimum wind stress and can be derived from a knowledge of wind stress alone.

The intense currents that develop on the western sides of the oceans. such as the Kuroshio in the North Pacific, the Gulf stream in the North Xtlantic and the Agulhas current in the Indian ocean. likewise are not related to the local winds. Henry Stommel between *1948* and 1951 showed that this westward intensification of surface currents results from the variation of Coriolis force with latitude, and that. although the winds add energy to the current system of each ocean over the whole ocean, this energy is dissipated mainly in the strong western current. W. S. von Arx confirmed this finding by modelexperiments in 1952. G. Neumann in 19*jj* accounted for the lack of such a pronounced western current in the South Atlantic by showing that there the change in Coriolis force with latitude is nearly offset by a corresponding change in the depth of the current system.

Fig. 5 clearly justifies the division of the ocean into seven main oceans. Each ocean has its own virtually closed suriace circulation, that of the Antarctic being to the eastward around Antarctica and that of the Arctic (not shown) entering from the Atlantic in the Barents sea, proceeding northeastward. circling the pole and leaving down the east coast of Greenland. In comparison, the exchange with the Pacific through Bering strait is much less important, though Martin Johnson has shown from study of the zooplankton that appreciable quantities of water reach the Arctic coast of Alaska from the Bering sea. It is particularly noteworthy that in the suriace circulation of the ocean very little water crosses the equator. except where the South Equatorial current impinges on the bulge of South America. This flow makes up for the water that sinks below the surface in the northern North Xtlantic in winter and crosses the equator near the bottom.

Measurement of **Currents.**—Numerous means, direct and indirect, have been developed for measuring ocean currents. If the navigator of a ship keeps careful records of his course and speed, the difference between the position so given (the dead reckoning) and the position actually fixed by astronomical or electronic means can be attributed to the effect of current. Hundreds of ships report daily observations of this sort to the world's hydrographic offices, and although the results of necessity average the current over fairly large distances. sufficient observations are available to permit averaging out of all random errors. These results form the basis of generalized current maps of large areas, such as fig. 5. A somewhat similar method involves the dropping of bottles or cards (bottle post or drift cards) at known positions and noting the position of recovery. This method is excellent when practical applications are desired. such as the fate of selvage or oil disposed of at sea or the drift of fish eggs. but it tells very little about the actual path of the currents between the points of release and recovery.

An elaboration of the drift bottle is a drogue, or other object, which will be acted on by the current at a predetermined depth and will tow a light or radar reflector floating on the surface. Such a drogue can be followed from a boat for days or weeks and its successive positions determined. A further refinement. developed by J. C. Swallow in 195*j*, is to provide the float with a simple sound-generating apparatus. leaving it independent of any connection with the surface, and to follow its course by listening with directional hydrophones. This method has provided information on currents as deep as 5,000 ft.

Surface currents are readily determined from anchored ships by the same methods as those used to find a ship's speed through the water. Numerous observations of tidal currents have been made in this way from lightships. The Ekman meter, used for subsurface currents from an anchored ship, is essentially a propeller steered into the current by a vane. Mechanisms are fitted for stopping and starting at predetermined times, and counting dials read the number of turns of the propeller in the elapsed time. Lead or bronze pellets drop at intervals into a compartmented compass box to show the current direction. The Roberts meter is somewhat similar in principle, but transmits its readings electrically or by radio from a buoy at the surface. There have been many other developments along similar lines, but the principal drawback with such devices is the difficulty of anchoring a ship in deep water.

A method developed in 1948 by Von Arx is to make use of the electrical properties of sea water itself. Since sea water is an electrical conductor, any motion it makes in the earth's magnetic field will set up an electrical current. A pair of electrodes in tandem, towed behind a ship, will record an electrical signal proportional to the component of the ocean current normal to the ship's course. A 90° change in course, therefore, will provide both components of the ocean current. The geomagnetic electrokinetograph, or GEK, thus has no problems of anchoring in deep water; in shallow water the electrical conductivity of the bottom needs to be considered. Joseph L. Reid. Jr., in 1952 showed that the observed drift of a drogue at 30 or 60 ft. among the islands off southern California agreed excellently with the integrated currents obtained simultaneously with the GEK.

A variation on the same principle is to use fluctuations in electrical current recorded in a submarine cable. This method has been employed in the English channel and in the Straits of Florida to measure the total current transport through the strait, and excellent agreement with flow deduced from tide, sea level and winds has been obtained in the Straits of Dover with this method by K. F. Bowden.

The geomagnetic methods. drogues and meters all give the total resultant water movement at any point, inertial, tidal and wind driven as well as permanent. By determining accurately the density of the water at a number of points, it is possible to compute the permanent currents, since, as shown above, the density gradient is matched by Coriolis force. In practice this is done by stopping a ship at intervals of about 60 mi, and lowering sampling bottles equipped mith recording thermometers to a number of depths. Commonly 1j or more samples are taken to depths of down to 4,000 ft. or more, the samples being only 30 ft. apart near the surface but at greater intervals as the depth increases. The temperature is read at each depth to .03° or .04° F. ;the salinity of the water sample is determined to $.02^0/_{00}$, and from these the density or specific gravity is calculated to .01 in σ_t. Each vertical series of samples constitutes an oceanographic station, and at each station the average density is computed for the vertical water column by an ingenious series of approximations. Since pressure is the product of density × gravity × depth, the height of the nater column above levels of identical pressure at two adjacent stations will vary inversely nith the mean densities, and the difference in height is equivalent to a difference in sea level between the t\\ stations. On a nonrotating earth, the water would flow like a river, downhill from the higher level to the lower; but since on the rotating earth the density gradient is assumed to be balanced by Coriolis force, the motion must be directed not down the slope but 90° cum sole. The downslope acceleration. slope × gravity, thus equals $2\omega v \sin\phi$, or $v = \text{slope} \times \text{gravity}/2\omega \sin\phi$. At latitude 45°, for two stations roo mi. apart, if the difference in sea level (or dynamic height) is one foot, the slope is 1/528,000 or 1.89×10^{-6}; gravity is 21.94 mi. per hour per second; and $2\omega \sin\phi$ is $2 \times .729 \times 10^{-4} \times .707$ or 1.03×10^{-4} radians per second. Hence the current speed is

$$\frac{21.94 \times 1.89 \times 10^{-6}}{1.03 \times 10^{-4}} = .40 \text{ m.p.h.}$$

In regions like the Gulf stream, where speeds of 4 m.p.h. are often observed, the sea level therefore changes about one foot in ten miles. In practice, a map of the sea surface is prepared. much like a weather map, on which contours of equal dynamic height are drawn. The current direction is along the contours, and its speed is inversely proportional to the spacing of the contours.

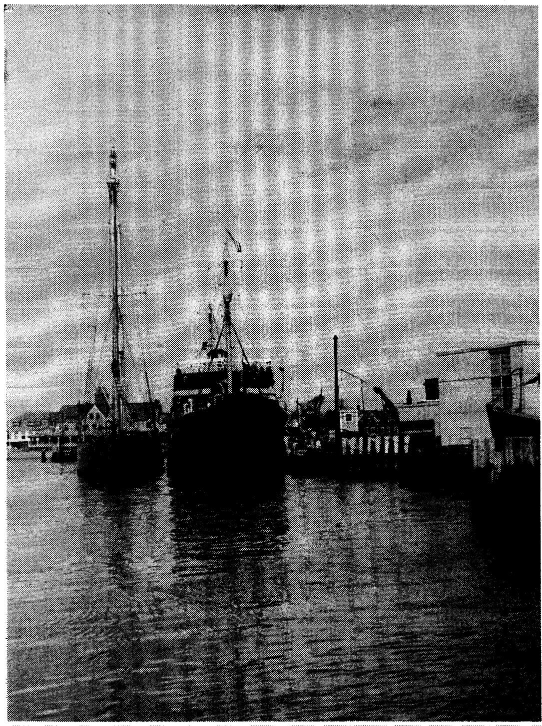
This geostrophic, *i.e.*, earth's rotation, method, of course, is not valid near the equator, where Coriolis force vanishes in respect to horizontal movement. Its main drawback elsewhere is its dependence on locating a level of no motion above which the densities are averaged. But the validity of the assumption that friction can be neglected and hence the details of computed current flow will agree with those observed by other methods has been repeatedly demonstrated: in the Gulf stream by Georg Wüst in 1924, comparing direct current measurements from an anchored ship; on the Grand Banks by the International Ice patrol, comparing observed drifts of icebergs; and in many other cases. The geostrophic method is also of less use in very deep water, since there the variations in density are not much greater than the uncertainties in their measurement.

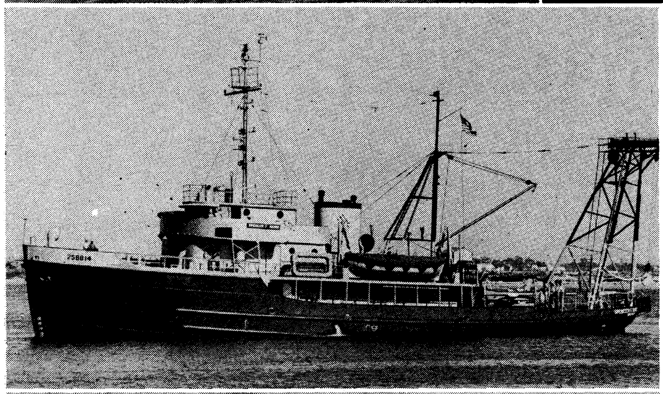
Subsurface Currents. — In general, in the upper layers of the sea, the geostrophic method can be employed to determine currents belo the surface as well as at the surface itself. It has shown that the California current extends to a depth of less than 1,500 ft., the Kuroshio and Gulf stream to 3.000 or even 5,000 ft., and the West Wind Drift in the Antarctic to 10,000 ft. In certain areas the currents at depth are opposite to those at the surface. Thus, Rust in 1955 computed that at a depth of 10.000 ft. along the Atlantic coast of South America there are currents setting southerly with speeds up to 0.28 m.p.h., while near the bottom, in depths of 11,500 ft. or more, there are currents setting in the opposite direction with speeds as high as 0.3j m.p.h. Stommel in 1956 showed that similar currents should exist beneath the Gulf stream. and such southerly setting currents at depths of 8.200 to 9,200 ft.. with speeds up to 0.2 or 0.3 m.p.h. were observed there using Swallow floats from the R.R.S. "Discovery II" in 1957. Photographs of the ocean bottom confirm the existence of strong currents at great depths, as they frequently show the presence of ripple marks.

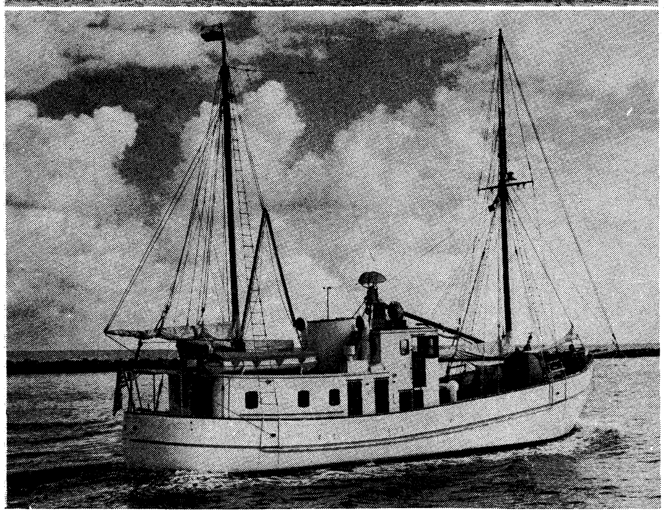
A subsurface current of a much different character was demonstrated by Townsend Cromwell in 1952 on the equator in the central Pacific. The surface current, the Equatorial current, set west at about 1 m.p.h., while drogues placed at a depth of only zoo ft. revealed the existence of a narrow current (which has been named the Cromwell current) setting at an even greater speed in the opposite direction.

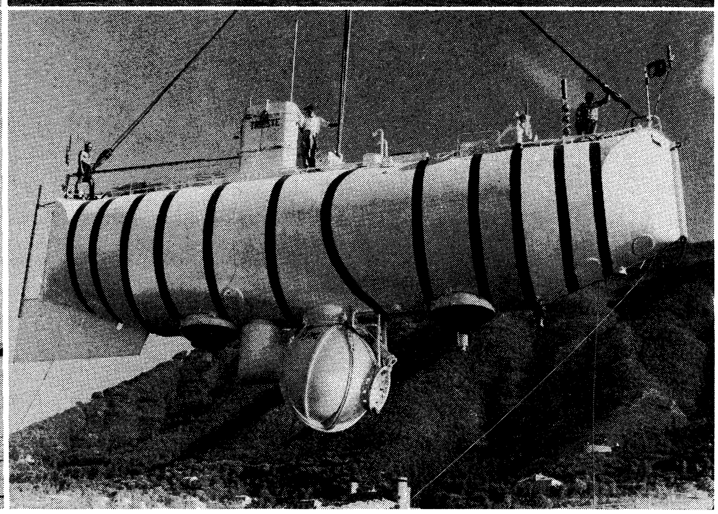
Density Currents. — Certain permanent currents in the ocean are unrelated to the general wind-driven circulation that has just been considered. For example, in the Straits of Gibraltar there is a strong surface current (up to 4 m.p.h.) entering the straits above an equally strong subsurface current flowing in the opposite direction. This circulation results from evaporation in the Mediterranean, which produces water of high salinity that sinks below the surface in the winter months. Although the net evaporation from the Mediterranean amounts to only 1.5 cu.mi. per day. it sets up an exchange of about 25 times as much water, so that the inflow through the straits is 36.3 cu.mi. per day and the subsurface outflow 34.8 This influx of water is equivalent to the total volume of the Mediterranean every 75 years.

Turbidity Currents. — Another type of transport in the sea completely unrelated to the kinds of current previously described is the turbidity current. This type of flow is thought to take place chiefly down the continental slopes, where loose mixtures of sediments and water collect. From time to time. it is believed, these collections of material dislodge. often under the impetus of earthquakes, and the turbulent mixture of sediments and water! with an average density much greater than water but with many of the properties of a fluid, cascades down the slope like an avalanche. For many years the existence of such currents was accepted only by geologists, on the basis of small-scale laboratory experiments and of the observed characteristics of marine sediments, sedimentary rock and submarine canyons, which are otherwise very difficult to explain. Bruce C. Heezen and Maurice Ewing in 1952, however. presented information from the, timing of breaks of transatlantic telegraph cables after an earthquake near the Grand Banks









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OCEANOGRAPHIC VESSELS AND AN INSTITUTION

Top left: The "Atlantis" of the Woods Hole Oceanographic institution (left), and the Royal Research ship "Discovery II" of the National Institute of Oceanography (Eng.)

Top right: View of Scripps Institution of Oceanography, La Jolla, Calif.

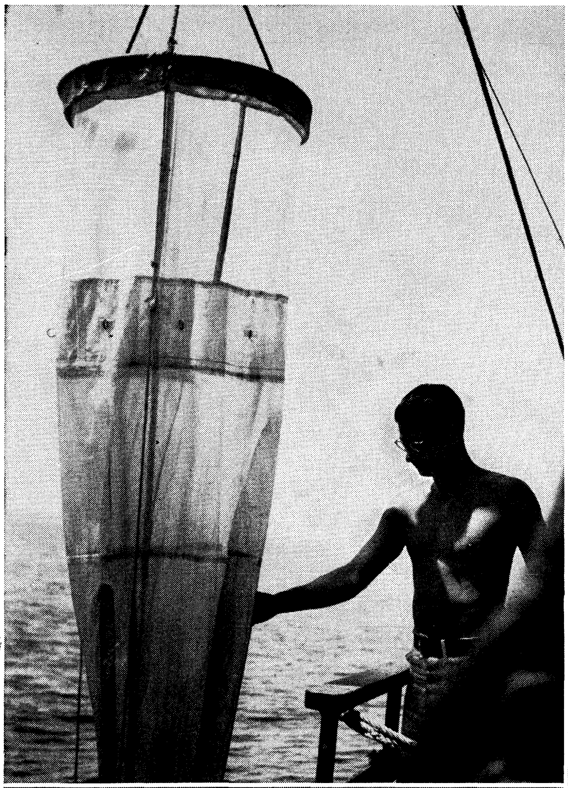
Centre left: The "Spencer F. Baird," oceanographic vessel of Scripps Institution of Oceanography

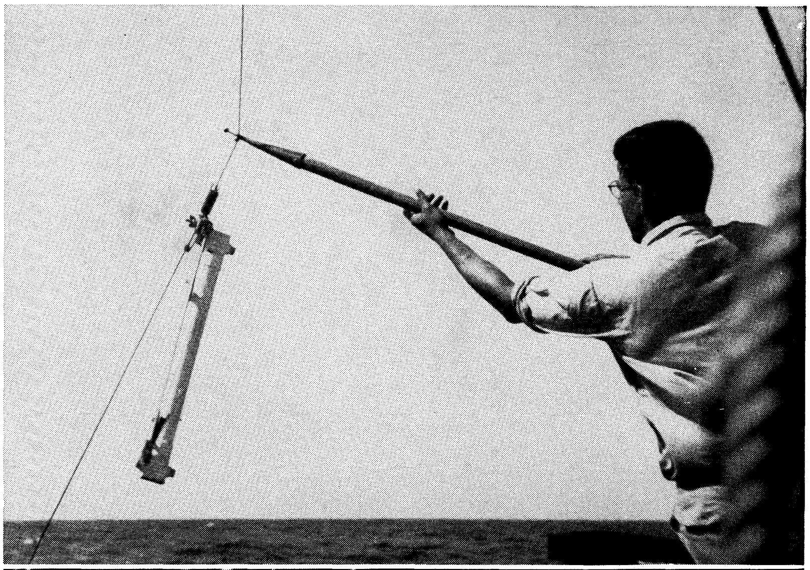
Centre right: C.N.A.V. "Whitethroat" of the Pacific Oceanographic group, Nanaimo, British Columbia

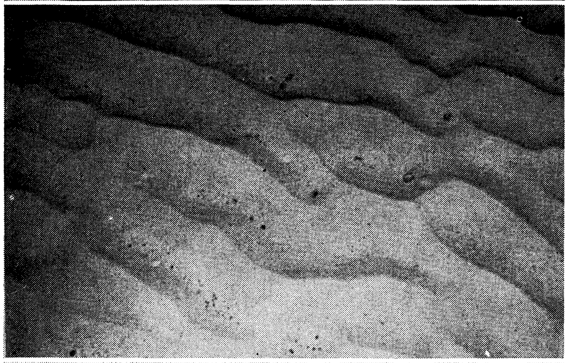
Bottom left: The "Gerda" of the Marine Laboratory of the University of Miami at Virginia Key, Fla.

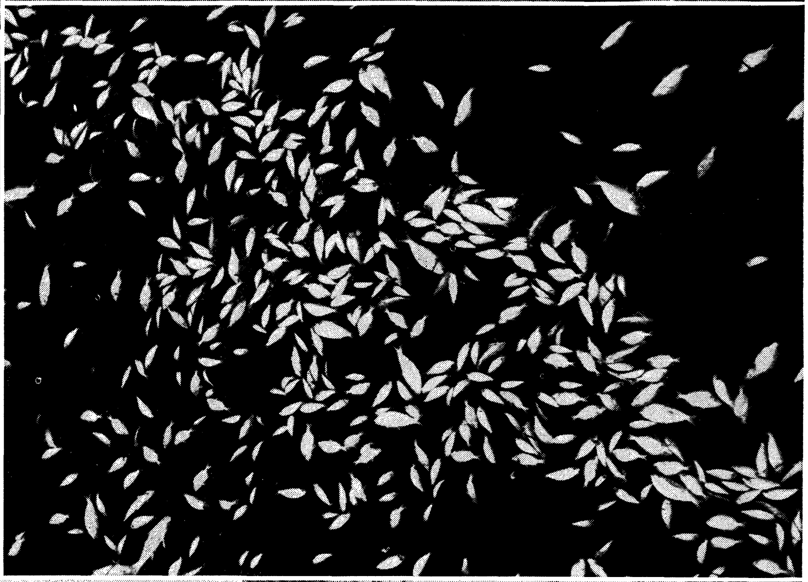
Bottom right: The bathyscape "Trieste," an underwater observation vessel

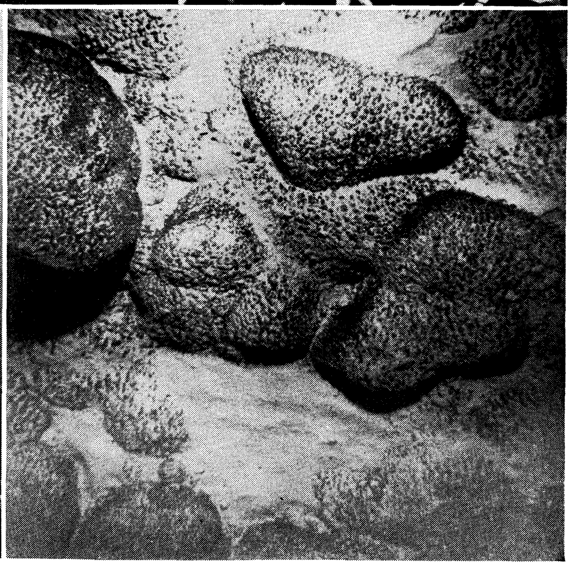
OCEAN AND OCEANOGRAPHY











BY COURTESY OF (TOP LEFT, TOP RIGHT) JOHN LYMAN, (CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT) OFFICIAL U.S. NAVY PHOTOS, BY (CENTRE LEFT, BOTTOM RIGHT) CARL J. SHIPEK, (CENTRE RIGHT) "ST PETERSBURG TIMES

OCEANOGRAPHIC INSTRUMENTS AND OBSERVATIONS

Top left: Net used for gathering plankton

Top right: Oceanographer recovering a Nansen bottle after it has been used to take a deep-sea water sample

Centre left: Ripple marks on sand bottom, photographed at a depth of 6,600 ft. near Eniwetok, Marshall islands

Centre right: Dead fish (herring and other species) killed off the west coast of Florida by the "red tide," a growth in surface waters of a dino-flagellate which produces a substance toxic to fish and other marine life

Bottom left: A team of oceanographers equipped with self-contained under-water breathing apparatus, examining bottom conditions in a kelp bed off southern California

Bottom right: Manganese dioxide-crusted boulders photographed near Bikini, Marshall islands, at a depth of 4,500 ft.

in 1929 which showed that a disturbance had proceeded down the continental slope at a rate up to 60 m.p.h., and they subsequently demonstrated that the basin at the foot of the slope mas covered with freshly deposited sediment of shallow-water origin. Although this report was by no means universally accepted at the time as proof of the existence of such turbidity currents, an earthquake at Orléansville, Alg., in 1954 broke cables in a similar fashion, yielding a downslope speed up to 45 m.p.h.

Vertical Water Movements.—When a persistent wind blows along a coast that lies to the left of the wind direction (in the northern hemisphere) the net transport of water in the wind-induced current is offshore. Since the coast acts as a barrier, water to replace that blown offshore can only come from the deeper layers. This phenomenon is known as upwelling, and it exists along the coast of northern California in summer and off Morocco, Peru and South-West Africa. The replacement water comes from a depth of 600 to 1,000 ft., that is, from well down the thermocline and below the euphotic zone, so that the water is both appreciably colder and richer in plant nutrients than the water it replaces. Zones of upwelling, therefore, considerably modify the climate of the coasts where they occur (the coastal fogs of California result from this cause, for example). They are also productive fishing areas.

Table VI.—*Abundance of Elements in Sea Salt*
(in parts per 000,000 parts of sea water by weight)

Element	Average concentration	Remarks	Element	Average concentration	Remarks
Hydrogen	2.7	(also in water) major constituent	Silver	.0003	...
Helium	...	(only as a gas)	Cadmium	.00011	...
Lithium	2	conservative	Indium	.02§	...
Beryllium	...	...	Tin	.003	...
Boron	4.8	major constituent	Antimony	.0005§	...
Carbon	28	major constituent	Tellurium	...	...
Nitrogen	.5*	nonconservative	Iodine	.05	nonconservative
Oxygen	1,920†	major constituent	Xenon	...	(only as a gas)
Fluorine	1.3	major constituent	Caesium	.0005	...
Neon	...	(only as a gas)	Barium	.0062	conservative
Sodium	10,680	major constituent	Lanthanum	.0003	...
Magnesium	1,290	major constituent	Cerium	.0004	...
Aluminum	.01	conservative	Praseodymium	...	...
Silicon	3	nonconservative	Neodymium	...	...
Phosphorus	.07	nonconservative	Promethium	‡	...
Sulfur	895	major constituent	Samarium	...	...
Chlorine	19,215	major constituent	Europium	...	...
Argon	...	(only as a gas)	Gadolinium	...	...
Potassium	385	major constituent	Terbium	...	...
Calcium	410	major constituent	Dysprosium	...	...
Scandium	.00004	...	Holmium	...	...
Titanium	.001	...	Erbium	...	...
Vanadium	.002	nonconservative	Thulium	...	...
Chromium	.00005	...	Ytterbium	...	...
Manganese	.002	nonconservative	Lutecium	...	...
Iron	.001	nonconservative	Hafnium	...	...
Cobalt	.0005	nonconservative	Tantalum	...	...
Nickel	.0005	nonconservative	Wolfram	.0001	...
Copper	.003§	nonconservative	Rhenium	...	...
Zinc	.01§	nonconservative	Osmium	...	...
Gallium	.00003	conservative	Iridium	...	...
Germanium	.00007	conservative	Platinum	...	...
Arsenic	.003	nonconservative	Gold	.000004	...
Selenium	.004	...	Mercury	.00003	...
Bromine	65	major constituent	Thallium	.00001§	...
Krypton	...	(only as a gas)	Lead	.003	...
Rubidium	.12	conservative	Bismuth	.0002	...
Strontium	8	major constituent	Polonium	...	...
Yttrium	.0003	nonconservative	Astatine	...	...
Zirconium	...	...	Radon	...	(only as a gas)
Niobium	...	...	Francium	...	...
Molybdenum	.01	nonconservative	Radium	3×10^{-11}	...
Technetium	t	...	Actinium	...	...
Ruthenium	...	...	Thorium	.0007	...
Rhodium	...	...	Protactinium	...	...
Palladium	...	...	Uranium	.003	conservative

*Also as gas. †Also as gas and in water. ‡Probably does not occur in nature. §Or less.
Source: Based on compilations by FAO, WHO and E. D. Goldberg.

In the open sea, areas of similar upward water movement are found in regions of divergence—lines along which the currents tend to flow away on both sides. Again the continuity is maintained by water that rises to the surface. Generally the vertical movement is less than 1,000 ft., as along the Pacific equator and the northern boundary of the Equatorial countercurrent, but in the Antarctic. particularly south of the Atlantic, deep water rises to the surface.

Convergences are lines toward which currents flow from both sides and where water, therefore, must be sinking. The water sinks only to the depth where water of corresponding density is found, which in most regions is not far below the surface, and there it spreads out sideways. The bottom water of the Mediterranean, however, is renewed by surface water that sinks in winter along its northern coasts; the Arctic ocean is filled with water that has been cooled in the Norwegian sea; the deep water of the North Atlantic is renewed from the surface just to the south of Greenland; and the rest of the ocean derives its bottom water mainly from the Antarctic, where the densest water is formed in winter along the continental shelf, particularly in the Weddell sea. Lines of convergence exist all around Antarctica (the Antarctic convergence), as well as in the subtropics, the tropics, the Equatorial current svstem and the North Pacific.

V. CHEMISTRY OF SEA WATER

Elements in the Sea Salts.—About 60 of the first 92 elements in the periodic table have been detected in sea water. They exist mainly as dissolved salts, although some are dissolved gases, some are mainly in particulate form, and hydrogen and oxygen of course make up the water itself. In each 1,000 parts by weight of sea water, on the average, there are 965.1 parts of water and 34.9 of salt. The water is composed of 108 parts of hydrogen and 857.1 parts of oxygen, in addition to which 1.9 parts of oxygen and a trace of hydrogen are in chemical combination in the salts, mainly with the sulfur, carbon and boron. There is also a significant quantity of oxygen present as dissolved gas (*see* Table VI).

Although no sharp line can be drawn, it is possible to distinguish between the major constituents and the minor constituents in the salt. The major constituents consist of the cations of sodium, potassium, magnesium, calcium and strontium and the anions of sulfate, chloride, bromide, fluoride, carbonic acid and boric acid. They are found everywhere in the ocean in virtually the same proportions and make up 99.997% of the total dissolved salts. The minor constituents are all the rest of the elements. They in turn can be separated into conservative and nonconservative elements. The conservative elements, like the major constituents, are found everywhere in constant proportion to the total salts. The nonconservative elements show a variation in their relative concentration, principally through being selectively removed from the water by plants and animals. Table VI lists the elements in order of atomic number and gives their average concentration in sea water as far as they have been determined.

The Plant Nutrients in the Sea.—In agriculture, the main plant nutrients with which the farmer concerns himself are nitrogen, phosphorus, potassium and, to a lesser extent, calcium and magnesium. In the sea, as Table VI shows, potassium, magnesium and calcium are so abundant relative to the other necessary elements that they can be ignored as limiting factors in growth of plants. However, a new element, silicon, makes its appearance in the sea as a plant nutrient, since it is required by diatoms in the formation of the tiny shells (frustules) of silica with which they surround themselves. Although silicon is one of the most abundant elements in the earth's crust, the extremely low solubility of its compounds limits its availability in sea water. The main plant nutrients in the sea therefore are phosphorus, nitrogen and silicon.

All three of these elements are characteristically in short supply in the surface layers of the ocean in the depths where sunlight is adequate for photosynthesis. Below this depth, they undergo rapid increases in concentration resulting from the redissolving of their compounds from the organic detritus sinking from above. or from the metabolism of the bacteria and animals living in the deeper water. Phosphorus occurs in the sea chiefly as dissolved phosphate, although there are also significant quantities of organic phosphate compounds dissolved in the waters near the syrface. Fig. 6 shows the typical distribution of phosphate with depth in the North Pacific. The association of a maximum in the phosphate curve uith a minimum in the oxygen curve is characteristic of all the oceans There is less phosphate in the waters of the Atlantic, a typical curve for that ocean increasing from zero at the surface to 60 parts of phosphorus per 1,000,000,000 parts of sea water (by neight) at 3,000 ft. depth and decreasing again to about 45 at

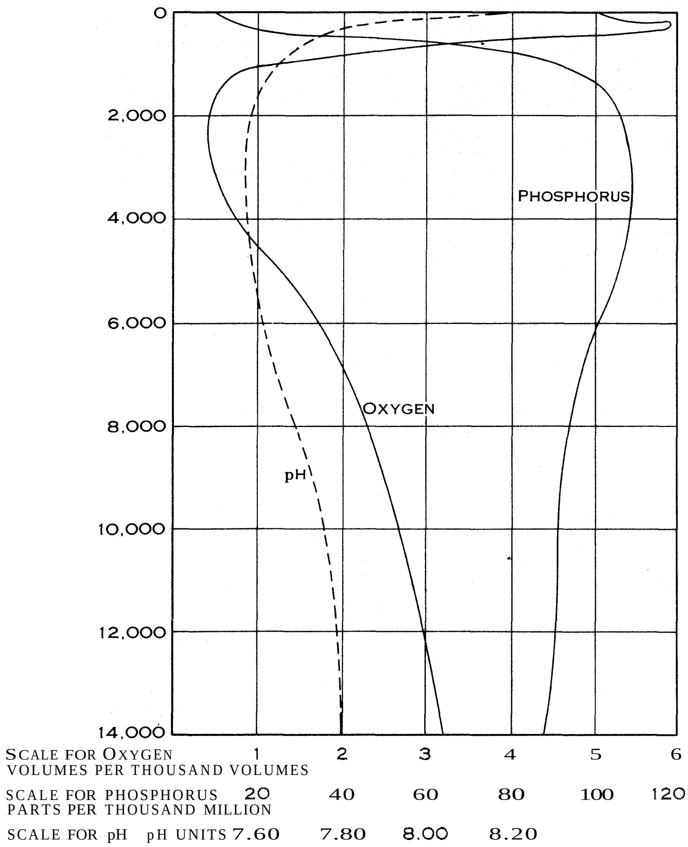


FIG. 6 — DISSOLVEDOXYGEN. PH. AND DISSOLVED INORGANIC PHOSPHORUS. SHOWING TYPICAL VARIATION WITH DEPTH IN THE PACIFIC OCEAN OFF SOUTHERN CALIFORNIA

Multiplying the phosphorus values by 6.5 would furnish a good approximation to the curve for nitrogen (in nitrate)

6,000 ft. Occurrence in the Indian ocean is intermediate between the Atlantic and Pacific.

Like phosphorus, nitrogen occurs to some extent in dissolved organic compounds in the sea, but their distrihution is not well known. Most of the dissolved nitrogen in the sea is in the form of nitrate. The distribution of nitrate with depth is very similar to that of phosphate. and all the statements in the preceding paragraph and in fig. 6 about phosphate will be equally true for nitrogen, if the values for phosphorus are multiplied by 6.j. Ammonia also occurs to some extent in the sea. as the first step in the decomposition of organic matter. either by bacteria or metabolically. In the illuminated layers it is utilized by plants as readily as nitrate, and in the deeper layers it is oxidized by bacteria, first to nitrite and then to nitrate.

Silicon occurs both in solution, as silicate. and in particulate matter, as clay or undissolved fragments of diatoms. The same kind of increase of silicate with depth is observed as with nitrate and phosphate, typical values ranging from 300 parts of silicon per 1,000,000,000 at the surface to 5.000 at a depth of 6,000 ft. in the Pacific and from 50 at the surface to 1,000 at 6,000 ft. in the Atlantic. Since silicon is not needed by bacteria in their metabolism, its regeneration in the water must be entirely from physical solution of the silica in diatoms. and hence maxima do not occur in association with oxygen minima.

In comparison with the total amount in the sea, very little phosphate or nitrate enters the sea from rivers. Silica. however, is delivered to the ocean in abundance from the weathering of rocks. Thus there is usually enough silicate in the upper layers of the sea to support diatom growth after the nitrate and phosphate are used up, and silicate therefore is less often a limiting factor in plant growth than phosphate or nitrate.

Trace Elements. — Although most of the elements present in sea water are in quantities that the chemist would designate as traces, this term refers specifically to certain elements that are needed to support plant and animal life, but in quantities much smaller than those of the carbon, oxygen, hydrogen, nitrogen, calcium, phosphorus, silicon, sulfur, sodium, potassium and chlorine that make up 99.9% of the weight of living organisms. They are not needed for general tissue building or skeletal formation, but enter into specific compounds that serve such purposes as catalysts in respiration. Examples are magnesium in the chlorophyll molecule, iron in hemoglobin. copper in the hernocyanin of crustaceans, iodine in thyroxin or di-iodo-tyrosine in seaweeds and fluorine in teeth enamel. Other elements that are known to be required in the nutrition of plants are boron, zinc, molybdenum, cobalt and manganese.

Vanadium is accumulated by certain holothurians and tunicates (niobium may replace vanadium in one species of tunicate); bromine is incorporated into organic compounds in some corals and marine snails; and other marine organisms concentrate arsenic and nickel. Of these elements, cobalt and nickel are the least abundant in sea water. but there is no evidence to show that this low concentration limits plant growth. Iron and manganese, however, which are only slightly more abundant, very likely do limit growth in the sea, since their compounds are present in sea water mainly in particulate form and must be supplied largely by erosion or drainage from the continents. The other trace elements are for the most part sufficiently abundant in the ocean to take care of the requirements of most marine organisms. The vanadium-rich holothurians and tunicates are an exception. Their blood contains up to 10% vanadium. which is 50,000,000 times as much as there is in sea water. The requirement for collection and concentration of these trace elements is probably the main factor controlling the growth and abundance of these animals, although the role played by vanadium (or niobium) in their metabolism is not yet understood.

Dissolved Gases. — Besides the dissolved salts, sea water contains appreciable concentrations of dissolved gases. The exact amounts depend on the previous history of the water. The values given in Table VII represent saturation of the gases in equilibrium with the atmosphere at the standard pressure of one atmosphere and the stated temperatures. In addition radon. which is radioactive with a half life of about four days, has been detected in sea water to the extent of about 3×10^{-12} millilitres per litre (ml./l.). Because of its short half life, it is not in equilibrium with the atmosphere.

Dissolved nitrogen is the most abundant gas in the ocean, as it is in the air. Although both nitrate-fixing bacteria and denitrifying bacteria have been identified in bottom mud! it appears that they lack sufficient nitrate and other food sources to operate to any significant extent in the sea. The dissolved nitrogen in sea water therefore shows little fluctuation and always corresponds closely to equilibrium with the atmosphere at the temperature and salinity of the water sample.

Dissolved oxygen, on the other hand, shows great variations in the ocean. Where photosynthesis takes place in the upper, illuminated layers of the ocean. oxygen values may exceed 120% of saturation. On the other hand. where biological oxidation is taking place in the absence of photosynthesis or renewal from the surface, the oxygen will be depleted. The distribution of dissolved oxygen with depth thus characteristically shows a marked decrease below the illuminated layers. with the curve going through a minimum and then increasing again with depth as in fig. 6. In the Atlantic, the values at great depth are often higher than at the surface, but in the North Pacific the increase is not so great. This difference in the oxygen content at depth reflects the different sources of supply of the deep water, which in the Atlantic is renewed by sinking from the surface both in the Arctic and the Antarctic, whereas the Pacific is cut off from the Arctic basin by Bering strait and can be renewed only from the south. Fig. 2, a plot of oxygen values at 13,000-ft. depth, well illustrates this difference. The oxygen values for the North Pacific (at the bottom of the figure) are below 3.5 ml./l., whereas at the same latitude and depth in the North Atlantic, the values are 5.0 to 6.0.

TABLE VII.—*Saturation of Gases*
(solubility in volume of gas per coo volume of sea water [ml./l.])

Gas	At 39° F.	At 77° F.
Helium	.00004	.00004
Nitrogen	13.0	8.9
Oxygen	7.2	4.8
Carbon dioxide	.38	.20
Neon	.00018	.00014
Argon	.36	.23
Krypton	.00007	.00005
Xenon	.00001	.00001

Under special conditions, oxygen depletion in the sea can he carried to the point where all the dissolved oxygen is used up. This effect occurs when the supply of decaying organic material sinking from above exceeds the supply of oxygen. Under such conditions. sulfate-reducing bacteria multiply, obtaining their oxygen requirement from the abundant sulfate ions in sea water and producing hydrogen sulfide. This gas is poisonous to practically all other forms of life in the sea. In the presence of oxygen it is quickly oxidized to sulfate and water.

The figures in Table VII for the solubility of carbon dioxide refer only to the amount in true physical solution. It will be observed that carbon dioxide is relatively much more soluble in water than the other gases, as it makes up nearly 2% of the gases in equilibrium with the atmosphere. in which it amounts to only .03%. Besides this great physical solubility, carbon dioxide is also in chemical combination in the dissolved salts, principally in the form of bicarbonate ion. In general, for each molecule of oxygen that is used up in respiration or oxidation, one molecule of carbon dioxide is produced, so that the curve for carbon dioxide as a function of depth should be a mirror image of the curve for oxygen. At great depths, however, the total carbon dioxide continues to increase, as the result of the redissolving of calcium carbonate particles which slowly sink through the depths from the photosynthetic zone where they were formed as mollusk shells, foraminifera tests and the like.

The high solubility of carbon dioxide in the sea is of great importance in understanding long-range changes of climate. Carbon dioxide in the atmosphere acts much like the glass in a greenhouse, passing the shorter radiation received from the sun but trapping the longer infrared radiation that originates on the earth's surface. Doubling the carbon dioxide content of the atmosphere would increase the surface temperature of the earth by $6\frac{1}{2}$° F. Until the 20th century, the atmosphere and the ocean were in a steady state with regard to carbon dioxide, with precipitation of calcium carbonate in marine sediments proceeding about as fast as production of carbon dioxide by volcanoes. However, the great expansion in combustion of coal. oil and natural gas since about 1900 is supplying carbon dioxide from these "fossil fuels" at a rate estimated to provide a 30% increase in atmospheric carbon dioxide in a century. There is about 60 times as much carbon dioxide in the sea as in the atmosphere, but the rate at which the sea comes to equilibrium with the atmosphere is unknown. One of the principal problems investigated during the International Geophysical year in 1957–58, therefore, was the distribution of carbon dioxide between the surface layers of the sea and the atmosphere, in order to determine how rapidly the sea will absorb the extra atmospheric carbon dioxide.

Helium, neon, argon, krypton and xenon belong to the family of "noble gases," which are chemically inert and are thus without significance in the sea. The atmosphere also contains traces of hydrogen gas, but there is no information as to whether the sea is in equilibrium with the atmosphere with regard to dissolved hydrogen. Methane and perhaps other hydrocarbon gases are known to be produced during the decomposition of organic matter, but their distribution in the sea has never been investigated.

Direct Production of Chemicals From Sea Water.—By appropriate chemical treatment, certain elements can be extracted directly from sea water without preliminary concentration. Thus, sea water is first acidified and then chlorinated to liberate bromine, which is extracted by blowing it out of the water with a current of air. The recovered bromine in turn is used to make ethylene dibromide, a constituent of ethyl gasoline.

Similarly, magnesium hydroxide is precipitated from sea water when the water is made alkaline. The alkali commonly used is calcium hydroxide, made by calcining oyster shells. The precipitate of magnesium hydroxide is filtered from the sea water. It is used directly as milk of magnesia, calcined to magnesia (MgO), converted to magnesium carbonate or treated with hydrochloric acid to produce magnesium chloride, which in turn, through electrolysis of the molten salt, is the basis for production of metallic magnesium. For the recovery of salts from sea water by evaporation, see SALT.

Gold From Sea Water. — Much popular interest has been aroused by the reported analyses of sea water for gold, silver and uranium. The hypothetical value of these substances in a cubic mile of the ocean is impressive. However, to obtain one troy ounce of gold from the sea (assuming 100% recovery) would require the processing of 8,000,000 tons of sea water and involve the separation of the gold from 280,000 tons of salts. Although 80 oz. of silver and 50 lb. of uranium would theoretically also be obtainable, it appears entirely impractical to obtain precious metals on a commercial basis. See also GEOCHEMISTRY.

VI. BIOLOGICAL OCEANOGRAPHY

It is virtually impossible to draw a firm line of division between marine biology (*q.v.*) and biological oceanography. However, we can include under biological oceanography the interrelationship between the plants and animals of the sea and its waters, currents and sediments, and consider marine biology as being concerned primarily with the form, functions and life histories of the organisms themselves. Many of the interactions between organisms and the chemistry of sea water and between organisms and the bottom sediments have already been covered.

Organisms and the Physical Properties of Sea Water.—Excepting the plants and animals of the intertidal zones, those that live in the sea are surrounded by an abundance of water at all times, and hence they do not develop the special tissues and organs for conserving water that are found in land forms. Likewise, the giant seaweeds have no need for the complicated vascular structure of trees, and their "roots" are simply devices for anchoring (holdfasts), not for collecting water. The buoyant support offered by water permits the development of such creatures as jellyfish, which entirely lack any skeletal structure and in fact are 96% sea water and 4% protoplasm (which itself is five-sixths water). Likewise, the organic matter in diatoms consists of about 6% chlorophyll, whereas the green leaves of land plants are only about 0.8% chlorophyll, since the large majority of the plant cells have to serve other functions than photosynthesis. Whales grow to a length of 100 ft. and a weight of over 100 tons; yet in the water they are swift and agile. A land-dwelling quadruped of like dimensions would have hopelessly overloaded limbs.

From the standpoint of temperature, the sea is a much more comfortable environment than the land. The total annual range of temperature, which may amount to 100° F. or even 125° F. on land, does not exceed 15° F. in the ocean, and the elaborate leaf-shedding that most land plants undergo in the temperate zones in order to minimize storm and ice damage in the winter is unknown in the marine environment. As long as light is available, marine plants thrive, whatever the temperature, and ice floes often are stained on their undersides by proliferating layers of diatoms. The open sea, however, lacks the firm support that terrestrial creatures derive from land, and therefore the drifting organisms of the sea (plankton) generally are equipped with some mechanism that keeps them from sinking to the depths. Thus. most diatoms, which are single-celled algae with a siliceous covering that has a greater density than sea water, are shaped to provide the maximum drag, so that they will sink as slowly as possible. In addition they manufacture oil. which not only is lighter than water so that their average density is reduced but has a lower compressibility than sea water so that upon sinking they acquire positive buoyancy. Dinoflagellates, chlorophyll-containing protozoa which are second only to the diatoms as primary producers of organic matter in the sea, have similar adaptive structures and are also equipped with a pair of oarlike flagellums with which they are to a limited extent self-propulsive.

The acoustic properties of water are utilized by only a few marine organisms. Numerous kinds of fish are known to make drumming or grunting noises, for purposes not entirely clear; porpoises and other cetaceans also emit sounds; and certain shrimp found over rocky bottom in subtropical waters produce sharp crackling sounds by snapping the joint of a lobsterlike claw. As individuals none of these amounts to much as a noise producer, but collectively, when croakers gather on their spawning grounds in breeding season, porpoises collect in schools of hundreds of individuals or the shrimp live as they normally do, in swarms of millions. the production of noise can be tremendous and it can effectively interfere with the use of Sonar and similar underwater acoustic gear. In the case of porpoises, W. N. Kellogg in 1958 demonstrated that the production of sound is for echo-ranging purposes, since porpoises easily find fish and avoid obstructions that they cannot see.

Hydrostatic pressure in the sea is of little concern to most forms of life, just as the ordinary atmospheric pressure is of slight influence on terrestrial forms. At sea level, for example, an average man, with a skin area of about 19 sq.ft., is supporting a total atmospheric load of about 40,000 lb.; yet, since this pressure is exerted equally in all directions, it is self-equalizing and insensible. Likewise the tremendous pressures at great depths in the sea are self-equalizing.

Pressure changes are significant to two groups of organisms. One is the fishes equipped with swim bladders. They are unable to make rapid adjustments to changes of depth, and it is not uncommon for fish caught even in moderate depths of water (as cod on continental shelves) to reach the surface with swim bladders abnormally distended. The other group is the air-breathing animals, which for the most part are unable to operate very far below the sea surface. In free dives, men have penetrated to a depth of about 200 ft. without special equipment, 300 ft. with compressed air and 350 ft. with special atmospheres. Helmeted divers have reached 600 ft., breathing a mixture of oxygen and helium. These achievements are far overshadowed by those of the sperm whale. Bruce Heezen in 1957 reported 13 cases of whales tangled in submarine cables, which showed that sperm whales regularly swim along the ocean bottom at depths as great as 3,700 ft. The physiological mechanism that permits them to accomplish this was not explained.

One great difference in physical characteristics between the land and the aqueous environment is in the availability of solid surfaces. These are so common on land as to be taken for granted, but this is not the case in the ocean. It has been shown that in order to carry out their metabolic functions efficiently, bacteria must have a nearby solid surface. Thus the limiting factor in the growth of marine bacteria is usually the lack of surfaces, not of nutrients. A fresh surface introduced into the sea is quickly covered with a slimy film of multiplying bacteria. Organisms such as diatoms, gorgonian corals and probably others secrete antibiotics to inhibit growth of bacteria, but inorganic particles are soon coated with them. Marine sediments are rich in bacteria, which were carried to the bottom on settling particles and were then able to multiply vigorously with a plentiful supply both of food and of solid surfaces.

Phosphorescence. — The production of light by organisms is primarily a phenomenon of the sea (*see* BIOLUMINESCENCE). Phosphorescence, as it is generally called by the mariner, is found in many of the animals of the deep ocean, where it may serve as lure for prey, as protection to frighten away attackers or as an aid in mating, but its most spectacular manifestations are among the plankton of the surface layers, especially in warmer waters. Here a disturbance such as breaking waves or the wake of a ship may stimulate millions of tiny organisms into glowing. Individually each is but a speck, but collectively the light can be bright enough for reading the proverbial newspaper. A special form of this surface luminous activity has been observed in the Arabian sea, where it has long been known to seamen as the "wim-wams." It consists of revolving bands of light, several miles long, rotating slowly about a centre like spokes of a wheel. In 1955 a reliable report was made of several cases where luminous patches in the sea responded to stimulation by the ship's radar. but no explanation of the connection was available:

Mass Mortalities in the Sea.—The preceding discussion of life in the ocean has emphasized the factors that encourage organisms to grow and multiply. There also exist, however, physical and chemical relationships in the sea that result in catastrophic destruction of living forms. These relationships can have causes as simple as lowered temperature from an unusually cold winter or lowered salinity from exceptional river discharge. Changes in current can also be responsible, such as the famous El Niño of Peru, which brings unusually warm water south along the coast, with destructive effects first on the fish and then on the guano birds that feed on them. Vertical mixing can carry to the surface water low in oxygen (as in Walvis bay, south-west Africa) or high in hydrogen sulfide (as in the Black sea), with fatal results to the surface fauna.

Another more complicated cause is uncommonly heavy growth of dinoflagellates in the surface layers. In many parts of the world these organisms from time to time multiply in such numbers as to colour the ocean surface red. They also produce toxic substances, which if concentrated by mussels or other shellfish render them highly poisonous, and which may also kill fish and invertebrates. The "red tide" of the west coast of' Florida is the result of concentrated growth of the dinoflagellate *Gymnodinium brevis*. Both chemical and physical factors are involved in its extraordinary growth. Growth-stimulating factors derived from the coastal bayous are carried out to sea at times of increased river discharge; but only when currents and water temperatures happen to be suitable, so that the growth-promoting substances are not widely dispersed, can an outburst of the "red tide" develop.

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OCEANIA commonly refers to land areas scattered throughout the south-central Pacific ocean. The word has, however, been used with many meanings; the most inclusive, though least useful, embraces all insular regions between Asia and the Americas. A more practical definition excludes such nontropical areas as the Ryukyu and Aleutian islands and the Japan archipelago. The most popular usage delimits Oceania further by eliminating Indonesia, the Philippines and Formosa, since those islands and their peoples seem more closely related to the Asian mainland. This leaves an island area bordered by and including New Guinea, Palau and the Mariana Islands on the west, Hawaii and Easter Island on the north and east respectively, and extending southward to Australia and New Zealand. Europeans, when they charted these islands, divided Oceania into four parts: (1) Australia; (2) Melanesia (New Guinea eastward to Fiji); (3) Micronesia (Mariana, Caroline, Marshall and Gilbert islands); and (4) Polynesia (a triangle of many islands, including Hawaii, New Zealand and Easter Island). Ethnological studies cut across the traditional divisions of Oceania. This article reviews events in the settlement of the area, changes involved in the process and gives a survey of the archaeology of Oceania. For later history, administration, trade, further geographical description, etc., see PACIFIC ISLANDS; MELANESIA; MICRONESIA and POLYNESIA; also separate articles on AUSTRALIA, COMMONWEALTH OF; HAWAII; etc.

ETHNOLOGY

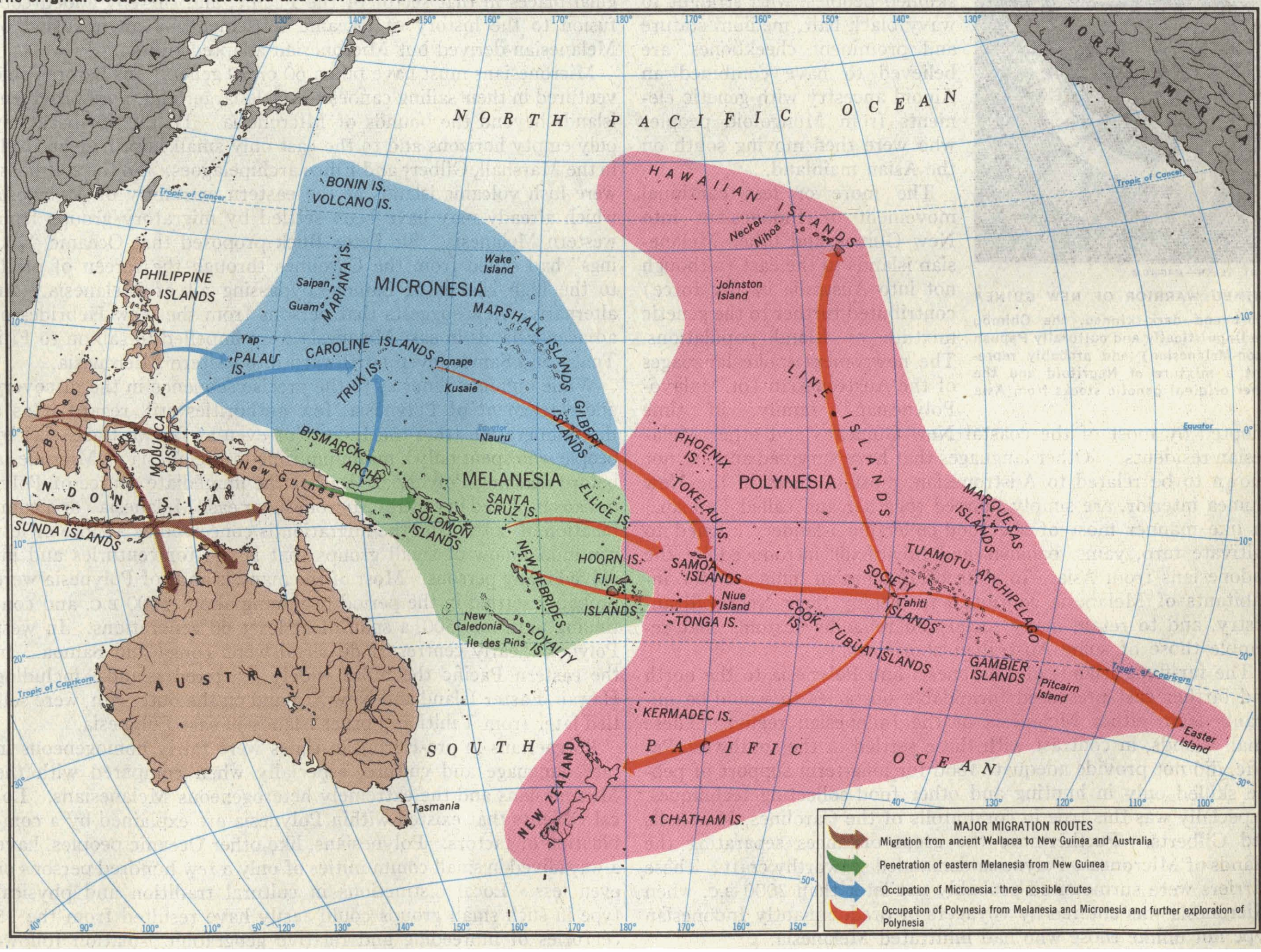
Oceania includes more than 10,000 islands and nearly 500,000 sq.mi. of land. Thirty thousand years ago no human beings lived there. When men entered the area they brought with them plants and animals new to Oceania together with social, political, economic and religious customs from their Asian homeland. Each island became a laboratory in which small communities of people experimented with local resources. Innovation also resulted from contact among island populations, each of which gradually evolved a unique pattern of life. By mid-20th century approximately 2,500,000 islanders were living in Oceania; their earlier cultures were being revolutionized by increased contact with the rest of the world.

Migrations — scientists still debate the of Oceanic migrations, but there is overwhelming agreement on the east-Asian origin of Oceanic peoples. It is well established that during the Pleistocene epoch (Ice Age), that ended possibly 11,000 years ago, early forms of men were living in Asia and the westernmost islands of the Indies. These islands were then part of a single land mass (Sunda-land) joined to the mainland of Asia. Later, as glacial expanses in the northern hemisphere melted, the waters of the Pacific rose as much as 300 ft. and drowned the land bridges. New Guinea and Australia were also united (as parts of Sahul-land, separated from Sunda-land by a geologically unstable zone of islands including, *e.g.*, the Moluccas, Lesser Sundas and Celebes). Named Wallacea, the intervening region was characterized by ocean depths up to 16,000 ft., with islands never more than 60 mi. apart.

Throughout the last major Pleistocene period small bands of people, employing rafts or crude canoes, crossed Wallacea and made their way by slow stages to New Guinea and Australia. These first arrivals in southwest Oceania have been regarded as representing three principal racial stocks. The Oceanic Negrito stock, dominant among inhabitants of the tropical jungle of Queensland and in the interior of New Guinea, is revealed by short stature, dark skin and frizzly hair. The Murrayian or Ainoid element, present also in the aboriginal Ainu of Japan, char-

PATTERN OF PACIFIC MIGRATIONS BASED UPON THE THEORY OF THE EAST-ASIAN ORIGIN OF OCEANIC PEOPLES

The original occupation of Australia and New Guinea from the mainland is believed to have begun during the last period of the Pleistocene, about 20,000 years ago



acterized by lighter skin, wavy hair and short, quite hairy bodies, survives in mixed form in southeast' Australia and' in the high plateaus of New Guinea. The Carpentarian stock (sometimes called Veddoid because of similarities with the linear build, dark skin and wavy hair of men of south India) is detected in the appearance of central and north Australians and among the tribes of north and south coastal New Guinea.

The earliest immigrants from the Indies lived by hunting, fishing and collecting wild plant food. They lacked many of the cultural accomplishments of later arrivals from the Asian mainland. Wherever they settled, each group adapted to local conditions and many unique cultures and languages evolved. This heterogeneity became much more pronounced later, and the physical appearance of each population came to reflect differences resulting from mutation, natural selection, admixture, selective mating and small population.

These conditions continued in the southwest Pacific for perhaps the first three-quarters of man's residence in Oceania. All of Australia and most of Melanesia were eventually discovered and settled by small colonies of these primitive food-collectors. Before the end of that period, however, a major cultural revolution had begun in Asia, best described as a shift to economies based on plant cultivation and livestock domestication. Such changes favoured a more stable existence, the development of specialized skills and the concentration of larger populations in more permanent settlements. 'By 3000–2000 B.C. the first effects of these changes reached Oceania, apparently introduced from east' Asia via the Indies and the Philippines by immigrants who are often referred to as Indonesians (or Proto-Malays). These brown-skinned peoples, with straight to wavy black hair, medium stature and prominent cheekbones, are believed to have combined an Ainoid ancestry with genetic elements from Mongoloid peoples who were then moving south on the Asian mainland.

BURT GLINN—MAGNUM

CHIMBU WARRIOR OF NEW GUINEA

Short and dark-skinned, the Chimbu are linguistically and culturally Papuan (non-Melanesian) and probably represent a mixture of Negritoid and the other original genetic stocks from Asia

The mote or less continua1 movement of Indonesians into New Guinea and other Melanesian islands to the east (although not into Australia in any force) contributed further to the genetic mixture of island populations. The newcomers spoke languages of the Austronesian (or Malayo-Polynesian) family, in time adopted by most of the coastal New Guineans and other Melanesian residents. (Other languages that have survived and are not known to be related to Austronesian, most of them in the New Guinea interior, are simply lumped together and called Papuan.) In like manner most of the food-collecting islanders learned to cultivate taro, yams, bananas and breadfruit introduced by the Indonesians from Asia. In spite of Indonesian influence, the inhabitants of Melanesia continued to display their Negritoid ancestry, and to retain many social and s customs that resemble those of some Australian aborigines.

The far-flung islands of Micronesia and Polynesia to the north and farther east presented formidable obstacles to would-be migrants from either 'Melanesia or the Indonesian region. These small islands, in contrast with those settled in the southwest Pacific, did not provide adequate food for long-term support of people skilled only in hunting and other food-collecting techniques. Especially was this true in coral atolls of the Carolines, Marshalls and Gilberts. Furthermore the great distances separating the islands of Micronesia-Polynesia demanded seaworthy craft. These barriers were surmounted probably not later than 2000 B.C. when Micronesia was entered by voyagers of predominantly Indonesian type not unlike those who had infiltrated Melanesia.

Limited evidence of prevailing winds, ocean currents and flyways of migratory shore birds suggests that pioneer voyages into nesia may have started from the Moluccas in the Indies or from the Bismarcks northeast of New Guinea. Archaeological evidence alternatively suggests a connection with the Philippines. Food producers with improved stone tools in those island regions could have built seaworthy canoes with sails and stabilizing outriggers. In the west Carolines, Palau is only 450 mi. from the Moluccas with four coral isles as convenient stopovers, and is no farther from the Philippines. Truk in the central Carolines is farther from the Moluccas and closer to the Bismarcks but is separated from the latter by nearly 500 mi. of water and only two intervening atolls. Drift voyages by fishermen or local travelers carried off course in storm or calm were probably more significant in the discovery of Micronesian islands than adventurous or colonial expeditions.

By whatever routes they came the discoverers of Micronesia made the small islands livable by supplementing the rich marine resources with such efforts as the cultivation of root and tree crops and the breeding of pigs and chickens, The contrasting environment of high volcanic islands (the Marianas and Palau, Yap, Truk, Ponape and Kusaie in the Carolines) and low coral atolls influenced these adaptations. Unique local development was fostered by geographic isolation, but to the extent that interisland trade existed in some areas (notably the Carolines) local differences perhaps were minimized. In support of these trading expeditions skills improved in canoe construction and handling, and navigation by the stars. Growing communities, associated with larger and more dependable food reserves, sought additional land for expansion. As the flow of immigrants continued—many of them probably forced out by population pressure from east Asia—many Micronesians were vanquished, absorbed or pushed out. Perhaps some even.returned to the Melanesian islands of their ancestors or sought refuge in marginal places in that sector of the Pacific, and thereby added sunfusion to the history of Oceanic settlement by — intrusion of Melanesian-derived but Micronesian-adapted traits.

Micronesians must have taken 60 or 70 generations before some ventured in their sailing canoes to settle larger and more provident islands beyond the bounds of Micronesia. To the northeast lay only empty horizons and to the east only small improvident atolls in the Marshall, Gilbert and Ellice archipelagoes. To the southeast were lush volcanic islands at the eastern extremity of Melanesia which already may have been settled by migratory groups from western Melanesia. Sir Peter Buck proposed that Oceanic "vikings" had sailed from the Carolines through the screen of atolls to the, high islands of Samoa, bypassing all of Melanesia. alternative view suggests that persons from the New Hebrides or adjacent islands in east Melanesia were impelled to sail on to Fiji, Tonga and Samoa, even northward into eastern Micronesia.

While opinions differ as to the precise sequence in the discovery and settlement of Polynesia, few authorities still regard it as a direct migration from the Indies (or even as far west as Asia) by people who spent only a minimum time in Melanesia or Micronesia before reaching Polynesia. Rather the immediate source of Polynesians is placed in central Micronesia or east Melanesia (or a combination of both), and the migration is conceived as a more or less continuous flow of small groups that lasted for centuries and involved many persons. Most of the many islands of Polynesia were probably settled in the period beginning about 1000 B.C. and continuing until A.D. 500,% span of & least 60 generations. In west Polynesia, early centres of dispersal were Tonga and Samoa. In the eastern Pacific the more widely scattered islands, including Hawaii, Easter Island and New Zealand on the outer rim, were settled later from Tahiti and other islands in east Polynesia.

Polynesians in pre-European times were fairly homogeneous in race, language and culture, especially when compared with the Micronesians and the extremely heterogeneous Melanesians. Local variants that existed within Polynesia are explained by a combination of factors. Polynesians, like other Oceanic peoples, have always lived in small communities of only a few hundred persons or even less. Local distinctions in cultural tradition and physical type in such small groups could easily have resulted from the 25 centuries of inbreeding and relative geographic isolation following the first Polynesian settlement. Also, if all Polynesians were not descended from a single group that entered the area in 1000 B.C., but stemmed from a more enduring migration over many generations, then it is reasonable that changes in race, language and culture had meanwhile occurred in the region in which the migration had been initiated. All subsequent migrants into Polynesia from that outside source would reflect these changes.

E. AUBERT DE LA RÜE

IRRIGATED TARO GARDEN ON HUAHINE, SOCIETY ISLANDS

A basic foodstuff of the region, taro came from Melanesia to Micronesia and Polynesia with early settlers. Livestock and such crops as taro helped make many of the small, distant islands habitable

Whatever mixture of racial types exists in the Polynesian people is believed to have occurred mainly prior to dispersal within the Polynesian area. Generally speaking, Polynesians are taller and more robust than Micronesians but this may simply be the product of better living conditions in Polynesia. Although Micronesians display more physical diversity than Polynesians, they are predominantly of the brown-skinned Indonesian type. The Carolinians (apart from Palauans who, like the Marshallese at the other end of Micronesia, exhibit some Negritoid features) closely resemble the Polynesians, with the Gilbertese of east Micronesia intermediate both geographically and genetically. Most Polynesians are regarded as primarily of Indonesian type with a Negritoid strain suggested. This is consistent with the idea of a people that originated in central Micronesia and was exposed to Negritoid elements in east Melanesia before entering Polynesia.

Linguistically, Polynesians reveal a close affiliation with Fijians (most other Melanesian languages are quite divergent, an indication of greater antiquity), and are not greatly different from most Micronesians. Only Palauan and Chamorro (spoken in the Marianas) are excepted since these are more nearly akin to languages of the Philippines and the Indies. About the time that Polynesia was being settled, Mongoloid Malayans from east Asia (also called Deutero-Malay to distinguish them from the earlier, less Mongoloid Proto-Malay) overran the Indies and the Philippines, forcing many earlier residents into less desirable inland regions. This tide of Asian humanity touched Micronesia only in its western extension and Melanesia only in places along the north coast of New Guinea. The Polynesians meanwhile, continuing their wanderings well into the Christian era, reversed the direction of their earlier expeditions and left their imprint on such western Pacific communities as Kapingamarangi and Nukuoro in Micronesia, and in Fiji, New Hebrides, Loyalty Islands and various Polynesian outliers along the fringe of Melanesia as far west as the Bismarcks. (*See also* AUSTROASIATIC LANGUAGES; MALAYO-POLYNESIAN LANGUAGES.)

Cultural Change.—When men from England, France, Germany, Holland and Spain explored the Pacific from the 16th to the 18th centuries, their journals reported a seemingly unlimited variety of ways in which Oceanic peoples had met and solved problems of living in a tropical ocean-bound environment. In the New Guinea interior Europeans observed Negrito hunters living in small bands with a minimum of technological and political attainments. They described similarly impoverished aborigines in the Australian wasteland who nonetheless performed elaborate ceremonials and had a seemingly complex kinship organization that defied the visitors' understanding. In some parts of Melanesia they met dark-skinned islanders in small autonomous communities who practised agriculture and accumulated wealth in pigs and shell money but conducted tribal initiations resembling those of Australian hunters. In other Melanesian islands they found other dark-skinned people who showed little interest in the spiritual, but who revealed a consuming passion for genealogies, aristocratic hierarchies and organized warfare, as did many Polynesians and some Micronesians. But in Micronesia Europeans also discovered brown-skinned natives who in many social institutions more closely resembled the mystically inclined gardeners of Melanesia.

Oceania has been described as a vast laboratory in which human experiments in living were tried by about 1,000 groups with as many unique results. The relationship between experimental group and environment was reciprocal. Pottery could not be made in islands without clay deposits, outrigger canoes could serve; no purpose in the highland interior of New Guinea, breadfruit trees could not be grown on coral atolls in dry zones. But the islanders did exercise controls over the environment. They bred chickens and pigs on islands that before had supported none; they invented sleeping bags as protection against disease-bearing insects; they transported soil to coral isles where taro plants could not otherwise have been cultivated. The immigrant Indonesians with their superior technology survived in Micronesia where the hunting peoples of Australia would probably have failed.

In social organization, political authority and religious belief the relationship of Oceanic customs to the physical setting was less significant. Thus it was possible for technologically simple tribes in Australia and New Guinea to be as different from each other as they were in kinship and ceremonial practices. Similarly, though Polynesians shared an economy based on fish, coconuts and taro, some groups combined the functions of chief and priest in one man (usually the informal head of an extended family) while Hawaiians developed a semifeudal system of land tenure and political control reinforced by a corps of religious specialists.

Attempts to reduce the cultural systems of Oceania to an orderly scheme have depended much on the divisional concepts of Micronesia, Polynesia, Melanesia and Australia. However, scientific understanding of Oceanic prehistory has been hindered by the perpetuation of these divisions. Melanesia and Australia may be differentiated by certain features of the landscape, but while economic activities of the respective inhabitants were often notably different, social and religious practices suggested a commoner background. The divisional notions of Polynesia and Micronesia fail to distinguish between high and low island habitats that occur in both areas and, as with Australia-Melanesia, the separation of Polynesia from Micronesia is clouded by the occurrence of certain sociocultural institutions in both regions. The distribution of specific traits frequently overrides traditional borders, for example, loom weaving in the Carolines, a few Melanesian islands and none of Polynesia; a simplistic form of wood carving art in Micronesia,

CHILDREN OF MOOREA, SOCIETY ISLANDS, FRENCH POLYNESIA

Like its neighbour Tahiti, Moorea is largely a high island of basaltic lavas. The low island in the background, however, is coral reef

WERNER STOY FROM FPG

Fiji, Tonga and Samoa; hereditary ruling aristocracies in Hawaii, Tahiti and Tonga, some of Micronesia and only Fiji in Melanesia. The traditional divisions of Oceania are useful for geographic description but they fail to coincide with cultural patterns.

Reconstruction of Oceanic history requires information about the physical setting, the techniques, institutions and values brought by island migrants to new settlements and the nature of contacts with other groups, whether based on trade, warfare or ceremonial exchange. But even this knowledge is not enough, since vital clues to any community's history lie concealed in the individual's contribution to group life. Unfortunately Oceanic peoples were not historians in the European sense; they kept no written records but transmitted their knowledge orally. The individual in those traditions remained largely anonymous or assumed some legendary character that may or may not have been related to historic fact.

In a few centuries since Europeans discovered Oceania a revolution has occurred comparable to the changes initiated more than 4,000 years earlier by food-producing Indonesians. The impact of enormously increased contact in World War II was still having its effects in the 1960s. A new culture in the Pacific was emerging, but the same processes of change could be counted upon to produce island communities adapted to the changing scene. (L. E. MN.)

ARCHAEOLOGY

Studies of the archaeology of the Pacific are concerned with interisland migrations and the growth and history of man's adaptation to the unusual and far-flung domain. The migrations depended on the use of developed water craft. Except in Australia-Tasmania, all the peoples of the Pacific were agriculturists with domesticated animals. All their food plants. except the sweet potato, are of Asian origin, as are their linguistic stocks.

For this discussion Oceania will include the island worlds of the Pacific, excepting Indonesia, plus Australia-Tasmania (thus departing from the geographical limits adopted in the preceding section). During the Pleistocene epoch climatic changes and movements of the earth's crust led to plant and animal change. This period saw enough of the earth's waters locked in the ice sheets to lower the seas by about 200 ft. Men could walk over areas that were later shallow seas and swim or drift by raft over deeper, narrowed straits.

The first cultural base that can be traced archaeologically is that called Mesolithic (Middle Stone Age). Finds in Melanesia, primarily in New Guinea, suggest that there may have been a still earlier, probably Late Paleolithic, penetration of those islands. That this reached Australia is very dubious and that it moved out into the islands of Polynesia is highly improbable. The Mesolithic people, with a simple hunting, fishing and shellfish-gathering culture, spread widely from Asia and southeast Asia through Indonesia and Melanesia into Australia-Tasmania. The Mesolithic way of life must have ended as an important cultural component by 3000–2500 B.C. in Indonesia; remnants of it still endure among a few Australian aborigines on reservations.

Neolithic (New Stone) changes were represented by the addition to the old Mesolithic base of pottery, agriculture, domesticated animals, techniques of abrading, grinding and polishing stone, water craft (canoes) adequate for travel on the high seas and the use of massive stone in building and sculpture. The Neolithic was, until recently, the cultural base of the peoples of Melanesia and Micronesia-Polynesia. Australia-Tasmania, to judge from the Mesolithic cultural level, was settled relatively early, probably during the last glaciation. Tasmanian archaeology is not well understood, but the links that exist point toward Australian relationships. Physically the Tasmanians show Negritoid relationships, indicating that they must have moved out of Melanesia—for it is there that the nearest true Negritoids live—as very early migrants.

In Australia there were no early or mid-Pleistocene cultures. The Cohuna and Talgai skulls do not vary greatly from Australian norms. Australian prehistory falls into inland and coastal aspects. Since the inland depends upon surface collections, their chronologic relationships are not well understood. A few coastal middens have long period sequences and offer the best hopes of arriving at time sequences for both the coast and, comparatively, the interior. The types of stone tools indicate a relationship with widespread Indonesian and Melanesian Mesolithic cultures.

Specifically, the Hoabinhian I of Indonesia and its pebble choppers, cores and hammerstones are similar to those tools of southeast Australia. Most intriguing of the old Australian stone industries is the Microlithic (small stone). Tiny chipped blades are abundant on inland sites in the southern parts of the continent. These small tools are a world-wide aspect of the Mesolithic. Thus the problems of Australian prehistory are not isolated but are an integral part of those of southern Oceania-Indonesia and southeastern Asia. The chronology of Australian-Tasmanian cultural sequences depends primarily on radiocarbon dating, climatological and geological complexes. South-central Australia undoubtedly supported a culture using microliths and small projectile points as early as 4000 B.C., while a sequence in the Sydney area shows well-developed local cultures about 2,000–3,000 years earlier. These dates are probably minimal.

Melanesia, the land of Oceanic Negroids, was settled before Australia-Tasmania, first by a Negritoid and then by an Australoid population, both apparently with Mesolithic cultures, and later by Neolithic Negroids. The three subracial groups have mixed extensively and this has beclouded knowledge of their physical past. Early archaeological remains, presumably often located along the strands, have been covered by waters rising from the glacial ebb about 200 ft. or more below the present stand. Archaeological work in Melanesia as a whole is scant and early sites are rare. An aspect of Oceanic Neolithic culture of southeastern Asian origin is megalithic construction. These large stone remains include platforms, walled areas, heroic human and animal figures, large mortars and pestles, etc. A concentration of Melanesian megaliths exists in eastern New Guinea, the highlands and adjacent islands. Mesolithic sites with older Australian and Indonesian affiliations have been studied. Investigations in the tumuli of the interior of the fle des Pins, New Caledonia, show large coral-ironstone "concrete" cylinders 6–10 ft. in diameter in their centres, covered with earth. Their builders and functions remain a mystery.

Three levels of cultural change appear in Fiji Neolithic sites: an early level with pig and chicken bones and potsherds showing relief decoration; a middle level in which dog bones were first found and plain pottery prevailed; and the late level characterized by shell concentrations, previously lacking, and incised pottery. Radiocarbon dates place the early period around the time of Christ, the mid-period through the 7th to 10th centuries A.D. and the late period to the 14th century. Pottery relates to the west, into Indonesia. New Caledonian radiocarbon dates run from about 3,000 years ago to within the last few centuries. Therefore Neolithic agricultural pottery makers had penetrated into eastern Melanesia about 1000 B.C.

Major migratory movements of the ancestral Polynesians were almost certainly out of Indonesia. Once thought to have been first into western Micronesia and thence on to the east, they now appear to have skirted along northern Melanesia and finally centred strongly into western Polynesia (Samoa-Tonga) and thence moved on to the Tahiti (Society Islands) and Cook Islands whence populations fanned out over the entire Polynesian triangle. Linguistic and archaeological evidences combine to suggest that Samoa was reached by at least 1000 B.C. and Tahiti only a few centuries later. The earliest radiocarbon dates secured are A.D. 79 for Samoa, 130 B.C. for the Marquesas Islands, A.D. 386 for Easter Island, A.D. 124 for Hawaii and A.D. 1015 for New Zealand. All these dates must be looked upon as less than final. It appears, however, that the vast area of Polynesia was explored and settled by Neolithic sailors in about a millennium and a half, with New Zealand the latest to be discovered and exploited. It is not possible to consider the later chronology in Polynesia without using the information derived from the carefully kept genealogies which record migrations out from the Society Islands in the 9th, 11th and 14th centuries. These memorized genealogies do not help with the more ancient periods, however, for two reasons: they do not and cannot be expected to carry back that far, and there is a strong possibility that social development had not then evolved a place or need for such records. Sites on the Hawaiian islands of Nihoa and

Necker have an archaic type of Polynesian culture, apparently less strongly agricultural and with a less rigidly set social structure. These sites were probably inhabited in the 10th and 11th centuries; local cultural change and probably migrants from the Society Islands in the 12th to 14th centuries brought about the highly developed way of life encountered by the first Europeans.

In the older periods in central Polynesia the assembly courts and long narrow terraced platforms *(ahu)* were separate. In later periods these were combined into the *marae,* a large paved area with a high, often almost pyramidlike terraced platform at one end. Upright monoliths, or slabs in series, were employed as constructional or architectural items. This fusion of different features into the *marae* must have occurred in the Society Islands after the migrations to Easter Island, or the architectural lines of development in the two groups were otherwise separated, because the terraced *ahu* alone is used on Easter Island. The giant stone heads of Easter Island find their closest stylistic relatives in eastern Polynesia from New Zealand to the Marquesas. The technical and mechanical details of carving and handling the statues were within the capabilities of the high Neolithic Polynesians. The Easter Island "script," which is not true writing, is apparently an almost calligraphic sequence of decorative motifs and perhaps of mnemonic aids. Easter Island lacked large forest trees for canoes, hence few woodworking tools are found there. *(See* also EASTER ISLAND.)

Polynesian culture could mold itself to differing environments and mold these to its uses with equal ease. The migrants to New Zealand (Maori) moved from the small tropical Society Islands to a large temperate country. The great forests contained logs for canoes and buildings; fine stones (basalts and jades) existed for tools and ornaments. The New Zealanders developed a stone tool inventory beyond that of the usual Polynesian. Again, the full-fledged *marae,* with *ahu,* does not appear in New Zealand. A large Maori population resulted in the development of extensive middens. Excavations of the earlier sites have indicated that the first colonizers hunted the later extinct giant forms of the flightless bird which they called the moa. These archaic "moa hunters" must have known agriculture when they arrived in New Zealand, but no evidence of it is found in their middens. Perhaps they became less dependent upon cultivation as they learned to hunt the large and easily conquered game. They lasted, culturally, beyond the period when they could depend on the moa for food—into the 13th century. Whether or not they developed culturally into the classic Maori is not known. The latter may have been new migrants from Tahiti, as some of their artifacts suggest and as the genealogies state. New Zealand, then, was apparently discovered and settled in the 9th, 10th and 14th centuries by several different movements of peoples, called Fleet Maori, from the Society Islands.

Among the items that the Fleet Maori are said to have brought with them was the sweet potato, the *kumara.* This is a South American plant and must have been brought from Peru by an 8,000-mi. round-trip voyage from the Tuamotus or Marquesas, or have made the trip to inner Polynesia from Easter Island after it had been transferred there from South America. At any rate it could not have arrived in Tahiti later than the 13th century and its presence there attests that these islanders were making the longest high seas voyages that man had made up to that time.

The Tonga group of western and central Polynesia was influenced by contact with Fiji; Tongans transferred Melanesian traits from there to other parts of Polynesia and returned the favour with Polynesian traits brought to Fiji. Most interesting archaeologically is the fact that pottery, most like some from New Caledonia, was once made on Tonga and then, not proving to be a necessary adjunct of the culture, became a lost art. Pottery has also been found on Samoa, associated with an occupation dated by radiocarbon in the 1st century A.D. Pottery appears in the Marquesas in the earliest excavation dated there, also by radiocarbon, about a century later. Thus the early, and probably the earliest, settlers in these islands made and used pottery. Probably they were absorbed or extirpated by later arrivals who did not. The *langi* of Tonga, stone-faced burial mounds, cannot be older than the 11th century. The great Tongan trilithon is a three-piece gateway 17-ft. high and 19-ft. wide. The visible portion of the monument must weigh approximately 100 tons. There are traditional data concerning the methods employed and the reasons for its erection. Tongan stonework appears to have had a quick efflorescence in the 13th to 16th centuries. Widespread rough stonework, rarer stonecutting, failure to break joints, occasional use of L-shaped stones as corner ties and cut slabs often weighing many tons are characteristic of Polynesian architectural stonework.

Highly conventionalized stone carvings, developed upon a tradition of wood carving, employed a heavy squat body, flexed legs with short thighs, heavy calves, forearms over the abdomen and exaggerated head and facial characteristics. These variations are discernible from Hawaii to New Zealand in stone, wood and as petroglyphs. This art style appears to have its origins early in Indonesia. Burial practices of Micronesia and Polynesia are varied. Commoners were often buried or exposed on the strand while nobles were buried in vaults, mummified or coffined.

Most of the islands of Micronesia are atolls, as are the equatorial islands of Polynesia. These low islands offered little to the Neolithic migrant in the way of arable land, forests or stone; *Trzdacna* shell became a substitute for stone for tools—adzes, pestles, etc. It is only on the largest atolls and on the few volcanic islands in the Carolines and Marianas that archaeological evidence can be expected, not only of recent cultural change but of traces of the earliest migrants.

Megalithic constructions occur throughout Micronesia on the high (volcanic) islands, as they do in Polynesia. Excavations on the Marianas have uncovered extended burials, shallow middens and an enormous number of potsherds of a red utilitarian ware. Later material is dated by radiocarbon at A.D. 845; the earliest date, 1527 B.C., is associated with a hard red pottery. Even older material is found and Neolithic settlers were in Saipan at least as early as 2000 B.C., if the radiocarbon dates may be trusted.

The Palau Islands and Yap also supported peoples who made pottery and who are related linguistically and culturally to the Philippine Islands and Malaysia to the southwest. Stone platforms and the stone cartwheel money of Yap are the megalithic traits of that island. Palau, although partly volcanic, lacked good stone for cutting tools, and most of the adzes, etc., were made of *Tridacna* shell. Archaeological remains include megalithic constructions and carvings, large terraced hills and money of glass armrings, sawed into sections, and glass beads, presumably traded from the Philippines. Pottery from the later period is a coarse red ware. Deep in the terraced sites this is replaced by a thin dark ware. Both archaeology and tradition vouch for periods of population growth and cultural evolution, with megalithic and earthwork construction, followed by cultural decay and abandonment of the great sites on the volcanic islands, and then a resettlement only a few centuries before European contact. On Yap a radiocarbon date of A.D. 176, the earliest secured, indicates that agricultural people, making a fine red pottery, were living at this period on those islands.

To the southwest of the Palaus a string of small islands leads southwest and to the west is the Philippine group. This is Indonesia again, the homeland of this greatest of man's water-borne adventures in exploration. *See* also references under "Oceania" in the Index volume. (D. O.)

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(L. E. MN.; D. O.)

OCEANSIDE, a resort city of southern California on the Pacific coast, is 40 mi. N.W. of San Diego at the mouth of the San Luis Rey river. One of the famous California missions, San Luis Rey, founded in 1798, is located there and Camp Pendleton, a major U.S. marine corps base, is immediately to the north.

Incorporated in 1888, Oceanside grew slowly before World War II. From 1940 to 1950, however, the population nearly tripled. A mild, dry climate combined with an ocean beach, fishing facilities, municipal swimming pools, a community centre and several golf courses provide recreation for residents and vacationers. The economic life depends largely on the tourist trade, services to Camp Pendleton and light industry. Oceanside established the council-manager form of government in 1947. For comparative population figures *see* table in CALIFORNIA: *Population.* (A. F. MN.)

OCEANUS, in Greek mythology, the river that encircles the earth (conceived as flat). Beyond it, to the west, are the land of the Cimmerii where the sun never shines, the country of dreams and the entrance of the underworld. In Hesiod's *Theogony,* Oceanus is the son of Uranus and Ge, the husband of Tethys, father of 3,000 streams and 4,000 ocean nymphs. In Homer he is the origin of the gods. As a common noun the word gets practically the modern sense of ocean.

OCELLUS LUCANUS (OCELLUS OF LUCANIA; Greek spellings of the name vary between OKELLOS, OKKELOS, EKELLOS, etc.) (6th?–5th century B.C.), Greek philosopher of the Pythagorean school, was perhaps a pupil of Pythagoras himself. His name was attached to a later treatise On *the Nature of the Universe* (current in the 1st century B.c.), which reflects many of the views ascribed to Philolaus (*q.v.*). The best edition is by R. Harder, with commentary (1926). There is also an English translation by Thomas Taylor (1831).

For Ocellus, *see* Diels-Kranz, *Fragmente der Vorsokratiker,* vol. i, 7th ed. (1954); for the treatise, R. Beutler, "Okellos," Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft,* Halbband 34 (1937).

OCELOT (*Felis pardalis*), an American species of the cat family (Felidae) ranging from southwestern Arkansas, Texas and Arizona southward to Paraguay. Adults are from 40 to 50 in. long, with the tail an additional 13–15 in., and stand about 16 to 18 in. at the shoulder. Females are generally smaller than males. The colour of the upper parts varies from pale gray to deep brown. The head has small black spots, and there are two black bars on the cheeks. Four or five parallel black stripes are present on the neck, and black-edged elongate spots of dark colour are arranged in oblique bands on the body. The underparts are whitish, and the tail is marked above with dark bars or blotches.

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OCELOT (FELIS PARDALIS)

Ocelots are excellent climbers and inhabit forested or brushy regions. They hunt chiefly at night and feed upon small to medium-sized reptiles, birds and mammals. Breeding may occur at any season, and a litter usually contains two young, which resemble the adults in colour pattern but are of a darker shade. Ocelots are easily maintained in captivity and some are readily tamed. The smaller margay (*q.v.*) resembles the ocelot in general appearance and in range, but differs in certain features of the pelage and skull. *See* also CAT; CARNIVORE. (J. N. L.)

OCHINO, BERNARDINO (1487–1564), Italian Reformer, was born at Siena. He entered the order of Observantine friars, the strictest sect of the Franciscans, and rose to be its general, but, craving a yet stricter rule, transferred himself in 1534 to the newly founded order of Capuchins, of which in 1538 he was elected vicar-general. In 1539 he delivered at Venice a remarkable course of sermons, showing a tendency to the doctrine of justification by faith, which is more marked in his *Dialogi VII* published soon after. He was suspected and denounced, and when the Inquisition was established at Rome, Ochino was at once cited, but was deterred from presenting himself at Rome by the warnings of Peter Martyr and of Cardinal Contarini. After some hesitation he escaped across the Alps to Geneva. He was cordially received by Calvin, and within two years published six volumes of *Prediche* (Eng. trans., 1548), tracts rather than sermons, explaining and vindicating his change of religion. He mas minister of the Italian Protestant congregation at Augsburg from 1545 until 1547, when the city was occupied by the imperial forces in the Schmalkaldic War. Escaping by way of Strasbourg he found an asylum in England, where he was made a prebendary of Canterbury, received a pension from Edward VI's privy purse, and composed his chief work, *A Trajedy or Dialogue oj the Unjust Usurped Primacy of the Bishop of Rome* (1549), originally written in Latin, but extant only in the translation of John Ponet, bishop of Winchester. The conception of the *Trajedy* bears a remarkable resemblance to that of *Paradise Lost;* and it is almost certain that Milton, whose sympathies with the Italian Reformation were so strong, must have been acquainted with it, and with some of Ochino's later works. In the *Labyrinth* (dedicated to Queen Elizabeth), he assailed the Calvinistic doctrine of predestination.

The accession of Mary in 1553 drove him from England, and he became pastor of the Italian congregation at Zürich. In 1563 the publication of his *Thirty Dialogues,* in one of which his adversaries maintained that he had justified polygamy under colour of a pretended refutation, led to his banishment. He found refuge in Poland until the edict of the 6th of August, 1564, banished all foreign dissidents. He died at Schlakau in Moravia, about the end of 1564.

See *Life* by B. O. Benrath (2nd ed., 1892; Eng. trans. by Helen Zimmern, 1876).

OCHOA, SEVERO (1905–), Spanish-U.S. physician and biochemist, co-winner with Arthur Kornberg of the 1959 Nobel prize for medicine, was born in Luarca, Spain, on Sept. 24, 1905. He received an A.B. degree from Malaga college in 1921 and an M.D. degree from the University of Madrid in 1929. In 1929–31 he was a student and research associate at the Kaiser Wilhelm institute in Berlin, and in 1932–33 he was at the National Institute of Medical Research in London. He returned to Spain in 1934 to teach in the physiology department of the University of Madrid, but left again in 1936 because of the Spanish Civil War. He pursued his researches at Heidelberg in 1936–38 and at Oxford in 1938–40. In 1940 he went to the United States, working first as an instructor and research assistant in pharmacology at Washington university in St. Louis. In 1941 he joined the faculty of the college of medicine of New York university as a research assistant in pharmacology; he was chairman of the school's department of pharmacology from 1946 until 1954, when he became chairman of the department of biochemistry.

Ochoa's major contributions were in the intermediary metabolism of the cell. He was one of the first to provide evidence that the energy from metabolism is stored and utilized by means of the so-called "high energy" phosphate compounds. He and his co-workers did much to clarify the details of the metabolic transformation of such key compounds as ascetic and pyruvic acids to carbon dioxide, fat, etc. In 1955 he described the finding of an enzyme system that led to the synthesis of compounds resembling naturally occurring ribonucleic acid (RNA); for this work he was awarded a share of the 1959 Nobel prize. The increasingly positive evidence that RNA is the chief template or specific pattern for protein synthesis by the cell marked this finding as uniquely important. (R. LE.)

OCHOA Y RONNA, EUGENIO DE (1815–1872), Spanish scholar and writer, was born in Lezo (Guipuzcoa). Of minor importance for original works, his militantly literary review El *Artista* (1835–36) contributed significantly to the success of romanticism and he was the first critic to acclaim the realist novel of Fernán Caballero *La gaviota* in 1849. As editor for Ribadeneyra, Madrid, and more particularly of Spanish classics (ballads, novels, prose, plays of L. de Moratin, Lope de Vega, Calderbn de la Barca and Tirso de Molina) for Baudry, Paris, he reintroduced Europe to Spanish literature. His *Apuntes para una bib-*

lioteca de escritores españoles contemporáneos (1840) is still useful. He compiled a catalogue of Spanish manuscripts in the libraries of Paris (1844). He died in Madrid. (R. F. B.)

OCHRE, a native earth coloured with hydrated iron oxide. It varies in colour from pale yellow to deep red, brown and violet. There are two kinds—one having a clayey basis, while the other is a chalky earth; the former variety is in general the richer and purer in colour of the two. Both kinds are widely distributed in beds or pockets, mainly in stratified rocks and rubble and rarely as extensive deposits. Some ochres require only grinding, whereas other varieties require calcination whereby the original colour is modified.

In this process the associated earth exercises a marked influence, clayey ochres developing red and violet tints, while chalky varieties take brownish-red and dark brown hues. The well-known ochre, terra di Siena, which in its native state is a dull-coloured earth, assumes when burned a fine warm mahogany-brown hue highly valued by artists. Ochres containing much organic matter are sometimes calcined to improve their drying properties in varnish or oil.

Ochres are also artificially prepared in large quantities—Mars yellow is either a pure hydrated ferric oxide or an intimate mixture of that substance with an argillaceous or calcareous base, and by careful calcination they can be transformed into Mars orange, violet or red, all reliable pigments.

For more detailed information on pigments, *see* PAINTS, CHEMISTRY OF.

OCHS, ADOLPH SIMON (1858–1935), U.S. newspaper publisher who made the *New York Times* one of the world's greatest newspapers, was born in Cincinnati, O., on March 12, 1858, of Jewish parents who had emigrated in their youth from Bavaria. In 186j the family settled in Knoxville, Tenn. While still a schoolboy Adolph delivered newspapers; at the age of 11 he was an office boy and at the age of 14, a printer's devil on the *Knoxville Chronicle*. In 1875–76 he was a compositor for the *Louisville* (Ky.) *Courier-Journal;* in 1877 he helped establish the *Chattanooga Dispatch;* and in 1878, at the age of 20, he gained control of the decrepit *Chattanooga Times* for $250. He soon placed the *Times* on a firm basis, and made it one of the leading newspapers in the south.

In 1896 Ochs acquired controlling ownership of the financially faltering *New York Times,* and formed the New York Times company. He steadily strengthened the paper's journalistic and financial position, raising its circulation from 9,000 in 1896 to 466,000 daily and 730,000 Sunday copies in 1934. In 1901 Ochs purchased the *Philadelphia Times,* which he merged with the *Public Ledger* and sold to Cyrus Curtis in 19x2. He was a founder of the Southern Associated Press: and from 1900 to his death in 193j was a director of the Associated Press.

The influence of Ochs upon newspaper publishing in the United States was marked and highly beneficial. Entering New York publishing when "yellow journalism" was at its height, in competition with the richest and most powerful newspapers in America, he boldly adopted the slogan, "All the News That's Fit to Print," and devoted his paper, not to sensations, but to giving intelligent readers a daily news report that was trustworthy and complete. In a few years he made the *New York Times* an outstanding example of enterprise in news gathering, and ultimately the most widely respected and quoted newspaper in the United States. Ochs introduced such innovations as a book-review supplement and rotogravure printing of pictures and pressed for higher standards in the presentation of advertising,

Interested in making accurate source material available to the public, in 1913 he began publishing the *New York Times Index,* the only complete U.S. newspaper index, and, in 1925, advanced $50,000 annually for ten years toward the cost of the editorial preparation of the *Dictionary of American Biography,* repayment to be made from royalties. In 1918 the *Times* was awarded the first Pulitzer gold medal in journalism for meritorious public service. Ochs died on April 8, 1935, in Chattanooga.

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OCKLEY, SIMON (1678–1720), English orientalist, whose chief work is *The Conquest of Syria, Persia, and Ægypt, by the Saracens,* generally known as *The History of the Saracens.* Born at Exeter in 1678, he was educated at Queen's college, Cambridge, later becoming a fellow of Jesus college and vicar at the nearby village of Swavesey. In 1711 he was appointed professor of Arabic at Cambridge. Being the father of a large family and insufficiently paid he fell into debt in his later days and was for a time imprisoned in Cambridge castle. His troubles are related in Isaac D'Israeli's *Calamities of Authors.* He died at Swavesey on Aug. 9, 1720.

Ockley's first book was the *Introductio ad linguas orientales* (1706) in the preface of which he urged the importance of a knowledge of oriental literature for the study of theology. For his *History of the Saracens* he took as his authority a manuscript of the pseudo-Waqidi's *Futuh al-Sham* ("Conquest of Syria"), which is historical romance rather than history, but his book was widely read and long remained the standard English work on the early history of Islam. He also published a number of translations including *The Sentences of Ali* (1717), a translation of the sayings of the Prophet's son-in-law.

O'CLERY, MICHAEL (1575–1643), Irish chronicler, grandson of a chief of the sept of O'Clery in Donegal, was born at Kilbarrow on Donegal bay, and was baptized Tadhg (or "poet"), but took the name of Michael when he became a Franciscan friar. He had already gained a reputation as a student of Irish history and literature, when he entered the Irish college of St. Anthony at Louvain. In 1620, through the initiative of Hugh Boy Macanward (1580–1635), warden of the college, and himself a famous Irish historian and poet, and one of an old family of hereditary bards in Tyrconnell, he began to collect Irish manuscripts and to transcribe everything he could find of historical importance; he was assisted by other Irish scholars, and the results were his *Reim Rioghroidhe* (Royal List) in 1630, *Leabhar Gabhala* (Book of Invasions) in 1631. and his most famous work, called by John Colgan (d. 1659), the Irish biographer, the "Annals of the Four Masters" (1636). Subsequently he produced his *Martyrologium* of Irish saints, based on various ancient manuscripts, an Irish glossary and other works. He lived in poverty, and died at Louvain.

O'CONNELL, DANIEL (1775–1847), Irish statesman, known as "the Liberator," was born on Aug. 6, 1775, near Cahirciveen, Kerry. While a boy he was adopted by his uncle, Maurice O'Connell of Derrynane, and sent to a school at Queenstown, and then to the colleges of St. Omer and Douai in France. In 1798 O'Connell was called to the bar of Ireland.

From early manhood O'Connell had turned his mind to the condition of Ireland and the mass of her people. The worst severities of the penal code had been, in a certain measure, relaxed, but the Catholics were still in a state of vassalage, and they were still pariahs compared with the Protestants. The rebellion of 1795 and the union had dashed the hopes of the Catholic leaders, and their prospects of success seemed very remote. O'Connell gave the Catholic movement an energy it had not before possessed. He formed the bold design of combining the Irish Catholic millions, under the superintendence of the native priesthood, into a vast league against the existing order, and of wresting the concession of the Catholic claims from every opposing party in the state by continuous agitation within constitutional limits, though menacing and shaking the frame of society. The Catholic Association was formed and, after a conflict of years, all Catholic Ireland was arrayed in a powerful organization. O'Connell's election for Clare in 1828 proved the forerunner of the inevitable change, and the Catholic claims were granted the next year.

O'Connell joined the Whigs on entering parliament, and gave effective aid to the cause of reform. The agitation, however, on the Catholic question had quickened the sense of the wrongs of

Ireland, and the Irish Catholics were engaged ere long in a crusade against tithes and the established church, the most offensive symbols of their inferiority in the state. It may be questioned whether O'Connell was not rather led than a leader in this; the movement, at least, passed beyond his control, and the country for many months was terrorized. Lord Grey proposed measures of repression which O'Connell opposed with extreme vehemence. This caused a breach between him and the Whigs; but he gradually returned to his allegiance to them when they practically abolished Irish tithes, cut down the revenues of the established church and endeavoured to secularize the surplus. In the British house of commons O'Connell stood in the front rank as a debater; and his oratory, massive and strong in argument, made a powerful impression. O'Connell steadily supported Lord Melbourne's government, gave it valuable aid in its general measures, and repeatedly expressed his cordial approval of its policy in advancing Irish Catholics to places of trust and power in the state, though personally he refused a high judicial office. He sincerely advocated the rights of conscience, the emancipation of the slave and freedom of trade. But his rooted aversion to the democratic theories imported from France grew stronger with advancing age. His conservatisin was most apparent in his tenacious regard for the claims of property. He actually opposed the Irish Poor law, as encouraging a communistic spirit; he dèclared a movement against rent a crime, though he advocated a reform of the precarious tenure enjoyed by the Irish peasant.

O'Connell changed his policy as regards Ireland when Sir Robert Peel became minister in 1841. He declared that a Tory régime in his country was incompatible with good government, and he began an agitation for the repeal of the union. He had denounced the union in early manhood as an obstacle to the Catholic cause; he had spoken against the measure in parliament; he believed that the claims of Ireland were set aside or slighted in what he deemed an alien assembly; and, though he had ceased for some years to demand repeal, and regarded it as rather a means than an end, he was throughout life an avowed repealer. In his judgment the repeal of the union would not weaken the real bond between Great Britain and Ireland. The Catholic association of 1828–29 was recreated for the new project. Enormous meetings convened by the priesthood, and directed or controlled by O'Connell, assembled in 1842–43, and probably nine-tenths of the Irish Catholics were unanimous in the cry for repeal. O'Connell seems to have thought success certain; but he had not perceived the essential difference between his earlier agitation and this. The enlightened opinion of the three kingdoms for the most part approved the Catholic claims, and as certainly it condemned repeal. After some hesitation Peel resolved to put down the repeal movement. A vast intended meeting was proclaimed unlawful, and in Oct. 1843 O'Connell was arrested and held to bail, with 10 or 12 of his principal followers. He was convicted (Feb. 1844) after the trials that followed, but the judges were biased, and the sentence of imprisonment for a year and a fine of £2,000 was reversed on a writ of error by the house of lords (Sept. 1844), and he and his colleagues were again free. The spell, however, of O'Connell's power had vanished; his health had suffered much from a short confinement; he was verging upon his seventieth year; and he was disturbed by the growth of a party in the repeal ranks who scoffed at his views, and advocated the revolutionary doctrines which he had always feared and abhorred. Before long famine had fallen on the land, and under this visitation the repeal movement, already paralyzed, collapsed. O'Connell died on May 15, 1847, at Genoa, while on his way to Rome. His body was brought back to Dublin and buried in Glasnevin cemetery.

Catholic Ireland calls O'Connell its "Liberator" still; he possessed the wisdom, the caution and the tact of a real statesman. But the battle in which he fought was not to be won in his generation. O'Connell married in 1802 his cousin Mary O'Connell, by whom he had three daughters and four sons, Maurice, Morgan, John (1810–1858), known as the "Young Liberator," and Daniel, all of whom sat in parliament.

Bibliography.—His son John's *Life* (1846) and *Recollections and Experiences* (1849), the biographies by W. Fagan (1847), M. F. Cusack (1872), J. O'Rourke and O'Keefe (1875), and J. A. Hamilton (1888); also R. Dunlop, *Daniel O'Connell and the Revival of National Life in Ireland* (1900), R. Houston, *Daniel O'Connell: his Early Life and Journal, 1795–1802* (1906), and A Zimmermann, *Daniel O'Connell der Befreier und seine politische Bedeutung für Irland und England* (Paderborn, 1909).

O'CONNOR, FEARGUS EDWARD (1794–1855), Chartist leader, was the son of the Irish Nationalist politician Roger O'Connor. He entered parliament as M.P. for Cork and a follower of Daniel O'Connell in 1832; but three years later the "Liberator" had him unseated, by petition, for his indiscipline. He turned to radical agitation in England and on the publication of the Charter in 1838 became one of the best-known Chartist leaders. Owing to his rough humour, his energy and his invective he became their most popular speaker, and the circulation of his journal, the *Northern Star*, outstripped all others. He advocated physical force, generally, however, with the proviso that moral force must be tried first, and at the Chartist convention of 1839 acquiesced in William Lovett's "moral force" leadership. Although not concerned in the insurrection of 1839 he was imprisoned for a year upon another charge. In 1841 he reorganized the movement by the foundation of the National Charter association, and attained a position of such power that he was able practically to expel or silence Lovett and all others who advocated compromise with the middle class. But though he raised Chartism to its greatest power he was unable to direct it to victory. He permitted the general strike of 1842; in the midst of it his fears overcame him and he condemned it, securing its immediate defeat. After this fiasco he diverted Chartist energies to the support of his land company scheme for settling town workers on small holdings. For a while this appeared successful, and a first settlement, named O'Connorville, was opened at Herringsgate, Bucks. He was also elected M.P. for Nottingham in 1847. Next year, however, the company was found to be bankrupt, and the ignominious collapse of the revolutionary agitation of that year, to which he had pinned his hopes, made O'Connor's behaviour, already eccentric, plainly maniacal. He was, very belatedly, declared insane in 1852 and died in 1855. His funeral procession, 50,000 strong to Kensal Green, may be regarded as the last Chartist demonstration.

O'Connor was a tall, loud-voiced, handsome man, of unlimited devotion and energy and great oratorical powers; he was, however, vacillating, excessively vain, jealous and of small intellectual powers.

See Chartism. (R. W. P.)

O'CONOR, CHARLES (1804–1884), U.S. lawyer, was born in New York city on Jan. 22, 1804. He was admitted to the bar in 1824. From 1853 to 1854 he was United States district attorney for New I'ork. After the American Civil War he became senior counsel for Jefferson Davis on his indictment for treason, and was one of his bondsmen. He took a prominent part in the prosecution of William M. Tweed and members of the "Tweed Ring" and published *Peculation Triumphant, Being the Record of a Five Years' Campaign against Official Malversation, A.D. 1871–1875* (1875).

O'Conor moved to Nantucket, Mass., in 1881, and died there on May 12, 1884.

OCORONAN, a small group of tribes of South American Indians, provisionally regarded as constituting an independent linguistic stock. The Ocoronas live or lived in eastern Bolivia along the upper Mamore river, at the missions of San Ignacio, San Martin and Santa Rosa de Moxos.

With the exception of brief references to them by the early missionaries. little is known concerning their culture. Rivet believes that the Ocoronas are merely a subgroup of the Chapacuran stock.

See G. de Crequi-Montfort and P. Rivet, "La Famille linguistique Capakura" (*J. Soc. Américanistes de Paris* [n.s.] vol. x., pp. 119–173).

OCOTEPEQUE, a small department in western Honduras that borders El Salvador and Guatemala.

Population (1961) 52,989. The departmental capital and largest town. Nueva Ocotepeque, had only 4.118 people in 1961. The population, consisting mostly of highland Indians, is exceedingly isolated and has to depend entirely on pack and cart transportation.

The department has no all-weather roads and all settlements are in small highland valleys.

Although only 15% of the land in farms is cultivated, Ocotepeque ranks first in the nation in the production of wheat, third in tobacco and seventh in potatoes. Several handicraft industries are significant locally. (C. F. J.)

OCOTILLO (*Fouquieria splendens*), a North American shrub of the candlewood family (Fouquieriaceae), called also coachwhip, Jacob's staff and vine cactus. It is a characteristic shrub of rocky deserts from western Texas to southern California and southward in Mexico. Near the base the stem divides into several slender, erect, furrowed, intensely spiny branches, usually from 8 to 20 ft. high. It bears small rounded leaves, the midribs of which harden into the spines, and showy bright-scarlet flowers in terminal clusters. The ocotillo is sometimes grown as a hedge plant; in Mexico the branches are woven into fences.

OCTAHEDRON: *see* SOLIDS, GEOMETRIC.

OCTAVE, a period or series of eight members. In ecclesiastical usage the octave is the eighth day after a particular church festival, the feast day itself and the "octave" being counted. The octave thus always falls on the same day of the week as the festival, and any event occurring during the period is said to be "in the octave." In music, an octave is the eighth full tone above or below any given note. It is produced by double or half the number of vibrations corresponding to the given note. In the interval between a note and its octave is contained the full scale, the octave of a note forming the starting-point of another scale of similar intervals to the first. The interval between a note and its octave is also called an octave. The name is also applied to an open metal stop in an organ, and to a flute (more usually known as the piccolo) one octave higher in pitch than the regular flute. It is also a term for a "parade" in fencing. The "law of octaves" was a term applied in 1865 to a relationship among the chemical elements enunciated by J. A. R. Newlands.

In literature an octave is a form of verse consisting of eight iambic lines, and complete in itself. From its use by the poets of Sicily, the form is usually called the Sicilian octave. It is distinguished from a single stanza of *ottava rima* by having only two rhymes, arranged *abababab*. In German literature the octave has been used not infrequently since 1820, when Ruckert published "Sicilianen," as they are called in German, for the first time. The word is often used to describe the eight opening lines of a sonnet.

OCTAVIA, the name of two princesses of the Augustan house. (1) Octavia, daughter of Gaius Octavius and sister of the emperor Augustus, was the wife of Gaius Marcellus, one of the bitterest enemies of Julius Caesar. In 41 B.C. her husband died, and she was married to Marcus Antonius, with the idea of bringing about a reconciliation between him and her brother. Her efforts were at first successful, but in 36 Antony left for the Parthian War and renewed his intrigue with Cleopatra. Though Octavia took out troops and money to him (35), he refused to see her and formally divorced her in 32. (2) OCTAVIA, daughter of the emperor Claudius, was the wife of Nero, by whom she was put to death. A Latin tragedy on her fate is attributed, though wrongly, to Seneca.

OCTOBER, the eighth month of the old Roman year, which began in March. In the Julian calendar, while retaining its old name, it became the tenth month, and had 31 days assigned to it. Several attempts were made to rename the month in honour of the emperors. Thus it was in succession temporarily known as Germanicus, Antoninus, and Herculeus, the last a surname of Commodus. The senate's attempt to christen it Faustinus in honour of Faustina, wife of Antoninus, was equally unsuccessful. By the Slavs it is called "yellow month," from the fading of the leaf; to the Anglo-Saxons it was known as Winterfylleth, because at this full moon (*fylleth*) winter was supposed to begin.

OCTOPUS, the name given in zoology to a single genus of eight-armed Cephalopoda (*q.v.*), one of whose distinguishing characters is the presence of two rows of suckers on each arm. As a less strictly defined term the name may be given to all the eight-armed Cephalopoda, of which some 36 genera have been described (*e.g., Eledone, Cirroteuthis, Argonauta*). The genus *Octopus* is a large one containing upwards of 140 species. Its representatives occur in nearly all seas (though it is poorly represented in Arctic and Antarctic waters) and some are found at great depths. *Octopus vulgaris* is found on British coasts (principally in the south), but it has a limited distribution in these waters, and is not often taken, the allied *Eledone cirrosa* being more common.

The sucker-bearing arms, strong jaws and sinister appearance of these animals have conferred on them a name for ferocity which is not undeserved. The stories of their attacks on man are sufficiently well attested, though they are often exaggerated.

The octopus moves about by means of its arms on the sea bottom, and is not habitually free-swimming, though like other Cephalopods, it can propel itself through the water by means of the funnel (*see* CEPHALOPODA). *Octopus* and the related genus *Eledone* live on the sea-bottom and are mainly found in shallow coastal water. According to Lo Bianco the common octopus in the Gulf of Naples prefers rocky situations for its lair during its early years. Certain forms (*e.g., Benthoctopus*) are found in very deep water, the greatest depth from which a member of the genus *Octopus* has been obtained being 1,875 fathoms. Other Octopods, however, are inhabitants of the open sea and are found swimming or floating at the surface (*Argonauta*) or at greater depths (*Eledonella, Cirroteuthis*). A species of *Eledonella* has been taken at a depth of 2,900 fathoms. Those which live permanently in very deep water are usually highly modified, having gelatinous tissues, large medusiform webs and reduced gills and dentition.

The common octopus feeds principally on crabs. Lo Bianco has shown that before killing its victims it paralyses them with a poison secreted by its salivary glands. The same observer has recorded that the common octopus in captivity will devour its own arms even if it is amply supplied with its normal food. Certain species of octopus attain a considerable size. The common octopus, *O. vulgaris,* sometimes spans over six feet with its arms and the giant *O. apollyon* of the western coast of the United States has been known to have a diameter of 28 feet.

Most species of this genus lay eggs in grapelike clusters. Lee states that the female *O. vulgaris* broods over the clusters, holding them in the membranous expansion of its arms and syringing them with jets of water from its funnel (*see* CEPHALOPODA).

Octopods are eaten fresh or dried by the natives of many parts of the world. The flesh of young *O. vulgaris* is still considered a delicacy in Naples.

It has been mentioned above that the true octopus (*Octopus vulgaris*) is usually rare on the English coast. In 1899 and 1900, however, they became so abundant on the south coast as to attract general notice, and to constitute a veritable plague.

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OCTOSTYLE, in architecture, a portico with eight columns or a building with such a portico in front; *e.g.,* Parthenon at Athens.

OCTROI, an indirect or consumption tax levied by a local political unit, normally the commune or municipal authority, on certain categories of goods on their entry into its area (Fr. *octroyer,* from Low Lat. *auctorizare,* to confer, authorize, empower; *i.e.,* in this relation, the empowering of the subordinate political unit to impose certain taxation within its precincts; hence by extension the taxation system itself). The institution of such tax in Italy goes back to Roman times, when it bore the title of *vectigal* or *portorium,* and in France to the 13th century. Suppressed in the latter country under the Revolution in 1791, the tax was re-established five years after; and until the close of the first quarter of the 20th century was operative very generally throughout the land. It was abolished in Belgium in 1870 and in Egypt in 1903; after World War II it still persisted in France, Italy, Spain, Portugal and Austria, but there was a marked tendency toward radical reduction in its total area of operation, or even its general suppression. The last octrois which had survived in France were suppressed from

Jan. 1, 1949, by a decree of Dec. 9. 1948.

France provides an outstanding example of this evolution. Public opinion in that country — critical for generations of a tax system highly irksome, inconvenient in its mode of collection and unduly costly in relation to its yield (the levy process sometimes absorbed 50%)—was turned decisively against the system by the phenomenal increase of motor traffic.

Commodities that might be subjected to this tax in France mere prescribed by law and were divided into the following six classes: (1) liquids (artificial gaseous drinks. nonalcoholic beverages; vinegar; vegetable oils); (2) foods (meats. poultry, game, fish, butter, egg.,. cheese. jams, fruits. etc.); (3) fuel (mood. coal. coke, candles, mineral oil, etc.); (4) fodder (fresh oil cakes, dog biscuits, etc.); (j) building materials (plaster, lime. stone, bricks. slates, metals, sanitary appliances. woods, glass, etc.); and (6) miscellaneous (soaps. polishes, varnishes. paints, etc.). For all the separate commodities within these six groups maximum rates of tariff were promulgated by presidential decree, specific rates being fixed for the three (until the law of Jan. 6, 1941, six) separate sorts of octroi area, established on the basis of population, namely, communes having (1) less than 10.000 inhabitants, (2) from 10.000 to 50.000 and (3) more than 50,000. The maximum rates applicable in 1945 in these three groups were fixed as follows: for meat at 30 fr., 40 fr. and 50 fr., for butter at 24 fr., 40 fr. and 60 fr. and for coal at 0.90 fr., 1.50 fr. and 2 fr. per 100 kg. respectively.

The Paris octroi yielded from 200,000,000 fr. to 250,000,000 fr. yearly in the 1920s, nearly 600,000,000 fr. in 1938 but only 314,000,000 fr. in 1942, the shrinkage being caused mainly by the nonarrival of supplies in the area. From Aug. 1943 the tax was suppressed for the city and for the 60 suburban communes. Important provincial towns (*e.g.,* Lyons. Bordeaux, Clermont-Ferrand. Troyes, Perpignan, etc.) had abolished the system many years before World War II. In May 1945 only 200 octroi areas, holding a total population of less than 1,000,000, were still existing in France; there had been 1,491 in 1918 and approximately 1,050 (with a total population of 14,500,000) in 1926.

The tax was finally suppressed from Jan. 1, 1949, as mentioned above, because of the excessive formalities and the cost of its collection and control.

See M. Tardit and A. Ripert, ***Traité** des octrois **municipaux*** (Paris, 1904); L. Hourcade, *Manuel encyclopédique des contributions indirectes et des octrois* (Poitiers, 1925).

O'CURRY, EUGENE (1796–1862), Irish scholar, was born at Dunaha, county Clare, in 1796, the son of a farmer who was a man of unusual intelligence. After being employed for some time in the topographical and historical section of the Irish ordnance survey, O'Curry earned his living by translating and copying Irish manuscripts. The catalogue of Irish manuscripts in the British Museum was compiled by him. On the founding of the Roman Catholic University of Ireland (1854) he was appointed professor of Irish history and archaeology. His lectures were published by the university in 1860. Three other volumes of lectures were published posthumously, under the title On the Manners and Customs of the Ancient *Irish* (1873). His voluminous transcripts. notably eight huge volumes of ancient Irish law, testify to his unremitting industry.

O'Curry died in Dublin in 1862.

ODAENATHUS or ODENATUS (Gr. *'Οδαίναθος,* "palm," אחינר, "little ear"), the Latinized form of ODAINATH, the name of a famous prince of Palmyra in the second half of the 3rd century A D who succeeded in recovering the Roman east from the Persians and restoring it to the empire. He belonged to the leading family of Palmyra, which bore, in token of Roman citizenship. the *gentilicium* of Septimius; hence his full name was Septimius Odainath. It is practically certain that he was the son of Septimius Hairan, the "senator and chief of Tadmor," the son of Septimius Odainath, "the senator."

The year when he became chief of Palmyra is not known, but already in an inscription dated A.D. 258 he is styled *vir consularis, i.e*, of consular rank. He possessed the characteristic vigour and astuteness of the old Arab stock from nhich he sprang; and in his wife, the renowned Zenobia (*q.v.*), he found an able 'supporter of his policy.

The defeat and captivity of the emperor Valerian (A.D. 260) left the eastern provinces largely at the mercy of the Persians; the prospect of Persian supremacy was not one which Palmyra or its prince had any reason to desire. At first, it seems, Odainath attempted to propitiate the Persian monarch Shapur (Sapor) I; but when his gifts were contemptuously rejected he decided to throw in his lot with the cause of Rome. Odainath initiated that active policy which, while it added to his own fame, in a short time brought his native city to its ruin. He fell upon the victorious Persians who were returning home after the sack of Antioch, and before they could cross the Euphrates inflicted upon them a considerable defeat.

Then. when two usurping emperors mere proclaimed in the east (A.D. 261), Odainath took the side of Gallienus the son and successor of Valerian, attacked and put to death the usurper Quietus at Emesa (Homs), and was rewarded for his loyalty by the grant of an exceptional position (A.D 262).

Odainath may have assumed the title of king before; but he now became corrector *totius* Orientis, not indeed joint ruler, nor Augustus, but "independent lieutenant of the emperor for the East" (Theodor Mommsen, Provinces, ii, p. 103)[1]. In a series of rapid and successful campaigns, during which Odainath left Palmyra under the charge of Septimius Worod, his deputy, he crossed the Euphrates and relieved Edessa, recovered Nisibis and Carrhae and even took the offensive against the pomer of Persia and twice invested Ctesiphon, the capital, itself; probably also he brought back Armenia into the empire.

These brilliant successes restored the Roman rule in the east; and Gallienus did not disdain to hold a triumph with the captives and trophies which Odainath had won (A.D. 264).

While observing all due formalities toward his overlord, there can be little doubt that Odainath aimed at independent empire; but during his lifetime no breach with Rome occurred. He was about to start for Cappadocia against the Goths when he was assassinated, together with Herodes his eldest son, by his nephew Maeonius; there is no reason to suppose that this deed of violence was instigated from Rome.

After his death (A.D. 266–267) Zenobia succeeded to his position, and practically governed Palmyra on behalf of her young son Wahab-allath or Athenodorus. (See PALMYRA.)

(G. A. C.; X.)

ODDFELLOWS, ORDER OF, a secret benevolent and social society and, subsequently, a friendly benefit society also, having mystic signs of recognition, initiatory rites and ceremonies and various grades of dignity and honour. Great antiquity has been claimed for the order of Oddfellows, but the members themselves now generally admit that the institution cannot be traced back beyond the first half of the 18th century and explain the name as adopted at a time when the severance into sects and classes was so wide that persons aiming at social union and mutual help were a marked exception to the general rule. Mention is made by Defoe of the society of Oddfellows. but the oldest lodge of which the name has been handed down is the Loyal Aristarcus, no. 9, which met in 1745 "at the Oakley Arms, Borough of Southwark; Globe Tavern, Hatton Garden; or the Boar's Head in Smithfield, as the noble master may direct." The earliest lodges were supported by each member and visitor paying a penny to the secretary on entering the lodge, and special sums were voted to any brother in need. If out of work he was supplied with a card and funds to reach the next lodge, and he went from lodge to lodge until he found employment. The lodges gradually adopted a definite common ritual and became confederated under the name of the Patriotic Order. Touard the end of the century many of the lodges were broken up by state prosecutions on the suspicion that

[1] The Roman chronicler Trebellius Pollio goes further and asserts "Odenatus rex Palmyrenorum optinuit totius Orientis imperium. . . . Gallienus Odenatum participato imperio Augustum vocavit," *Hist. Aug.*, xxiii, 10 and 12. This is not borne out by the evidence. The highest rank claimed for him by his own people is recorded in an inscription dated 271 (Cooke. *North Semitic Inscrs.*, no. 130) set up by the two generals of the Palmyrene army: Odainath is styled "king of kings and restorer of the whole city"; but this dues not mean that he ever held the title of Augustus, and the inscription was set up after his death and during the revolt of Palmyra.

their purposes were "seditious," but the society continued to exist as the Union Order of Oddfellows until 1809. In 1813, at a convention in Manchester, was formed the Independent Order of Oddfellows, Manchester Unity, which now overshadows all the minor societies in England. Oddfellowship was introduced into the United States from the Manchester Unity in 1819, and the grand lodge of Maryland and the United States was constituted on Feb. 22, 1821. It now rivals in membership and influence the Manchester Unity, from which it severed its connection in 1842. In 1843 it issued a dispensation for opening the Prince of Wales Lodge No. 1, at Montreal, Canada. The American society, including Canada and the United States, has its headquarters at Baltimore. Organizations connected either with the United States or England have been founded in France, Germany, Switzerland, Denmark, The Netherlands, Norway, Sweden, Poland, Czechoslovakia, the British dominions and elsewhere.

The most complete and trustworthy account of the institution is that in *The Complete Manual of Oddfellowship, its History, Principles, Ceremonies and Symbolism,* privately printed (1879). (*See* also FRIENDLY SOCIETIES.)

ODE, a form of stately and elaborate lyrical verse. The original signification of an ode was a chant, a poem arranged to be sung to an instrumental accompaniment. There were two great divisions of the Greek *melos* or song. One of them, in the hands of Alcaeus, Anacreon and Sappho, came close to what modern criticism knows as lyric. On the other hand, the choir-song, in which the poet spoke for himself, but always supported, or interpreted, by a chorus, led up to what is known as ode proper. It was Alcman who first gave to his poems a strophic arrangement, and the strophe (*q.v.*) has come to be essential to an ode. Stesichorus, Ibycus and Simonides of Ceos led the way to the two great masters of ode among the ancients, Pindar and Bacchylides. The form and verse-arrangement of Pindar's great lyrics have regulated the type of the heroic ode. It is now perceived that they are consciously composed in very elaborate measures. So far from being, as critics long supposed, utterly irregular, they are more like the *canzos* and *sirventes* of the mediaeval troubadours than any modern verse. The Latins lost the secret of these complicated harmonies, and made no serious attempt to imitate the odes of Pindar. The ode, as it was practised by the Romans, returned to the lyrical form of Sappho and Alcaeus. This was exemplified, in the most exquisite way, by Horace and Catullus.

The earliest modern writer to perceive the value of the antique ode was Ronsard, who attempted to recover the fire and volume of Pindar; his principal experiments date from 1550 to 1552. The, poets of the Pléiade recognized in the ode one of the forms of verse nith which French prosody should be enriched, but in their use of Greek words crudely introduced, and in their quantitative experiments, they offended the genius of the French language. The ode died in France almost as rapidly as it had come to life. Early in the 19th century the form was resumed, and we have the *Odes* composed between 1817 and 1824 by Victor Hugo, the odes of Lamartine, those of Victor de Laprade (collected in 1844), and the *Odes funambulesques* of Théodore de Banville (1857).

The earliest odes in English, using the word in its strict form, were the *Epithalamium* and *Prothalamium* of Spenser. Ben Jonson introduced a kind of elaborate lyric to which he gave the name of ode; and some of his disciples, in particular Randolph, Cartwright and Herrick, followed him. The "Hymn on the Morning of Christ's Nativity," begun by Milton in 1629, may be considered an ode, and his lyrics "On Time" and "At a Solemn Music" belong to the same category. But it was Cowley who introduced into English poetry the ode consciously built up, on a solemn theme and as definitely as possible on the ancient Greek pattern. He was no more perspicacious than others, however, in observing what the rules were which Pindar had followed. He published his "Pindaric" odes in 1656. These shapeless pieces became very popular after the Restoration, and enjoyed the sanction of Dryden in three or four irregular odes which are the best of their kind in the English language. In 1705 Congreve published *a Discourse on the Pindarique Ode,* and he wrote odes, in strophe, antistrophe and epode, which were the earliest of their kind in English; unhappily they were not very poetical. The attempts of Gilbert West (1703–56) to explain the prosody of Pindar (1749) inspired Gray to write his "Progress of Poesy" (1754) and "The Bard" (1756). Collins, meanwhile, had in 1747 published a collection of odes devised in the Aeolian or Lesbian manner. The odes of Wordsworth, Coleridge and Tennyson are entirely irregular. Shelley desired to revive the pure manner of the Greeks, but he understood the principle of the form so little that he began his "Ode to Naples" with two epodes, passed on to two strophes, and then indulged in four successive antistrophes. Coventry Patmore, in 1868, printed a volume of irregular *Odes.* Swinburne, although some of his odes, like those of Keats, are really elaborate lyrics, written in a succession of stanzas identical in form, cultivated the Greek form also, and some of his political odes follow very closely the type of Bacchylides and Pindar. Neither Sir William Watson nor Laurence Binyon, each of whom wrote memorable odes, adopted the Pindaric form.

See Philipp August Böckh, *De metris Pindari* (1811); Wilhelm Christ, *Metrik der Griechen und Römer* (1874); Edmund Gosse, *English Odes* (1881).

ODENKIRCHEN, former German town, 21 mi. by rail S.W. of Diisseldorf, and at the junction of lines to Munich, Gladbach and Stolberg. Pop. was 19,194. Odenkirchen becamea town in 1856 and united with Gladbach-Rheydt in 1929. It carried on cotton spinning and weaving, tanning and dyeing.

ODENSE, a city of Denmark, the chief town of the *amt* (county) of its name, which forms the northern part of the island of Fyn (Fiinen). Pop. (1950) 100,940. Odense, or Odinsey, originally Odinsoe, *i.e.,* Odin's island, is one of the oldest cities of Denmark. St. Canute's shrine was a great resort of pilgrims throughout the middle ages. In the 16th century the town was the meeting-place of several parliaments, and down to 1805 it was the seat of the provincial assembly of Fyn. The city lies 4 mi. from Odense fjord on the Odense Aa, the main portion on the north side of the stream, and the industrial Albani quarter on the south side. It has a station on the railway route between Copenhagen and Jutland and Schleswig-Holstein via Korsør. A canal, $15\frac{1}{2}$ ft. to 21 ft. deep, gives access to the town from the fjord. St. Canute's cathedral is one of the largest and finest buildings of its kind in Denmark. It is constructed of brick in a pure Gothic style. Originally dating from 1081–93, it was rebuilt in the 13th century. Under the altar lies Canute (Knud), the patron saint of Denmark, who intended to dispute with William of Normandy the possession of England, but was slain in an insurrection at Odense in 1086; Kings John and Christian II. are also buried within the walls. Our Lady's church, built in the 13th century and restored in 1851–52 and again in 1864, contains a carved altar-piece (16th century) by Claus Berg of Liibeck. Odense castle was erected by Frederick IV., who died there in 1730. Exports, mostly agricultural produce (butter, bacon, eggs); imports, iron, petroleum, coal, yarn and timber.

ODENWALD, a wooded mountain region of Germany, almost entirely in Hessen, with small portions in Bavaria and Württemberg-Baden. It stretches between the Neckar and the Main. and is 50 mi. long by 20 to 30 broad. Its highest points are the Katzenbuckel (2,054 ft.), the Neunkircher Höhe (1,985 ft.) and the Krahenberg (1,965 ft.). The wooded heights overlooking the Bergstrasse are studded with castles and mediaeval ruins.

ODER (Lat. *Viadua;* Slavonic *Vjodr*), a European river, 550 mi. long, which rises in the Odergebirge (Lower Carboniferous rocks of the Bohemian massif). After flowing southeast it quickly turns northeast and after a short distance northwest enters upon the Silesian plain, which general direction it maintains across the recent deposits of the lowlands in a wide valley and with low banks. In its lower course it frequently bifurcates, forming many islands. and its main channel passes Stettin into the Grosses Haff. which is connected with the Baltic sea by three arms, the Peene. Swine and Dieyenov forming the islands of Usedom and Wollin. The Swine in the middle is the main channel for navigation.

Rising in Czechoslovakia it touches the Upper Silesian coalfield and enters Germany above Ratibor, after forming the frontier between Germany and Poland from Bohumin. It receives a number of left-bank tributaries from the gneisses and granites of the Bohemian massif, the chief being the Glatzer Neisse. Katzbach, Bober and Lausitzer Neisse, but the biggest affluents are those on the right-bank, the Warthe with its tributaries the Netze (Notéc) and the Obra, the Malapane and Bartsch, all of which rise in Poland. The most important towns on the river banks are Ratibor, Oppeln, Brieg, Breslau, Glogau, Frankfort-on-Oder, Küstrin, Stettin and Swinemünde. The river forms an important highway into eastern Germany, Poland and Czechoslovakia. It is utilized by three main currents of traffic, traffic between Stettin and Berlin, goods transported to or from the mining area of Upper Silesia (this traffic was reduced by the partition of Upper Silesia between Germany and Poland) and the traffic to and from Poland by the Warthe and its connections. The river begins to be navigable for barges at Ratibor, when it is about 100 ft. wide, and for larger vessels at Breslau where constant dredging is always necessary. Several parts of the main stream have been canalized, especially in the low-lying reaches, in its upper courses and between Stettin and the sea. It is now possible for sea-going vessels, drawing 24 ft. of water to reach Stettin. In addition navigation is possible on the Warthe, Netze and Obra, and the river is connected by canals with the Vistula, the Havel and the Spree.

By the Treaty of Versailles (1919) Poland extended her territory westwards to include the province of Posen (Posnania) but, although the boundary nowhere touches the Oder, long portions of its right-bank are now in Poland. The treaty also declared international the Oder and all navigable portions of its system which provide natural access to the sea for more than one State, and also appointed a commission consisting of three representatives of Prussia, and one each of Poland, Czechoslovakia, Great Britain, France, Denmark and Sweden to prepare an Act of Navigation. The work of this commission was by no means easy, for unforeseen difficulties arose upon the question of the right of the commission to legislate for the upper reaches of the Warthe, the Netze and the Old Netze.

ODESSA, a seaport of the Odessa *oblast* in the Ukrainian S S.R., U.S.S.R.. in 46° 29′ N., 30° 44′ E., on the southern shore of a semi-circular bay, at the north-west angle of the Black sea Pop. (1959) 667.000. It has five harbours; the Quarantine. New Harbour, Pratique and Cabotage harbours are sheltered by two breakwaters, 4.020 ft. and 2.120 ft. in length. The Petroleum harbour is sheltered by a breakwater 840 ft. in length. There is very good anchorage in the inner roads and a floating crane with a capacity of 40 tons. There are two patent slips and a double-sided floating dock, lifting power 4,800 tons. The harbours freeze for a few days in each year, and the bay occasionally freezes. Navigation is interrupted on an average for 16 days per annum, though the powerful icebreaker now installed lessens this time. The climate is influenced by its proximity to the steppe, and is continental. Average January temperature 23.2" F, July 72.8° F, average rainfall 14 in. per annum. The exports are mainly grain, linseed, wool, cattle, sugar and timber, and the imports coal, naphtha, iron, machinery, agricultural implements, raw cotton, tobacco, manufactured goods and tea, coffee and other colonial goods. Coal cargoes are discharged in the new harbour, several travelling steam cranes being fitted for the purpose. The Cabotage harbour is reserved for Russian coasting vessels. A repairing yard with a pontoon and fitting out basin is situated near the petroleum harbour. Improvements to the port are now being carried out, with a view to providing quayside and berths for 21 steamers, with warehouses and railway lines along the quay.

The town is picturesquely situated on a plateau 150 ft. above sea-level, which is intersected by ravines and forms the limit of the steppe region. The climate is milder than that of the rest of the Ukraine and in the vicinity of Odessa are numerous health resorts along the limans. In these limans, or former river mouths now cut off from the sea by the silting up of the rivers, are waters containing concentrated salt solutions, with high proportions of magnesium and calcium salts, iodine and bromine. Their mud is strongly impregnated with sulphuretted hydrogen and is highly beneficial to sufferers from rheumatism, nervous disorders and skin diseases. Spring gives the environs of Odessa a brief glory of brightly coloured blossoms but summer heat and drought soon parch the vegetation. The broad streets of the town have been planted with trees, peculiarly grateful in the brief intense heat of summer and in contrast with the general treeless condition of the surrounding steppe. The population is exceedingly mixed even for a seaport, and includes Great Russians, Ukrainians, Jews, Poles, Germans, Greeks, Armenians, Tatars and Turks, among others.

History. — The bay of Odessa has had a chequered history; it was colonised by Greeks at a very early period, but their ports Istrianorum Portus, Isiacorum Portus and Odessus at the mouth of the Tiligul liman disappeared in the 3rd and 4th centuries.

In spite of its favoured position between the Dniester and the Dnieper estuaries, no further settlements were made until the 14th century, when a Tatar chief Khaji Beg or Bey founded a fort on the present site of Odessa. Olgerd, prince of Lithuania, captured the fort in 1396 and it remained alternately in the power of Lithuania and Poland until its capture by Tatars in the 16th century. During the whole of this period it continued to be an important export centre for grain, salt and fish. The Turks captured it from the Tatars in the 16th century and built a fortress Yeni-Dunia to protect the harbour. In 1774 during the Russo-Turkish War, the Russians captured the town, but returned it to the Turks, finally occupying it and the whole territory between the Dniester and the Bug in 1789. A French captain, de Ribas, who had led the Russians in their assault on the town, was afterwards entrusted with the planning, in consultation with the French engineer Voland, of a military and commercial port, and a finely laid out Russian city replaced the former Turco-Tatar settlement.

In 1803 Odessa became the chief town of a separate municipal captaincy under Armand, duc de Richelieu, who developed its trade and importance. In 1824 it became the seat of the governors of Novorossia (New Russia) and Bessarabia and, as a free port, became very prosperous. Railway communication with Kiev and Kharkov and with Jassy in Rumania was established in 1866. The free port was closed in 1859. The town successfully resisted a Turkish attack in 1876–77. A numerous floating population began to be attracted, abundant work being available in years of good harvest, but unemployment became rife in years of bad harvest. In the 1905 revolution the workers, supported by the insurrectionary battleship "Potemkin," of the Black sea fleet, took active part in the revolutionary movement. The rising was suppressed, but broke out with renewed vigour in October of the same year and was again suppressed.

After the overthrow of the Kerensky government in October 1917, the Ukrainian Rada (Petlura) occupied the town. In January 1918 the Bolshevik workers of the town, aided by troops from the former Rumanian front and from the Black sea fleet expelled the follouers of Petlura and proclaimed a soviet republic. In mid-March German and Austro-Hungarian troops occupied the town, and later the Ukrainian government, installed under German protection, called in the Entente troops, who occupied the greater part of the tonn. The French fleet bombarded the wretched inhabitants and French, Serbian, Polish and later Greek troops uere landed. Eventually, however, a second soviet government was set up in April 1919, but was overthrown by General Denikin in August 1919. In February 1920 the soviet finally captured the town.

During this disastrous period a third of the houses were destroyed and numbers of the population were killed, while others fled into the surrounding villages. During 1921 and 1922 famine and famine diseases further devastated the town and lack of fuel caused the inhabitants to pull down many wooden buildings. But in 1923 conditions became somewhat easier and since then trade has slowly returned. Another difficulty, however, faced the town. Formerly much of its trade came via the Dniester river and Akkerman (now Cetatea Alba) from Bessarabia and in the absence of diplomatic relations between Rumania and Russia, a state of armed neutrality existed on that river and trade was practically nonexistent. However, in spite of all these adverse conditions, the population in 1926 had reached normal size, increasing in 1937 to 534,000 and in 1939 to 604,223, thus showing an increase of about 40% as compared with 1926. The city gradually returned to normal conditions and trade and shipping were flourishing, making Odessa the principal seaport and commercial centre on the Black sea.

In the course of World War II Odessa played a very considerable role. The enormous strategic and economic importance of Odessa, not only for the Ukraine but for the entire U.S.S.R., made it quite necessary for the invading Germans to take possession of it in the shortest possible time in order to secure their flank and to use it as a basis for expansion over the Ukrainian industrial and mining area and the North Caucasian region. Besieged by the German and Rumanian troops Odessa fell after a gallant defense on Oct. 16, 1941, and was liberated only in the course of the great German retreat in 1943–44.

Industry. — In addition to its trading, port and shipbuilding activities Odessa has numerous industrial enterprises, among which the production of salt takes an important place. There are also glass, metal and brick works and factories for producing machinery, especially for agricultural purposes, and munitions, superphosphates, tin, cork, glue and oil from oleaginous seeds are produced. Recently introduced industries are the manufacture of cinematograph apparatus, of water gauges, of twine and of preserved foods. There is also an aeroplane factory and a regular air service has been established between Odessa and Kharkov, with intermediate stations at Poltavo and Zinovievsk. The water supply of the town is obtained from the Dniester river. The town has several theatres and museums. The former University of South Russia has been converted into a Technical institute, and there are Medical and Agricultural institutes, a State Public library and a Jewish Academical library. The medley of languages has encouraged the use of Esperanto and there is an Esperanto institute.

There is a zoological garden. laid out chiefly for purposes of acclimatization, and animals destined for the more severe conditions of the north are kept there for some time. The Bacteriological station was the first of its kind in Russia.

ODESSA, a city of western Texas, U.S., is on the southern high plains 45 mi S E of the southeastern corner of New Mexico and is the seat of Ector county.

One of the largest known meteor craters in the United States is located a short distance south of Odessa. It is more than 600 ft. in diameter and more than 150 ft. deep.

In 1881 the site was named for Odessa, Russia, by railroad construction workers who noted the similarity of the region to their Russian homeland. The town was established in 1886 by German wheat farmers from the north, but the county was devoted entirely to ranching when it was organized in 1891. Incorporated in 1927, the city adopted a council-manager form of government in 1946.

Oil was discovered in the late 1920s, and, with the establishment of the petroleum and related industries, the town's population, which was less than 3,000 in 1930, increased more than twentyfold in 30 years. Pop. (1960) 80,338. The Odessa standard metropolitan statistical area, which includes Ector county, had a population (1960) of 90,995. Located in the geographic centre of the Permian basin, one of the largest known oil reserves, Odessa is a major distribution and servicing point for the petroleum industry. Manufactures include oil-field equipment, petroleum products, synthetic rubber, cottonseed oil, chemicals and tile. Large deposits of carbon black, potash, salt, limestone and potassium are also mined and processed in the vicinity. Stock and poultry raising are also carried on. Odessa junior college (1946), located within the city, is municipally controlled. For the geography of the region *see* LLANO ESTACADO. (E. WE.)

ODIN or **OTHIN,** the chief god of the northern pantheon, is represented as an old man with one eye. Frigg is his wife. Thor and Balder, among other gods, are his sons. He is also said to have been the father of several legendary kings. His exploits and adventures are a common theme in the poetic and prose Eddas. Here his character is distinguished rather by wisdom than martial prowess, and reference is frequently made to his skill in poetry and magic. In *Ynglinga Saga* he is represented as reigning in Sweden. In notices relating to religious observances Odin appears chiefly as the giver of victory or as the god of the dead. He receives the souls of the slain, who in his palace, Valhalla (*q.v.*), live a life of fighting and feasting, similar to that which has been their desire on earth. Human sacrifices were frequently offered to Odin, especially prisoners taken in battle. In the poem *Hávamál* the god himself is represented as sacrificed. The worship of Odin seems to have prevailed chiefly, if not solely, in military circles. To the Anglo-Saxons he was known as Woden (*q.v*) and to the Germans as Wodan (Wuotan). Owing to the peculiar character of this god and the prominent position which he occupies, the mythology of the north presents a striking contrast to that of Greece. See TEUTONIC PEOPLES, ad *fin.;* and WODEN.

ODOACER or ODOVACAR (c. 434–493), the first barbarian ruler of Italy, son of Aedico or Idico, was born in the district bordering on the middle Danube about the year 434. He was probably one of the tribe of Scyrri who had invaded Pannonia about 430. It is said that as a tall young recruit for the Roman armies, dressed in a sordid vesture of skins, on his way to Italy, he entered the cell of St. Severinus, to ask his blessing. The saint had an inward premonition of his future greatness, and in blessing him said, "Fare onward into Italy. Thou who art now clothed in vile raiment wilt soon give precious gifts unto many."

Odoacer was probably about 30 years of age when he thus entered the imperial service. By the year 472 he had risen to some eminence. In the year 47j the emperor Nepos was driven into exile, and the successful rebel Orestes was enabled to array in the purple his son, a handsome boy of 14 or 15, who was named Romulus after his grandfather, and nicknamed Augustulus, from his inability to play the part of the great Augustus. Before this puppet emperor had been a year on the throne the barbarian mercenaries rose in mutiny, demanding to be made proprietors of one-third of the soil of Italy. To this request Orestes returned a peremptory negative. Odoacer now offered his fellow-soldiers to obtain for them all that they desired if they would seat him on the throne. On Aug. 23, 476, he was proclaimed king; five davs later Orestes was made prisoner at Placentia and beheaded. Augustulus was compelled to descend from the throne. but his life was spared.

Odoacer was 42 years of age when he thus became chief ruler of Italy, and he reigned 13 years with undisputed sway. The administration was conducted as much as possible on the lines of the old imperial government. The settlement of the barbarian soldiers on the lands of Italy probably affected the great landowners rather than the labouring class. To the herd or *coloni* and *servi* it probably made little difference whether the master whom they served called himself Roman or Rugian.

In 477 or 478 the dethroned emperor Nepos sent ambassadors to Zeno, emperor of the east, begging his aid in the reconquest of Italy. These ambassadors met a deputation from the Roman senate, sent nominally by the command of Augustulus, really no doubt by that of Odoacer, to declare that they did not need a separate emperor. The senate had chosen Odoacer, and they therefore prayed Zeno to confer upon him the dignity of patrician, and entrust the "diocese" of Italy to his care. Zeno returned a harsh answer to the senate, requiring them to return to their allegiance to Nepos. In fact, however, he did nothing for the fallen emperor, but accepted the new order of things, and even addressed Odoacer as patrician. On the other hand, the latter sent the ornaments of empire to Constantinople as an acknowledgment of the fact that he did not claim supreme power. Information as to the actual title assumed by the new ruler is somewhat confused. He does not appear to have called himself king of Italy, but only king of the tribes of barbarians that followed him. By the Roman inhabitants of Italy he was addressed as "dominus noster," but his right to exercise power would in their eyes rest, in theory, on his recognition as patricius by the Byzantine Augustus. At the same time he marked his own high pretensions by assuming the prefix Flavius. His internal administration was probably, upon the whole, wise and moderate, and he may be looked upon as a not altogether unworthy predecessor of Theodoric.

In the history of the papacy Odoacer figures as the author of a decree promulgated at the election of Felix II in 483, forbidding the pope to alienate any of the lands or ornaments of the Roman Church, and threatening any pope who should infringe this edict with anathema.

The chief events in the foreign policy of Odoacer were his Dalmatian and Rugian wars. In the year 480 the ex-emperor Nepos, who ruled Dalmatia, was traitorously assassinated in Diocletian's palace at Spalato by the counts Viator and Ovida. In the following year Odoacer invaded Dalmatia, slew the murderer Ovida, and reannexed Dalmatia to the western state. In 487 he appeared as an invader in his own native Danubian lands. War broke out between him and Feletheus, king of the Rugians. Odoacer entered the Rugian territory, and defeated and captured Feletheus. In the following year Frederick, son of the captive king, endeavoured to raise again the fallen fortunes of his house, but was defeated by Onulf, brother of Odoacer, and took refuge at the court of Theodoric the Ostrogoth.

This Rugian war was probably an indirect cause of the fall of Odoacer. His increasing power rendered him too formidable to the Byzantine court. At the same time, Zeno was embarrassed by the formidable neighbourhood of Theodoric the Ostrogoth. In these circumstances arose the plan of Theodoric's invasion of Italy, the details of which belong properly to the life of Theodoric. It is sufficient to state here that he entered Italy in August 489, defeated Odoacer at the Isontius (Isonzo) on the 28th of August, and at Verona on the 30th of September. Odoacer then shut himself up in Ravenna, and there maintained himself for four years, with one brief gleam of success, during which he emerged from his hiding place and fought the battle of the Addua (Aug. 11, 490), in which he was again defeated. A sally from Ravenna (July 10, 491) was again the occasion of a murderous defeat. At length, the famine in Ravenna having become almost intolerable, and the Goths despairing of ever taking the city by assault, negotiations were opened for a compromise (Feb. 25, 493). It was stipulated that Ravenna should be surrendered, that Odoacer's life should be spared, and that he and Theodoric should be recognized as joint rulers of the Roman state. The arrangement was evidently a precarious one. and was soon terminated by the treachery of Theodoric. He invited his rival to a banquet in the palace of the Lauretum on the 15th of March, and there slew him with his own hand. "Where is God?" cried Odoacer when he perceived the ambush into which he had fallen. "Thus didst thou deal with my kinsman," shouted Theodoric, and clove his rival with the broadsword from shoulder to flank. Thelan, his son, was not long after put to death by order of the conqueror. Thus perished the whole race of Odoacer.

BIBLIOGRAPHY.—The chief authorities for the life of Odoacer are the so-called "Anonymus Valesii," generally printed at the end of Ammianus Marcellinus; the *Life* of *Severinus, by* Eugippius; the chroniclers, Cassiodorus and "Cuspiniani Anonymus" (both in Roncalli's collection); and the Byzantine historians, Malchus and John of Antioch. A fragment of the latter historian, unknown when Gibbon wrote, is to be found in the fifth volume of Muller's *Fragmenta Historicorum Gvaecorum.* There is a thorough investigation of the history of Odoaccr in R. Pallmann's *Geschichte der Völkerwanderung,* vol. ii (Weimar, 1864). *See* also T. Hodgkin, *Italy and Her Invaders,* vol. iii (Oxford, 1885).

ODOFREDUS, Italian' jurist **of** the 13th century. He was born at Bologna and studied law under Balduinus and Accursius. After having practised as an advocate both in Italy and France, he became professor at Bologna in 1228. The commentaries on Roman law attributed to him are valuable as shouing the growth of the study of law in Italy, and for their biographical details of the jurists of the 12th and 13th centuries. Odofredus died at Bologna on Dec. 3, 1265.

Over his name appeared *Lecturae* in *codicem* (Lyons, 1480), *Lecturae* in *digestum vetus* (Paris, 1504), *Summa de libellis formandis* (Strasbourg, 1510), *Lecturae in tres libros* (Venice, 1514) and *Lecturae in digestuin novum* (Lyons, 1552).

ODONATA, an order of insects (*q.v.*) comprising the dragonflies and damselflies (see DRAGONFLY).

O'DONNELL, the name of an ancient and powerful Irish family, lords of Tyrconnel in early times, and the chief rivals of the O'Neills in Ulster. Like the family of O'Neill (*q.v.*), that of O'Donnell was descended from Niall of the Kine Hostages, king of Ireland at the beginning of the 5th century; the O'Neills, or Cinel Owen, tracing their pedigree to Owen (Eoghan), and the O'Donnells, or Cinel Connell, to Conall Gulban, both sons of Niall. Tyrconnel, the district named after the Cinel Connell, where the O'Donnells held sway, comprised the greater part of the modern county of Donegal except the peninsula of Inishowen; and since it lay conterminous with the territory ruled by the O'Neills of Tyrone, who were continually attempting to assert their supremacy over it, the history of the O'Donnells is for the most part a record of tribal warfare with their powerful neighbours, and of their own efforts to make good their claims to the overlordship of northern Connaught.

The first chieftain of mark in the family was Goffraidh (Godfrey), son of Donnell Mor O'Donnell (d. 1241). Goffraidh, who was "inaugurated" as "The O'Donnell," *i.e.,* chief of the clan, in 1248, successfully raided Tyrone and Connaught, and was severely wounded in the battle of Roscede (1257). In the following year he defeated Brian O'Neill, but died soon after from his old wounds. He was succeeded in the chieftainship by his brother Donnell Oge.

In the 16th century, when the English began to make determined efforts to bring the whole of Ireland under subjection to the crown, the O'Donnells of Tyrconnel played a leading part, cooperating at times with the English, especially when such cooperation appeared to promise triumph over their ancient enemies the O'Neills, at other times joining with the latter against the English authorities.

MANUS O'DONNELL (d. 1564), son of Hugh Dubh O'Donnell, was left to rule Tyrconnel during his father's pilgrimage to Rome about 1511; and retained the chief authority when Hugh Dubh returned. A family quarrel ensued, but with the help of the O'Neills, Manus established his hold over Tyrconnel. In 1522, however, the O'Neills and O'Donnells were again at war. Conn Bacach O'Neill, 1st earl of Tyrone, determined to subjugate the O'Donnells. Supported by several septs of Munster and Connaught, and assisted by English contingents and the MacDonnells of Antrim, O'Neill took the castle of Ballyshannon, and after devastating a large part of Tyrconnel encamped at Knockavoe, near Strabane. Here he was surprised at night by Hugh Dubh and Manus O'Donnell, and severely defeated. The war continued, however, and in 1531 O'Donnell applied to the English government for protection, giving assurances of allegiance to Henry VIII. In 1537 Lord Thomas Fitzgerald and his five uncles were executed for rebellion in Munster, and the English government made every effort to lay hands also on Gerald, the youthful heir to the earldom of Kildare, a boy of 12 years of age who nas in the secret custody of his aunt Lady Eleanor McCarthy. This lady, in order to secure a powerful protector for the boy, accepted an offer of marriage by Manus O'Donnell, who on the death of Hugh Dubh in July 1537 was iriauguratrd The O'Donnell. Conn O'Neill nas a relative of Gerald Fitzgerald, and this event accordingly led to the formation of the Geraldine League, a federation which combined the O'Neills, the O'Donnells, the O'Briens of Thomond, and other powerful clans; the primary object of which was to restore Gerald to the earldom of Kildare, but which afterwards aimed at the complete overthrow of English rule in Ireland. In Aug. 1539 Manus O'Donnell and Conn O'Neill were heavily defeated by the lord deputy at Lake Bellahoe, in Monaghan.

In the west Manus continued to assert the supremacy of the O'Donnells in north Connaught, where he compelled O'Conor Sligo to acknowledge his overlordship in 1539. In 1542 he went to England and presented himself, together with Conn O'Neill and other Irish chiefs, before Henry VIII. In his later years Manus was harassed by his son Calvagh, who imprisonrd him in 1555, and deposed him from all authority in Tyrconnel. He died in 1564 Manus O'Donnell is also described by the Four Masters as "a learned man, skilled in many arts, gifted with a profound intellect, and the knowledge of every science" At his castle of

Portnatrynod near Strabane he supervised if he did not actually dictate the writing of the Life of *Saint Columbkille* in Irish, which is preserved in the Bodleian library at Oxford. Manus was several times married. His first wife, Joan O'Reilly, was the mother of Calvagh, and two daughters, both of whom married O'Neills; the younger, Margaret, was wife of the famous rebel Shane O'Neill. His second wife, Hugh's mother, by whom he was ancester of the earls of Tyrconnel (see below), was Judith, sister of Conn Bacach O'Neill, 1st earl of Tyrone, and aunt of Shane O'Neill. He died in 1564.

CALVAGH O'DONNELL (d. 1566), eldest son of Manus O'Donnell, in the course of his above-mentioned quarrel with his father and his half-brother Hugh, sought aid in Scotland from the MacDonnells, who assisted him in deposing Manus and securing the lordship of Tyrconnel. Hugh then appealed to Shane O'Neill, who invaded Tyrconnel at the head of a large army in 1j57 to secure supremacy over Ulster, and encamped on the shore of Lough Swilly. Calvagh surprised the O'Neills in their camp at night and routed them. Calvagh was then recognized by the English government as lord of Tyrconnel: but in 1561 he and his wife mere captured by Shane O Neill in the monastery of Kildonnell. His wife, Catherine Maclean, who had previously been the nife of the earl of Argyll, was kept by Shane O'Neill as his mistress and bore him several children, though grossly ill-treated by her savage captor; Calvagh himself was subjected to atrocious torture during the three years that he remained O'Neill's prisoner. He was released in 1564 on conditions which he had no intention of fulfilling; and crossing to England he appealed to Queen Elizabeth. In 1566 Sir Henry Sidney marched to Tyrconnel, and restored Calvagh to his rights. Calvagh, honever, died in the same year, and as his son Conn was a prisoner in the hands of Shane O'Neill, his half-brother Hugh MacManus was inaugurated The O'Donnell in his place. Hugh, who in the family feud nith Calvagh had allied himself with O'Neill, now turned round and combined with the English to crush the hereditary enemy of his family; and in 1567 he utterly routed Shane at Letterkenny. compelling him to seek refuge with the MacDonnells of Antrim, by whom he was put to death. In 1592 Hugh abdicated in favour of his son Hugh Roe O'Donnell (see below); but Niall Garve, second son of Calvagh's son Conn, resented the passing of the chieftainship to the descendants of Manus O'Donnell's second marriage. His elder brother was Hugh of Ramelton, whose son John, an officer in the Spanish army, was father of Hugh Baldearg O'Donnell (d. 1704), known in Spain as Count O'Donnell, who commanded an Irish regiment as brigadier in the Spanish service. This officer came to Ireland in 1690 and raised an army in Ulster to be used in the service of James II, afterwards deserting to the side of William III, from whom he subsequently accepted a pension.

NIALL GARVE O'DONNELL (1569–1626), grandson of Calvagh, made terms with the English government, to whom he rendered valuable service both against the O'Neills and against his cousin. But in 1601 he quarrelled with the lord deputy, mho, though willing to establish Niall Garve in the lordship of Tyrconnel, would not permit him to enforce his supremacy over Cahir O'Dogherty in Inishowen. Charged with complicity in Cahir O'Dogherty's rebellion in 1608, Niall Garve was sent to the Tower of London, where he remained till his death in 1626. He married his cousin Nuala, the sister of Hugh Roe and Rory O'Donnell. When Rory fled with the earl of Tyrone to Rome in 1607, Nuala, who had deserted her husband when he joined the English against her brother, accompanied him, taking with her her daughter Grania. She was the subject of an Irish poem. of which an English version was written by James Mangan from a prose translation by Eugene O'Curry.

HUGH ROE O'DONNELL (1572–1602), eldest son of Hugh MacManus O'Donnell, and grandson of Manus O'Donnell by his second marriage with Judith O'Neill, was the most celebrated member of his clan. His mother was Ineen Dubh. daughter of James MacDonnell of Kintyre; his sister, the second wife of Hugh O'Neill, 2nd earl of Tyrone. These family connections with the Hebridean Scots and with the O'Neills made the lord deputy, Sir John Perrot, afraid of a powerful combination against the English government, and induced him to establish garrisons in Tyrconnel and to demand hostages from Hugh MacManus O'Donnell, which the latter refused to hand over. In 1587 Perrot conceived a plan for kidnapping Hugh Roe (Hugh the Red), now a youth of 1j. who had already given proof of exceptional ability. A merchant vessel laden with Spanish wines was sent to Lough Swilly, and Hugh Roe with some youthful companions was enticed on board, when the ship immediately set sail and conveyed the party to Dublin. The boys were kept in prison for more than three years. In 1591 young O'Donnell escaped; and after enduring terrible privations he made his way to Tyrconnel, where in the following year his father handed the chieftainship over to him.

Red Hugh then led an expedition against Turlough Luineach O'Neill, who was at war with his kinsman Hugh, earl of Tyrone, with whom O'Donnell was in alliance, at the same time assuring the lord deputy of his loyalty. Determined to vindicate the traditional claims of his family in north Connaught, he aided Hugh Maguire against the English, though on the advice of Tyrone he abstained for a time from committing himself too far. When, however, in 1594 Enniskillen castle was taken and the women and children flung into the river from its walls by order of Sir Richard Bingham, the English governor of Connaught, O'Donnell sent urgent messages to Tyrone for help; and while he himself hurried to Derry to withstand an invasion of Scots from the isles, Maguire defeated the English uith heavy loss at Bellanabriska (The Ford of the Biscuits). In 1595 Red Hugh again invaded Connaught, putting to the sword all above 1j years of age unable to speak Irish; he captured Longford and Sligo, which placed north Connaught at his mercy. In 1596 he agreed in conjunction with Tyrone to a cessation of hostilities with the English, and met the government commissioners near Dundalk.

The terms he demanded mere, honever, refused. He hoped for help from Philip II of Spain, with uhom he and Tyrone had been in correspondence. In the beginning of 1597 he raided Connaught, where O'Conor Sligo had been set up by the English as a counterpoise to O'Donnell, He devastated the country and returned to Tyrconnel with rich spoils; in 1598 he helped to defeat the English at the Yellow Ford on the Blackwater; and in 1599 he defeated an attempt by the English under Sir Conyers Clifford, governor of Connaught, to succour O'Conor Sligo in Collooney castle, nhich O Donneil captured, forcing Sligo to submission The government non sent Sir Henry Docwra to Derry, and O'Donnell entrusted to his cousin Niall Garve the task of opposing him. Niall Garve, however, went over to the English, making himself master of O'Donnell's fortresses of Lifford and Donegal. While Hugh Roe was besieging Donegal in 1601, he heard that a Spanish force had landed in Munster. He marched rapidly to the south, and nas joined by Tyrone at Bandon, but a night attack on the English besieging the Spaniards in Kinsale having utterly failed, O'Donnell, nho attributed the disaster to the incapacity of the Spanish commander, took ship to Spain on Jan 6, 1602 to lay his complaint before Philip III He was favourably received by the Spanish king, but he died at Simancas on Sept. 10 in the same year

RORY O'DONNELL, 1st earl of Tyrconnel (1575-1608). second son of Hugh MacManus O'Donnell. and younger brother of Hugh Roe. accompanied the latter in the expedition to Kinsale: and when his brother sailed for Spain he rransferred his authority as chief to Rory.

In 1602 Rory gave in his allegiance to Lord Mountjoy. the lord deputy; and in the following summer he went to London with the earl of Tyrone when James I created him earl of Tyrconnel In 1605 he was made the king's lieutenant in Donegal But the arrangement between Rory and Niall Garve insisted upon by the government displeased both O'Donnells and Rory. like Hugh Roe before him, entered into negotiations with Spain. His country had been devastated by famine and war, and his own extravagance had plunged him in debt. These circumstances and the fear that his designs were known to the government induced him to leave Ireland

In Sept. 1607 "the flight of the earls" (see O'NEILL) took place, Tyrconnel and Tyrone reaching Rome in April 1608, where Tyrconnel died on July 28. His wife, the beautiful daughter of the earl of Kildare, was left behind in the haste of Tyrconnel's flight. and lived to marry Nicholas Barnewell, Lord Kingsland. By Tyrconnel she had a son Hugh; and among other children a daughter Mary Stuart O'Donnell, who, born after her father's flight from Ireland, was so named by James I after his mother. This lady, after many romantic adventures, married a man called O'Gallagher and died in poverty on the continent.

Rory O'Donnell was attained by the Irish parliament in 1614, but his son Hugh, who lived at the Spanish court, assumed the title of earl; and the last titular earl of Tyrconnel was this Hugh's son Hugh Albert. who died without heirs in 1642, and who by his will appointed Hugh Baldearg O'Donnell (see above) his heir, thus restoring the chieftainship to the elder branch of the family.

To a still elder branch belonged Daniel O'Donnell (1666–1735), a general of the famous Irish brigade in the French service, whose father, Turlough, was a son of Hugh Dubh O'Donnell, elder brother of Manus, son of an earlier Hugh Dubh mentioned above.

Daniel served in the French army in the wars of the period, fighting against Marlborough at Oudenarde and Marlplaquet at the head of an O'Donnell regiment. He died in 1735.

The famous Cathach, or Battle-Book of the O'Donnells, was possessed by Gen. Daniel O'Donnell, from whom it passed to more modern representatives of the family, who presented it to the Royal Irish academy, where it is preserved. This relic, of which a curious legend is told (*see* P W Joyce, *A* Social History of *Ancient* Ireland, vol i, p 501, 1903), is a Psalter said to have belonged to St Columba, a kinsman of the O'Donnells, which was carried by them in battle as a charm or talisman to secure victory. Two other circumstances connecting the O'Donnells with ancient Irish literature may be mentioned. The family of O'Clery, to which three of the celebrated "Four Masters" belonged, were hereditary Ollaves (doctors of history, music, law, etc.) attached to the family of O'Donnell; while the "Book of the Dun Cow" (*Lebor-na-h* Uidhre), one of the most ancient Irish mss., was in the possession of the O'Donnells in the 14th century; and the estimation in which it was held at that time is proved by the fact that it was given to the O'Connors of Connaught as ransom for an important prisoner, and was forcibly recovered some years later. *See* O'NEILL, and the authorities there cited.

O'DONNELL, LEOPOLD (1809–1867), duke of Tetuan, Spanish general and statesman, was born at Santa Cruz, Teneriffe, on Jan. 12, 1809. General of division in the army of Queen Christina, he accompanied her into exile in 1840; attempted unsuccessfully a rising in her favour at Pamplona in 1841, helped in the overthrow of Espartero (1843) and from 1844–48 served the new government in Cuba. War minister (1854) under Espartero, he plotted successfully against his chief in 1856 and became head of the cabinet from the July revolution until October, and again in July 1858. He took command of the expedition to Morocco (Dec. 1859) and was made duke after the surrender of Tetuan. He resigned office in 1863 until 1865, resumed it and resigned again in favour of Narvaez in 1866. He died at Bayonne, Nov. 5, 1867.

ODONTOGLOSSUM, a genus (of the family Orchidaceae) of more than 100 species of showy, tropical American, tree-perching orchids; over 30 are grown in greenhouses for ornament. The baby orchid O. grande of Guatemala and O. *crispum* of Colombia have flowers three to six inches wide in handsome clusters. With their many hybrids these are among the showiest and most easily grown of all orchids (*q.v.*). (N. TR.)

ODO OF BAYEUX (c. 1036–1097), Norman bishop and English earl, was a uterine brother of William the Conqueror, from whom he received, while still a youth, the see of Bayeux (1049). But his active career was that of a warrior and statesman. He found ships for the invasion of England and fought in person at Senlac; in 1067 he became earl of Kent, and for some years he was a trusted royal minister. At times he acted as viceroy in William's absence; at times he led the royal forces to chastise rebellions. But in 1083 he was suddenly disgraced and imprisoned for having planned a military expedition to Italy. He was accused of desiring to make himself pope; more probably he thought of serving as a papal condottiere against the emperor Henry IV. The Conqueror, when on his deathbed, reluctantly permitted Odo's release (1087). The bishop returned to his earldom and soon organized a rebellion uith the object of handing over England to his eldest nephew, Duke Robert. William Rufus, to the disgust of his supporters, permitted Odo to leave the kingdom after the collapse of this design (1088), and thenceforward Odo was the right-hand man of Robert in Normandy. He took part in the agitation for the first crusade, and started in the duke's company for Palestine, but died on the way, at Palermo (Feb 1097). Little good is recorded of Odo. His vast wealth was gained by extortion and robbery. His ambitions were boundless and his morals lax. But he was a patron of learning and, like most prelates of his age, a great architect. He rebuilt the cathedral of his see, and may perhaps have commissioned the unknown artist of the celebrated Bayeux tapestry.

Odo must be distinguished from three other persons of the same name. Odo or Oda (d. 959), archbishop of Canterbury, was bishop of Ramsbury from 927 to 942, and in 942 succeeded Wulfhelm as archbishop of Canterbury. Odo (d. 1200), abbot of Battle, was a monk of Christ Church, Canterbury, and prior of that house at the time when Thomas Becket was murdered. Odo or Odda (d. 1056), a relative of Edward the Confessor, built the minster at Deerhurst in Gloucestershire. (H. W. C. D.; X.)

ODORIC (c. 1286–1331), Franciscan friar, traveler and a *Beatus* of the Roman church who spent three years in China, was born about 1286 at Villa Nuova, a hamlet near Pordenone in Friuli. At an early age he took the vows of the Franciscan order and entered their house at Udine. Between 1316 and 1318 Friar Odoric was sent to Asia where he stayed until 1329. During these years there was a great extension of missionary activity.

His route to the east lay by Trabzon and Erzurum to Tabriz and Sultaniah. in all of which there were Franciscan houses, thence by Kashan, Yázd, Persepolis and the Shiraz and Baghdad regions to Hormuz on the Persian gulf; at the last, he embarked for India. He landed at Thana near Bombay about 1322. After visiting many parts of India, and possibly Ceylon, he sailed in a junk to Sumatra calling at several ports along the northern coast, to Java, to the coast of Borneo (possibly), to Champa (south Cochin China) and to Canton.

He traveled extensively in China and visited Hangchow (*Cansay*, Khanzai or Quinsai, i e., Kingsze or royal residence), then renowned as the greatest city in the world (he included many details about its splendours in his narrative). Continuing northward, he crossed the Yangtze Kiang, embarked on the Great canal and traveled to Peking (Cambalec). He stayed for three years in Peking, and nas possibly attached to one of the churches founded by Archbishop John of Monte Corvino.

Returning to Europe by way of central Asia, Odoric seems to have journeyed through Tibet, possibly visiting Lhasa. Thereafter, he appears to have traveled to northern Persia, to Millestorte, once famous as the land of the assassins in the Elburz highlands, and thence, probably by way of Tabriz, to Venice. The account of the last stages of his homeward journey is vague and fragmentary. During at least a part of his long journeys Odoric was accompanied by Friar James, an Irishman.

Shortly after his return Odoric entered the Minorite house attached to St. Anthony's at Padua; there in May 1330 he related the story of his travels; his itinerary was taken down in simple Latin by Friar William of Solagna. Several months later while on his way to the papal court at Avignon, Odoric fell ill at Pisa. He was taken to the Franciscan house at Udine where he died on Jan. 14, 1331.

The fame of Odoric's journeys seem to have made a greater impression on the laity of Udine than on his Franciscan brethren. The latter were about to bury him, when the chief magistrate (gastald) of the city interfered and ordered a public funeral. Odoric's body was buried in the presence of the patriarch of Aquileia and other dignitaries. Popular acclamation made him an object of devotion and the municipality erected a shrine for his body. Although his fame had spread far and wide before the middle of the 14th century, he was not formally beatified until 17jj.

Numerous surviving copies of Odoric's narrative (of the original Latin text as well as of versions in French and Italian) show how quickly it became popular. The substance of Sir John Mandeville's supposed travels in India and China were taken without acknowledgment from Odoric.

BIBLIOGRAPHY.—Of the many manuscripts of Odoric's narrative extant, the chief one is in Paris (Bibliothèque Nationale, Mss. Lat. 2584, fol. 118r.–127v., of *c.* 1350); it was first printed at Pcsaro in 1513. The best editions are G. Venni, *Elogio storico alle gesta del Beato Odorico* (1761); *H.* Yule (ed.), *Cathay and the Way Thither,* vol. i, pp. 1–162 and vol. ii, appendix, pp. 1–42 (1866). (E. M. J. C.)

O'DUFFY, EOIN (OWEN) (1892–1944), Irish military leader, was born on Oct. 30, 1892, near Castleblayney, County hfonaghan. Ire. He joined Michael Collins' Irish rebels in 1917, but was captured and imprisoned in Belfast as leader of a rebel division. After release, he rejoined Collins in 1921, became chief of staff (1921–22) and then general officer commanding the Irish Free State forces (1924–25). He was also chief commissioner of the Civic guard (1922–33) but was removed from that post by Eamon de Valera. O'Duffy then joined the opposition, which he helped weld into the United Ireland party with the avowed purpose of fighting communism; he became its president in 1933. During this period. he also headed the Blue Shirts, a fascist offshoot organization of the U.I. party with a one-time boasted membership of 120,000. O'Duffy, however, was a poor politician and the U.I. disintegrated under his leadership. He himself resigned in 1934. To revive his waning prestige, he recruited 1,400 volunteers who joined Francisco Franco's "holy crusade against bolshevism" in Spain in 1936. But the O'Duffy brigade lost heart after a taste of battle and returned home in disgrace after six months in Spain. With this fiasco, O'Duffy lost what was left of his prestige. He died in Dublin on Nov. 30, 1944.

ODUM, HOWARD WASHINGTON (1884–1954), U.S. sociologist best known for his studies of social problems of the south, was born on May 24, 1884, near Bethlehem, Ga. He was educated at Emory university, the University of Mississippi, Clark college (Ph.D., 1909) and Columbia university (Ph.D., 1910). After joining the University of North Carolina in 1920, he pioneered in the development of social science, founding and heading departments of public welfare and sociology, a research institute and the journal *Social Forces.* Odum did his first important work on the social life and folk culture of the Negro, using both sociological and literary materials. In *Rainbow Round My Slzoulder* (1928) he achieved literary artistry. At Pres. Herbert Hoover's request. Odum and William F. Ogburn organized and edited the report *Recent Social Trends* (1933). In *Southern Regions of the United States* (1936) he developed regional analysis and theory as a contribution to the South's reintegration in national life. In public service he sought new standards in race relations, public welfare, higher education, regional planning and penal reform. His major avocation, the breeding of Jersey cattle, brought him a master breeder's award. Odum's last book was *American Sociology* (1953). His system of sociology is best presented in his text, *Understanding Society* (1947). He died on Nov. 8, 1954, in Chapel Hill, N.C. (R. B. V.)

ODYSSEUS, called ULIXES by the Romans and ULYSSES generally since. Homeric hero prominent in western literature and imagination. His characteristics are intelligence. experience and endurance. sometimes seen as low cunning and insensitivity. He was the son of Laertes and Anticleia (or of Sisyphus), the husband of Penelope, the father of Telemachus and a protégé of Athena.

In the *Iliad* Odysseus at the behest of Athena restores Agamemnon's authority and rallies the disaffected Greeks, who are already rushing to their ships (ii, 142–335; for synopses of *Iliad* and *Odyssey* see HOMERIC POEMS). When Agamemnon too has had enough. Odysseus points out that there is nothing for a hero to do but stay and fight (xiv. 85–87). The death of friends also must simply be endured (xix. 220–233). In the end Achilles too realizes that there is no alternative to battle and no recompense for death—his own or Patroklos'. Odysseus' realism is seen at its grimmest in the night raid on the Trojan camp (book x), where he acts as Diomedes' preceptor in stealthy butchery. In sum, Odysseus in the *Iliad* is the effective man of worldly wisdom.

In the *Odyssey* Odysseus is the taker of Troy and even more prominently the man of experience. Here is first mentioned his stratagem of the wooden horse (*see* TROY) and his being judged more worthy than Ajax (*q.v.*) of the arms of Achilles. Not that his unpleasant side is ignored; rather. a virtue is made of it. Odysseus' burglar-grandfather Autolycus gave him the significant name "Odysseus," meaning something like "giver of pain" (xix, 405–409), and Odysseus saved that name from oblivion by living up to it. His first deed on leaving Troy is to sack a city, whereupon he is roughly handled. Yet the alternative to city-sacking, as expressed in the affair of the Lotos-eaters, involves "forgetting one's home." Next, he advances from being "No-man" to announcing himself as "Odysseus"—"giver of pain"—by putting out the Cyclops' eye with a red-hot stake. One of the analogues suggested is that to be born is a Cyclopean adventure—to pass from anonymity to crying one's name in the teeth of a hostile universe. This seems to be a necessity, for when Aeolus suspends nature's contrariness, Odysseus becomes trustful for a moment, and homecoming is lost. The Laestrygones are the cannibal giants whom Odysseus does not defy, and who thereupon destroy his fleet. With Circe it is the show of force that turns her menace to balm. The adventure in the land of the dead suggests the pain that lies at the heart of things, and its value. The dead recognize Odysseus in terms of the pain he connotes, and the speech of Hercules, the most hostile-appearing shade of all, implies that pain, given and suffered, wins immortality itself. Odysseus next safely negotiates the Sirens and their temptation to hear about life rather than experience it. Scylla and Charybdis give the *Odyssey's* choice in its most schematic form: face certain trouble from the monster, or be swallowed by the maelstrom. (The same choice is present at the beginning of the poem: oblivion with Calypso "the Hider" or certain trouble on the sea.) The cattle and sheep of the Sun suggest days and nights—there are 350 of each. To court oblivion by eating them merely to avoid the pain of hunger is like consuming one's days in inactivity to avoid the pain of a life in which to act is to injure and be injured but not to act is not to know and be known. Odysseus, resisting the temptation to oblivion, acts. Good, mild king though he has been, only his willingness to kill his enemies and deceive his friends can put his kingdom to rights and keep his name alive.

The later tradition found this strong stuff. Pindar (*Nemeans,* 7 and 8) thinks Odysseus despicable and his defeat of Ajax a fraud. In Sophocles' *Ajax,* heroic intransigence confronts Odysseus' wisdom, as in the *Iliad;* in *Pltiloctetes* Odysseus and Neoptolemus remind one of Odysseus and Diomedes in book x of the *Iliad.* (Stories making this second pair partners in crime, like the murder of Palamedes (*q.v.*) or the theft of the Palladium (*q.v.*), suggest the same source.) In Euripides' *Hecuba, Troades* and *Iphigenia at Aulis* Odysseus is a ruthless politician; in his satyr play *Cyclops* Odysseus is a burlesqued sophist. Plato gives him credit for intelligence and at the same time condemns his Homeric career by making him at the end of the *Republic* choose an obscure life for his next existence. Odysseus is a villain in the *Aeneid,* as he is in Seneca's adaptations of Euripides. Dante puts Odysseus and Diomedes together in one flame in the *Inferno.* But not all versions of Odysseus were unfavourable. Archilochus, Theognis, the Stoics and Cynics. Cicero and Horace all admired him. So did Racine and Fénelon, followed by Giraudoux. Calderon reformed. Tennyson romanticized and Hauptniann made a madman of him. In Shakespeare's *Troilus and Cressida* he is an enigmatic man of the world. In Joyce's *Ulysses,* as Leopold Bloom. the man of hostility becomes a man of peace. with a name fecund rather than predatory in its connotations.

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OEBEN, JEAN FRANÇOIS (*c.* 1715–1763), influential French cabinetmaker of German ancestry, was born probably between 1715 and 1720. In 1751 lle began to work under Charles Joseph Boulle (son of André Charles Boulle) in the Louvre, Paris; and in 1754 he became "joiner and cabinetmaker to the king." He died in Paris on Jan. 21, 1763.

Oeben's style marks the transition from Louis XV to Louis XVI. His work is characterized by wood marquetry in various colours and by solid, elegant bronze mounts. He also produced furniture with secret compartments and mechanical devices. His masterpiece, now in Versailles, is the *bureau du roi,* a magnificent desk which he began in 1760 and which was finished by J. H. Riesener in 1i69.

See H. Vial, A. Marcel and A. Girodie, *Les Artistes décorateurs du bois,* vol. ii (1922); and F. de Salverte, *Les Ébénistes français du XVZII^e siècle,* new ed. (1953). (S. Gr.)

OECOLAMPADIUS, JOHN (1482–1531), German Reformer. whose real name was Hussgen or Heussgen, was born at Weinsberg, a small town in Wiirttemberg. but then belonging to the Palatinate. He went to school at Weinsberg and Heilbronn, and then, intending to study law, he went to Bologna, but soon returned to Heidelberg to study theology, taking his bachelor's degree in 1503. He became cathedral preacher at Basel in 1515. serving under Christopher von Uttenheim, evangelical bishop of Basel. From the beginning the sermons of Oecolampadius centred in the Atonement, and his first reformatory zeal showed itself in a protest *(De risu paschali,* 1518) against the introduction of humorous stories into Easter sermons. In 1520 he published his *Greek* Grammar. The same year he was asked to become preacher in the high church in Xugsburg. Germany was then ablaze with the questions raised by Luther's theses. and his introduction into this new world, when at first he championed Luther's position especially in his anonymous *Canonici indocti* (1519), seems to have compelled Oecolampadius to severe self-examination. which ended in his entering a monastery fbr a short time. But in Feb. 1522 he made his way to Ebernburg. near Creuznach, where he acted as chaplain to the little group of reformers who settled there under the leadership of Franz von Sickingen.

In Nov. 1522 Oecolampadius returned to Basel as vicar of St. Martin's and (in 1523) reader of Holy Scripture at the university. After more than a year of earnest preaching and four public disputations in which the popular verdict had been given in favour of Oecolampadius and his friends, the authorities of Basel began to see the necessity of some reformation. They began with the convents, and Oecolampadius was able to refrain in public worship on certain festival days from some practices he believed to be superstitious. Basel was slow to accept the Reformation; the news of the Peasants' War and the inroads of Anabaptists prevented progress; but at last, in 1525, it seemed as if the authorities were resolved to listen to schemes for restoring the purity of worship and teaching. In the midst of these hopes and difficulties Oecolampadius married. in the beginning of 1528, Wilibrandis Rosenblatt, the widow of Ludwig Keller. After his death she married Capito, and. when Capito died. Bucer. She died in 1563 In Jan. 1528 Oecolampadius and Zwingli took part in the disputation at Berne which led to the adoption of the new faith in that canton, and in the following year to the discontinuance of the Mass at Basel. The Anabaptists claimed Oecolampadius for their views, but in a disputation with them he dissociated himself from most of their positions. He died on Nov. 24, 1531.

Oecolampadius was not a great theologian, like Luther, Zwingli or Calvin. and yet he was a trusted theological leader. With Zwingli he represented the Swiss views at the unfortunate conference at Marburg. His views on the Eucharist upheld the metaphorical against the literal interpretation of the word "body." but he asserted that believers partook of the sacrament more for the sake of others than for their own, though later he einphasized it as a means of grace for the Christian life. To Luther's doctrine of the ubiquity of Christ's body he opposed that of the presence and activity of the Holy Spirit in the church. He did not minutely analyze. the doctrine of predestination as Luther. Calvin and Zwingli did. contenting himself with the summary "Our Salvation is of God. our perdition of ourselves."

See W Hadorn in Herzog-Hauck's *Realencyklopädie fur prot Rel. u. Kirche.*

OECUMENICAL: *see* Ecumenical *Movement.*

OEDIPUS, the central figure of the Theban saga (Gr *Oidipous,* probably "Swell-foot"). In Homer we are told that he unwittingly killed his father and married his own mother, Epicaste (the Jocasta of later writers). and that she hanged herself when the matter became known. Oedipus continued, though in great tribulation, to reign in Thebes. apparently until his death. *(Odyssey* xi, 271 *et seq., Iliad,* xxiii. 679.) According to the post-Homeric story, Laius, king of Thebes, received an oracle that his son should slay him; therefore: when his wife Jocasta bore a son. he exposed him on Mt. Cithaeron. with a spike driven through his feet. He was saved, however. and was adopted by the childless Polybus. king of Corinth. Reaching manhood, he had occasion to visit Delphi. where he was told that he would slay his father and wed his mother. Departing in great horror. and resolving never to return to Corinth, he met Laius, whom he did not recognize, and killed him in a quarrel. Coming to Thebes. he found the city plagued by the Phix or Sphinx, a winged monster, usually represented with the head of a woman, who asked all passers-by a riddle. killing them if they could not answer. Oedipus solved the riddle, the Sphinx killed herself in disgust, and he was rewarded, according to the promise made by the regent. Creon, son of Menoeceus, with the kingdom and the hand of his sister, the widowed queen. They had two sons, Eteocles and Polynices, and two daughters, Antigone and Ismene. But later. the whole story came to light; Jocasta hanged herself, Oedipus put out his own eyes. and then lived shut up in a room of the palace (ordinary version), or went into exile; ultimately dying at Colonus and becoming a protecting hero of Attica (Athenian version, *see* Sophocles, *Oedipus Coloneus).* His sons proved undutiful and he cursed them. Therefore they quarreled over the kingship. finally agreeing to reign alternately. Eteocles' turn came first; Polynices went into temporary exile, and married Argeia, daughter of Adrastus. king of Argos, whose other daughter. Deiphyle, married Tydeus of Calydon. The latter had gone into exile for homicide; he and Polynices met and quarreled, and Adrastus recognized them, by their dress or their shield-devices, as the lion and boar to whom the gods had bidden him betroth his daughters. At the end of a year, Polynices claimed to rule Thebes in his turn; Eteocles refused, and Xdrastus gathered an army to restore his son-in-law. The chieftains, besides the three already named, were Capaneus, Amphiaraus (*q.v.*), Eteoclus, and Parthenopaeus, son of Atalante. Of these, known as the Seven against Thebes, only Xdrastus returned. Tydeus would have been made immortal for his valour, but Xthena saw him gnaw the head of a slain enemy as he lay dying, and in disgust withheld the intended gift. Amphiaraus was swallowed up in the ground, and in later times was much revered as an oracular hero or god. I'olynices killed Eteocles and was killed by him. Creon then became king; he ordered the bodies of the dead Argives to bc left unburied. but Xntigone secretly buried her brother. Polynices. For this. despite the entreaties of his son. Haemon, to whom she was betrothed. Creon walled her up in a tomb (a form of ordeal; the gods might save her if they approved of her conduct). She hanged herself, Haemon. who had broken into the tomb, killed himself. and so did Creon's wife Eurydice, on hearing the news (so Sophocles; in Euripides, Antigone escaped and lived happily with Haemon, at least for several years; *see* the fragments of his *Antigone* in Nauck). According to an Attic legend, Theseus (*q.v.*) attacked Thehes at the prayer of the mothers of the slain. and forced the Thebans to bury them; Creon was killed by Theseus in the battle. Another story represents him as surviving for many years, to be ultimately killed by the usurper Lycus (so Euripides. *Herc. Fur.,* 33). Oedipus died before, or soon after, the war's end.

Adrastus bided his time, and when the sons of the Seven (known as the Epigoni, or second generation, hence the application of the word to successors of the Diadochi [*q.v.*], the immediate successors of Alexander the Great) came to manhood. he once more attacked the city. On the advice of Teiresias (*q.v.*) the Thebans evacuated by night. Adrastus led his army back. but died on the way, at Megara, from grief at the death of his son Aigialeus, only one of the Epigoni to fall in the campaign.

There is no reason to doubt that this legend has a historical basis, probably in the events of Minoan-Mycenaean times. Gems from

Thisbe show incidents strongly resembling the fight between Oedipus and Laius, and the former's encounter with the Sphinx. Several incidents, such as the prophecies and the incestuous marriage, are patently folk tales.

Medieval Legends.—In the *Golden Legend* of Jacobus de Voragine (13th century) and the *Mystère de la Passion* of Jean Michel (15th century) and Arnoul Gréban (15th century), the story of Oedipus is associated with the name of Judas. The main idea is the same as in the classical account. The Judas legend, however, never really became popular, whereas that of Oedipus was handed down both orally and in written national tales (Albanian, Finnish, Cypriote). The Theban legend, which reached its fullest development in the *Thebaïs* of Statius and in Seneca, reappeared in the *Roman de Thèbes* (the work of an unknown imitator of Benoît de Sainte-More). Oedipus is also the subject of an anonymous medieval romance (15th century), *Le Roman d'Oedipus, fils de Layus,* in which the Sphinx is depicted as a cunning and ferocious giant. The Oedipus legend was handed down to the period of the Renaissance by the *Roman* and its imitations, which then fell into oblivion. The legend has survived among the modern Greeks, without any traces of the influence of Christianity (B. Schmidt, *Griechische Märchen,* 1877). The works of the ancient tragedians (especially Seneca, in preference to the Greek) came into vogue, and were followed by modern imitators down to the 17th century.

See L. Constans. *La Le'gende d'Oedipe dans l'antiquité, nu moyen âge, et dans les temps modernes (1881)*; D. Comparetti's *Edipo* and Sir Richard Jehb's introduction to his edition of Sophocles, *Oedipus Tyrannus.* (H. J. R.)

OENGUS, SAINT (OENGUS MAC OENGOBANN, called THE CULDEE) (fl. 8th/9th century). an Irish monk associated with a movement that aimed at the reform of Irish monasticism and author of the *Félire.* The reformed monks called themselves "Fellows of God" (*Céli dk,* anglicized "Culdees"). What littlé is known about Oengus personally derives mainly from an Irish poem that is found in one manuscript of his *Félire.* He was a monk at Clonenagh in Leix, then became a pupil of Máel-Rúan of Tallaght near Dublin, who was prominent among the monastic reformers. Later Oengus founded his own church, Disert-Oengusa in Leix. His feast day is March 11.

About the year 800 he composed in Irish his *Félire* (calendar) in 365 quatrains (one for each day of the year) with a prologue and epilogue. Under each day are listed the names of Irish and foreign saints, each with a conventional epithet or. occasionally, with some historical or legendary detail. The recitation of this and similar verse "calendars" both in Irish and in Latin was probably a form of devotion to all the saints, which seems to have held an important place in the liturgy of the early Irish church.

The Middle Irish *Saltair na Rann,* a versification of biblical history, was written by a later Oengus Céle DC.

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OENOMAÜS in Greek legend, son of Ares and Harpinna, king of Pisa in Elis and father of Hippodamia. It was predicted that he should be slain by his daughter's husband. His father gave him winged horses and Oenomaiis promised his daughter to the man who could carry her off in a chariot; he himself was to drive after. and spear the suitor if he could catch him. This may be founded on some marriage rite of simulated capture. Thirteen aspirants having thus perished. Pelops (*q.v.*) arrived. and won. having winged horses which Poseidon had given him. He is usually said to have bribed Oenomaus' charioteer Myrtilus to take out his master's linchpins and substitute wax dummies; Oenomaiis was thus thrown and killed.

OENONE, in Greek legend. daughter of the river god Cebren and wife of Paris, who deserted her to kidnap Helen (*q.v.*). Just before the capture of the city. Paris. wounded by Philoctetes. sought the aid of Oenone. who had told him that she alone could heal him if wounded. She refused to help him. and Paris returned to Troy and died of his wound. Oenone soon repented and hastened after him, but finding that she was too late to save him slew herself from grief at the sight of his dead body.

OENOTHERA, the generic name of the evening primrose and sundrops. several species of which are favourite garden plants. The genus. comprising numerous species, is confined to America and belongs to the family Onagraceae. The common evening primrose (*O. biennis*) is often a troublesome weed both in North America and Europe; the form known as var. *grandiflora* or *0. lamarckianu* is a showy plant, sometimes cultivated for its flowers. Other species grown in gardens are *0. missouriensis* and *O. speciosa,* the latter with white flowers. grading to pink. The evening primrose acquired importance in connection with Hugo De Vries' theory of mutations. *See* PRIMROSE.

OERSTED (ØRSTED), **HANS CHRISTIAN** (1777–1851), Danish physicist and chemist, the discoverer of electromagnetism. was born Aug. 14, 1777 in Rudköbing. He was graduated as a pharmacist from the University of Copenhagen in 1797, received gold medals for essays in aesthetics and medicine, and obtained the Ph.D. degree in 1799 for a dissertation on Kant's philosophy. After extensive foreign travel and lecturing. he became professor at the University of Copenhagen in 1806. In 1829 he founded the Danish Engineering college and became its president.

Oersted's first physical researches dealt with galvanism and acoustics. For nearly 30 years he investigated the cornpressibilities of liquids and gases. His most important contributions to chemistry were the preparation of metallic aluminum (1825) and the discovery of piperidine (1820). Influenced by a philosophical belief in the unity of the forces of nature, he made many attempts to show that chemical and magnetic forces. and light, are caused by electricity. During an evening lecture in April 1820 he discovered that a magnetic needle is deflected by an electric current (*see* INSTRUMENTS. ELECTRICAL MEASURING). The fundamental importance of this discovery was at once recognized, and he was honoured as one of the great physicists of the age.

Oersted was an inspiring teacher and lecturer and wrote numerous popular articles. In 1824 he founded a society devoted to the spreading of scientific knowledge among the general public. Since 1908 this society has awarded an Oersted medal for outstanding contributions by Danish physical scientists. In 1937 the American Association of Physics Teachers established an Oersted medal awarded to eminent physics teachers. In 1934 the name "oersted" was adopted for the unit of magnetic field strength.

See essays by Kirstine Meyer in *H. C. Oersted: Scientific Papers* (1920). (J. R. Ns.)

OERTEL, HANNS (1868–1952), German linguist known especially for his contributions to Sanskrit syntax, was born in Geithain, Saxony, on April 20, 1868. Educated in the United States (W.D., Yale, 1891), he taught successively at Yale, Basel, Marburg and Munich. He wrote on Vedic literature, on general linguistic problems and particularly on Sanskrit syntax, and for many years was one of the editors of the *Zeitschrift fur vergleichende Sprachforschung.*

In his *Syntax of Cases in the Narrative and Descriptive Prose of the Brahmanas* (1926) Oertel followed the lead of Berthold Delbrück (*q.v.*), but his plans for further work in that direction were brought to an end by the destruction during World War II of his house, library and carefully catalogued references. His *Lectures on the Study of Language* (1901), although interesting, is considered outmoded. Oertel died in Munich on Feb. 7, 1952. (MY. F.)

OETA (mod. Katavothra), a mountain in Greece, 7,060 ft. high, to the S. of Thessaly (Thessalia), between the valleys of the Spercheius and the Boeotian Cephissus. Its east end. Callidromus, overhangs the sea at the famous pass of Thermopylae (*q.v.*). There was also a high pass W. of Callidromus into the upper Cephissus. In mythology Oeta is the scene of the death of Heracles.

OFFA (757–796), king of Mercia, is the central figure in English history in the second half of the 8th century. A civil war gave him the Mercian kingdom in succession to his cousin Aethelbald (716–757) who in his later years had been overlord of all the English peoples south of the Humber. The first part of Offa's reign was spent in the re-establishment of the Mercian supremacy. He was strongly resisted in several of the smaller kingdoms, notably Kent, but he succeeded in creating what was in effect a single state covering the whole country between the Humber and the channel. He treated the lesser kings of this country as his subjects, exacting their formal submission, insisting that their grants of land to their own retainers or to churches needed his consent, confirming their charters and requiring them to attend his court. He married one of his daughters to Beorhtric, king oi Wessex (789), and another to Aethelred, king of Northumbria (792), thereby extending his direct influence beyond the Humber. His reign marks by iar the greatest advance hitherto made toward the political unification of England.

His position was recognized on the continent. His younger contemporary Charlemagne, king of the Franks, regarded him as the outstanding English ruler of his time. Their relations mere oiten uneasy and a personal dispute led to a suspension oi cross-channel traffic shortly before 790. Its renewal was followed by a commercial treaty (796) which shows Charlemagne and Offa dealing with each other on equal terms. The closeness of their previous association is illustrated by a rumour current at Rome to the effect that Gffa had proposed to Charlemagne the deposition of Pope Adrian I and the election of a Frankish churchman in his place. The pope himseli disbelieved the story, but its circulation proves at least the reality of Offa's fame.

Offa, in fact, was on terms with Pope Adrian which enabled him to carry through a remarkable, if temporary, change in the organization of the English church. The archbishop oi Canterbury, whose authority covered the whole of southern England, had his seat in the kingdom where Offa's political domination was most strongly resented. To free the churches oi his own country from the control of an archbishop belonging to an uniriendly province. Offa induced Pope Adrian to send the pallium which mas the symbol oi metropolitan authority to Hygebeorht, bishop of Lichfield. It was certainly with Offa's good will, and probably at his request. that in 786 the pope sent two legates to England, who secured the acceptance oi a program of reform by the clergy and nobility of both the northern and southern provinces.

It is probable that Offa used this unprecedented mission as a means of acquainting the Roman court with his design of creating an archbishopric of Lichfield. He may well have taken the same opportunity of securing the papal approval ior the consecration of Egirith, his son, as king of the Mercians which took place in 787 and is the first recorded ceremony of the kind in English history.

There still survives a memorial oi Offa's effective power in southern England in the remains of the great earthwork knomn as Offa's dike which he caused to be drawn between his own kingdom and the Welsh tribes beyond his border. It was the object oi the dike to draw a boundary line between English and Welsh settlements from the estuary of the Dee in the north to that of the Wye in the south. The line is not now continuous, partly because it has been worn down in the course oi 12 centuries, but also because in forest country such as the Herefordshire plain the iorest itself was regarded as a sufficient barrier. But on open ground and in the high places of the mountain zone its remains are most impressive. Its line is always drawn so as to command the country to the west and the trackways leading from Welsh into English territory. Throughout its course it shows the activity of a directing mind.

The most permanent achievement of Offa's reign was the establishment of a new form of currency composed of silver pennies bearing the king's namc and title and also the name oi the moneyer responsible for their quality. They are remarkable for a delicacy of execution and a refinement of portraiture which set the best examples apart from all, other coins in the Old English series. Amid infinite varieties of design, the principles governing Offa's coinage were maintained by later kings, and until recent times there has never been any break in the continuity of the English currency since his day. His own attitude toward the currency as an advertisement of the royal dignity is shown by the issue oi coins closely resembling his own in type, but bearing the name and portrait oi Cynethryth his queen.

No contemporary account of Offa has survived, and the history of his reign is a collection of iragmentary reierences. The laws which he is known to have issued have long disappeared. There are no adequate materials for a picture oi his character. He was a patron of learning and a notable benefactor to many churches, but his rule was arbitrary and he was ruthless to all who opposed him. What can be said is that he left a deeper impression on English history than any other king before Alfred.

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OFFA, the most famous hero of the early Angli. He is said by the Anglo-Saxon poem *Widsith* to have ruled over Angel, and the poem refers briefly to his victorious single combat, a story which is related at length by the Danish historians Saxo and Svend Aagesen. Offa (Uffo) is said to have been dumb or silent during his early years, and to have only recovered his speech when his aged father Wermund was threatened by the Saxons, who insolently demanded the cession of his kingdom. Offa undertook to fight against both the Saxon king's son and a chosen champion at once. The combat took place at Rendsburg on an island in the Eider, and Offa succeeded in killing both his opponents. According to *Widsith* Offa's opponents belonged to a tribe or dynasty called Myrgingas, but both accounts state that he won a great kingdom as the result of his victory. A somewhat corrupt version of the same story is preserved in the *Vitae duorum Offarum*, where, however, the scene is transferred to England. It is very probable that the Offa whose marriage with a lady of murderous disposition is mentioned in Beowulf is the same person; and this story also appears in the *Vitae duorum Offarum*, though it is erroneously told of a later Offa, the iamous king of Mercia. Offa of Mercia, however, was a descendant in the 12th generation oi Offa, king of Angel. It is probable from this and other considerations that the early Offa lived in the latter part of the 4th century.

See H. M Chadmick, *Origin of the English Nation* (1907), where references to the original authorities will be iound.

OFFALY, a county of Ireland, in the province of Leinster, bounded north by Meath and Westmeath; west by Roscommon and Galway (the boundary being the Shannon) and Tipperary; south by Tipperary and Laoighis county, and east by Kildare. The land area of the county is 771 sq.mi. Pop. (1956) 51,970. The relief in general is rather monotonous. the greater part of the county lying at a level seldom exceeding 200 ft. Along the Laoighis border the ground rises to the Slieve Bloom mountains (highest point, 1,734 ft.). These mountains are formed mainly of Old Red Sandstone rocks with a core of Silurian beds. They are lapped around dry Carboniferous Limestone on which has developed a peneplain at about 200 ft. Occasional low rolling hills rise above the general level. The effects of glaciation are seen everywhere, mainly in the cover of boulder clay which has resulted in the development of many large bogs. especially toward the Shannon. Numerous eskers occur: showing as ridges and embankments of stratified sand and gravel. These have always formed routes avoiding the boglands. The county shares in the advantage of the navigation of the Shannon, which skirts its western side. The Brosna, which issues from Loch Ennell in Westmeath. enters the county near the town of Clara, and joins the Shannon after receiving the Clodiagh and the Silver. A small portion of the northeastern extremity is skirted by the upper Boyne. The Barrow forms the southeastern boundary with Laoighis. The Little Brosna. which rises in the Slieve Bloom mountains, forms the boundary of Offaly county with Tipperary and flows into the Shannon.

Offaly county, with portions of Tipperary, Laoighis and Kildare, at an early period formed one kingdom under the name oi Offaly, a title which it retained after the landing of the English. Subsequently it was knomn as Glenmallery, Western Glenmallery corresponding closely to the present Offaly county and Eastern Glenmallery to Laoighis county. These two divisions were iormed into shires in 1556, being then known as King's county and Queen's county respectively.

There are many raths, and a chain of moats commanding the passes of the bogs extended throughout the county. On the borders of Tipperary is an ancient causeway leading presumably to a crannog or lake dwelling. The most important ecclesiastical ruins are those of the seven churches of Clonmacnoise (*q.v.*) on the Shannon in the northwest, where an abbey was founded by St. Kieran in j48 and where the remains include those of churches, two round towers, crosses, inscribed stones and a castle. Other famous religious houses were Durrow abbey, iounded by St. Columba about 550; Monasteroris founded in the 14th century by John de Bermingham, earl of Louth; and Seirkieran abbey, founded in the beginning oi the jth century. The principal old castles are Leap castle, an ancient O'Carroll stronghold near Seirkieran; and Birr. The market town of Banaghcr commands the crossing of the Shannon and there Anthony Trollope wrote his first novels.

The whole of the county appears to have been covered formerly by a vast forest, and the district bordering on Tipperary is still richly wooded. The soil is generally either a deep bog or a shallow gravelly loam. On the borders of the Slieve Bloom mountains there are rich pastures, and there are also extensive sheep-grazing districts on the borders oi Westmeath. Along the banks of the Shannon there is good meadowland. With the exception of the tract occupied by the Bog oi Allen, in the northeast, where a great deal of peat is dug, the county is nearly all under cultivation. Oats. barley and rye, potatoes and turnips are all considerably grown. Cattle, sheep. pigs and poultry are widely bred; dairies are numerous in the north of the county, and sheep are pastured chiefly in the hilly districts.

Small but vigorous industries exist in several oi the towns—the woollen and worsted yarn factory in Tullamore and a thriving jute factory in Clara. Considerable development of the boglands has taken place, especially around Ferbane in the west and Clonsast in the east, the peat being used mainly as fuel ior large power generating plants in their vicinity.

The county is traversed southeast to northwest by the Coreas Iompair Eireann (C.I.E.) railway. The Grand canal runs irom east to west, entering the Shannon at Shannon harbour.

The administrative counties of Laoighis and Offaly together return five members to Dail Eireann. The county town is Tullamore (pop., 1951, 6,165).

OFFENBACH, JACQUES (1819–1880), French composer of *opéra bouffe,* was born at Cologne, of German-Jewish parents, on June 20, 1819. In 1833 he was sent to Paris to study the violoncello at the Conservatoire. As a member of the orchestra of the Opera-Comique he turned his opportunities to good account and eventually was made conductor at the Théâtre Français. His first complete work. *Pepito* (1853), was followed by a crowd of light dramatic pieces which effected a complete revolution in the popular taste of the period. Offenbach obtained a lease of the Théâtre Comte in the Passage Choisrul, reopened it in 1855 under the title of Les Bouffes Parisiens and produced a succession of brilliant, humorous trifles. Among many other librettists Ludovic Halévy was associated with him irom the first, but still more after 1860, when Halévy obtained Henri Meilhac's collaboration. The series culminated in 1867 with La *Crande Duchesse de Gérolstein,* perhaps the most popular *opéra bouffe* ever written, not excepting even his *Orphée aux enfers,* produced in 1858 and reiasbioned in 1874, and *La Belle Hélène* of 1864. In 25 years Offenbach produced more than, 100 complete dramatic works, including two ballets. Offenbach died at Paris on Oct. 4, 1880. *Mamzelle Moucheron* mas produced posthumously in 1881. *Les Contes d'Hoffmann,* his only opera as distinct from operettas and other light pieces, became the most popular of all his works. He left it unfinished, and it was completed and orchestrated by Ernest Guiraud.

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OFFENBACH, a town of Germany. in the *Lund* of Hesse, on the left bank of the Main. j mi. E.S.E. of Frankfurt-on-Main, with which it is connected by the railway to Bebra and by a local electric line. Pop. (1950) 89.030. The earliest mention of Offenbach is in a document of 970. In 1486 it came into the possession of the counts of Isenburg, and in 1816, when their lands were mediatized. it was assigned to Hesse. French Protestant refugees settled there at the end of the 17th and the beginning of the 18th century and brought prosperity which increased with the accession of Hesse to the German Zollverein in 1828. The most interesting building in the town is the Renaissance chbteau of the counts of Isenburg.

Offenbach is the principal industrial town of the *Land,* and manufactures include chemicals, boilers! machines, wire goods and celluloid. Its characteristic industry, however, is the manufacture of fancy goods in leather.

OFFENBURG, a town of Germany, in Württemberg-Baden, 27 mi. by rail S.W. of Baden, on the Kinzig river. Pop. (1939) 20,521. Offenburg is first mentioned about 1100. In 1223 it became a town; in 1248 it passed to the bishop of Strassburg; and in 1289 it became an imperial free city. Soon this position was lost, but it was regained about the middle of the 16th century, and Offenburg remained a free city until 1802, when it became part of Baden.

The chief industries are dyeing and the making of cotton, linen, silk, cement, machinery, cigars and glass.

OFFICE MACHINES AND APPLIANCES. For a variety of reasons the mork load of the modern business office increased in striking fashion during the 20th century. Much of this work is repetitive and routine, and development and use of office machinery has been the natural result.

The decision to shift irom manual to machine operation is, of course! determined by a comparison of costs incurred with costs saved. Specifically, the following items are important in assessing the desirability of mechanizing office tasks:

1. The desirability of saving labour. This is basically a matter of determining estimated savings in office direct labour charges over the life of the equipment, and comparing these savings with estimated machine costs.

2. The desirability of saving time. Time saved in office routine may greatly improve operations elsewhere in the enterprise. On the other hand no advantage may derive from time saving. The latter is usually true where the volume of work in the office is so small that the machine under consideration is likely to stand idle most of the time.

3. The importance of accuracy. Although accuracy is always desirable the consequences of error, in terms of cost, vary considerably in different situations.

4. The effects upon personnel. Mechanization involves important changes in job requirements. Training and morale problems must also be anticipated. Difficulties in this area may create an unfavourable cost situation which will nullify the savings discussed under 1.

The major office machines in current use are described below. They are classified according to the relationships of the operations that they most commonly perform.

Writing and Reproducing Machines.—The majority of office machines fall into this category, and the bulk of the office work load is handled by them. Thousands of accessories are available to permit performance of various detail operations.

The typewriter, most common of office machines, produces text material on a page in type similar to printer's type. On the manual typewriter this is accomplished mechanically when the operator strikes keys arranged on a keyboard. Type bars, containing raised characters and actuated by the keys, strike the page. Printing is accomplished by the automatic interposition of an inked ribbon between the type bar and the page. The page is held in position against a movable cylindrical rubber roll or platen. The platen, in turn, is mounted in a carriage which travels transversely. This arrangement permits vertical and horizontal spacing.

Electric typewriters use electrical power to multiply the energy of the operator's touch. Noiseless typewriters utilize a special type-bar to reduce the noise of the impact of the type bar upon the page. Correspondence type riters employ a specific type face, letterspacing and line spacing. Special-purpose typewriters utilize a variety of special attachments to achieve variation in type face and spacing. The Van-Typer, in appearance and operation a typewriter, is actually an office type-composing machine permitting production of copy in any of hundreds of type faces. Completely flexible letterspacing produces copy on this machine closely resembling typeset material. Automatic typewriters are power-driven machines which operate from a "player piano" type roll which has been cut on a standard typewriter. These machines are used for mass production of material with a hand-typed appearance. Special inserts can be made manually at predetermined points in the copy.

The typewriter when used in conjunction with a computing machine functions as a bookkeeping machine. This type is best considered as a variety of accounting machine, discussed below.

Dictating and transcribing machines provide for storage, and later reproduction, of spoken messages. Dictating machines, by a combination of electronic and mechanical means, record the voice on a variety of mediums, including wax cylinders, plastic disks, wire and coated tape. These materials can be removed from the machine after dictation and transported (even by mail) to the point of transcription. The transcribing machine, in a manner similar to the dictating machine, reproduces the voice. By use of these machines stenographic transcription tasks can be fitted into the working time of both the executive and the stenographer in much better fashion than when dictation is taken directly by the stenographer.

A large variety of duplicating machines has been developed. Regardless of variation in process, all of these machines utilize a master copy prepared manually, from which duplicate copies are made by the machine. Before describing these specific processes, note should be made of the fact that the use of carbon paper inserts makes the typewriter into a duplicating machine Used extensively when a small number of copies is desired, this process has a practical limit of about 12 copies on the manual and about 18 copies on the electric typenriter.

The stencil method of duplicating employs a coated fibre sheet (the stencil). Use of a typewriter (without ribbon) or a hand stylus places the copy on the stencil by simply pushing aside the coating and exposing the fibre base where contact is made with the stencil. The exposed portion will transmit ink. The stencil is fastened to the outer surface of a hollow rotating cylinder. The padded interior surface of the cylinder is saturated with ink. The ink flows to the stencil through the pad as the cylinder rotates. Simultaneously sheets of paper are passed under the cylinder and applied to the stencil under light pressure. Up to 5,000 copies can be made in this fashion from a single stencil. Stencils can be stored for reuse for considerable periods of time.

The hectographic method of duplicating uses a paper master sheet. In the liquid process the master is prepared with a special carbon paper behind it. This results in a reversed carbon image. The master sheet is then fastened to a rotating drum. Copy sheets, slightly moistened by a special liquid, are applied in the same fashion as for the stencil method. A minute amount of the carbon is thus transferred to the copy sheet.

The gelatin process requires the use of a special master paper upon which the copy is typed or written. This sheet is then pressed, face down, against a prepared moist gelatin surface and the image is transferred to the gelatin in reverse form. Copy sheets pressed against this gelatin receive an image impression. The impression process can be accomplished on a machine similar to that used in the stencil method. The practical limit on hectographic copies is about 300. It is possible to preserve the master copy in the liquid process only.

Offset processes of duplicating require chemical fixing of copy on a metal sheet or, in more recent developments, preparation of a paperlike master copy. This master impression is inked and brought against an intermediate composition agent (usually rubber) to which the image is transferred. The image is immediately transferred to a copy sheet. This operation is performed by a power-driven machine. Many thousands of copies can be produced and masters can be stored for indefinite periods.

Rased-image duplicating processes use a variety of techniques for producing a master form on which the text stands in relief. Typesetting machines closely resemble those used in the printer's office. Another machine, commonly used for production of form letters or for addressing envelopes, uses a soft metal strip or plate upon which the text is embossed. When used for addressing. the machine feeds the plates into place in rapid succession. This machine has also been adapted to pay-roll printing work.

A group of various photographic processes have been devised for producing copies of drawings or written material. The contact processes operate without use of a camera or lens. The most commonly used processes in this category are blueprint and dye line. In the first process the master (typed, drawn or printed upon a translucent paper or cloth sheet) is placed upon sensitized paper and exposed to light. The paper is then developed by wetting in a chemical solution and washing in clear water. Dye line operates in similar fashion, but avoids washing in clear water. A dry-line process uses ammonia fumes rather than liquid to develop the image and thus obviates problems of paper shrinkage. In both blueprint and dye line. machines have been developed which perform all operations automatically.

In contrast with the contact processes are the camera processes, wherein cameras are used to "take pictures" of the material to be reproduced. In most processes a negative results from which positive copies in various sizes may be produced.

A modern development is the microfilm camera which produces negative images on film. This process is invaluable in saving space when storing documents of all sorts. The film may be studied through a viewer or used to make reproductions of the original copy.

A host of specialized reproducing machines exist. The most widely used are cheque-writing machines which print names on cheques so that they cannot be altered; and cheque-signing machines. Numbering dating. receipting machines are small devices manually operated, the names of which are largely self-descriptive. The mdchines, which use rubber or metal type form, are preset to produce correct impressions.

Computing **and** Accounting Machines.—These machines, widely varied in form, handle the arithmetical tasks common to most offices. They are frequently combined with certain other writing and reproducing machines mentioned and, in such form, produce a high volume of work with a minimum of error.

Adding and subtracting machines perform the arithmetical operations indicated by the name. Some varieties list figures on a paper tape; some do not. Keys on the machine are depressed in proper order to set the mechanism in operation. Key-driven machines operate the mechanism directly upon pressing the keys. Crank-driven machines need the additional operation of pulling a lever. In many cases electric motors, actuated by depressing a bar, perform the bulk of the work of operation. Full keyboard machines provide a column of ten keys for each digit position. Ten-key machines have only ten keys with digit position being shifted to the left successively with each depression of a key. This latter type keyboard is especially useful when large numbers are involved

Registering machines are listing-type adding machines designed for special tasks. Cash registers simultaneously record cash transactions on a tape, produce printed slips and operate cash drawers. These machines keep running totals of the transactions, classified into a number of categories. Calculating machines are designed to perform multiplication and division operations. They are also used for addition and subtraction. Commonly electrically powered, these machines may be of a printing (listing) or non-printing type. Keyboards, again, may be either full or ten-key type.

Sote should be taken here of the development of electronic-mechanical calculators capable of performing extremely complex computations. These are beyond reach of the typical office because of cost and the high skill required of operators. The services of these machines are available in some areas on a fee basis.

Accounting machines (or bookkeeping machines) are complex machines combining features of the computing machines already described with some provision for writing. These machines take over much of the labour of bookkeeping. Billing machines, for example, are designed to write (with the built-in typewriter) name, address and description, to multiply and extend, to figure discounts and to add net total.

Accounting machines typically post to several accounts simultaneously and frequently accumulate in the manner of cash registers to permit summarizing and distributing accounts. The window-posting accounting machine is in common use in banks, hotels and retail stores. Customer statements or books are inserted into the machine. The transaction is printed on these forms as well as on an audit sheet. After automatically calculating new balances the machine prints these balances on the forms described.

Classifying and Selecting Machines.—These machines are characterized by use of cards upon which coded data is recorded; their function is to facilitate sorting and tabulation of numerous diverse data. A common use in the office is preparation and presentation of accounting data.

The simplest card systems function by notching the perforated perimeter of the card according to some code. These systems are limited to performance of sorting tasks. They are operated by a simple machine or device (frequently merely a metal rod) which is inserted in a specific perimeter location of a stack of cards. It will thus penetrate both notched and unnotched holes.. When the rod is lifted those cards with notched holes will fall out.

The punched-card system uses a card which can be punched throughout its area. Data is punched into these cards according to a specific code. When the cards are passed through any of various machines the punched holes cause transmission, by mechanical or electrical means, of impulses to other functioning parts of the machines. Basic machines are the punching machine which punches data into the cards, the sorting machine, which sorts out cards according to various classifications, and the tabulating machine which prepares printed reports from the sorted cards.

The punched-card system is extremely flexible and permits sorting and tabulation of an immense number of items. In addition to accounting uses, the system is very useful in market research work, production planning, materials ordering, etc.

Coin-Handling Machines. — In some offices large quantities of coins must be handled. To facilitate this job a variety of machines have been developed to sort, count, wrap or dispense coins.

Sorting is accomplished by the simple process of "sifting" the various size coins. Trip counters count the coins. Wrapping machines wrap a standard number of coins in a standard paper wrapper. The coin-dispensing machine releases a specific sum in coin, upon depression of the appropriate key on a keyboard similar to that of an adding machine. The coins are stacked in the machine in trays.

Mail-Handling Machines. — These are designed to expedite handling of large quantities of incoming and outgoing mail. The bulk of the work occurs in handling outgoing mail and most machines, consequently, are designed to aid in the mailing task.

Folding machines, inserting machines and envelope sealers. with self-explanatory titles, perform the tasks of placing letters in envelopes. Stamp-affixing machines mechanically separate stamps from a roll, moisten them and apply them to envelopes. Postage meters print stamp charges directly on a dry or moistened adhesive strip. The machines are set by postal employees to yield a number of impressions according to the amount of deposit paid.

Intercommunicating Systems. — The modern office is frequently of such size that efficient communication becomes a key item in maintaining the flow of work. Equipment described in this section is utilized to speed and improve communication between specific posts (desks, counters, etc.) or persons in the office; it includes, of course. the public telephone system.

Paging systems are used in conjunction with the telephone system for locating persons not accessible at their usual posts. One such system involves dialling of a special number (a portion of which is specific to the individual being sought), whereupon a special audible signal is sounded. The person being paged may, upon hearing the signal, pick up any telephone, dial another special number and be connected with his caller. Other paging systems use the amplified human voice to request an individual to call a given number.

Two-way voice systems operate on the telephone principle. In a commonly used version, the individual may call any one or any combination of a limited number of stations by depressing appropriate keys on the receiver-transmitter box. When he speaks into the box his voice, amplified electrically, is broadcast from similar boxes at the various stations. Others may then reply in similar fashion from their stations.

Telewriting and teletype systems provide written or typed communications between two or more points. Messages are received and recorded even though no person is in attendance at the receiving machine. These systems are especially valuable for rapid intercommunication among a number of widely separated offices. Teletype systems, for example, frequently span the entire country.

Conveying systems are available for very rapid transmission of small materials. Pneumatic tubes are frequently used in retail department stores for movement of sales tickets. cash, etc.

Paper Processing Machines. — To aid in changing the form or size of large quantities of paper, paper cutters, paper punches, binding equipment and folding equipment are available in a nide range of sizes. The names are nearly self-explanatory.

Document destroying equipment disposes of outdated paper documents by shredding or chopping. Collating equipment provides mechanical aid in assembling pages of printed matter in a specific order. As is frequently the case with office machines, the equipment designed for high-volume output is motorized, while smaller models are manually operated.

Time-Recording Machines. — Machines in this category combine a clock mechanism uith a recording device. The objective is to provide a quick, correct recording of the time of occurrence of certain routine events.

Time stamping machines are manually actuated machines which stamp the correct time (at stamping) upon letters. documents etc., which are inserted in the machine. Time-recording clocks record the times of arrival and departure of employees from the office (or other workplace.) This is accomplished by the employee's inserting a special card into the machine at the time he arrives, and again upon departure. Job recording clocks function in identical fashion to record time of beginning and finishing particular tasks.

(W. H. Le.; H. E. Wp.)

OFFICE MANAGEMENT. The office is that part of an enterprise which is devoted to the direction and co-ordination of the various activities of the enterprise. It is characterized by the gathering, classification and preservation of data of all sorts; the making, using and preservation of all kinds of records; the analysis and utilization of these data in planning, executing and determining the results of operation; the preparation, issuing and preservation of instructions and orders and the composition, copying and filing of written messages.

Though clerks and clerical work have existed for centuries and large groups of clerks for decades, it is only in recent years that the management of clerks or office management, has become a problem of importance. This is wholly due to the rapidity of industrial change, which is best shown in the United States. In 1880, when there were but 172,575 clerks in that country, mostly bookkeepers and accountants. the problem might be considered as practically non-existent; but in 1920, when the number of clerical workers of all kinds had grown to 2,951,008, it assumed proportions that could not be ignored. In 1920, one in ten of all persons engaged in "gainful occupations" was a clerical worker. The change was necessitated by the exigencies of an ever-growing large-scale industry. While business organizations were small, and direct contact existed between producer and consumer, beyond simple bookkeeping few records were required, there was little written communication between sections of an organization, and consequently few clerks were needed. All this has changed, and to-day the office has attained a position of major importance in business.

Many offices employ more than 100 clerks each and a considerable number employ several thousands. Evidently the employment of such numbers of workers requires management of a high order, yet it is only recently and among the most progressive companies that the subject has received the attention it deserves. Ingenious systems of record keeping and filing have been invented. scores of clever appliances and marvellous office machines are available (see Office Machines and Appliances), but the problem of securing the greatest result for the least expenditure of effort has not been given the attention in the office that it has in other lines of endeavour. This is due to the newness of the problem, but there are signs that this condition is sure to change as time passes.

Frederick Winslow Taylor (*q.v.*), the "father of scientific management," was himself probably the first person to apply — at least in a limited measure — scientific principles to office work. In Copley's biography of Taylor is shown a "Time Note," dated about 1885. giving "piece-work" rates on 17 clerical operations, the implication being that Taylor had at least studied these operations, found the best method of performing them and controlled them to the extent that he offered an incentive wage for their accomplishment.

THE HUMAN ELEMENT

The major divisions of office work are given herewith, but not necessarily in the order of their importance.

Organization. — The most essential factor here is clearly defined lines of authority. and its lack is the greatest defect to be found in many companies. In the struggle for advancement it seems difficult to prevent officers from claiming more authority than is granted them, and where confusion of this kind exists, loss of morale invariably results. Functionalization — one of the leading principles of scientific management — is as efficacious in the office as elsewhere. The office manager himself holds a functional position — that of managing clerks, wherever placed. Where this principle is fully carried out. work, instead of being departmentalized. will be functionalized, and therefore performed much more effectively. Thus. a stenographer employed exclusively in taking notes and transcribing letters, will do much more effective work than one who also keeps and files records, answers telephone calls and performs other miscellaneous work. Functionalization, however, is to its fullest extent only feasible in large offices. It is uneconomical to have too many departments under the charge of one officer. A chart of the organization, and an organization diagram, both giving not only the position of each individual in the office but his duties and relation to others, are necessities. Also there should be standard methods for performing each task, and written standard practice instructions so that the carefully devised methods may be perpetuated. Otherwise great loss of output will result.

Personnel Methods.—Progressive records of each employee's performance are necessary as they serve as a basis for future advancement. Special tests for ascertaining the ability of new employees will prevent to a large extent the great wastage of continuous hiring and discharging. Many psychological tests, special ability and trade tests have been prepared, extensively used and found advantageous. (See PSYCHOLOGICAL TESTS AND MEASUREMENTS.) While there are many clerical positions which demand the very highest intelligence, all clerical work does not, and much of the simpler clerical work is found irksome when allotted to those capable of a higher grade of activity. Training is extremely important. though often sadly neglected. In some offices the various lines of promotion are laid down and made known to all employees. so they can prepare themselves for advancement Some offices also have officers who devote their activities wholly to employment, and all persons who are to be discharged are referred for final adjudication to this officer—the employment manager. The advantage here is that competent employees are not lost to the organization solely because of the personal pique of some hasty or temperamental officer. The employment manager also ascertains by tactful questioning the reasons why employees leave. and by a careful. classified record of such reasons is enabled to check bad practices, and to determine any other causes for dissatisfaction.

Turnover.—The "rate of turnover," that is, the ratio of employees leaving to those on the pay roll, is a most important factor in good office management. An average cost of over $100 is represented in the training of a new employee who replaces one who has left, so that it is evidently desirable to retain employees for long periods. Turnover is dependent upon many factors. If employees are not properly selected, many replacements will be needed; if salaries are not right, physical conditions bad, or the relations of officers not as they should be, there will be many voluntary separations. A minimum turnover is considered to be about 10% annually. Length of service depends upon much the same conditions as rate of turnover.

Routines and Methods.—A routine is a collection of separate operations through which a piece of work successively passes. Division of labour has been highly developed in office work, and few operations are complete in themselves. Routines as a rule are seldom consciously developed but come into existence gradually through the use of machinery combined with hand-work. As a result, operations wholly or partially useless and of little or no value to the "finished product"—the result desired—are frequently found. Methods also have generally speaking a similar evolution, and yield great results from scientific research. Unless both routines and methods are carefully studied, there is apt to be much waste.

Control of Output.—To secure maximum results for minimum effort, a continuous and uninterrupted flow of work is necessary, and this is one of the most difficult achievements in office work. In the manufacturing of any material commodity the work can be precisely scheduled, step by step, and the maintenance of a steady flow is largely a mechanical problem, as every piece of similar character goes through precisely the same steps. But in the office there is the added difficulty that office work of similar character does not always take the same course; and even in some work of exactly the same nature, the flow is governed by conditions beyond the control of the office manager. Because of this fact it was, until very recently, considered impossible to plan and schedule office work. Peaks, that is, periods demanding intensified and additional work, were handled either by overtime work, or by the permanent maintenance of a sufficient force of clerks to handle them, both plans being evidently wasteful. Analysis of this matter, however, showed that in many cases they could be adequately met by pre-planning. The office force should be well balanced, and sufficiently large to handle average conditions; but a sufficient number of clerks should be trained in several operations. Then by utilizing the idea of the "flying squadron"—a selected group of clerks that can be used almost anywhere in an emergency—most of the minor peaks can be handled without difficulty. Major peaks can be dealt with by a re-adjustment of working force and the employment of extra clerks for positions which require only a minimum of training.

Clerical Output.—On this subject all the major factors of office management converge, and all have a bearing upon it. Under conditions where all factors have been scientifically studied, clerical output is invariably much greater than in organizations in which they are largely ignored. Thus in the office of the latter character the average output of a stenographer will rarely exceed 100 sq.in. per hour, while in a scientifically managed office this particular output will be increased to an average of 200 sq.in. per hour. The maintenance of the latter rate does not depend alone upon the skill and application of the stenographer—for 200 sq in. per hour is but 30 words a minute, while the world's typewriting record is over 800 sq in. per hour—but largely upon other factors outside the control of the operator and decidedly within that of the office manager. As with typewriting, so it is with all other clerical operations; the output usually depends much more upon the efforts of the management than upon those of the individual clerk. The effort should not be to obtain the highest possible output from any individual, but that which should be expected from a first-class worker.

The Incentive Wage.—Still another factor which aids in obtaining a high clerical output is an incentive wage of some kind, wherever it is possible to measure the work. The various methods of incentive wage used in other lines of business endeavour have all been tried in the office, some with considerable success, others with disastrous results. In the cases of failure the main causes generally are that (1) work was not properly standardized; (2) not properly measured; (3) steady flow not obtained; (4) work not properly controlled; and (5) no adequate check upon its quality. Piece-work in the office is not so generally applicable, because the worker must have a guaranteed minimum wage, and it is not always possible to supply him with sufficient work to make that wage on a piece-work basis.

THE MECHANICAL SIDE

The preceding factors deal almost wholly with the management of the human element, and now other factors must be considered—those physical factors without which efficient management is not possible.

Arrangement.—The physical arrangement of an office affects all other factors of management. As most offices are in large cities, rentals are high and therefore space must be conserved. For this reason the cubicles of the old-fashioned office are giving way to the open office. Departments having relations with each other should be contiguously situated, and the seating of the workers in each department be regulated also on this principle. Work should flow in straight lines. Adequate light, both daylight and artificial, should be provided, the standard of the latter being placed by experts at not less than 10 foot-candles. (*See* LIGHTING). The completely indirect system. in which the light is thrown from its source to the ceiling. and thence reflected down. is considered the best. ventilation is an important matter also. Experiments show that the best ventilating system is that which brings in fresh air from the outside without altering it in any way. this being superior to the elaborate washed and heated air systems. (*See* HEATING AND VENTILATION.) Excessive noise is also detrimental to good work. and noisy machines. if numerous. should be segregated.

Equipment.—Under this head are included desks, tables, chairs. filing cabinets and similar furnishings. The old-fashioned roll-top desk has disappeared, and as the present tendency is to the extended use of small loose-leaf books and cards, the high-standing book-keeper's desk is seldom seen. At present the usual office desk is too large and contains too many drawers, and as clerks have little need for more than one or two drawers, a table is generally preferable. The size of a desk depends naturally upon the character of the work, but a desk larger than 54×30 in. is rarely needed, though no desk should be smaller than 40×30 inches. Chairs to be comfortable require designing to fit the human anatomy in an upright seated position. A few good anatomical chair types are available.

Office Machinery. — Here the greatest development has taken place, office appliances being now available for almost every occasion. (See OFFICE MACHINES AND APPLIANCES.) There was a tendency to use machines to the exclusion of competent brainwork, but office managers are beginning to see that this is a mistake.

Correspondence. — This is naturally an extremely important part of office management, not only between the company and outside correspondence, but within the organization itself. The present tendency is toward brevity and clarity, and the florid style and redundant expressions of the so-called "business English" are in process of elimination.

Filing. — The vertical system of filing has almost entirely superseded the old-fashioned flat file, and elaborate systems have been greatly simplified. Its greatest present misuse is the filing of valueless and superfluous material. The filing problem requires not only adequacy in equipment and system, but also accuracy, which necessitates adequately trained operators, for misfiled papers may easily cause great loss.

Stock-keeping. — In a large office the maintenance and issue of an adequate stock of all forms in use becomes a problem in scientific stock-keeping. Order and neatness are necessary, and an adequate location system, so that material can be found with a minimum loss of time. Stores should be classified according to some well-devised system, and there should be a perpetual inventory and a systematic method of issuing stores to, or on the order of, authorized persons.

Intercommunications. — This factor is a most important one in large offices. The telephone is of course the most common method, but there is usually a large transfer of papers from one part of the organization to another, and this must be taken care of by well-organized messenger systems with regularly scheduled trips. In many offices automatic belt systems or other forms of conveyors are used. Mechanical devices of other kinds are automatic signalling systems, automatic telephones and so forth.

Forms. — Most office work is performed by writing upon some kind of blank form, whether they be detached or loose-leaf forms. The quality of paper selected for any form should be governed by the use to which it is put. If it is to be written upon with pencil it is wasteful to use a high-grade paper designed for writing with ink. When forms have a temporary value only, the paper should be of a cheaper quality than that of forms to be kept for a number of years. Selecting standard qualities of paper for these various purposes requires considerable study. A large variety of colours should not be used, as many of them — particularly the reds and blues with their varying shades — are difficult to read under artificial light. Not more than nine standard sizes of forms are usually needed.

Salary Standards. — In most offices salaries vary widely and often unreasonably, clerks doing similar work frequently receiving widely different salaries. Some of the best-managed organizations have made a careful gradation of salaries, with a maximum and minimum for each class of worker. The minimum is that salary which a clerk is entitled to as soon as he is assigned his position, and the maximum the highest salary which the company can afford to pay for that type of work. Such gradation eliminates gross inequalities, gives more equitable payment for results and minimizes dissatisfaction among the office force.

SUMMARY

Office management is highly complicated, and requires a specialist—a manager of high order who at the same time thoroughly understands clerical work. The scientific approach to office management may be briefly defined. First. the purpose of any work about to be undertaken must be defined thoroughly, for if this is neglected subsequent investigation is likely to follow incorrect lines.

Then the problem should be carefully analysed into its factors. The next step involves a careful search for all the facts which govern all factors. It is common to gather abundant facts on one part of a problem, and ignore or minimize others. To infer, without investigating, is a most prolific source of error, the method of actual test being by far the best. These three steps may be called the scientific method of thinking out a problem. By its use, the office manager can correctly approach each problem and devise the best method. It is then necessary to select the person best fitted to perform it. The person best fitted for any particular task will invariably produce better results than the so-called "average" person. When found, the person thus selected must then be taught.

These steps constitute the basic procedure in any form of scientific management and lead to .planning. Without careful planning, all that has gone before will be wasted. Finally. it is vitally important to win the co-operation of the workers. An office force labouring without interest or enthusiasm will accomplish some results. but certainly not of the type desired by a competent office manager. The management which does not and cannot secure co-operation is necessarily defective. These steps cover the basic principles of scientific management in all activities.

There is also a considerable tendency toward the simplification of office methods and the entire elimination of much that has been done in the past. on the ground that it is either superfluous or not worth the effort expended. (W. H. LE.; X.)

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OFFICERS, a term designating persons holding military—army, navy and air force — commissions and differentiating them, as leaders, from the enlisted or "other ranks" military manpower of a nation. The term officer usually refers to persons on active or full-time duty and indicates that there is a contractual arrangement between them and the state. These persons devote themselves to their country's defense as a principal and regular means of gaining a livelihood. Reserve officers and commissioned militiamen are also included as officers when on active duty, and in all nations they qualify in some measure under the term officer even when on an inactive status. since they give part-time service to the state under less binding contractual agreements. Though social custom maintains the use of the term for them when not on active duty, their military avocation is secondary to other professional pursuits. Therefore, the term officer in the following context will usually refer to the commissioned members of the regular, active armed forces. This includes the women who hold commissions in the feminine, usually noncombatant components of the armed forces of most nations.

HISTORICAL DEVELOPMENT

Ancient and Medieval. — Ancient armies were normally commanded by members of the nobility. In Egypt, for instance, military leaders ranked in society as the second of seven castes. In Assyria military men were the top social group in the nation. In neither of these cases could the noblemen who commanded the armies be considered officers in the modern sense that their livelihood was primarily military. Moreover, they were not bound to the state by a contract.

The citizen soldiers of both Greece and Rome were officered by those among their number who exhibited qualities of leadership. However, in both cases the citizen soldiers eventually resigned their position as amateurs to professional long-service regular soldiers. As a result, citizens in Greece and Rome who had a liking for the military remained in service as officers. Usually they commanded lower-class citizens of their nations, mercenaries and barbarians. Marius opened the officer ranks to Roman citizens regardless of their social position. Not until the time of the French Revolution did military leaders come as close to the modern professional sense of the term as did officers of the Roman empire.

There was no general. long-service military class in feudal times. Each nobleman had his serfs for military duties in the short-lived campaigns of the dark ages and the early middle ages. The main business of the knights was agriculture. The annual 40 days of service owed by the serfs to their lords prevented warfare from being more than a desultory occupation and in no way qualified the feudal nobles as professional officers.

Professionalism took its most significant step in the 15th century when free companies of Swiss, Italian and German soldiers sold their services wherever they were needed. These mercenaries were thoroughly international freebooters, and their captains were competent leaders who, to some extent, qualified as officers in the modern sense. Their livelihood was warfare; they made a business of fighting. contracting with various princes or dukes for so much professional service. Their mercenary business passed out of existence about the middle of the 17th century with the disappearance of feudalism and the rise of dynastic standing armies.

17th and 18th Centuries.— In the Thirty Years' War the modern grades or ranks of regimental officers developed in the well-organized Swedish army of Gustavus Adolphus. He established the modern idea of the regiment with its colonel, and the battalion commanded by a lieutenant colonel. assisted by a major as the administrative chief and by an additional officer, a captain, who arranged for supplies. The companies were commanded by captains as a continuation of the free company method, while the subordinate officers in the unit were lieutenants.

It was during this period that the proprietary system replaced the obsolete combination of feudalism and free companies Cnder this the colonel was the proprietor of his regiment, the captain the proprietor of his company. The king accepted them as his officers and armed them with authority to raise men. Initially under this system armies nere raised for each campaign, and the regiments were made up from qualified volunteers During the latter part of the 17th century, however, armies became permanent. or standing. and were kept up to strength by the regular influx of untrained recruits. The crown supplied the recruits and the money for maintaining the forces. the proprietorship of the colonels and captains being thus somewhat restricted.

The proprietary system gave to military office not only responsibilities but also certain profits. The officer was paid for the number of men that he mustered and was furnished other funds for their arms and food. Besides the profit resulting from economical —and sometimes parsimonious or fraudulent—discharge of his proprietary rights, the officer could sell his proprietary interest when he retired. Commissions, therefore. nere valuable. and as late as 1871 could be purchased in the British army. even though the proprietary system had long since vanished. The purchase of the commission of a lieutenant colonel in a first-class regiment might cost as much as $30,000 (£6,200).

The general terminology for the grades of regimental officers having been established by Gustavus Adolphus, it remained largely for the French to develop the ranks above that of colonel.

Usually the king or prince was the "general" of a field army. The second in command was the lieutenant general, a nobleman who customarily commanded the aristocratic cavalry. A professional soldier—not necessarily a nobleman—usually commanded the infantry and was variously known as the sergeant major general or simply major general. It was his duty to form the army for battle and to take care of other administrative matters for the king or prince. (The title of sergeant major was carried through the regiments and battalions. where the sergeant major—sometimes called major or adjutant major—was the principal staff officer) When, as was usually the case, the army was disbanded at the end of a campaign, the lieutenant general and major general had no command and thus lost their rank as well, reverting usually to their proprietary positions as colonels of permanent regiments.

Gradually, however, the title of marshal or field marshal was developing into a recognized. permanent rank in the French army. This resulted from the establishment of a permanent list of officers whose distinction and experience qualified them to serve as general, lieutenant general or major general in a field army. This marks one of the most important points in the evolution of the military officer—his permanent classification by rank and not by the actual temporary command he happened to hold. Following the establishment of the rank of marshal in the French army. there was the gradual, logical development of a list showing the precedence by rank of all officers in an army. The establishment of such general army lists naturally undermined the proprietary system of independent regiments. and this system passed out of existence for the most part in the late 18th century.

As armies grew larger in the 17th and 18th centuries, more general officers were needed. In time a lieutenant general, previously the designation for the second in command of an army. also became a permanent rank, immediately below that of marshal. The next lower grade was that of the sergeant major general, later shortened to major general. The lowest grade of general officer, that of brigadier. was created by Louis XIV.

French Revolution to Mid-20th Century.— During this period officer status was gradually opened to qualified soldiers in the ranks. Significantly, too, officer status was opened to a great number of technical positions unknown in warfare before the Industrial Revolution; for instance, officers supervising the production of guns and those responsible for signal communications.

In the British services prior to the 20th century. officers normally were paid so little that only the wealthy could afford commissions. Promotions from the ranks became common during World War I and soon after its termination measures were taken to extend the system to the regular army in peace. Annually a limited number of young soldiers from the rdnks (known as Y cadets) went to the royal military colleges for training as officers. In 1938 the British government made it a condition that all cadets for army commissions should serve for a short period in the ranks. The number of commissions granted from the ranks of the navy and air force was also increased. This reform in part did away with such disabilities as the low pay that required augmentation from a private income, and also eliminated the inactive status during which a regular officer had sometimes found himself on half pay Consequently, the British officer class became more representative of the nation as a whole. Even the social barriers were broken down so that service as a British officer more closely paralleled that in the U S. forces.

In Germany, even before the unification of the country in 1871, the influence of Prussia was pre-eminent in military affairs. This influence. nhich to a certain extent pervaded all Europe, continued right up to World War II. The Prussian landholding aristocracy, the Junkers, were the most powerful element of an essentially military society. Most officers came from the aristocracy of Prussia or the other German states, and by the end of the 19th century all were required to have a university degree or its equivalent. Approximately 40% came from cadet schools; the remainder had been reservists on active duty who had been recommended by their commanders as possessing the requisite military and social qualifications The Junkers were able to assure that members of their group rose to high command and staff positions in the army. The arrogance of the Prussian officer was communicated to the rest of the German army and to the navy There can be no question that this, as nell as the Prussian emphasis on mechanical efficiency, detracted to some extent from the human qualities that have been found so essential to the making of good officers in democratic countries. Nevertheless, German thoroughness and attention to detail resulted in a high standard of efficiency throughout the entire army, and later in the German navy and air force. At the same time the German promotion system brought many brilliant and imaginative officers to positions of high command. In the development of the new German army of the German Federal Republic after World War II, a conscious effort was made to eliminate the nondemocratic and mechanical characteristics of the old German officer corps, while retaining the traditionally high standards of efficiency. In this period the Germans looked to the United States for guidance in the organization of armed forces consistent with democratic principles.

The French nobility had largely been eliminated from influential military positions in the Napoleonic era. Men who might never have been more than sergeants in the armies of Louis XIV rose to marshals under Napoleon. Against this background, the selection of officers in France during the 19th century was probably more democratic than that in any nation other than the U S. Nevertheless. aristocratic influences remained strong in the top command positions of the French army up to World War I. Throughout the 19th century and to mid-20th century, French officers were well-schooled and able men, though officer positions declined in standing mainly because of the low pay.

In the far east the Japanese services were largely officered by the nobility. Descendants of the traditional samurai class generally attained highest rank in both command and staff in the Japanese army and navy. A certain similarity developed betneen Germany and Japan in the rise of an essentially military society. Japanese officers displayed much of the arrogance found in the German armed forces of the 19th and early 20th centuries. The parallel continued after the crushing defeat both suffered in World War II. Like the Germans, the Japanese, with U.S. assistance, also endeavoured to eliminate the autocratic abuses that had existed in their prewar forces. while retaining traditional military efficiency.

Russia, under the tsars, gave officer status almost entirely to the nobility. Before World War I the standards of the Russian officer corps were lax; there were a few capable officers but many were unbelievably careless and incompetent. This resulted in disastrous defeats in the Russo-Japanese War and World War I. Upon the Bolshevik Revolution. Lenin created an army from the proletariat, taking his leaders from among labourers and revolutionists.

During the period between World Wars I and II the Soviet army developed slowly but steadily, and many excellent officer schools were established. The growing efficiency and morale of the officer corps mere seriously impaired, however, in the Stalinist purges of 1937. Glaring weaknesses were revealed in the Russo-Finnish War of 1939–40, but this experience enabled the Russian leadership to make many last-minute improvements before Hitler attacked in 1941. At that time the top commanders were still the old Bolshevik leaders. but after the Soviet army suffered crushing defeats, these men were replaced by younger and better trained officers. The vast area of Russia and the stubborn defensive qualities of the Russian soldiers provided advantages that gave these new commanders a chance to gain experience in battle. under the inadvertent tutelage of the superb German officer corps.

Soviet social and political experiments in the army were not wholly successful. After the Revolution officers and men were given common social status, but this soon proved unworkable. The trend was reversed until by mid-20th century there was a greater distinction between officers and men in the Soviet forces than in those of the democracies. The Soviet leadership was slower to acknowledge the failure of its system of political commissars. Until the early days of World War II there had been in each army unit commissars whose function was to indoctrinate the troops with Communist propaganda and to check on the political reliability of the officers. While there was a partial return to this system after World War II, these political officers no longer wielded their former power.

Officers in the U.S. services have always represented a cross section of the population and have been obtained by various systems of selection. In the early days of the republic, men ignorant of military affairs became officers through political influence. The evils of this practice were great; history mentions companies electing captains in the American Revolution on the condition that they share their pay with the other men. There were similar experiences in the War of 1812 and again to a lesser degree in the Civil War, when governors of states appointed officers in the volunteer forces. often without regard to their experience. Many of the small nucleus of regular officers who had been trained at the U.S. Military academy got their chance in the war by obtaining volunteer appointments from state governors at ranks far higher than the permanent ones they held. The experience of Gen. Philip Sheridan, who fought as a captain in the regular army for a full year before he was elevated to a colonelcy of volunteers, was common among the regulars.

After comparable experiences in the Spanish-American War, the United States made strong efforts in both World Wars I and II to select and promote officers on the basis of merit. In these wars, positions in the higher command and staff were given most often to regular officers. But in World War II more than 98% of army officers and 96% of navy officers were nonregulars. Some had been reserve officers before the war, but most were essentially civilians, selected from the greatly expanded enlisted ranks and trained at officer candidate schools. A few specialists, lawyers, doctors, railroadmen, etc., had duties identical with their civilian work.

During World War I the role of the air officer, usually a pilot, became significant in the armies and navies of all major belligerents. In Britain toward the end of World War I, and in Germany between World Wars I and II. a co-equal service—the air force—was established; but air units remained elements of the armies and navies of the other major nations until after the close of World War II. In 1947 the U.S. air force became a separate entity, but in the U.S.S.R. the air force remained an integral part of the Soviet army.

THE OFFICER AS A LEADER

In the 20th century the forces of social evolution and revolution have tended to reduce, but not to eliminate, the traditional distinctions between officers and enlisted men in pay, social status and privileges. Nations today draw their officers from a cross section of their people and make it possible for enlisted men to become officers.

The distinction between officers and enlisted men, or "other ranks," is one primarily of professional status and responsibility. Many enlisted men of the regular services in most nations are highly skilled and trained technicians; senior noncommissioned officers are generally as dedicated to their military careers as any officer. Enlisted men, however, lack the professional background, education and motivation that are considered to be the fundamental officer characteristics. Because of this essential difference, enlisted men under the military and civil law of most nations cannot assume the legal responsibilities of command that an officer cannot avoid.

Armed forces exist to support and to carry out national policy and particularly to defend their nations from hostile attack. It is the function of officers to provide leadership for these military establishments. This leadership is exercised in three major categories of activity: (1) the armed forces must be recruited, organized and equipped: (2) they must be trained; (3) they must be controlled and led in military operations The objective of this exercise of leadership must be to assure success in battle, whether or not the individual officer and his men are ever actually engaged in combat.

Leadership is a concept defying precise analysis in its military as well as its nonmilitary manifestations. Through a study of history, hog-ever, it is possible to deduce certain qualities that all military leaders should possess. While the general nature of military leadership is comparable with that in any field of human endeavour, it is nonetheless distinguished by the highly specialized characteristics that the officer must possess.

Military Competence.—This is the first and most distinctive of military leadership qualities. It requires a profound knowledge of military theory as well as understanding and skill in applying this theory. Nothing is more difficult in the military profession. The officer may prepare for the day of battle for many years, but the exercise of his leadership in war usually occupies a relatively brief period. Obviously, then, there is an aspect of unreality in his preparation. Furthermore, what he has learned by study and artificial peacetime experience can easily become outdated before he is called upon to exercise leadership in combat. Only through alertness in responding to technological developments and by repeated training exercises can the officer hope to obtain and preserve this essential skill. His success is demonstrated by his ability to take positive action in the flexible application of technical knowledge and theoretical principles to a wide variety of specific situations.

Knowledge of Tools.—The officer must know thoroughly the tools that will be available in war. While this naturally includes weapons and all manner of complex equipment, the most important tools are the men he leads in battle. The officer must understand their general human and national qualities, and further must be aware of the characteristics and limitations of the specific individuals who will be under his command in battle. Knowledge of the military art. flexibility and all the other requirements of leadership avail nothing if the officer does not understand how to deal with the human beings over whom he holds a position of power.

Training and Discipline.—An understanding of his men does not mean that an officer must fatalistically accept their limitations. On the contrary, he should endeavour to minimize inherent weaknesses and to improve the quality of the human tools with which he must fight, This is done through training and the simultaneous achievement of high standards of discipline.

In the armies of modern democratic countries discipline cannot be achieved through the so-called Prussian system of unthinking obedience from mechanical soldiers. Such a system is not compatible with democratic concepts or the requirements of modern warfare. The increasing destructiveness and efficiency of weapons has compelled increasing dispersion of land, naval and air forces in battle. In the isolation of individuals or small units there is an incessant demand for the exercise of initiative and the display of moral and physical courage that can be derived only from confidence fostered by an understanding system of discipline.

This confidence is not merely the result of thorough: painstaking training of men in the use of weapons and equipment; it stems equally from the officer's diligence in care of his men, resolute justice, creative intelligence and respect for the dignity of the individual. The object of the relationship between officers and their men is so to strengthen the will and abilities of the latter that they will be able to take voluntary action in the heat of battle. The officer-leader stands or falls on the results of those vital moments when the decision is in the hands of the men he has trained and lived with.

Inspirational Ability.—The officer must be able to inspire in his men a desire to work together toward a common goal. This cannot be achieved either by routine performance of his duties or by trying to gain the friendship and liking of his subordinates. He must demonstrate his dedicated enthusiasm for national objectives and ideals and for the honour and glory of the organization he commands. This, combined with military competence and insistence upon high standards of discipline, will ensure the respect, confidence and loyalty of his men.

Personal Courage.—This is an absolutely indispensable quality. Since the officer will have normal. human reactions to danger, he must exercise the strongest self-discipline in combat. This does not mean that he should recklessly expose himself to danger or pretend an absence of fear. He must, however, share the risks of his men, must never demand them to perform actions that he would not dare himself and must remain cool and self-possessed in combat.

Perseverance in Adversity.—Finally the leader must be able to endure calamity without loss of equilibrium. He should be able to persevere in adversity and carry on with flexibility and determination to achieve assigned objectives, regardless of setbacks or even crushing defeat.

RANKS OR GRADES OF OFFICERS

A common pattern of officer ranks or grades has developed in the armed forces of the principal nations. despite differences in titles. The nature of the pattern, the commonest titles of ranks and grades and major differences between services and nations are shown in the table. It should be noted that officer grades in the U.S. air force are practically identical with those of the U.S. army, and that there is comparable similarity in the grades of the French army and air force.

Warrant Officers and **Cadets.**—Below the normal officer grades there are frequently two categories of ranks in which the individuals enjoy officer status but do not have full officer responsibility.

Warrant Officer.—Warrant officers' duties are generally administrative or technical in nature. It should be noted that in the British army the term warrant officer (like that of adjudant in the French army) applies to senior noncommissioned officers, who do not possess officer status comparable with that of U.S. warrant officers, for instance. In the Royal Navy the commissioned warrant officer enjoys full officer privileges without the full status.

Cadet.—This term generally applies to young men attending special training schools in preparation for regular careers in the armed forces. U.S. and British naval cadets are called midshipmen.

Company Officers.—This is an army (and often air force, though not Royal Air Force) term applying to the lowest of three major groupings of commissioned officer grades. There is no comparable naval term, though members of the lower ranking group are sometimes referred to as "junior officers." The grades are as follows:

Second *Lieutenant*.—This officer is usually an assistant platoon commander in the army. The Royal Air Force rank is pilot officer.

Lieutenant.—In the U.S. army and air force this officer is a first lieutenant; in Belgium he is known as the platoon chief, which is indicative of his typical responsibility. He may also be second in command of a company. In the Royal Navy he is a sub-lieutenant. while in the Royal Air Force he is a flying officer. It should be noted here that the Soviet army has three grades of lieutenant rather than two as in most nations.

Captain.—In most armies this officer is a company commander, the title going back to the days of mercenary companies. In the British army he may sometimes be second in command of a company.

Field Officer Grades.—This is the U.S. army and air force term for the second major grouping of officers. In the navy and British services these grades are sometimes called senior officers. They are as follows:

Major.—In most armies this officer, lineal descendant of the historical sergeant major, is second in command of a battalion, though in the French army he may command a battalion. while in the British army junior majors often command companies. In navies the lieutenant commander usually commands small combat vessels, such as frigates or destroyer escorts.

Lieutenant Colonel.—In most countries this officer commands an infantry battalion, or is second in command of a regiment of more than one battalion. In the British army he also commands a cavalry, artillery, engineer, etc., regiment. The equivalent naval rank is commander, an officer who usually commands intermediate size vessels, such as destroyers, or who may be executive officer of a larger vessel.

Colonel.—In most armies this rank denotes command of a regiment or battle group. The equivalent naval rank is captain. In the British army it is often held by senior staff officers, but not by active regimental officers. The British regiment is an administrative unit and has a dignitary called the colonel of the regiment. He acts as the "father of the regiment" and is usually one of its distinguished serving or retired senior officers. Many British regiments also have a colonel in chief. who is always a member of the British. or a foreign, royal family. A few units—mostly in the territorial army—have, in addition, "honorary colonels," who are usually distinguished persons selected because of some past connection with the unit.

Brigadier.—This is a special rank found only in the British army and the armies of nations which have adopted British organization. This officer commands a brigade—the combat organization comparable to the regiment in other armies. Some staff positions are also held by brigadiers. In the British army the brigadier is

Corresponding Ranks in the U.S., British, French and Russian Armed Forces

U.S. army*	British army	U.S. navy	British navy	British air force	French army	Russian army
Warrant officer		Warrant officer	Warrant officer	Warrant officer		
Cadet	Cadet	Midshipman	Midshipman	Cadet	Cadet	Officer cadet
2nd lieutenant	2nd lieutenant	Ensign	Sublieutenant	Pilot officer	Underlieutenant	Junior lieutenant
1st lieutenant	Lieutenant	Lieutenant junior grade		Flying officer	Lieutenant	Lieutenant Senior lieutenant
Captain	Captain	Lieutenant	Lieutenant	Flight lieutenant	Captain	Captain
Major	Major	Lieutenant commander	Lieutenant commander	Squadron leader	Commandant	Major
Lieutenant colonel	Lieutenant colonel	Commander	Commander	Wing commander	Lieutenant colonel	Lieutenant colonel
Colonel	Colonel Brigadier	Captain	Captain Commodore	Group captain	Colonel	Colonel
Brigadier general		Rear admiral (lower half of list)		Air commodore	Brigadier general	Major general
Major general	Major general	Rear admiral (upper half of list)	Rear admiral	Air rice-marshal	Divisional general	Lieutenant general
Lieutenant general	Lieutenant general	Vice-admiral	Vice-admiral	Air marshal	Corps general	General
General	General	Admiral	Admiral	Air chief marshal	Army general	Colonel general
General of the army	Field marshal	Fleet admiral	Admiral of the fleet	Marshal of the Royal Air Force	Marshal of France	Marshal

*Ranks for officers of the U.S. air force are the same as for the U.S. army except that the highest rank is general of the air force.

not a general officer, but is a colonel who is given special appointment with the temporary rank of brigadier while holding his specific command or staff position. The position of commodore in the Royal Navy is comparable in that it is not a separate rank, but is a special appointment of a captain.

General, or Flag, Officer Grades.—Flag officer is the naval term for this third and most exclusive grouping of officers, which includes those in senior command and staff positions.

Brigadier General.—Traditionally this was the title of the commander of a brigade of two regiments. Such organizations are rarely found in modem armies. (As noted above, the British brigade is a smaller organization, and its commander, the brigadier, is not considered a general officer.) Brigadier generals are normally second in command of divisions, or in command of divisional or corps artillery establishments, or of specially organized task forces of several combined arms, or may hold senior staff positions. The Soviet major general is comparable to brigadier general in other armies. In the U.S. navy the rank of commodore is rarely used, and officers in the lower half of the list of rear admirals are considered to rank with brigadier generals. Air commodore is the equivalent Royal Air Force rank.

Major General.—The commander of a division (usually consisting of three regiments and supporting troops) is given this title in practically all armies of the world; also most high general staff positions are given this rank. In the U.S. navy, officers in the upper half of the list of rear admirals rank with army and air force major generals. In the Soviet army lieutenant generals are ordinarily the equivalent of other major generals.

Lieutenant *General*.—In most armies this officer commands a corps of two or more divisions. The comparable Soviet rank is general. In most navies the equivalent rank is vice-admiral.

General.—This grade is normally identified with the commander of a field army. Senior generals may command army groups of two or more field armies, or command combat theatres of operations in wartime. The equivalent naval rank is admiral. In the U.S. services there is no higher peacetime rank. In the Soviet army the comparable rank is colonel general.

Field Marshal.—In Britain this ancient rank is held by a few senior army officers. If not already a field marshal, the chief of the imperial general staff is usually made one soon after being appointed. In the Royal Navy the comparable rank is admiral of the fleet, and the air equivalent is marshal of the Royal Air Force. In the Soviet army this rank is generally held by officers commanding army groups or higher command. In France the title of *maréchal* de France is purely honorary and is awarded by the French government only to especially distinguished, victorious generals.

After World War I the U.S. congress conferred the unique title of general of the armies on Gen. John J. Pershing. The ranks of general of the army, general of the air force and fleet admiral were created by congress in World War II as the equivalent of field marshal and conferred on selected commanders: Generals George C. Marshall, Douglas MacArthur, Dwight D. Eisenhower and Henry H. Arnold; Admirals William D. Leahy, Ernest J. King and Chester A. Nimitz. Later Gen. Omar Bradley attained the rank of general of the army and Adm. William F. Halsey became a fleet admiral. See also INSIGNIA, MILITARY. (T. N. D.)

Brevet.—This term, a diminutive of the Fr. bref, originally denoted a brief official note; more commonly it applies to a form of military commission used in the American and British armies. Under the system wherein an officer was customarily promoted within his regiment or corps, a brevet conferred upon him a rank in the army-at-large higher than that held in his corps. Frequently, but not always in the American service, it carried with it the pay, right to command and uniform of the higher grade. In the United States especially, brevet rank was widely bestowed as a reward for outstanding service; it became the subject of extensive confusion and controversy during the Civil War. After 1865, American brevet rank was gradually stripped of its benefits and officers were rewarded instead by decorations. (*See* MEDALS AND DECORATIONS). Commission by brevet was declared obsolete in 1922. Special commissions bearing some of the characteristics of the brevet have been used in other armies. (F. P. T.)

SOURCE OF OFFICER MATERIAL

In all major nations the primary sources of regular officers are special military, naval and air academies or colleges. These service academies, while differing among nations and services, have much in common. They are generally open to youths between 17 and 22 years of age, and all have strict physical and mental requirements for admission and require that candidates be unmarried. In addition, most nations offer opportunities to outstanding enlisted men and to graduates of universities and colleges to qualify for commissions as officers, either directly, or through the service academies, or through intensive courses at officer candidate schools.

U.S. Officer Preparation.—Regular officers in the United States services are obtained from three principal sources: from the three service academies; from civilian colleges and universities; and from among selected reserve officers. Some of the reserve officers obtain their commissions through Reserve Officer Training corps courses in civilian colleges, others through successfully completing officer candidate schools as enlisted men.

Many regular army officers are graduates of the U.S. Military academy at West Point, N.Y. This academy, established in 1802, is one of the oldest service academies in the world. The naval equivalent is the U.S. Naval academy at Annapolis, Md., which was established in 1845. The U.S. Air Force academy, to be permanently located at Colorado Springs, Colo., was initially founded at Denver, Colo., in 1954.

The student bodies for these academies are filled by congressional appointment. Selection of cadets and midshipmen is usually by competitive examination. The president has a number of appointments, often used for the sons of deceased veterans. The regular services and the national guard also have appointments, open to enlisted men on a competitive basis.

All three academies offer a four-year college-type curriculum at government expense, leading to a bachelor of science degree. In addition there is intensive military instruction. The objective of the schools is to produce officers who have the qualities and character essential to their continuing development as leaders. The academies generally seek to implant a high sense of duty and patriotism, while assuring mental and physical fitness.

Upon successful completion of the four-year course, the graduate is commissioned a second lieutenant in the army or air force, or an ensign in the navy. At mid-20th century West Point and Annapolis had riot furnished even a majority of regular officers in the services; since far larger numbers had been commissioned from U.S. colleges or had entered from the reserve officer group. The Air Force academy, of course, was only beginning to supply officers for its service.

British Officer Preparation.— Great Britain has obtained most of its regular officers from its military colleges. Medical, legal and some other technical officers, as in the U.S., have been obtained mostly from graduates of civilian universities. Prior to World War II, Britain had two cadet schools for its army: the Royal Military college at Sandhurst (1799) and the Royal Military academy at Woolwich (1741). Sandhurst was a school for officers of the infantry, tank corps and other line elements, while Woolwich trained artillery, engineer and signal officers.

Up to 1914 entry into these colleges was confined almost solely to the sons of upper-class parents. Between World Wars I and II, however, various changes were made and the colleges put on a more democratic footing. By 1938 a short period in the ranks, as a prerequisite to officer candidacy. had become the rule rather than the exception. The changes of 1938 also made it possible for a youth who could meet the entrance requirements to obtain military training at government expense. Both Woolwich and Sandhurst differed considerably from the U.S. Military academy in that emphasis was upon military training, no effort being made to obtain a university degree for the cadets in the shorter. two-year course. Since the great majority of cadets had attended public schools or universities, however, by the time they received their commissions they had the equivalent of a college education. These schools furnished about three-fourths of the regular officer corps. the remainder coming from university graduates, directly from the army and from commonwealth nations.

In the post-World War II period. Sandhurst and Woolwich were consolidated into a single Royal Military academy located at Sandhurst. Because the reform of 1938 had broadened the source of applicants, there was some lowering of the standards of prior education of cadets from pre-World War II days. Consequently, there has been increased emphasis on academic subjects.

The Britannia Royal Naval college at Dartmouth (1729) and the Royal Air Force college, Cranwell (1920), the latter of which trains cadets for regular commissions as pilots and navigators, are the British naval and air counterparts of Sandhurst. Their courses are somewhat longer than at Sandhurst; otherwise they are comparable in scope and objectives. The Royal Air Force technical college at Henlow gives professional training for officers of the technical branch of the service.

French Officer Preparation.— The principal source of officers for the French army is the École Spéciale Militaire. formerly located at St. Cyr, near Versailles, but moved to Brittany as the result of the destruction of its buildings in World War II. Like Sandhurst, St. Cyr (as it is still called) has a two-year course, except that selected noncommissioned officers may obtain a commission in one year of intensive study.

In past years most French artillery and engineer officers received their cadet training in a two-year course at the École Polytechnique in Paris. Polytechnique has become essentially a civilian engineering school, and at mid-20th century only a few members of each class were electing to enter the military forces as a career. It is a government school, however, including military training, and a certain percentage of its graduates become reserve officers who must serve a period of active duty in the army.

The French navy obtains most of its officers from the École Navale, near Brest in Brittany, while the air force school is the École de l'Air, at Salon-de-Provence. Both schools feature three-year courses. The navy and air force, like the army, also obtain some of their technical officers from the École Polytechnique.

Soviet Officer Preparation.— Before World War II the U.S.S.R. had no cadet colleges similar to those of the western nations. However, there were many branch officer candidate schools, including 15 for the infantry and a smaller number for the artillery. Qualified enlisted men are still allowed to compete for admission to these schools, receiving commissions after a course of three years. Some technicians, particularly engineers, are given direct commissions after university graduation.

During World War II the professionalization of the Soviet army was given impetus by the establishment of a number of Suvarov junior military academies. These schools accept boys— frequently from military families— at the age of nine or ten and subject them to seven years of training in military and secondary school subjects, after which they are sent on to the three-year officer candidate schools. The Nakhimov schools for the navy are similar to the army's Suvarov schools.

OFFICER TRAINING

All modern armies lay great stress on the continuous training of officers after they have received their commissions. This is particularly important because peacetime experience can never duplicate that of war and rapidly becomes outdated. Officers are schooled in the theories of tactics and strategy, in the principles of war and in the latest weapons systems and techniques whereby these theories and principles are applied in modern combat. Flexibility of mind is the goal in military education.

The army officer recently graduated from a military academy is usually given two or three years in command of a platoon of soldiers to acquaint him with the problems of leadership and to impress upon him the necessity for knowing small-unit tactics as they apply to the soldier in the ranks. Moreover, in such experience the young officer learns each soldier's job, so that he can show a rifleman or machine gunner how to handle his weapon. After a period of command, the officer may go to a school of his arm, such as infantry or artillery, to obtain a basic knowledge of its tactics and techniques. In some armies, this training of the early years is reversed on the theory that the junior officer is better qualified to command men if he has had the benefit of tactical schooling.

In general. the training of army officers runs to the following pattern in most nations: (1) basic military and academic education in military academy; (2) command at platoon level or its equivalent; (3) basic school of the arm; (4) command at the company level; (5) advanced school of the arm; (6) staff at battalion or regimental level; (7) staff college; (8) staff assignment in a higher headquarters; (9) command at the battalion level; (10) war college: and (11) the remainder of the career usually including both command and staff assignments. Into this pattern, from time to time, may come special assignments such as duty with reserve components or with a military mission in a foreign country. While the pattern of service for naval and air force officers naturally varies somewhat from that of army officers, these follow a similar scheme of rotation of duties, including school, command, staff and special assignments.

Much of the officer's training is concentrated on learning tactics and staff procedure by application so that these can be performed almost automatically. This is not to say that schooling is unthinking or adjusted to the mediocre. Rather it is based upon the requirements of service and the need for established, well-understood procedures, so that action will be prompt and efficient in the stress of combat, and to assure maximum co-ordination under any circumstances between officers who may never have had an opportunity to practise working together. Experience has proved that close adherence to a soundly formulated military doctrine is the surest guarantee of obtaining the best-trained men and of assuring uniformly high standards of training and achievement through the entire service.

United States.--Officer training in the U.S. services at mid-20th century followed very closely the pattern noted above. Only those officers showing the greatest potential for staff and command duties— approximately 50% of the officer corps— are selected for staff college. These are usually captains or majors in their early 30s. A smaller percentage— colonels. about 10 or 15 years older—are selected to attend the National War college, the Industrial College of the Armed Forces or one of the three service war colleges. Many of these, as lieutenant colonels or commanders, have attended a joint staff college for special training in operations of the combined services.

During the first ten years of his career, an army officer who began his service in a line branch—infantry, artillery or armour—may receive specialist training in one of the technical branches, such as ordnance, signal communications or engineers. Some of these officers will transfer permanently to the service branches, with further training in civilian universities. From these, for the most part, are eventually selected the students who attend the Industrial college, where they study the economic aspects of war and industrial mobilization. There are also specialist opportunities for young navy and air force officers, many of whom also complete their military schooling in the Industrial college.

Great Britain.—The British army officer at mid-century, like his U.S. counterpart, becomes a platoon commander shortly after he is commissioned. He is expected after two years of service to have a knowledge of the interior management, economy and discipline of a company. Subsequently he is required to pass professional examinations in order to qualify for promotion and in order to qualify for attendance at the higher military schools. The patterns for officers of the Royal Navy and Royal Air Force are similar.

After about eight years' service, specially selected officers attend one of the service staff colleges. On graduating, these officers can expect staff assignments, either in one of the service ministries in London or in major commands in Great Britain or overseas. There is a special staff college for joint service operations, and above that is the Imperial Defence college, equivalent to the American National War college, for the study of higher strategy and military policy by officers of all services of all commonwealth countries.

France.—The French training system was the chief model for the U.S. and Great Britain. Great emphasis is placed upon qualification both in education and military training. After attending branch or specialist school, an army officer can expect to attend the École de Guerre some time between the ages of 28 and 38. This school, with its ten-month course, is designed to train officers for staff duties and the command of larger units. At about the age of 45, selected colonels attend the French war college—the École Superieure de Guerre—for a two-year course in the higher art of war. The higher schooling of French navy and air force officers is similar.

Soviet Union.—Officers of the Soviet forces are trained at branch service schools, much as in the western democracies. Also the more capable officers are sent to staff schools and eventually to a war college. A Soviet officer can count on spending almost twice as much time in schools as his western counterpart. The Soviet services place great emphasis on two items: political beliefs of the individual and ability to command troops.

THE OFFICERS' SERVICE

While training requirements are similar for officers in the armed forces of all nations, there are great differences in the sort of places in which they serve and in the kind of duty they perform when not in school. The usual expectancy in most armies and air forces at mid-century was that officers would command troops or serve in combat units from one-fourth to one-half of their careers. A similar proportion of a naval officer's service would be at sea. This requirement, however, was constantly being lowered because of the growing complexity of war, which increased the demand for general staff officers and technical specialists.

The high command in most armies is normally given to the line officer, with a background in infantry, artillery or tanks, who has alternated his command experience with general staff duties. These officers will in time have taken very divergent paths from those of the technical experts, qualifying themselves in the later years of their service more as executives and administrators than as specialists in technical fields.

The duties of officers in the major countries require a certain amount of overseas service, either in military missions, strategic outposts or colonies. Accordingly, the officer alternately moves from an army post to an overseas garrison, or to a civilian community while on duty with militia or reserve units. The duties are varied and frequently stimulating because of new interests and new places.

General Staff.—An officer in this field is required to know the functions of personnel, intelligence, plans, operations, training or supply. The knowledge he brings with him of the men in the ranks assists him in determining whether his policy on paper can be carried out by men in units. Many general staff problems are concerned with political-military affairs and grand strategy. The training and background of the ordinary officer are not sufficient to equip him adequately in these matters. Consequently such jobs are assigned to officers who have demonstrated that they possess the necessary qualities of intellect, who have maintained a lively interest in world affairs and who have attained a sense of proportion in dealing with complex matters.

Technical and Supply Services.—Officers in these services may possibly be graduates of engineering schools as well as of a military academy. Their work in signal communications, ordnance or procurement of supplies brings them into frequent contact with business and industrial men. Mutual understanding by these groups is essential to the successful operation of industrial mobilization in the event of war.

Methods of Promotion.—In modem forces. officers are promoted through seniority in length of service, by selection on the basis of merit or, most frequently, by some combination of the two. For instance, most selection systems require a certain seniority before an officer can be pushed ahead of his contemporaries. In time of peace, when vacancies are few, the length of service requirements for selection may be increased. Promotion by seniority alone assures adequate reward for faithful service; it may, however, result in the promotion of less competent officers, at the same time failing to take full advantage of the potentialities of more capable, younger men.

In peacetime, promotion is normally a permanent advancement, while in wartime the tremendous expansion of the armed forces requires temporary promotions. Postwar contraction of the services often requires officers to drop back one or two grades from their advanced temporary rank. In World War II. for instance, in the U.S. services there were many cases of permanent captains who held the rank of brigadier and even major general, and many of these, despite proved ability, had to return to the grade of colonel after the war.

The armed forces of most nations use some sort of qualification report as an important basis for selecting officers for promotion. In the U.S. services these reports are submitted periodically, usually once or twice a year, and are prepared by the immediate commander or supervisor of the officer. After the next higher coinmarider adds his comments, these reports are sent to the service headquarters in Washington, D.C., for evaluation and file. Reports are evaluated by electronic means, and each report is given a rating. The average of these ratings over a period of years largely determines whether an officer qualifies for staff college or war college, and influences his selection for promotion in the higher grades.

The British services use the qualification report system but also require a junior officer to qualify for promotion, and for attendance at staff college, by passing rigid examinations. The examination system is also used by the U.S. navy.

CONCLUSION

An officer in a modern army, air force or navy has a responsible task. The lives of many of the nation's citizens depend upon his integrity, judgment and knowledge. Probably in no other field of endeavour is a leader thrust so quickly into a position of great responsibility as is the officer in time of war.

The officer is the product of his own nation's social system. But his colleagues in the armed forces of other countries share the difficulties resulting from the increasing complexity of modern warfare, and those of controlling human organizations in battle.

These are never-ending problems that the capable officer realizes must demand his constant study—knowing full well that complete understanding is an unattainable goal.

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OFFSET, in architecture, is a slanting plane, forming a transition between a thin wall above and a thick wall below. or between varying depths of a buttress. An offset buttress is one deeper at the bottom than at the top, with the difference between the upper and lower faces taken up by one or more offsets.

OFFSET PRINTING: *see* PRINTING.

OGADAI (UGEDEI or OGOTAI) (1186–1241), son and successor of the Mongol emperor, Genghis Khan. He was chosen for the succession by his father because of the bad feeling between his two elder brothers, Jagatai and Jochi (who died in 1227). He was the first to call himself khagan (chief khan), his father having used only the title khan. Ogadai built a capital, Karakorum, in northern Mongolia, completed the conquest of north China (but not of China south of the Yangtze), and sent armies into Iran, Iraq, Azerbaijan and Russia. The Mongols destroyed many cities in Russia between 1237 and 1241. In the latter year they also defeated an army of Poles and Germans, marched through Hungary and reached the Adriatic sea. After these events Russia remained tributary to the Mongols of the Golden Horde, ruled by the descendants of Jochi, for more than 200 years. Following Ogadai's death his widow Toragana ruled as regent until 1246 when she handed over the throne to Kuyuk, her eldest son by Ogadai. (See also MONGOLS.)

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OGASAWARA-GUNTŌ: *see* BONIN ISLANDS.

OGDEN, CHARLES KAY (1889–1957), British writer and linguist, nas the originator of Basic English, a minimum language sufficient for general needs selected from English. At Cambridge, after a first class in the classical tripos (1910), he founded a penny intellectual weekly, *The Cambridge Magazine,* to which Hardy, Wells, Shaw and others contributed. In 1919 he made it a quarterly to print *The Meaning of Meaning,* a study in theory of language. The chapter on definition contained the germ of Basic English (*q.v.*), which took final form in 1928. It consists of 850 headwords, few enough to be printed on a single sheet of note paper (rules in *The System of Basic English;* usage limitations in *The Basic Words).* The system became widely known and many books were printed in it (*e.g., The Basic Bible,* 1944). In 1943, Winston Churchill appointed a committee of ministers to study extension of its use. Ogden gave evidence before this body but the attempt proved premature. His own entry in *Who's Who* reads "1944–6, bedevilled by officials." Ogden died on March 22, 1957, in London. His work remains fruitful in improved conceptions of language learning. His great collection of books on Bentham and in language theory is in the library of University college, London. (I. A. Rs.)

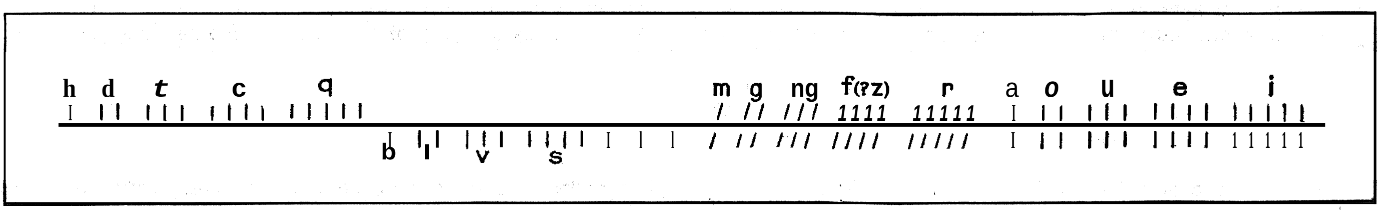
OGDEN, a city of north-central Utah, U.S., in the valley of the Great Salt lake. is located about 35 mi. N. of Salt Lake City; the seat of Weber county. A typical Utah garden city, green and tree-grown, Ogden sprawls near the foot of rough-hewn Wasatch mountain peaks on an old delta of the Ogden and Weber rivers which formed under the waters of ancient Lake Bonneville and slopes toward low-lying Great Salt lake. The Ogden river, from which comes the city's name, memorializes Peter Skene Ogden (1794–1854), a British fur trader who trapped in the mountains east of the modern city in May 1825. In 1846 the mountain man Miles M. Goodyear established Ft. Buenaventura, a log stockade with adjacent irrigated garden, on the site of Ogden, which gives the city the distinction of being the oldest continuously settled community in Utah; the "Goodyear cabin" is still preserved. Goodyear sold out to the Mormons when they arrived in 1847, and early in 1848 Capt. James Brown of the Mormon battalion was sent to take over the Goodyear property. Brownsville, as it was called for a while, was renamed Ogden after Brigham Young laid out the town in 1849, the name being selected by the legislature in 1850. The city was incorporated a year afterward, and in 1951 adopted a council-manager form of government.

After the completion of the Union Pacific railroad in 1869, Ogden became the primary rail centre of the intermountain region and a major distribution point for manufacturing, milling, canning and agricultural products, its stockyards being particularly notable. Industries include the processing of food and dairy products and the manufacture of storage batteries, jet engines, clothing and building materials. State institutions located in Ogden include an industrial school for delinquent children and a school for the deaf and blind. Weber college, founded by the Mormon church in 1889 as Weber Stake academy, and turned over to the state in 1933, was expanded from a junior to a senior college in the 1960s. Pop. (1960) 70,197; standard metropolitan statistical area (Weber county) 110,744. For comparative population figures *see* table in UTAH: *Population.* (D. L. M.)

OGHAM SCRIPT. The writing of the Ogham inscriptions is the oldest form of Goidelic with which scholars are acquainted. About 300 inscriptions have been discovered in this alphabet, the majority of them hailing from the southwest of Ireland (Kerry and Cork). In Scotland 22 are known, nhile in England and Wales about 30 have turned up. Most of the latter are in south Wales, but odd ones have been found in north Wales, Devon and Cornwall, and one occurs in Hampshire. The Isle of Man possesses two. The letters in the oldest inscriptions are formed by strokes or notches scored on either side of the edge of an upright stone. Thus we obtain the alphabet shown in the illustration.

This system, which was eked out with other signs, would seem to have been framed in the southwest of Ireland by a person or persons who were familiar with the Latin alphabet. Some of the inscriptions probably go back to the 5th century and may even be earlier. The simplest forms of Ogham inscriptions are: *Doveti maqqi Cattini, i.e.* "(the stone) of Dovetos son of Cattinos"; *Trenagusu Maqi Maqz-Treni* is rendered in Latin *Trenegussi Fili Macutreni hic jacit; Sagramni Maqi Cunatami,* "(the stone) of Sagramnos son of Cunotamos"; *Ovanos* **avi** *Ivacattos,* "(the stone) of Ovanus descendant of Ivacattus."

In the oldest of these inscriptions q is still kept apart from k (*c*), and the final syllables have not disappeared (cf. *maqqi,* O.Ir. *maicc)*; but it appears certain that in Oghamic writing stereotyped forms were used long after they had disappeared in ordinary speech. Several stones contain bilingual inscriptions, but the key



SYMBOLS OF THE OGHAM ALPHABET, ORIGINALLY USED BY THE CELTS IN BRITAIN AND IRELAND to the Ogham alphabet is supplied by a treatise on Oghamic writing contained in the Book of Ballymote, a manuscript of the late 14th century.

See R. R. Brash, *The Ogham Inscribed Monuments of the Gaedhil* (1879); R. A. Stewart hlacalister, *Studies in Irish Epigraphy, 3* vols. (1897–1907), and *Archaeology of Ireland* (1928). Welsh inscriptions are given in J. Rhys, *Lectures on Welsh Philology* (1879). The Scottish stones have also been treated by Rhys in the *Proceedings of the Scottish Society of Antiquaries* (Edinburgh, 1892). *See* also G. M. Atkinson ior the tract in the Book of Ballymote, *Kilkenny Journal of Archaeology* (1874). The Irish Christian inscriptions were published by Margaret Stokes as the annual volumes of the Roy. Hist. and Archaeol. Association of Ireland (1870–77), and have been republished by R. A. Stewart Macalister.

OGIER THE DANE, a hero of romance, identified with the Frankish warrior Autchar (Autgarius, Auctarius, Otgarius, Oggerius) of the old chroniclers. In 771 or 772 Autchar accompanied Gerberga, widow of Carloman, Charlemagne's brother, and her children to the court of Desiderius, king of the Lombards, with whom he marched against Rome. In 773 he submitted to Charles at Verona.

He finally entered the cloister of St. Faro at Meaux, and Mabillon (*Acta SS ord. St. Benedicti,* Paris, 1677) left a description of his monument there, which had figures of Ogier and his friend Benedict or Benoît, with smaller images of Roland and La Belle Aude and other Carolingian personages. In the chronicle the *Pseudo-Turpin* it is stated that innumerable *cantilenae* were current on the subject of Ogier, and his deeds were probably sung in German as well as in French. The Ogier of romance may be definitely associated with the flight of Gerberga and her children to Lombardy, but it is not safe to assume that the other scattered references all relate to the same individual. Colour is lent to the theory of his Bavarian origin by the fact that he, with Duke Naimes of Bavaria, led the Bavarian contingent to battle at Roncevaux.

In the romances of the Carolingian cycle he is, on account of his revolt against Charlemagne, placed in the family of Doon de Mayence, being the son of Gaufrey de "Dannemarche." The *Enfances Ogier* of Adenès le Rois, and the *Chevalerie Ogier de Dannemarche* of Raimbert de Paris, are doubtless based on earlier chansons. The *Chevalerie* is divided into 12 songs or branches. Ogier. who was the hostage for his father at Charleniagne's court, fell into disgrace, but regained the emperor's favour by his exploits in Italy. One Easter at the court of Laon, however, his son Balduinet was slain by Charlemagne's son, Charlot, with a chessboard (cf. the incident of Renaud and Bertholais in the *Quatre Fils Aymon*). Ogier in his rage slew the queen's nephew Loher, and would have slain Charlemagne himself but for the timely intervention of the knights, who connived at his flight to Lombardy. In his stronghold of Castelfort he resisted the imperial forces for seven years, but was at last taken prisoner by Turpin, who incarcerated him at Reims while his horse Broiefort, the sharer of his exploits, was made to draw stones at Meaux. He was eventually released to fight the Saracen chief Bréhus or Braihier, whose armies had ravaged France, and who had defied Charlemagne to single combat. Ogier consented to fight only after the surrender of Charlot, but the prince was saved from his barbarous vengeance by the intervention of St. Michael. The giant Bréhus, despite his 17 ft. of stature, was overthrown, and Ogier. after marrying an English princess, the daughter of Angart (or Edgard), king of England, received from Charlemagne the fiefs of Hainut and Brabant.

A later romance in Alexandrines (Brit. Mus. MS Royal 15 E vi) contains marvels added from Celtic romance. Six fairies visit his cradle, the sixth, Morgan le Fay, promising that he shall be her lover. He has a conqueror's career in the east. and after zoo years in the "castle" of Avalon returns to France in the days of King Philip, bearing a firebrand on which his life depends. This he destroys when Philip's widowed queen wishes to marry him, and he is again carried off by Morgan le Fay. The prose romance printed at Paris in 1498 is a version of this later poem.

The fairy element is prpminent in the Italian legend of *Uggieri il Danese,* the most famous redaction being the prose *Libro dele bataglie del Danese* (Milan, 1498), and in the English *Famous and renowned history of Morvine, son to Oger the Dane,* translated by J. M. (London, 1612).

The Spanish Urgel was the hero of Lope de Vega's play, the *Marques de Mantua.* Ogier occupies the third branch of the Scandinavian Karlamagnus saga; his fight with Brunamont (*Enfances Ogier)* was the subject of a Danish folk song; and as *Holger Danske* he became a Danish national hero, who fought against the German Dietrich of Bern (Theodoric "of Verona"), and was invested with the common tradition of the king who sleeps in a mountain ready to awaken at need. Whether he had originally anything to do with Denmark seems doubtful. The surname le Danois has been explained as a corruption of l'Ardennois and Dannemarche as the marches of the Ardennes.

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OGILBY, JOHN (1600–1676), British poet, translator and printer. a pioneer in the making of road atlases, was born in or near Edinburgh in Eov. 1600. His early career, as dancing master, tutor to the children of the earl of Strafford, with whom he went to Ireland (1633), deputy master of the Irish revels and successful proprietor of a Dublin theatre, ended when his finances were ruined by the outbreak of the Great Rebellion. Returning to England, destitute, he learned Greek and Latin and published translations of Virgil (1649), *Homer His Iliads* (1660) and *Homer His Odysses* (1665). At the Restoration, he won favour with Charles II and was entrusted with "the poetical part" of the coronation.

He returned to Ireland, where he opened another theatre, but subsequently settled in London and after the Great Fire of 1666, when he lost his property, was employed in surveying disputed property in the City. He set up as a printer with the title of "king's cosmographer and geographic printer" and produced many volumes notable for their typography and illustrations. His *Britannia . . . a Geographical and Historical Description of the Principal Roads* (1675), which formed part of a projected world atlas, was based on his own journeys on foot. and was a landmark in accurate description of the country's roads. The maps were printed on strips, the first time this method had been used for map production. As a translator and poet—he wrote epic and heroic poems which have been lost, and a play which remains unprinted—he is chiefly remembered by the ridicule of Dryden in *MacFlecknoe* and Pope in the *Dunciad,* but as a mapmaker his work had enduring value. He died in London, Sept. 4, 1676.

OGILVY, the name of a celebrated Scottish family of which the earl of Airlie is the head. The family was probably descended from a certain Gillebride, earl of Angus, who received lands from William the Lion. Sir Walter Ogilvp (d. 1440) of Lintrathen, lord high treasurer of Scotland from 1425 to 1431. was the son of Sir Walter Ogilvy of Wester Powrie and Auchterhouse. Sir Walter built a castle at Airlie in Forfarshire and left two sons. The elder of these. Sir John Ogilvy (d. c. 1484), was the father of Sir James Ogilvy (c. 1430–c. 1504), who was made a lord of parliament in 1491; and the younger, Sir Walter Ogilvy, was the ancestor of the earls of Findlater. The earldom of Findlater, bestowed on James Ogilvy, Lord Ogilvy of Deskford, in 1638, was united in 1711 with the earldom of Seafield and became dormant after the death of James Ogilvy, the 7th earl, in Oct. 1811.

Sir James Ogilvy's descendant, James Ogilvy. 5th Lord Ogilvy of Xirlie (*c.* 1541–1606), a son of James Ogilvy, master of Ogilvy, who was killed at the battle of Pinkie in 1547, took a leading part in Scottish politics during the reigns of Mary and of James I . His grandson, James Ogilvy (*c.* 1593–1666). was created earl of Xirlie by Charles I at York in 1639. A loyal partisan of the king. he joined Montrose in Scotland in 1644 and was one of the royalist leaders at the battle of Kilsyth. The destruction of the earl's castles of Airlie and of Forther in 1640 by the earl of Argyll, who "left him not in all his lands a cock to crow day," gave rise to the song "The bonny house o'Airlie." His eldest son, James, the 2nd earl (*c.* 1615–c. 1704), also fought among the royalists in Scotland; in 1644 he was taken prisoner, but he was released in the following year as a consequence of Montrose's victory at Kilsyth. He was again a prisoner after the battle of Philiphaugh and was sentenced to death in 1646, but he escaped from his captivity at St. Andrews and was afterward pardoned. Serving with the Scots against Cromwell he became a prisoner for the third time in 1651, and was in the Tower of London during most of the years of the Commonwealth. He was a fairly prominent man under Charles II and James II, and in 1689 he ranged himself on the side of William of Orange. This earl's grandson, James Ogilvy (d. 1731), took part in the Jacobite rising of 1715 and was attainted; consequently on his father's death in 1717 he was not allowed to succeed to the earldom, although he was pardoned in 1725. When he died his brother John (d. 1761) became earl *de jure,* and John's son David (1725–1803) joined the standard of Prince Charles Edward in 1745. He was attainted, and after the defeat of the prince at Culloden escaped to Norway and Sweden, afterward serving in the French army, where he commanded *le régiment Ogilvy* and was known as *le bel Ecossais.* In 1778 he was pardoned and was allowed to return to Scotland, and his family became extinct when his son David died unmarried in April 1812. After this event David's cousin, another David Ogilvy (1785–1849), claimed the earldom. He asserted that he was unaffected by the two attainders, but the house of lords decided that these barred his succession; however, in 1826 the attainders were reversed by act of parliament and David became 6th earl of Airlie. He died on Aug. 20, 1849, and was succeeded by his son, David Graham Drummond Ogilvy (1826–81), who was a Scottish representative peer for more than 30 years.

The latter's son, David William Stanley Ogilvy, the 8th earl (1856- goo), served in Egypt in 1882 and 1885, and was killed on June 11, 1900, during the Boer War while at the head of his regiment, the 12th Lancers. His titles then passed to his son, David Lyulph Gore Wolseley Ogilvy, the 9th earl (b. 1893).

A word may be said about other noteworthy members of the Ogilvy family. John Ogilvy, called Powrie Ogilvy, was a political adventurer who professed to serve King James VI as a spy and who certainly served William Cecil in this capacity. Sir George Ogilvy of Barras (d. *c.* 1679) defended Dunnottar castle against Cromwell in 1651 and 1652 and was instrumental in preventing the regalia of Scotland from falling into his hands; in 1660 he was created a baronet, the title becoming extinct in 1837.

OGLETHORPE, JAMES EDWARD (1696–1785), English general and philanthropist, the founder of the state of Georgia, was born in London on Dec. 21, 1696, the son of Sir Theophilus Oglethorpe (1650–1702) of Westbrook Place, Godalming, Surrey. He entered Corpus Christi college, Oxford, in 1714, but in the same year joined the army of Prince Eugène. He became aide-de-camp to the prince, and served in the campaign against the Turks, 1716–17, more especially at the siege and capture of Belgrade. After his return to England he was in 1722 elected member of parliament. With the idea of providing an asylum for persons who had become insolvent, and for oppressed Protestants on the continent, he projected the settlement of a colony in America between Carolina and Florida (*see* GEORGIA). In 1745 Oglethorpe was promoted to the rank of major-general. His conduct in connection with the Scottish rebellion of that year was the subject of a court-martial, but he was acquitted. In 1765 he was breveted general. He died at Cranham Hall, Essex, in 1785.

Sir Theophilus Oglethorpe, the father, had four sons and four daughters, James Edward being the youngest son, and another James having died in infancy. Of the daughters, Anne Henrietta, Eleanor and Frances Charlotte (Bolingbroke's "Fanny Oglethorpe") may be specified as having played rather curious parts in the Jacobitism of their time; their careers are described in the essay on "Queen Oglethorpe" by Miss A. Shield and A. Lang, in the latter's *Historical Mysteries* (1904). *See* also Lives by Harris (1841), Wright (1867), Bruce (1890), and Harriet C. Cooper (1904).

OGOOUÉ, a river of west central Africa, about 683 mi, long, rising in 3° S. in the highlands known as the Crystal range and flowing northwest and west, reaches the Gabon coast of the Atlantic by Cape Lopez, a little south of the equator. There it forms a considerable delta.

In its upper course the Ogooué is much obstructed by rapids as it descends the successive steps of the tablelands. It breaks through the outer chains of the mountainous zone, between 10° 45' E. and 11° 45' E. In its lower course the river passes through a lacustrine region in which it sends off secondary channels.

These channels, before reuniting with the main stream, traverse a series of lakes, one north, the other south, of the river. These lakes are natural regulators of the river when in flood. Of its tributaries the chief are the Lolo, which joins on the south bank in 12° 20' E., and the Ivindo, which enters the Ogooué a few miles lower down. Below the Ivindo the largest tributaries are the Ofooué, 400 yd. wide at its mouth (11° 47' E.), but unnavigable except in the rains. and the Ngunye, the largest southern tributary, navigable for 60 mi. to the Samba or Eugénie falls.

Apart from the narrow coast plain the whole region of the lower Ogooué is densely forested and the predominant industry of the region is the timber trade. The fauna includes the gorilla and chimpanzee.

The Ogooué rises in March and April and again in October and November; it is navigable for steamers at low water as far as the junction of the Ngunye and at flood time for a distance of 235 mi. to N'Jole. The first person to explore the valley of the Ogooué was Paul du Chaillu, who traveled in the country during 1857–59. The Ogooué lies wholly in former French Equatorial Africa.

For a vivid account of life on the lower Ogooué *see* A. Schweitzer, *On the Edge of the Primeval Forest* (1922).

O'GRADY, STANDISH JAMES (1846–1928), Irish man of letters, was born at Castletown, County Cork, on Sept. 18, 1846, the son of a Protestant clergyman, studied at Trinity college, Dublin, and after taking his degree in 1868 was called to the bar in 1872. He died at Shanklin, Isle of Wight, on May 18, 1928. O'Grady was one of the pioneers of the Celtic renaissance in Ireland. His interest in Irish antiquities was roused by the reading of O'Halloran's *History of Ireland,* and he set himself to awaken living interest in the Irish past by telling over again the Irish legends of the heroic age. He himself believed in the historical existence of the heroes of Irish epic, being convinced that primitive singers could not have invented them. His first work, *History of Ireland: the Heroic Period* (Dublin, 1878), was republished, in part, under the title of *Cuculain: an Epic,* in London (1882), and was succeeded by *History of Ireland: Cuculain and his Contemporaries* (Dublin, 1880). From these he developed his cycle of romantic histories: *Finn and his Companions* (1892), *The Coming of Cuculain* (1894), *In the Gates of the North* (Kilkenny, 1901), and the *Passing of Cuculain* (Dublin, 1917). He began a *History of Ireland, Critical and Philosophical,* of which the first volume only was written (Dublin, 1881). He also wrote *Ulrick the Ready* (1896); *The Bog of Stars* (1893); *Red Hugh's Captivity* (1889).

See Standish O'Grady, *Selected Essays and Passages* (Dublin, 1918).

OGYGES or **OGYGUS,** in Greek mythology, the first king of Thebes. During his reign came a great deluge (*see* DEUCALION); this is one of the two Greek versions of the widespread flood-legend. Ogyges is variously described as a Boeotian autochthon, as the son of Cadmus, or of Poseidon.

O'HAGAN, THOMAS O'HAGAN, 1st Baron (1812–1885), lord chancellor of Ireland, was born at Belfast on May 29, 1812. He was educated at Belfast Academical institution, and was called to the Irish bar in 1836. In 1850 he removed to Dublin, where he appeared for the repeal party in many political trials.

His advocacy of a continuance of the union with England, and his appointment as solicitor general for Ireland in 1861 and attorney general in the following year, lost him the support of the Nationalist party, but he was returned to parliament as member for Tralee in 1863. In 1865 he was appointed a judge of common pleas, and in 1868 became lord chancellor of Ireland in Gladstone's first ministry.

He was the first Roman Catholic to hold the chancellorship since the reign of James II, an act throwing open the office to Roman Catholics having been passed in 1867. In 1870 he was raised to the peerage, and held office until the resignation of the ministry in 1874. In 1880 he again became lord chancellor on Gladstone's return to office, but resigned in 1881. He died in London on Feb. 1, 1885, and was succeeded by his eldest son, Thomas Towneley (1878–1900), and then by another son, Maurice Herbert Towneley (1882–1961).

O'HARA, THEODORE (1820–1867), **U.S.** lawyer, soldier, journalist and poet, was born Feb. 11, 1820. He served with distinction in the U.S. army in 1846–48 during the Mexican War, took part in the filibustering expeditions to Cuba and was with the Confederate army during the U.S. Civil War. He wrote the well-known poem "The Bivouac of the Dead" in memory of soldiers who died at the battle of Buena Vista.

O. HENRY: see HENRY, O.

O'HIGGINS, BERNARDO (1778–1842), one of the foremost leaders in the Chilean struggle for independence and head of the first permanent national government, was a natural son of the Irishman Ambrosio O'Higgins, governor of Chile (1788–95), and was born at Chillán on Aug. 20, 1778. He was educated in England, and after a visit to Spain he returned to Chile in 1802 where he lived quietly on his estate until the revoiution broke out in 1810. Joining the nationalist party led by Martinez de Rozas, he distinguished himself in the early fighting against the royalist troops despatched from Peru, and was appointed in Nov. 1813 to supersede J. M. Carrera in command of the patriot forces. The rivalry that ensued, in spite of O'Higgins' generous offer to serve under Carrera, eventually resulted in O'Higgins being isolated and overwhelmed with the bulk of the Chilean forces at Rancagua in Oct. 1814.

O'Higgins with most of the patriots fled across the Andes to Mendoza, where José de San Martin (*q.v.*) was preparing a force for the liberation of Chile and Peru. San Martin espoused O'Higgins' part against Carrera, and O'Higgins, recognizing the superior ability and experience of San Martin, readily consented to serve as his subordinate. The loyalty and energy with which he acted under San Martin contributed not a little to the organization of the liberating army, to its transportation over the Andes, and to the defeat of the royalists at Chacabuco (Feb. 1817) and Maipú (April 1818).

After the battle of Chacabuco O'Higgins was entrusted with the administration of Chile, and he ruled the country firmly and weil, maintaining close connection with Argentina, co-operating loyally with San Martin in the preparation of the force for the invaiion of Peru, and seeking, as far as the confusion and embarrassments of the time allowed, to improve the welfare of the people. After the overthrow of the Spanish supremacy in Peru had freed the Chileans from fear of attack, an agitation set in for constitutional government. O'Higgins at first tried to maintain his position by calling a congress and obtaining a constitution (1822) which invested him with dictatorial powers. But popular discontent grew in force; risings took place in Concepción and Coquimbo, and on Jan. 28, 1823, O'Higgins resigned his post of director general, without attempting to retain it by force. He retired to Peru, where he was granted an estate and lived quietly till his death on Oct. 24, 1842. In 1839 the Chilean senate restored him to his honours and his military rank.

See B. Vicuña Machenna, *Vida de O'Higgins* (Santiago, 1882), and M. L. Armunàtegni, La *Dictadura de O'Higgins* (Santiago, 1853); both containing good accounts of O'Higgins' career, Also P. B. Figueroa, *Diccionario biográfico de Chile, 1550–1887* (Santiago, 1888), and J. B. Suarez, *Rasgos biográficos de hombres notables* de ***Chile*** (Valparaiso, 1886).

O'HIGGINS, KEVIN CHRISTOPHER (1892–1927), Irish statesman, youngest son of Dr. T. Higgins (who was murdered by unknown men in 1923), of Stradbally, Queen's county, was born in 1892 at Stradbally and educated at Clongowes and St. Patrick's college, Carlow, and in the National University of Ireland. He was articled to his uncle Maurice Healy, a solicitor in Cork. After the Easter rebellion in 1916 he joined the Sinn Fein movement, and was interned. While still in jail he was elected member for Queen's county (1918). He acted as assistant minister for local government to Mr. Cosgrave, and in 1922 became a member of the provisional government as minister of justice and vice president of the executive council. As minister of justice he established the civic guard, and put down disorder with a strong hand. He was called to the Irish bar in 1923, and in June 1927 added to his existing duties those of minister for external affairs.

In the midst of the controversy with De Valera over the taking of the oath in the Dail he was waylaid by three armed men while on his way to mass at Booterstown, outside Dublin, and shot dead (July 10, 1927). It was believed that the crime was connected with the fact that, as minister of justice, O'Higgins had been largely responsible for the 77 executions which were carried out in the course of the civil war. He married Bridget Mary Cole, of Dublin, in 1921, who, with the two children of the marriage, survived him.

O'HIGGINS, an inland province of central Chile. bounded north by Santiago, east by Argentina. and south and west by Colchagua. Area. 2.746 sq mi.; population (1960) 259.135. Named after Bernardo O'Higgins. the first president of the republic of Chile, the province nas included with that of Colchagua from 1928 to 1933, inclusive. Most of the western half of the province lies in the central valley of Chile, whose surface is interrupted in many places by the alluvial piedmont slopes of the Andes and the transverse valleys of perennial streams which have their sources in the snow-capped summits of the cordillera. The climate of the western part of the province is typically Mediterranean, with summers that are hot and rainless and winters that are mild and rainy. Eastward the climate reflects the control of increasing altitude; temperatures are lower, rainfall is heavier and much of the precipitation nhich falls in the winter is in the form of snow. The streams which give life to the central valley during the long. dry summer are fed by the melting snows of the high Andes. Under irrigation the valley lands are highly productive, although only a small fraction of the total area is under cultivation.

The principal crops on irrigated lands are wheat, corn, barley. oats, alfalfa, clover, legumes and grapes; the bulk of the nonirrigated land is pasturage having a low carrying capacity. Mining is carried on in the eastern highlands, the province being widely known for its production of copper.

Rancagua. the capital of the province (population 61.832 [mun.] in 1900). is in central O'Higgins, 51 mi. south of the nation's capital on the State railways. Rengo, the second largest city (26.257 [mun] in 1960), is about 20 mi. S.S.W. of Rancagua. Both cities are centres of commerce for the surrounding agricultural districts. The province is particularly noted for its hot springs and mineral waters, and many popular health resorts are within relatively short distances from the capital. Termas de Cauquenes (Cauquenes hot springs), significant in the history of the emancipation of Chile, and the most important centre of mineral waters in the country, is slightly more than 80 mi. by car E.S.E. from Rancagua. Also famous are the mineral waters of El Teniente and Baños de Cachantun, the latter being only 15 mi. from the provincial capital. (R. W. RD.)

O'HIGINN, TADHG BALL (O'HIGGIN, TEAGUE) **(d.** 1616), Irish poet, also known in Irish writings as Tadhg dall Ua hUiginn, was born at Magh Nenda, the plain between the rivers Erne and Drobhais on the southern boundary of Ulster. He was blind most of his life, and this accounts for his Irish sobriquet "dall."

O'Higinn advocated Irish nationalism in his poems, exhorting the Irish to unite their nations or clans and resist the English. His earliest extant poem was written before 1554. It was a work of 50 stanzas written to Eoghan óg MacSuibhne na dtuath to urge him to make friends with Shane O'Neill and Manus O'Donnell. He wrote a 52-verse panegyric on the O'Neills in 1573 entitled "Imda sochar ag cloinn Neill" ("Many the privileges belonging to the children of Niall"). He praised the residence of Shane O'Neill in a poem "Lios greine as Emhain dUlltaibh" ("A sunny fort is an Emania to Ulstermen"). In this poem he compared it to Emhain Macha, or Emania, nhich was the residence of the ancient kings of Ulster. About 1588 he wrote an address of 70 stanzas to Sir Brian na Murtha O'Rourke advising him to take the offensive against the English. Between 1566 and 1589 he wrote a 39-stanza poem "Mairg fhechus ar inischeithleann" ("Woe for him that looks on Enniskillen").

His last poem was "Sluagseisir tainic dom thig" ("A band of six men came into my house"). This was a satire on the six O'Haras who looted his house. A translation by S. H. O'Grady was printed with the original poem. O'Higinn died shortly before 1617.

OHIO, a north-central state of the United States, is bounded on the north by Michigan and Lake Erie, on the east by Pennsylvania and the Ohio river; the entire southern boundary is the river, separating Ohio from West Virginia and Kentucky, while on the west lies Indiana. Ohio's relatively square shape is reflected by its dimensions, the maximum length (north to south) being 220 mi. and width 225 mi. Its area of 41.222 sq.mi. excludes 3,457 sq mi. in Lake Erie and includes 250 sq.mi. of inland water surface. Lake Erie washes 184 mi. of its northern edge. Although only 35th in size and smaller than every state west of it except Indiana and Hawaii, Ohio ranked fifth in population in 1960. Admitted to the union in 1803 as the 17th state, Ohio was the first to be carved from the Northwest territory. The capital has been Columbus since 1816. Its popular name the "Buckeye state," emanates from the prevalence of the buckeye chestnut (*Aesculus glabra*). The state flower is the scarlet carnation. the bird is the cardinal, and the motto (adopted 1959) is "With God, All Things Are Possible." The state flag (adopted 1902) is the only one of burgee shape. Its triangular blue field bearing 17 white stars and a red circle (symbolizing the buckeye) in a white "O" is complemented by five horizontal alternating red and white stripes. The great seal of the state of Ohio (adopted prematurely in 1802 and modified several times thereafter) depicts the sun rising over a mountain range (reputedly the Mt. Logan chain in Ross county) in the background and shocks of wheat in the foreground.

PHYSICAL GEOGRAPHY

Physical Features. — Like its population and its economy, Ohio's topography is a composite. The state lies approximately between 38° 27' and 41" 57' N. lat., and between 80° 34' and 84° 49' W. long. The encroachment of the great glaciers of the Ice Age was largely responsible for Ohio's physical appearance for, as the ice sheets spread over the state, they leveled hilly terrain and created a flat or gently rolling surface noted for its fertility. The southeast, beyond the glaciers' penetration, is characterized by steep elevations. deep valleys and soil ill-suited to farming. Much of this section has been relatively unexploited.

Its singular location endowed Ohio with the characteristics of three different physiographic provinces — the Lake plains. the Central plains (or central Lowland), and the Allegheny plateau. The juncture of the three sections is near Cleveland, but the last two abut approximately through the centre of the state, north to south. The Lake plains area, encompassing northwest Ohio and a strip along the Lake Erie coast, was once entirely under water. It emerged monotonously flat and swampy, and not until drainage projects were successfully undertaken in the late 19th century could its fertile soil be used to good advantage. The Central plains embrace the western and southwestern counties. Having undergone much erosion prior to the coming of the glaciers, this area was consequently rather uniformly covered by the vast ice sheets, creating a comparatively level surface with soil of considerable depth. To the east, the Allegheny plateau includes both glaciated and unglaciated areas. The counties lying south of the terminal moraine (the limit of the glaciers' advance) lack the arable soil and the extensive pasture lands of the counties of the north and nest. On the other hand, the unglaciated regions offer rugged and spectacularly beautiful terrain noted especially for caves, precipitous valleys and breath-taking rock formations.

Ohio's average elevation above sea level is approximately 850 ft. The extremes, both of which occur in the Central plains, are 1,550 ft., near Bellefontaine, and 433 ft., on the Ohio river bank near Cincinnati. Most of the state rises to between 550 and 1.300 ft. in elevation.

A notable topographical feature of Ohio is the watershed which traverses the state from the middle of the western boundary to the northeast corner. Above the watershed, rivers flow north into Lake Erie. They are short and their courses are not parallel. Below it, the rivers flowing south to the Ohio river are about three times as long as their counterparts to the north, and they drain about 70% of the state's surface. Several gaps in the divide facilitated the development of transportation and, with the aid of easy portages. made possible important north-south water routes employing the Maumee and Miami rivers, the Sandusky and Scioto rivers, and the Cuyahoga-Tuscarawas and Muskingum rivers. Of lesser significance are the Huron, Vermilion and Black rivers in the north, the Olentangy, Licking. Hocking and Little Miami in central and southern Ohio, and the Grand and Mahoning in the east. The Ohio river flows for about 435 mi. through a narrow valley along southeastern and southern Ohio but it is not legally within the boundaries of the state. At various times the Ohio and some of the interior rivers have overflowed their banks, causing disastrous floods. So great a catastrophe occurred in 1913, especially at Dayton, that Ohio took steps to prevent a recurrence of the tragedy by establishing the Miami conservancy district (and later the Muskingum conservancy district). The 1914 law authorizing this action, which consisted basically of constructing a series of dams to control streams in their upper reaches, mas the first of its kind in the United States. The federal government built 19 dams on the Ohio river which have also substantially reduced the flood threat. A few serious floods have occurred since 1913 but their effects have been greatly mitigated by the existence of the dams.

Excellent natural harbours have helped to make Toledo, Sandusky, Lorain and Cleveland important lake ports. In the state are more than 100 lakes exceeding 40 ac. each in size. Twenty-seven of these are natural nhile the rest were man-made, some of them constructed originally as canal reservoirs. The latter include 16,000-ac. Lake St. Marys (Grand Reservoir), Lake Loramie, Indian lake and Buckeye lake.

Climate. — The principal characteristics of Ohio's climate are its changeability and its extremes of temperature. The result is a seasonal variation which to some extent compensates for extremes of heat and cold. high humidity and the like. The average annual temperature is a moderate 51.2° F., with the northern section at 49° about 6° lower than the southern. In the summer, of nhich July is usually the hottest month, the temperature averages 71.6°, and in the winter 29.8" with January customarily coldest. The recorded extremes of —39" at Milligan in Feb. 1897, and of 113° near Thurman in July of that year and at Gallipolis in July 1934, are seldom closely approached, but it is not uncommon for the temperature to vary as much as 100° within a year. Precipitation, averaging about 38 in. per year, is slightly heavier in the summer. The 21-in. average for the six months commencing April 1 exceeds that of the rest of the year by 4 in. The south receives 44 in. of rain, snow, etc, in an average year as compared with 32 in. in the north. The average annual snowfall presents a greater contrast; only 15 in. in the southern counties, it reaches 40–45 in. in the northern, producing a state-wide average of 27.8 in. Farmers usually can expect a growing season of 150–180 days, with those close to Lake Erie enjoying nearly 200 frost-free days.

Soil. — The nature and quality of the soil differs markedly between one section of the state and another. The southeast, which mas deprived of the deep and fertile drift deposited by the glaciers and in which the soil is largely residual sandstone and shale, is the least arable and productive. The glacial sandstone soil of central and northeastern Ohio supports some general farming but is best suited to grazing and pasture lands for the important dairy industry. The soil of the lower two thirds of the western half of the state, composed principally of glacial limestone, is the richest of all. To the north lies the second most prosperous agricultural area. There, after the vast swamps had been drained, the limestone soil was found to be highly productive.

Vegetation. — Dense forests formerly covered nine tenths of Ohio. Early explorers and woodsmen; as well as the first generation of settlers, literally disappeared from view after they crossed the Ohio river. So thick were the trees that for many years wisps of smoke rising here and there through the leafy overhead were the only visible signs of habitation. The most prevalent types were beech, oak, hickory, maple and chestnut, with others, especially pine, elm, ash and buckeye, occurring in smaller numbers. The forests which yielded the timber for buildings and furniture, fences and fuel, at the same time presented a serious obstacle to the settler's search for a livelihood through farming. Countless trees were burned to clear the land. Some of these have been replaced by second-growth trees, of which the commonest are oak, hickory, white elm, ash, beech, maple, willow. sycamore and yellow poplar. Most of the approximately 15% of Ohio that is woodland is set aside in protected preserves. Twenty of these are state forests, of which 35,000-ac. Shawnee State forest near Portsmouth is the largest. In addition to trees, both wild and domesticated flowers thrive throughout the state.

Animal Life. — Although some animals and birds common to Ohio as recently as the 19th century have since become extinct, at least 60 species of wild animals and about 175 species of songbirds still occur in significant numbers. Most of the animals are small —*e.g.,* rabbits, squirrels, foxes, raccoons, opossums and skunks — but there have been increasing numbers of some larger animals, including deer. Represented among the songbirds and birds of prey are most of those normally found in the temperate zone. So abundant are the 170 kinds of fish, among them bass, trout, pike, perch and muskellunge, that Ohio became the first state to remove all restrictions on fishing as to season and number and size of fish caught.

State and National Parks. — Ohio has two national parks: Perry's Victory monument at Put-in-Bay and the 68 ac. prehistoric Mound City group north of Chillicothe. State parks include historic, archaeological and natural history sites administered by the Ohio Historical society, as well as recreational facilities under the department of natural resources and the highway department.

Historic Sites and Museums. — Many historic sites are preserved and maintained by historical societies or other organizations. Stressing variously exhibit museums, historic buildings, research libraries and publications, numerous counties support historical societies, of which the best-known are those of Ross, Allen, Stark and Lucas counties. Of regional significance are the Western Reserve Historical society at Cleveland and the Historical and Philosophical Society of Ohio at Cincinnati. The state-supported Ohio Historical society has headquarters at the Ohio State museum at Columbus. The museum itself houses exhibits and extensive collections related to Ohio history, archaeology and natural history, and a specialized research library of more than 1,000,000 manuscripts, books, periodicals, newspapers and maps. There also are published the Ohio Historical *Quarterly* and other periodicals, leaflets and books. The society administers 60 properties throughout Ohio, including the birthplaces or residences of Thomas Worthington at Chillicothe, William T. Sherman at Lancaster, Rutherford B. Hayes at Fremont, Ulysses S. Grant at Point Pleasant, Benjamin R. Hanby at Westerville, and Paul Laurence Dunbar at Dayton. "Adena" at Chillicothe, "Glendower" at Lebanon, and the McCook house at Carrollton are interesting architectural examples. Reconstructed Schoenbrunn village and Gnadenhutten monument pay reverent tribute to the Moravian missionaries and their Indian converts. The Indian wars are commemorated at forts St. Clair, Jefferson, Recovery, Meigs and Miami and at the site of the battle of Fallen Timbers. Other historical state memorials range from the Friends' Yearly meetinghouse at Mount Pleasant to the site of the battle of Buffington Island. In addition to the famous glacial grooves on Kelleys island, the natural history areas include Cedar Swamp, Fort Hill and Flint Ridge. Prominent among the archaeological sites are Ft. Ancient, Great Serpent mound, Newark earthworks and Inscription rock on Kelleys Island.

The state is unique in the diversity of museums devoted to transportation. Automobiles are featured at the Thompson Automotive museum at Cleveland (besides private collections), aircraft at the Air Force museum at Dayton, steamboats and other river craft at the River museum at Marietta, lake vessels at the Great Lakes Historical society's Wakefield museum at Vermilion, and locomotives, interurbans and streetcars (some operating over nearly a mile of track) at the Ohio Railway museum at Worthington.

HISTORY

Prehistory. — In Ohio have been found identifiable remains of Asiatic migrants who developed a culture known as the Archaic (see ARCHAEOLOGY: Anglo-America: Archaic). Dwelling primarily along rivers, these people appeared in the western hemisphere about 5,000 to 7,000 years ago. They led a sedentary life and produced artifacts fashioned from bone, shell, flint and antler, but did not engage in agriculture and made little pottery. Archaic man was the first of a series of prehistoric peoples whose occupancy of the Ohio region has been conclusively established. The principal succeeding groups have been designated the Adena, Hopewell and Fort Ancient cultures. From 1901 when the Adena culture was first discovered near Chillicothe, many other examples have been located in the state. Intensive study of such evidence has enabled archaeologists and anthropologists to construct a revealing picture of the Adena people. They had flat heads, deliberately deformed in infancy, but they were more robust than their Archaic predecessors. That they possessed more artistic skill is apparent in the pottery and in the copper and mica ornaments they made. They cultivated certain vegetables, constructed circular dwellings and erected burial mounds which have inspired for them as well as for other prehistoric peoples the name Mound Builders. The Adena culture can be traced to as early as 800 B.C. The terminal date for the Adena culture is A.D. 800, while the extremes for the Hopewell culture which followed it range from 600 B.C. to A.D. 1500. The Hopewell Indians not only hunted, fished: farmed and traded with other peoples, but they made and deposited in their mounds exquisitely carved pipes and expertly executed ornaments of mica, copper, pearl and shell. The most visible evidence of their culture outside of museums is the number of remarkable effigy mounds and other earthworks they constructed. Among those still standing are Ft. Ancient (*q.v.*) in Warren county and the Newark earthworks in Licking county. (See also HOPEWELL; MOUND BUILDERS.)

The Hopewell people represented the apex of prehistoric cultural attainment in the Ohio valley. When they disappeared, they were followed by Indians about whom surprisingly little is known and whose period is designated Late Woodland. For 300 years or more preceding the arrival of European explorers in the Ohio region and probably surviving into the historic period, a people called Fort Ancient occupied parts of Ohio. This name has given rise to considerable confusion because the Ft. Ancient earthworks, as mentioned above. were actually built by the Hopewell and not until later occupied by the so-called Fort Ancient people. One well-supported theory is that the Shawnees were immediate descendants of the Fort Ancient group.

The French and British. upon penetrating the Ohio valley, found Indians representing four major tribes and several lesser ones. Dominating the region were the Miamis, Shawnees, Wyandots and Delawares: but they shared the scene to some extent with the Eries: Ottawas, Tuscaroras and Mingoes, or Senecas. These tribes produced some of the most famous American Indian warriors and statesmen, among them Tecumseh, Blue Jacket and Cornstalk (all Shawnee); Tarhe the Crane (Wyandot); Little Turtle (Miami); Buckongahelas (Delaware); and Pontiac (believed by some to have been an Ohio-born Ottawa). The Indians, who numbered a probable maximum of 15.000 in Ohio in the mid-18th century, resisted white settlement. Their opposition decreased after their defeat in the battle of Fallen Timbers (1794). Most tribes had departed from Ohio well before the final exodus of the Wyandots in 1842.

Exploration and Settlement. — A young Frenchman, René Robert Cavelier. sieur de La Salle, is generally acknowledged to have been the first white man to explore the Ohio country. La Salle set out from his estate near Montreal in 1669 to journey into the country south of Lake Erie. This exploration provided the basis for a French claim to the Ohio valley which was hotly contested by Great Britain through much of the following century. British assertions of ownership, as time went on, were predicated upon the increasing activity of traders. By their royal charters, which were sometimes contradictory, several colonies were granted all or part of this region. Virginia, for example, laid claim to a fan-shaped area stretching to the Pacific ocean and encompassing all of the Ohio country Pennsylvania's charter, on the other hand, conflicted with this and defined part of the Ohio country as being under that colony's jurisdiction. The French and British competed not only for control of the land but also for the favour of the Indians. In 1749 France took the initiative by sending Pierre Joseph de Céloron de Blainville down the Ohio river, along which he buried, at intervals, lead plates claiming French ownership. He returned to the St. Lawrence by way of the Great Miami and Maumee rivers and Lake Erie. His journey had little practical effect, however, and English traders continued their operations there. Moreover! a Virginia group known as the Ohio company in 1750 sent Christopher Gist, a veteran woodsman and trader, into and across Ohio to the Miami river town of Pickawillany. The diary Gist wrote, which has come to be regarded as one of the most important contributions to the literature on early Ohio, provided the information his employers sought relative to the nature of the country and the Indians. His mission also aroused the suspicions of the Pennsylvania traders and stimulated the hostility of the Indians who were apprehensive of white interest in their lands. The Anglo-French rivalry grew more intense during the 1750s. After an expedition dispatched from Virginia in 1753 and headed by George Washington failed to discourage French intentions to erect a string of forts through the Ohio valley, Governor Dinwiddie ordered construction of a fort on the site of present Pittsburgh (Feb. 1754). Before its completion, French forces seized it and named the strategic installation Ft. Duquesne. A detachment of French soldiers was surprised and captured at Great Meadows by Virginia troops under Washington's command, but shortly thereafter, on July 3, 1754, he and his men were obliged to surrender to a larger force, forfeiting to the French the control of the Ohio valley. This series of events triggered the French and Indian War (*q.v.*). The British successfully overcame the opposition of the French and their Indian allies by 1760. By the terms of the treaty of 1763, France surrendered to England its claims to Canada and the eastern half of the Mississippi valley.. One of the decisive events of the war had been the capture of Ft. Duquesne which the British renamed Ft. Pitt, for William Pitt whose brilliant statesmanship was partly responsible for the ultimate victory.

Although the French threat in eastern North America had been removed, the Indians in this territory continued to pose a serious problem. Uniting under the leadership of the Ottawa chieftain, Pontiac, they launched a campaign in 1763 which resulted in the capture of several forts and which was broken finally by the successful defense of Detroit and Ft. Pitt. In the following year the appearance of Col. Henry Bouquet with 1,500 men at the site of present Coshocton so impressed the Indians that they agreed to terms and released more than 200 captives, some of whom had been prisoners since childhood. Anxious to prevent further trouble with the Indians and to ,deter the expansion of the American colonies, England issued the Royal Proclamation of 1763 forbidding settlement west of the Alleghenies. This and other acts and policies during the next decade contributed to the resentment which culminated in the American Revolution. The victory bf the colonies brought not only recognition of independence but also theoretical possession of the lands east of the Mississippi. It remained for physical control to be asserted. Although not a major battleground during the American Revolution, the Ohio country was caught up in the maelstrom of Indian raids against Kentucky and Pennsylvania and retaliatory forays by Americans. It is a tragic footnote to history that the greatest atrocity of the war (and one of the most brutal massacres of all time) was perpetrated in Ohio by Americans. The Moravian Brethren, led by David Zeisberger, John Heckewelder and others, had been active in the 1770s in bringing Christianity to the Ohio Indians. primarily the Delawares. They established missions which became small Christian Indian villages, the original one in 1772 being Schoenbrunn, near present New Philadelphia (*q.v.*). Because of their pacifism and neutrality, these Indians were viewed with suspicion by both the Indians who sided with the British and the American frontiersmen. At length the converts were removed to the Sandusky region and made virtual prisoners of the Wyandots living there. Facing starvation, however, a group of them was permitted to return to the Tuscarawas river in northeastern Ohio to gather the corn they had abandoned in their fields. They were so engaged on March 7, 1782. when Capt. David Williamson and about 90 volunteer militiamen, mostly from the Pittsburgh area, arrived on the scene. Seeking revenge for recent depredations committed by other Indians, the Pennsylvanians held a kangaroo court and decreed death for the innocent Indians. The next morning, at the settlement of Gnadenhiitten, the prisoners were led from their cabins in pairs and slaughtered in cold blood. Only two boys escaped the fate that befell 62 adults and 34 children. As two leading authorities on Ohio history have expressed it, "the murder by a band of frontiersmen, supposedly Christians, of a group of noncombatant neutrals who had been taught to regard nonresistance as a Christian virtue is almost without parallel" in the annals of warfare. (E. H. Roseboom and F. P. Weisenburger, *A History of Ohio*, new ed. [1953], courtesy The Ohio Historical Society) Although Cornwallis had surrendered at Yorktown six months earlier, this massacre touched off what became known as "the bloody year" in the Ohio country. Of the incidents that followed, perhaps the most memorable was the capture of Col. William Crawford who had been elected by popular vote to carry the fight into the interior of Ohio. His command included many of Williamson's men whose presence aroused the Indians. The latter not only repelled the invasion but also captured Crawford whom they tortured unmercifully and burned at the stake in June 1782. The end of hostilities, though not the end of Indian resistance, came six months later.

The Northwest Territory.—Great Britain's cession of the area south of the Great Lakes and east of the Mississippi left the U.S. government faced with the complicated problem of providing for systematic settlement and administration. The situation was further muddled by the conflicting claims laid by several of the individual states upon the region (the Northwest territory, as it was to be designated, or, more formally, the Territory Northwest of the River Ohio). The other states demanded that title to these lands be transferred to the national government before they would agree to ratify the Articles of Confederation in 1777. New York was the first to comply, in 1780 (its claim was the most tenuous), followed by Virginia in 1784, Massachusetts in 1785 and Connecticut in 1786. Certain small areas were reserved, however, to be granted to war veterans, principally the Virginia military tract in southern Ohio and Connecticut's Western Reserve in the northeast. Two legislative measures of fundamental importance completed the foundation for the development of Ohio. These were the Land ordinance of 1785, establishing a system of surveying the land into six-mile square townships, and the Ordinance of 1787 (the Northwest ordinance), providing that a territorial government would at first administer the region, which would ultimately enjoy representative government and finally be divided into at least three but not more than five states. The pattern of settlement that followed gave Ohio a rather conglomerate population. From New England came members of the second Ohio company (*q.v*), recently formed, nho disembarked at the confluence of the Ohio and Muskingum rivers in April 1788, and founded Marietta, the state's oldest permanent settlement. This became the seat of the territorial government with the arrival three months later of Gen. Arthur St. Clair, the first governor of the Xorthwest territory. New Englanders, largely from Connecticut, also settled the Western Reserve, beginning with Cleveland in 1796. Meanwhile, Judge John Cleves Symmes of New Jersey headed a combine which secured a grant of approximately 250.000 ac. on the Ohio river between the Great Miami and Little Miami rivers. Cincinnati (1789) was destined to become the most important settlement in the so-called Symmes purchase. To the Virginia military tract, lying between the Scioto and Little Miami rivers, came growing numbers of Virginians, founding first Massieville in 1790, then Chillicothe in 1796 and ultimately other towns. This district would soon achieve great prominence in the development of Ohio. In addition to these relatively large groups of settlers, Ohio was peopled by Kentuckians from across the river, Pennsylvanians who moved westward, and even a sizable band of French citizens, who landed on the bank of the Ohio in 1790 and found a primitive wilderness instead of the promised civilized metropolis; they adapted to the rigorous conditions and carved out the town of Gallipolis (*q.v.*).

The treaty of Paris in 1783 removed neither of the menaces confronting Americans in the northwest. The British refused to withdraw their troops from the forts at Detroit, Sandusky, Michilimackinac and other posts on American soil. Their justification rested upon the nonpayment of private American debts to English merchants in accordance with the terms of the treaty. Continued occupancy of the forts was much to their advantage since it gave them control over the lucrative fur trade as well as the Indians who already were hostile toward the westward-moving Americans. The British finally evacuated these posts as a result of the treaty negotiated by John Jay in 1794, but by that date the Indian threat had been disposed of by the use of American arms.

Treaties made before 1790 with various more peaceful tribes were of little avail, for the bellicose Shawnees and others contended that no pact was binding unless acceptable to all the tribes. The increasing audacity of the Indians in their raids against the settlers prompted congress in 1790 to authorize the president to send the militia from Virginia, Kentucky and part of Pennsylvania to Ft. Washington at Cincinnati to launch a punitive campaign. In that year Gen. Josiah Harmar led a poorly trained and ill-equipped army as far as the site of present Fort Wayne, Ind., burning several Indian villages, but a third of his force was routed in encounters with the enemy. Harmar was exonerated personally but he was superseded in command by Gov. St. Clair in 1791. St. Clair had partially executed his plan of erecting a series of forts between the Ohio river and Lake Erie when at dawn on Nov. 4, 1791, Indians led by Little Turtle attacked without warning and decimated St. Clair's garrison. The assignment went next to Maj. Gen. Anthony Wayne, a Revolutionary War hero who had later fought the Creeks in Georgia. Wayne arrived at Cincinnati in the spring of 1793 with 2,500 men. Determined to instill discipline and to prepare his men for frontier fighting, he trained them for months before moving northward late in the year. While wintering at the newly erected Ft. Greene Ville, Wayne ordered construction nearby of another stockade, which was to be called Ft. Recovery, upon the site of St. Clair's defeat. When the British rebuilt Ft. Miamis in 1794, Wayne countered with a new fort, appropriately named Defiance, at the junction of the Auglaize and Maumee rivers. A decisive battle put an end to the Indian menace in Ohio and opened the land to settlement. At Fallen Timbers, a site above the present city of Maumee, where numerous trees, toppled by a hurricane two years earlier, afforded the Indians effective cover, Blue Jacket waited with more than 2,000 warriors. There in less than one hour on Aug. 20, 1794, the issue was resolved, for Wayne's thoroughly trained force charged through the brush, broke the Indians' left flank and left them demoralized and beaten. Further resistance was halfhearted and ineffectual, and on Aug. 3, 1795, more than 90 Indian leaders met with Wayne and other representatives of the United States and signed the treaty of Greene Ville. By its terms hostilities ceased and the Indians surrendered all of the territory east and south of a line extending from the Ohio river opposite the mouth of the Kentucky north to Ft. Recovery, east to a point above Ft. Laurens, and north to Lake Erie. This treaty, a milestone in the nation's early history, was honoured by the vanquished Indians until Tecumseh went on the warpath in the War of 1812. The Indian capitulation, coupled with the provisions of Jay's treaty, at long last gave the United States actual as well as nominal jurisdiction over land it had owned since 1783. In the next quarter of a century the Indians relinquished, either by cession or by sale, the remainder of their lands in Ohio.

Statehood. — Wayne's victory so expedited immigration into the Northwest territory that Ohio's population had reached 45,365 by 1800. Meanwhile, in accordance with the Ordinance of 1787, representative government had been achieved in 1799. The lower house of the legislature consisted of 22 elected members, 15 from the counties which would ultimately become Ohio and the others from the rest of the territory. From the names submitted by the lower house, Pres. John Adams chose five to constitute the council, or upper house. St. Clair continued as governor with curtailed authority, and the first territorial delegate to congress was William Henry Harrison. Since the population requirement for statehood was only 60.000, attainment of this goal, although it was opposed by St. Clair, appeared imminent. St. Clair's determination to forestall Ohio statehood stemmed in part from his Federalist beliefs as opposed to the strong Republican tendencies prevailing among the people of the territory. He proposed a division of the territory through the Scioto valley, the stronghold of Republicanism, with seats of government at Marietta and Cincinnati, the original and present capitals, respectively, and a third probably at Vincennes. St. Clair's plan was doomed, for the pro-statehood faction, led by Thomas Worthington and Edward Tiffin of Chillicothe, former Virginians, enlisted the support of Pres. Thomas Jefferson, and congress passed an Enabling act which received his signature on April 30, 1802. The 35 delegates to Ohio's first constitutional convention met at Chillicothe on Nov. 1 and after only 25 days emerged with an instrument of government for the new state. The legislature convened for its initial session on March 1, 1803, the year usually regarded as the one in which statehood was actually achieved. Because it had never been so designated officially, however, the U.S. congress by joint resolution in 1953 (Ohio's sesquicentennial year) declared March 1, 1803, to be the date of Ohio's admission as the 17th state of the union. The Jeffersonian Republicans dominated the new government, with Tiffin becoming the first governor and Worthington joining John Smith of Cincinnati as the first Ohioans to sit in the U.S. senate. Jeremiah Morrow of Warren county was Ohio's lone representative in the house for five consecutive terms. The state government was established at Chillicothe, where the new state house was the first public building constructed of stone in Ohio. Apparent political chicanery moved the capital to Zanesville from 1810 to 1812. It returned to Chillicothe in the latter year but was permanently located in 1816 in the centrally located, newly platted town of Columbus.

Ohio's early history is studded with noteworthy events, some to be recalled in later years with greater pride than others. The strange and seemingly nefarious scheme of Aaron Burr, the discredited former vice-president, inspired great excitement in 1806. Using Blennerhassett Island in the Ohio river below Marietta as a base of operations, Burr mustered a small expeditionary force which aroused the suspicions of the state government. The militia was called out and boats and supplies were confiscated. The Virginia militia wrecked Harman Blennerhassett's island mansion but Burr had moved on to the southwest; he was eventually returned and tried for treason.

The War of 1812. —Ohio's geographical position gave it a degree of importance in the War of 1812. Indignant over Gen. William Hull's ignominious surrender of Detroit to the British in 1812, forfeiting control of Lake Erie and the Michigan country, and over Gen. James Winchester's disastrous defeat at the Raisin river (Monroe, Mich.) in Jan. 1813, Ohioans turned to Gen. William Henry Harrison for a restoration of American prestige. Harrison had added to his public stature two years before by a foray at Tippecanoe creek (Indiana) against Indians united under Tecumseh, who, however, was absent at the time. In 1813 Harrison successfully endured a British siege of Ft. Meigs at the mouth of the Maumee river and Maj. George Croghan with one cannon and 150 men withstood an enemy assault upon Ft. Stephenson on the Sandusky river, but it was still impossible to mount an offensive until control of Lake Erie could be wrested from the British. This was accomplished in Sept. 1813, by the victory of Oliver Hazard Perry's small fleet at the battle of Lake Erie, off Put-in-Bay. Harrison pursued the advantage by invading Canada, where he registered a decisive conquest in the battle of the Thames River a few weeks later. The death of Tecumseh in this battle signaled the end of the Indians' organized support of the British, and the United States controlled the west throughout the balance of the war.

The fledgling state, suffering the effects of the postwar depression, attempted to tax the Bank of the United States out of existence in Ohio in 1819. Despite the precariousness of its position because of the U.S. supreme court's affirmation of the hank's constitutionality in *McCulloch* v. *Maryland,* Ohio imposed an exorbitant tax. The case was eventually argued before the supreme court by some of the most brilliant lawyers of the day. The 1824 decision upholding the bank in *Osborn* v. *Bank of the United States* ended Ohio's venture into the field of nullification, but by that time the issue had lost much of its practical significance.

Internal Improvements.— A more judicious remedy for the economic hardships of the time (although some questioned its wisdom also) was the launching of an extensive canal system within the state. An ardent leader in the movement for internal improvements, Gov. Ethan Allen Brown (1818–22) crystallized favourable sentiment and badgered the general assembly into establishing a canal commission. He served on this commission and later on the canal fund commission which negotiated loans and disbursed money during the period of construction. Brown's role was so important that he became known as the "father of the Ohio canals," a title sometimes also bestowed upon Alfred Kelley who supervised much of the actual digging. Gov. DeWitt Clinton of New York helped to ofiiciate at ground-breaking ceremonies near Newark on July 4, 1825. Two years later the first section of the Ohio canal was put into use and before long traffic on the entire 308-mi. waterway between Cleveland, on Lake Erie, and Portsmouth, on the Ohio river, was bringing prosperity to every locality along its route. In addition to feeders and several shorter canals, another major canal was built in the western part of the state. This, the Miami and Erie canal, joined Cincinnati and Toledo via the Miami and Maumee valleys. Ohio's canal building program was extremely costly and eventually the "ditches" were superseded by railroads, but they rescued the state from the financial doldrums of the 1820s and they nere of primary importance at least until mid-19th century. Without them, the state's agricultural and commercial development would have been seriously impeded.

The American Civil War.—The second quarter of the 19th century witnessed the passing of the frontier and a growth in the number and size of towns. It was marked also by an occasional flurry of excitement, such as the Toledo war, a dispute with Michigan over the boundary between the two states. A dominating influence during this period was the worsening conflict over slavery and abolition. Ohio's zealous antislavery sentiment resulted in disaffection from the Democratic party (the old Jeffersonian Republicans) at the end of the Jackson era, and the Whigs gained the upper hand for a time. In 1841 William Henry Harrison, a native of Virginia but long identified with Ohio, became the first president from the state. The 1850s found many constituents in Ohio for the Free-Soil and then the new Republican parties, and the state played a significant role in the Civil War. Besides furnishing such statesmen as Edwin M. Stanton and Salmon P. Chase and such military figures as Grant, Sherman and Sheridan, Ohio sent nearly 350,000 men into the Union army. Opposing the nar effort were the "Copperheads" (*q.v.*) of whom the most prominent was Clement L. Vallandigham of Dayton. Although in exile, he was nominated for governor by the Peace Democrats in the critical election of 1863. His overwhelming rejection by the voters inspired President Lincoln's assertion that "Ohio has saved the Union." The only time the war actually crossed the Ohio border was in July 1863. when Confederate Gen. John H. Morgan and 2,500 men commandeered two steamboats to ferry them from Kentucky to Indiana, swept across the southeast section of the latter state and eastward through Ohio From the time Morgan's cavalry passed through Cincinnati's suburbs, rumour ran rampant as to his objective. Fanciful assumptions to the contrary, his primary aim apparently was to create a diversion and to lessen the military pressures elsewhere. The column rode across southern Ohio, indulging in looting and some destruction along the way but refraining generally from the type of wanton depredation common to such invasions. Morgan's plan to recross the Ohio at Buffington island was thwarted by the arrival of the pursuing Federal cavalry. From the battle that ensued, Morgan extricated 1.200 men. They staged another attempt to ford the river 20 mi. upstream but only one fourth of the force had negotiated the crossing when Federal gunboats intervened. With his remaining 900 men Morgan set out on a zigzag course northward through eastern Ohio, seeking to cross into West Virginia or Pennsylvania. Ohioans mere terror-stricken at rumours of his approach—it mas seldom known exactly where he was—but the raid had become a rout and Morgan surrendered on July 26 near Salineville in Columbiana county; this was the northernmost penetration by a Confederate force during the war. In late Novernber Morgan and six of his officers escaped from the Ohio penitentiary at Columbus and made their way safely to the south.

Another dramatic incident of the war, one that occurred outside Ohio but with Ohioans in the feature roles, was the Andrews raid, or the so-called Great Locomotive Chase, in Georgia in April 1862. In this daring escapade, a score of men from Ohio units infiltrated Confederate territory to Marietta, Ga., stole a train at Big Shanty, and headed for Chattanooga, Tenn., bent upon destroying communication and transportation facilities along the way. Through the sheer determination and perseverance of the train's conductor and a series of remarkably adverse coincidences, the raiders were overtaken after 90 mi. and obliged to abandon the stolen "General" They were captured, imprisoned and subsequently convicted of espionage. The leader. James J. Andrews. and several others were hanged as spies. The survivors either escaped to freedom or were eventually exchanged. Their incredible exploit won for them promotions. an audience with President Lincoln and the first (congressional) medals of honor ever bestowed.

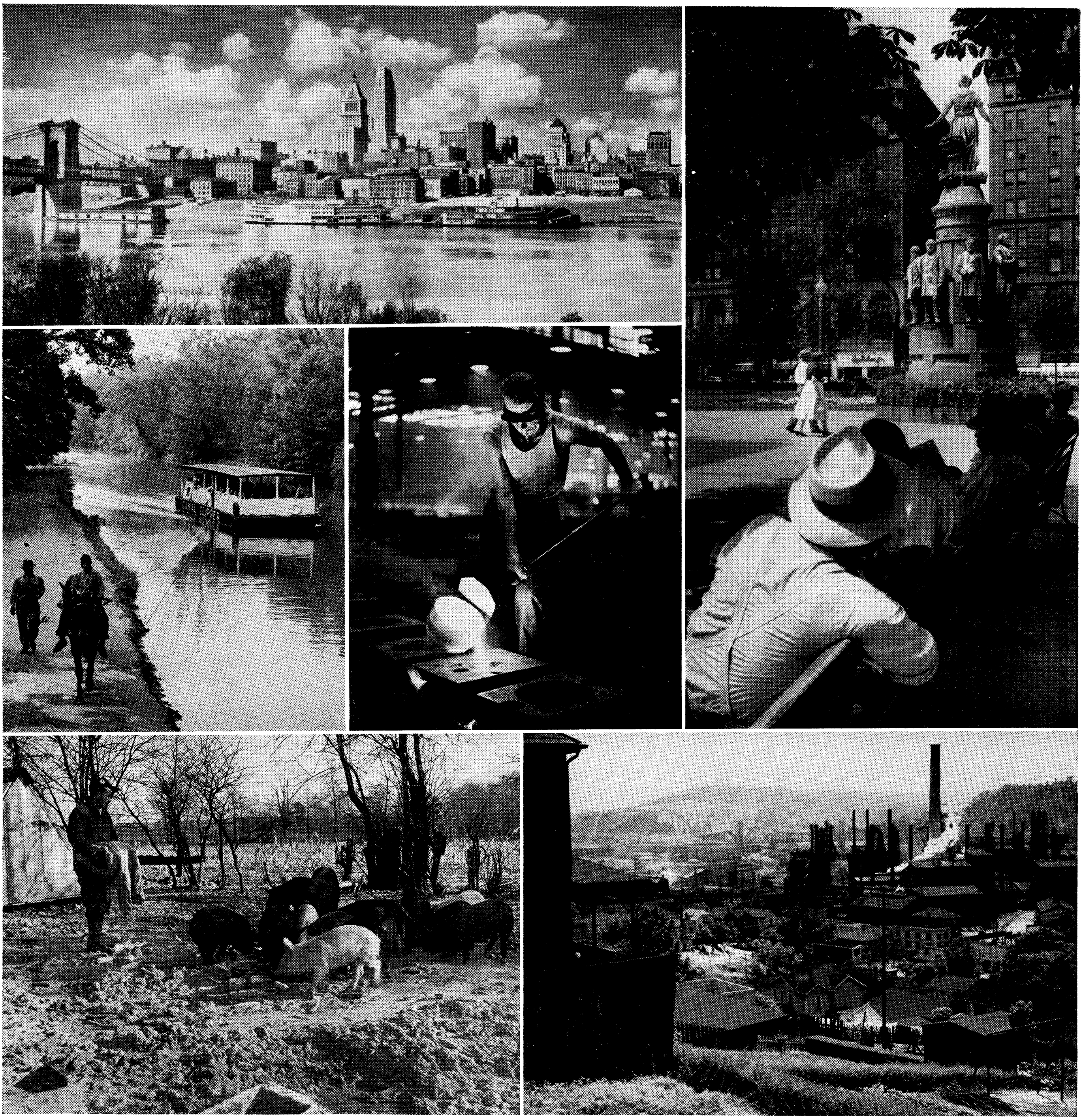
Emerging Political and Industrial Power.—In the postwar decades Ohio emerged as a political and industrial power, besides retaining its standing as a leading agricultural state. It sent to the White House three successive presidents—Grant, Hayes and Garfield—between 1869 and 1881. Hayes, who had been Ohio's first three-term governor, compiled the most creditable record of the three. The election of Benjamin Harrison and William McKinley in the waning years of the 19th century, and of William Honard Taft and Warren G. Harding in 1908 and 1920, respectively, gave Ohio its claim to the title "mother of presidents." Although generally Republican, Ohio voters occasionally have narmly endorsed a Democrat. The most popular of the latter since the Civil War were governors Judson Harmon, James M. Cox, Vic Donahey, George White, Martin L. Davey and Frank J. Lausche. For many years Republicans Robert A. Taft and John W. Bricker enjoyed both state and national prominence.

Industrially, Ohio has excelled in the 19th and 20th centuries in iron and steel, oil. ceraniics, rubber, glass, machinery and a host of other products. Industrialization and the urban trend brought to the growing population centres immigrants from foreign lands as well as Ohioans from the farms. The number of farm families was steadily decreasing in the second half of the 20th century and a way of life was fast disappearing.

GOVERNMENT

Administration.—By mid-19th-century Ohio's original constitution no longer fulfilled the needs of a rapidly expanding state. As a result, a constitutional convention met and drew up a new instrument of government which became effective in 1851. Twenty-two years later another convention wrote a constitution which was subsequently rejected by the voters. A fourth convention in 1912 decided to retain the existing constitution but submitted 41 amendments for the approval of the electorate. The 33 adopted reflected the Progressive sentiment of that era. Thus, Ohio is still governed under the 1851 constitution modified by numerous amendments.

The executive branch of the state government consists of a governor, lieutenant governor, secretary of state, treasurer, auditor



BY COURTESY OF (CENTRE LEFT) NATIONAL PARK SERVICE, PHOTO BY ABBIE ROWE; PHCTOGRAPHS, (TOP LEFT) LONGLEY, (TOP RIGHT) TOM O'REILLY, (CENTRE, BOTTOM LEFT) PAUL S. SOMCGYI, (BOTTOM RIGHT) CARL MANSFIELD

VIEWS OF OHIO

Top left: Business district of Cincinnati, Ohio's second largest city, seen from the Kentucky side of the Ohio river

Top right: My Jewels monument on the state house grounds at Columbus. Bronze figures of Ohio statesmen and soldiers surround the base of the monument; mounted on top is a statue of Cornelia, the Roman matron

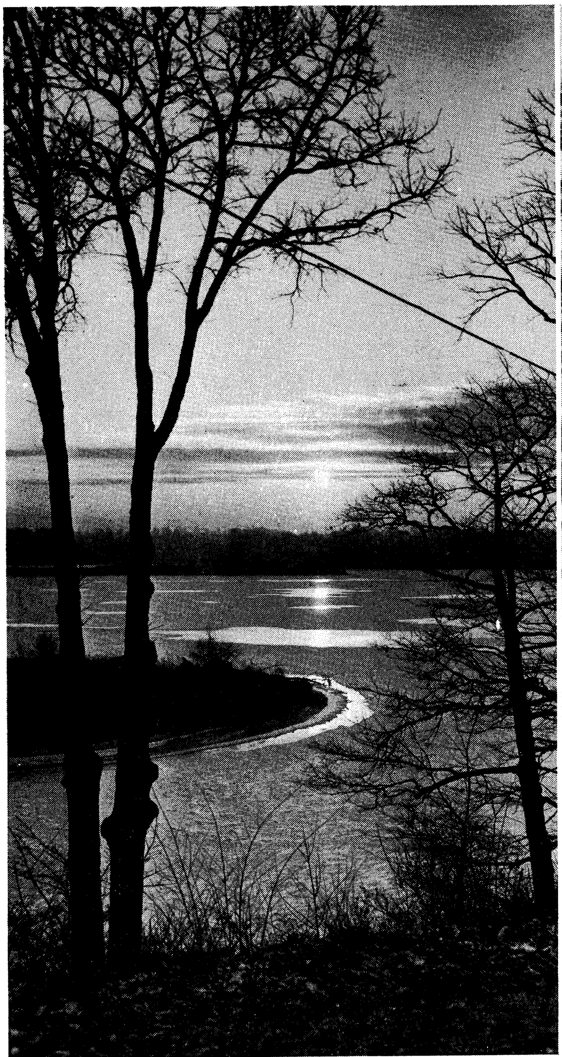
Centre left: A packet boat on an Ohio canal. Until the railroad came into wide usage, a network of canals was an important factor in the development of Ohio

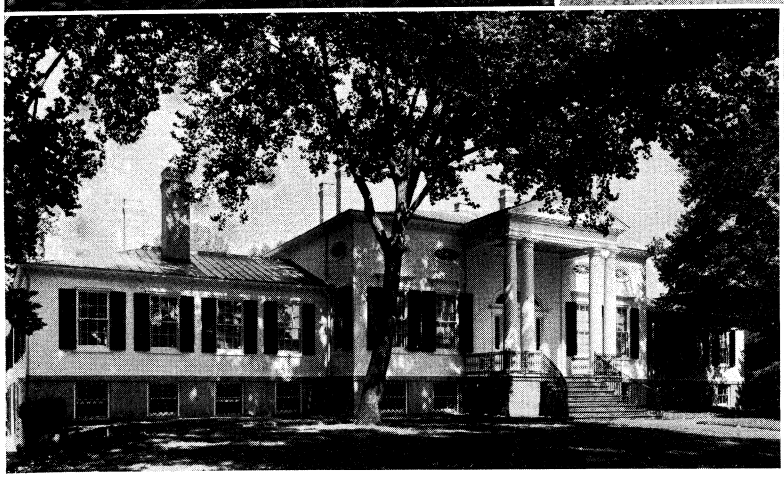
Centre: Pouring a lamp base at an Ohio metal company. Diversification has been an important factor in Ohio's industrial development and there are many small manufacturing centres throughout the state

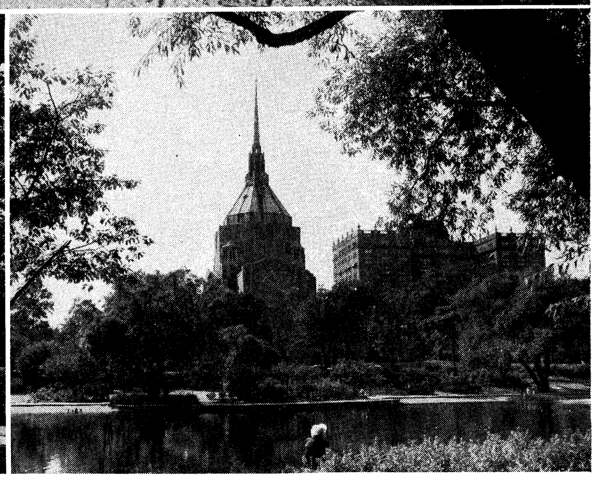
Bottom left: Feeding shoats on an Ohio farm. A large percentage of the state's agricultural income is derived from livestock and poultry products

Bottom right: Mingo Junction, a steel mill and coal mining city. Iron and steel are Ohio's chief manufacturing industries

OHIO







BY COURTESY OF (TOP RIGHT) STATE OF OHIO DEVELOPMENT AND PUBLICITY COMMISSION, (BOTTOM LEFT) CINCINNATI CONVENTION AND VISITORS BUREAU, INC.; PHOTOGRAPHS, (TOP LEFT) TOM O'REILLY, (CENTRE RIGHT) HOWARD OBERLIN, (BOTTOM RIGHT) FRANK H. MUTH

SCENES IN OHIO

Top left: Winter sunrise over the Maumee river near Toledo

Top right: Schoenbrunn memorial state park, an authentic restoration of the first village in Ohio, settled in the late 18th century by David Zeisberger as a home for his Moravian mission

Centre right: A typical Sunday scene in Holmes county, centre of the second largest Amish settlement in the United States

Bottom left: Taft House museum. a gift of the Taft family to the city of Cincinnati, contains a collection of fine arts

Bottom right: Epworth Euclid church in Wade park. The area surrounding the lagoon includes the Cleveland Fine Arts garden and attorney general. For many years the auditor was the only one of these officials elected to a four-year term, the others being two. This situation was changed, however, by the adoption of a constitutional amendment in 1954 providing for four-year terms for all of these officers starting with the election of 1958. Democrat Michael V. DiSalle of Toledo, the 60th governor, became the first elected for four years when he was inaugurated in Jan. 1959.

The general assembly is composed of two houses, the senate and the house of representatives. Members of the latter still are chosen for only two years, but a constitutional amendment in 1956 extended the terms of senators from two to four years.

The judicial system consists of a seven-man supreme court; nine courts of appeal with three judges each; courts of common pleas; probate, juvenile and municipal courts; and justices of the peace. Judges of the supreme court are chosen by direct popular vote, although until 1851 they were elected by the general assembly.

The principal units of local government are the county, township, city and village. The minimum population required for a municipality to become a city is 5,000. Official recognition as a city usually follows the decennial census but may be secured by holding a special census.

Finance. — The cost of operating Ohio's government approached $1,000,000,000 per year at the beginning of the 1960s. These expenses are paid from the general revenue fund which is derived largely from taxes on cigarettes and alcoholic beverages, a 3% retail sales tax and other forms of indirect taxation. Special undertakings, such as the construction of the multimillion-dollar Ohio turnpike, are financed by bond issues. During and after World War II a vast surplus had accumulated, hailed by some as evidence of wise fiscal management, assailed by others as a "penny-wise, pound-foolish" policy because of alleged negligence of needed improvements. By the close of the 1950s this reserve had been dissipated and, partly because of a reluctance to impose new or increased taxes, the state government faced a $13,000,000 deficit. Primarily by levying higher taxes on cigarettes and gasoline and by restoring the first cent of the sales tax, this deficit was erased by hug. 1959, and Ohio was once again out of the red. In addition to the expense of conducting the government's business and of maintaining and operating the numerous state institutions and agencies, major expenditures each year include the appropriations for education, highway construction and repair and health and welfare.

POPULATION

Since the residents of Ohio were first tabulated in a United States census in 1800, the state's population has not only increased spectacularly, but it has shifted its concentration and it has undergone significant changes in character and composition. Numbering only 45,365 in 1800, Ohioans ten years later outnumbered the residents of five of the original states. By 1830 Ohio's population had reached nearly 1,000,000, and this figure was doubled in the next 20 years. It passed 3,000,000 in 1880; 4,000,000 in 1500; 5,000,000 before 1920; and 6,000,000 before 1930. It was just short of 7,000,000 in 1940 and 8,000,000 in 1950; and by 1960 it had soared to 5,706,397, With the growth of cities and the exodus from the farms, the population by 1960 was more than 70% urban. As a whole, the state in 1560 had a relatively high population density of about 235.5 persons per square mile. but this figure was multiplied many times in the several large cities, with greater Cleveland's density highest at more than 2,000. This development is in stark contrast to the middle of the 15th century when 85% of Ohio's inhabitants lived on farms. Despite the general increase in population after 1950, 18 of Ohio's 88 counties (all but two of them in the south and southeast) not only failed to attract new residents but actually suffered a decline in numbers.

Throughout most of the 15th century, Ohio's original predominantly Anglo-Saxon stock was supplemented by additional immigrants from Great Britain, Ireland and Germany. In 1900 Ohio's foreign-born population consisted of 204,160 Germans and approximately the same number from all other nations combined. The percentage of foreign-born fluctuated little, amounting to between 11% and 14% in the period 1860 to 1920, after which it declined.

*Ohio: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	9,706,397	7,946,627	6,907,612	5,759,394	4,157,545
Akron	290,351	274,605	244,791	208,435	42,728
Alliance	28,362	26,161	22,405	21,603	8,974
Amherst†	6,750	3,542	2,896	2,485	1,758
Ashland	17,419	14,287	12,453	9,249	4,087
Ashtabula	24,559	23,696	21,405	22,082	12,949
Athens	16,470	11,660	7,696	6,418	3,066
Avon Lake	9,403	4,342	2,274	904	—
Barberton	33,805	27,820	24,028	18,811	4,354
Bay	14,489	6,917	3,356	751	—
Beachwood	6,089	1,073	372	225	—
Bedford	15,223	9,105	7,390	2,677	1,486
Bedford Heights	5,275	—	—	—	—
Bellaire	11,502	12,573	13,799	15,061	9,912
Bellefontaine	11,424	10,232	9,808	9,336	6,649
Bellevue	8,286	6,906	6,127	5,776	4,101
Belpre	5,418	2,451	1,717	1,317	—
Berea	16,592	12,051	6,025	2,959	2,510
Bexley	14,319	12,378	8,705	1,342	—
Blue Ash	8,341	—	—	—	—
...Green	13,574	12,005	7,190	5,788	5,067
Brecksville	5,435	2,664	1,900	—	—
Broadview Heights	6,209	2,279	1,141	—	—
Brooklyn	10,733	6,317	1,108	—	—
Brook Park	12,856	2,606	—	861	—
Brunswick	6,453	—	—	—	—
Bryan	7,361	6,365	5,404	4,252	3,131
Bucyrus	12,276	10,327	9,727	10,425	6,560
Cambridge	14,562	14,739	15,044	13,104	8,241
Campbell	13,406	12,882	13,785	—	—
Canton	113,631	116,912	108,401	87,091	30,667
Celina	7,659	5,703	4,841	4,226	2,815
Cheviot	10,701	9,944	9,043	4,108	—
Chillicothe	24,957	20,133	20,129	15,831	12,976
Cincinnati	502,550	503,998	455,610	401,247	325,902
Circleville	11,059	8,723	7,982	7,049	6,991
Cleveland	876,050	914,808	878,336	796,841	381,768
Cleveland Heights	61,813	59,141	54,992	15,236	—
Columbus	471,316	375,901	306,087	237,031	125,560
Conneaut	10,557	10,230	9,355	9,343	7,133
Coshocton	13,106	11,675	11,509	10,847	6,473
	5,521	4,614	4,337	[illegible]	3,282
Cuyahoga Falls	47,922	29,195	20,546	10,200	3,186
Dayton	262,332	243,872	210,718	152,559	85,333
Deer Park	8,423	7,241	3,510	824	—
Defiance	14,553	11,265	9,744	8,876	7,579
Delaware	13,282	11,804	8,944	8,756	7,940
Delphos	6,961	6,220	5,746	5,745	4,517
Dover‡	11,300	9,852	9,691	8,101	5,422
East Cleveland	37,991	40,047	39,495	27,292	2,757
Eastlake	12,467	[illegible]	—	—	—
East Liverpool	22,306		23,555	21,411	16,485
East Palestine	5,232	5,195	5,123	5,750	2,493
	5,034	4,242	3,552	3,210	3,155
	43,782	30,307	25,120	20,474	8,791
Euclid	62,998	7,847	12,866	3,363	—
	19,453	—	—	—	—
	9,734		—	—	—
Fairview Park	14,624	9,311	4,700	642	—
Findlay	30,344	23,845	20,228	17,021	17,613
Fostoria	15,732	14,351	13,453	9,987	7,730
Franklin	7,917	5,388	4,511	3,071	2,724
Fremont	17,573	16,537	14,710	12,468	8,439
Galion	12,650	9,952	8,685	7,374	7,282
Gallipolis	8,775	7,871	7,832	6,070	5,432
Garfield Heights	38,455	21,662	16,989	2,550	—
Geneva	5,677	4,718	4,171	3,081	2,342
Girard	12,997	10,113	9,805	6,556	2,630
Grandview Heights	8,270	7,659	6,960	1,185	—
	5,422	4,862	4,228	4,344	3,979
	5,407	3,005	2,677	—	—
Greenville	10,585		7,745	7,104	5,501
Grove City	8,107		1,787	905	656
Hamilton	72,354	57,951	50,592	39,675	23,914
Hilliard		610	583	451	376
Hillsboro	[illegible]	5,126	4,713	4,356	4,535
	7,137	4,560	4,188	3,320	1,230
Hubbard	5,197	2,515	1,827	1,703	1,708
Independence	6,868	3,105	1,815	1,074	—
Ironton	15,745	16,333	15,851	14,007	11,868
Jackson	6,980	6,504	6,295	5,842	4,672
Kent	17,836	12,418	8,581	7,070	4,541
Kenton	8,747	8,475	7,593	7,690	6,852
Kettering	54,462	—	—	—	—
Lakewood	66,154	68,071	69,160	41,732	3,355
Lancaster	29,916	24,180	21,940	14,706	8,991
Lebanon	5,993	4,618	3,890	3,390	2,867
Lima	51,037	50,246	44,711	41,326	21,723
Lincoln Heights (Hamilton County)	7,798	5,531	—	—	—
Lincoln Heights (Richland County)	8,004	2,722	—	—	—
Lockland	5,292	[illegible]	5,601	4,007	2,695
Logan	6,417		6,177	5,493	3,480
London	6,379	5,222	4,697	4,080	3,511
Lorain	68,932	51,202	44,125	37,295	16,028
Louisville	5,116	3,801	3,379	2,008	1,374
Loveland	5,008	2,149	1,904	1,557	1,260
Lyndhurst	16,805	7,359	2,391	—	—
Madeira	6,744	2,689	1,384	600	—
Mansfield	47,325	43,564	37,154	27,824	17,640
Maple Heights	31,667	15,586	6,728	1,732	—
Marietta	16,847	16,006	14,543	15,140	13,348
Marion	37,079	33,817	30,817	27,891	11,862
Martins Ferry	11,919	13,220	14,729	11,634	7,760
Massillon	31,236	29,594	26,644	17,428	11,944
Maumee	12,063	5,548	4,683	3,195	1,856
Mayfield Heights	13,478	5,807	2,696	—	—
Medina	8,235	5,097	4,359	3,430	2,232

*Ohio: Places of 5,000 or More Population (1960 Census)**
(Continued)

Place	Population				
	1960	1950	1940	1920	1900
Miamisburg	9,893	6,329	5,544	4,383	3,941
Middleburg Heights	7,282	2,299	1,225	—	—
Middletown	42,115	33,695	31,220	23,594	9,215
Mount Healthy	6,553	5,533	3,997	2,255	1,354
Mount Vernon	13,284	12,185	10,122	9,237	6,633
Napoleon	6,739	5,335	4,825	4,143	3,639
Newark	41,790	34,275	31,487	26,718	18,157
New Philadelphia	14,241	12,948	12,328	10,718	6,213
Newton Falls	5,038	4,451	3,120	1,100	732
Niles	19,545	16,773	16,273	13,080	7,468
North Canton	7,727	4,032	2,988	1,597	—
North College Hill	12,035	7,921	5,231	1,104	—
North Olmsted	16,290	6,604	3,487	1,419	—
North Royalton	9,290	3,939	2,559	—	—
Norwalk	12,900	9,775	8,211	7,379	7,074
Norwood	34,580	35,001	34,010	24,966	6,480
Oakwood	10,493	9,691	7,652	1,473	—
Oberlin	8,198	7,062	4,305	4,236	4,082
Oneida-Rolling Mill Park	6,504	2,248	—	—	—
Oregon	13,319	—	—	—	—
Orrville	6,511	5,153	4,484	4,107	1,901
Oxford	7,828	6,944	2,756	2,146	2,009
Painesville	16,116	14,432	12,235	7,272	5,024
Parma	82,845	28,897	16,365	—	—
Parma Heights	18,100	3,901	1,330	310	—
Perrysburg	5,519	4,006	3,457	2,429	1,766
Piqua	19,219	17,447	16,049	15,044	12,172
Port Clinton	6,870	5,541	4,505	3,928	2,450
Portsmouth	33,637	36,798	40,466	33,011	17,870
Ravenna	10,918	9,857	8,538	7,219	4,003
Reading	12,832	7,836	6,079	4,540	3,076
Reynoldsburg	7,793	724	652	491	339
Richmond Heights	5,068	891	507	265	—
Rittman	5,410	3,810	2,770	1,803	—
Rocky River	18,097	11,237	8,291	1,861	1,319
Rosedale	8,204	—	—	—	—
St. Bernard	6,778	7,066	7,387	6,312	3,384
St. Marys	7,737	6,208	5,532	5,679	5,359
Salem	13,854	12,754	12,301	10,305	7,582
Sandusky	31,989	29,375	24,874	22,897	19,664
Seven Hills	5,708	1,350	555	—	—
Shadyside	5,028	4,433	4,048	3,084	—
Shaker Heights	36,460	28,222	23,393	1,616	—
Sheffield Lake	6,884	2,381	1,099	—	—
Shelby	9,106	7,971	6,643	5,578	4,685
Sidney	14,663	11,491	9,790	8,590	5,688
Silverton	6,682	4,827	2,907	795	—
Solon	6,333	2,570	1,508	—	—
South Euclid	27,569	15,432	6,146	1,605	—
Springfield	82,723	78,508	70,662	60,840	38,253
Steubenville	32,495	35,872	37,651	28,508	14,349
Stow	12,194	—	—	—	—
Strongsville	8,504	3,504	2,216	—	—
Struthqrs	15,631	11,941	11,739	5,847	—
Sylvania	5,187	2,433	2,199	1,222	617
Tallmadge	10,246	5,821	3,452	—	—
Tiffin	21,478	18,952	16,102	14,375	10,989
Toledo	318,003	303,616	282,349	243,164	131,822
Toronto	7,780	7,253	7,426	4,684	3,526
Troy	13,685	10,661	9,697	7,260	5,881
Uhrichsville	6,201	6,614	6,435	6,428	4,582
University Heights	16,641	11,566	5,981	—	—
Upper Arlington	28,486	9,024	5,370	620	—
Urbana	10,461	9,335	8,335	7,621	6,808
Vandalia	6,342	927	378	257	284
Van Wert	11,323	10,364	9,227	8,100	6,422
Wadsworth	10,635	7,966	6,495	4,742	1,764
Wapakoneta	6,756	5,797	5,225	5,295	3,915
Warren	59,648	49,856	42,837	27,050	8,529
Warrensville Heights	10,609	4,126	1,175	—	—
Washington§	12,388	10,560	9,402	7,962	5,751
Wellston	5,728	5,691	5,537	6,687	8,045
Wellsville	7,117	7,854	7,672	8,849	6,146
Westerville	7,011	4,112	3,146	2,480	1,462
Westlake‖	12,906	4,912	3,200	1,754	—
Whitehall	20,818	4,877	—	—	—
Wickliffe	15,760	5,002	3,155	1,508	—
Willard¶	5,457	4,744	4,261	3,889	2,348
Willoughby	15,058	5,602	4,364	2,656	1,753
Willowick	18,749	3,677	915	—	—
Wilmington	8,915	7,387	5,971	5,037	3,613
Wooster	17,046	14,005	11,543	8,204	6,063
Worthington	9,239	2,141	1,569	705	443
Wyoming	7,736	5,582	4,466	2,323	1,450
Xenia	20,445	12,877	10,633	9,110	8,696
Youngstown	166,689	168,330	167,720	132,358	44,885
Zanesvilie	39,077	40,517	37,500	29,569	23,538

*Populations are reported as constituted at date of ,each census. †Known as North Amherst in 1900 ‡Known as Canal Dover prior to 1920 §Known as Washington Court House prior to 1950. ‖Known as Dover prior to 1950. ¶Known as Chicago Junction prior to 1920

Note. Dash indicates place did not exist during reported census period, or data were not available.

The sharp increase in eastern European immigrants, however, boosted the number of Hungarians, Poles, Italians, Austrians and Russians nearer to the declining number of Germans. Italians, Czechoslovakians and Yugoslavians continued to increase, especially in manufacturing centres such as Cleveland in which by 1920 one third of the people were foreign-born. This development had a pronounced effect on both political and cultural patterns in such cities.

Similarly, the Negro population has risen steadily. In 1920 the number of Negroes in Ohio (186,187) far exceeded that of the foreign-born from any single country. In the three decades that followed this figure nearly tripled, while the percentage doubled to nearly 6.5% of the total population.

Restrictions on immigration since the 1920s have substantially reduced the foreign-born in Ohio to about 3%, so that approximately nine of every ten Ohioans are native white.

EDUCATION

State School System. — Historically, the principle of public-supported schools was established in Ohio in the 1820s, but it was not fully implemented until many years later. Public elementary schools were widely accepted by the time of the Civil War, preceding by nearly a half century general adoption of the public high school. As the 20th century gained momentum, the long-familiar one-room school gradually disappeared from the Ohio countryside, superseded by consolidated schools serving larger areas. The number of school districts was reduced by 33%, from more than 1,500 to about 1,000 in one decade after World War II. In 1921 school attendance for children between the ages of 6 and 18 was made compulsory. In the second half of the 20th century Ohio's public-school system served about 2,000,000 pupils, more than two thirds of them in the elementary grades, at a total annual cost of approximately $500,000,000. Instruction was provided by about 70,000 teachers, of whom there was a persistent scarcity. Despite the construction of hundreds of schools in the post-World War II decades, bringing the total to well over 4,000, many of the facilities were still overcrowded. The system was administered by a superintendent of public instruction and a 23-member elected state school board created by the general assembly in 1955.

Colleges and Universities. — There are so many colleges and universities in Ohio (more than 50) that every resident lives within a few miles of at least one institution of higher learning. Of these, six receive financial support from the state. Ohio university at Athens was chartered in 1804, opened its doors five years later, and progressed from academy-type instruction to the standards of a full-fledged college about 1822. Miami university at Oxford followed a similar pattern, undergoing a formative stage from 1809 to 1824 when it achieved collegiate standing. Ohio State university, opened in 1873 as the Ohio Agricultural and Mechanical college, changed its name five years later and went on to become the largest of the group and one of the nation's leading universities. Kent State university and Bowling Green State university were normal schools which gained university status in 1935. Central State college, after nearly a century as the education and industrial arts section of Wilberforce university (for Negro students), near Xenia, became a separate institution in 1950. Of Ohio's other colleges and universities three are municipally operated, by Akron (founded 1870), Cincinnati (1819) and Toledo (1872), while a considerable number are denominational, among them Baldwin-Wallace college (1845) and Ohio Wesleyan university (1842, Methodist), Xavier university (1831) and John Carroll university (1886, Roman Catholic), Wittenberg university (1845, Lutheran) and Wilmington coilege (1863, Quaker). Oberlin college (1833, nonsectarian) had the distinction of being the first coeducational collrge in the nation.

HEALTH, WELFARE AND CORRECTIONS

The director of public welfare has under his general control administration of poor relief; aid to dependent children and to the aged, the blind and the disabled; maternal and child health and child welfare services and services for crippled children; state hospitals for the mentaily ill, epileptics and tubercular patients; institutions of the feeble-minded; a soldiers' and sailors' home; industrial schools for boys and girls; reformatories for men and women; a prison farm and penal honour camps; and Ohio penitentiary.

Ohio has launched a program to rectify conditions in its state mental hospitals. These institutions house nearly 30,000 inmates, besides another 8,000 in state schools for retarded children, a total which is more than triple the number of prisoners in the

Ohio penitentiary and the other penal institutions. The annual expenditures for the social and welfare programs and institutions (including general relief, aid for the aged, unemployment compensation and others, in addition to mental and correctional) nearly equal the entire cost of operating the public school system in the state.

THE ECONOMY

Living Conditions.—The steady decline in the number of farms in Ohio has been reflected in the occupational structure in the second half of the 20th century. In the early 1960s only about one out of every 20 wage earners was engaged in farming, unlike a few generations previously when agriculture provided occupations for a majority of the state's citizens. A significant side light on this is that at least half of the farming population worked at other jobs part of the time; a third worked off the farm more than 100 days per year. The number of industrial employees was about eight times as large, outnumbering all other groups. They were followed by the categories of trade, service and professional and transportation, communication, etc. Economic conditions were generally good and wages high. In per capita personal income Ohio ranked among the top 20% of the states.

Agriculture.—Although as individual entities Ohio's farms were disappearing at the rate of about 1% per year in the second half of the 20th century, nearly half the state's land surface was still in crop lands and three fourths of the 88 counties were rural in character. Agricultural production continued high, the chief products being corn, oats, hay, soybeans, tobacco, nheat, rye, barley. potatoes, apples. peaches, grapes, pears, sugar beets and maple syrup. Ohio ranked among the leading states in its annual yield of corn. oats and hay, producing. for example, about 8% of the nation's corn. In livestock. cattle were the most valuable, as well as the most numerous except for hogs. Sheep, chickens and turkeys also were raised in large numbers.

Industry.—Ohio manufacturing plants and factories, mills and foundries not only provided employment for two fifths of the xorking force in the 1960s but also supplied the world with diverse and useful products. The principal centres of industry are Cleveland. Akron. Youngstonn, Cincinnati. Columbus, Toledo, Lorain, Dayton, Canton and the Ohio river cities from East Liverpool down to Marietta. Some cities have been noted primarily for one industry: Akron for rubber; Dayton for cash registers; and East Liverpool for clay products. One fifth of the nation's production of iron and steel came from the mills of Cleveland, Lorain, Youngstown, Steubenville. Canton, Bellaire and Ironton. Chemical industries gave new vitality to the river valley in the vicinity of Marietta. Akron enabled Ohio to produce one fourth of the nation's rubber products. Also from Ohio came at least 10% of all the machinery, transportation equipment. primary metals. fabricated metal products and stone, clay and glass products manufactured in the United States. Other industries produced significant totals of electrical machinery, furniture, petroleum and coal products, chemicals. food products and paper.

Minerals.—Land that at first seemed valuable primarily for farming and timber mas found by 1850 to hold beneath its surface vast reserves of salt, copperas (ferrous sulfate, or green vitriol). gypsum, limestone. sandstone and coal. and clay suitable for pottery. By mid-19th century Ohio was fourth among the states in the quantity and value of salt produced. As early as 1840, about 125.000 tons of bituminous coal were being mined annually in eastern and southeastern Ohio. A century later, the state stood among the top six coal producers in the country. Petroleum. natural gas, cement, gravel and building stone all came to be recognized as important natural resources. Ohio still has great deposits of some of these. It is estimated that coal yet unmined may total as much as 50,000,000,000 tons, 5% of the nation's entire reserve. Ohio holds enough rock salt (2,000,000,000,000 tons) to supply the United States. at the present rate of use, for 150 000 years. Two principal petroleum fields have been located in the state, in the northwest and the southeast. About 1900 Ohio was one of the leading oil producers. Of the 200,000 wells drilled since 1860, approximately 14,000 are still active. In roughly the same period, about 175,000 natural gas wells produced more than 2,000,000,000,000 cu.ft., the peak year being 1915 with 79,000,000,000 cu.ft. About 7,000 gas wells are still producing, most of them in the eastern hill country. In the half century beginning in 1911, Ohio's total mineral production was valued at more than $7,000,000,000, seventh highest among the states. In the second half of the 20th century it has averaged between 12th and 15th in the nation in value, producing about 2% of the total. It has ranked first in the output of lime and fire clay and among the highest in the production of limestone, sandstone, sand and gravel, cement, stone and salt (about 15% of the U.S. total in salt).

Transportation and Communication.——Nature provided the best arteries of transportation in Ohio's early days in the waters of Lake Erie and the Ohio river, as well as in some of the smaller rivers within the state. These secondary streams were important for many years, and the sight of a steamboat far inland was not unusual. The use of the Ohio river declined during several decades of the 20th century, but it has been revitalized and cargo carried on river barges has increased to more than 60,000,000 tons annually.

The canals, discussed earlier, facilitated travel and shipping and contributed greatly to Ohio's economic well-being. Even before the canals'. completion, however, early attempts at railroad building were underway, and in 1836 one railroad was completed between Toledo and Adrian. Mich. The middle years of the 19th century brought intense activity in this field, resulting in an intricate network of railroads throughout the state. This hastened the demise of the canals as an important and practical means of travel. A phenomenon of transportation appeared in the early 20th century in the mania for the construction of interurban electric railways. Providing rapid and easy transportation between cities (and sometimes with those in neighbouring states). the interurban enjoyed a meteoric existence, reaching their zenith in 1917 and then plummeting to obscurity with the advent of the automobile and bus.

Early roads often followed old Indian trails and were quite primitive in character. Dirt was the predominant surface. relieved occasionally by log (or corduroy) roads. The first significant highway-building project was the extension of the National road across Ohio from Wheeling, W.Va., through Zanesville and Columbus to Springfield between 1825 and 1837, and ultimately westward to Indiana and beyond. In the 1950s Ohio focused its attention on the dire need for new modern express highways. The first fruit of this effort was the 241-mi. Ohio turnpike, opened Oct. 1, 1955. Many miles of major expressways have been completed each year, in addition to which several of the larger cities have undertaken construction of systems speeding traffic through or diverting it around congested areas. The state is crisscrossed by nearly 85,000 mi. of highways outside municipalities, of which about 16,000 mi. are state routes! the rest county or township.

Railroads have leveled off at approximately 8,400 mi. while the number of licensed airports has risen to about 100. Lake shipping is busiest at Toledo, Cleveland, Lorain, Ashtabula. Sandusky, Conneaut and Fairport. The completion of the St. Lawrence seaway stimulated commerce on the Great Lakes and brought numerous foreign ships to Ohio ports. The flags of Japan, the Netherlands: Sweden; and other foreign nations are familiar sights on the same waters over which only three centuries ago canoes carried the expedition of La Salle.

See also references under "Ohio" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (J. S. St.)

OHIO COMPANY, a name of two companies organized in the 18th century for the colonization of the Ohio valley. The first Ohio company was organized in 1749, partly to aid in securing for the English control of the valley, then in dispute between England and France, and partly as a commercial project for trade with the Indians. The company was composed of Virginians, including Thomas Lee (d. 1750) and the two brothers of George Washington, Lawrence (who succeeded lo the management upon the death of Lee) and Augcstine; and of Englishmen, including John Hanbury, a wealthy London merchant. In 1752 the company had a pathway blazed between the small fortified posts at Will's creek (Cumberland), Md., and at Redstone creek (Brownsville), Pa., which it had established in 1750; but it was finally merged in the Walpole company (an organization in which Benjamin Franklin was interested), which in 1772 had received from the British government a grant of a large tract lying along the southern bank of the Ohio as far west as the mouth of the Scioto river. The Revolutionary War interrupted colonization and nothing was accomplished.

The second company, the Ohio Company of Associates, was formed at Boston in 1786. The leaders in the movement were General Rufus Putnam, Benjamin Tupper (1738–92), Samuel Holden Parsons (1737–89) and Manasseh Cutler. Cutler was selected to negotiate with congress, and seems to have helped to secure the incorporation in the ordinance for the government of the Northwest territory of the paragraphs which prohibited slavery and provided for public education and for the support of the ministry. On Oct. 27, 1787, Cutler and Major Winthrop Sargent (1753–1820), who had joined him in the negotiations, signed two contracts; one mas for the absolute purchase for the Ohio company, 665 cents an acre, of 1,500,000 ac. of land lying along the north bank of the Ohio river, from a point near the site of Marietta, to a point nearly opposite the site of Huntington, W. Va.; the other was for an option to buy all the land between the Ohio and the Scioto rivers and the western boundary line of the Ohio company's tract, extending north of the tenth township from the Ohio, this tract being pre-empted by "Manasseh Cutler and Winthrop Sargent for themselves and others"––actually for the Scioto company (see GALLIPOLIS). On the same day Cutler and Sargent "for thernselves and associates!' transferred to William Duer, secretary of the treasury board, and his associates "one equal moiety of the Scioto tract of land mentioned in the second contract" — both parties were to be equally interested in the sale of the land and were to share equally any profit or loss. Colonists were sent out by the Ohio company from New England, and Marietta, first permanent settlement in the present state of Ohio, was founded in April 1788.

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OHIO **RIVER,** the principal eastern tributary of the Mississippi river, U.S. It is formed by the confluence of the Allegheny and Monongahela rivers at Pittsburgh, Pa., and flows northwest nearly to the west border of Pennsylvania, south-southwest between Ohio and West Virginia, west by north between Ohio and Kentucky and west-southwest between Indiana and Illinois on the north and Kentucky on the south. The Ohio contributes more water to the Mississippi than any other tributary (basin 203,900 sq.mi.): its volume (231,000 cu.ft. per second) is 34 times that of the next largest stream, the Missouri. Despite seasonal fluctuations which may reach flood proportions, its fairly uniform flow has supported an important commerce since first settlement began. In all its 975.5 mi., the Ohio has a total fall of only 429 ft., considerably less than some of its tributaries — the Big Miami, for instance, has a fall of 600 ft. in only 160 mi.

The Ohio valley floor is narrow, with an average width of less than ½ mi. between Pittsburgh and Wheeling; from Cincinnati to Louisville it averages a little over 1 mi. and below Louisville it is somewhat greater. There are islands in the river, varying in size from 1 to 4,000 ac. The one major hazard to navigation, the Falls of the Ohio, is at Louisville, where locks take care of a descent of about 24 ft. within a distance of 2½ mi.

Floods.––The Ohio and several of its tributaries have long been known for floods, such as those at Dayton and Johnstown (*qq.v.*). In Jan. 1937, an especially destructive flood set a record for high stages on that part of the river between Point Pieasant, W.Va., and the mouth of the Ohio and on the tributaries entering from the south. Fluctuation in stream level at Cincinnati may be 80 ft., with an average of one flood (varying crest) each 18 months. The Ohio valley lies in the path of prevailing cyclonic storms, annual precipitation averages about 40 in., with rainfall heavier from January to May, when runoff is greatest. On the tributaries of the Ohio, there is no definite flood season.

Tributaries. — Neither the Ohio nor its numerous tributaries has had much water power development, important exceptions being the Tennessee and Cumberland rivers. Nevertheless, several tributaries have been significant in other ways. Within the Ohio system are three major groups of tributaries, each contributing in its own way to the development of the nation's heartland. First of these is the extensive system of headwaters, second the northern tributaries and third the southern tributaries. The first to affect settlement policy were the northern tributaries. The divide between the Great Lakes and Ohio river drainage is not far south of the lakes margin; the tributaries from the north follow roughly parallel courses to the Ohio. The French from the St. Lawrence valley claimed, but were unable to hold, the major valleys between the Great Lakes and Ohio drainage. Since settlement began in 1787, the vitality of these trade routes has grown.

Robert Cavelier, Sieur de La Salle, asserted that he discovered the Ohio and descended it until his course was obstructed by a fall (thought to be the falls at Louisville). This was probably in 1670, but until the 1750s, when its strategic importance in the struggle of the French and the English for possession of the interior of the continent became fully recognized, little was generally known of it. By the treaty of 1763 ending the Seven Years' War, the English finally gained undisputed control of the territory along, its banks. By the treaty of 1783 the entire Ohio country became a part of the United States and by the famous ordinance of 1787 the north side was opened to settlement. Most of the settlers entered the region by the headwaters of the Ohio and carried much of their market produce down the Ohio and Mississippi to New Orleans. On any map of U.S. railroad traffic: the Muskingum, Hocking. Scioto, Miami, Wabash and Illinois river valleys localize enormous tonnages; only the Illinois now supports waterborne commerce.

A series of river improvements and basic changes in towboats and barges have enabled the headwater and Kanawha rivers to move an expanding tonnage to the Ohio. For more than a century the federal government has made improvements and it is virtually all the work of the U.S. army corps of engineers. The U.S. coast guard confines its attention to licensing commercial pilots and erecting the signs and lights for safety in navigation. The river itself remains a part of the states on its south bank.

Improvements. — The improvement of the Ohio for commerce has lagged behind the improvement in towboats and barges that carry the ever-growing freight. The channel is 9 ft. deep and there are 46 low-level, movable or roller type dams and their locks, each 600 ft. long and 100 ft. wide. A program was initiated in 1955 to reduce the number to 19, each with 1,200-ft. locks. With such installations, locking time is reduced by more than 33% and traffic costs are reduced 50%.

Use.––Ohio river towboats vary in characteristics depending upon the type of service for which they are designed; most of them used for medium- or long-haul service for coal and general cargo are fairly uniform. A typical towboat is a twin-screw 3,000 h.p. diesel-powered boat 150 ft. long, 35 ft. in the beam and drawing 7 ft. of water when loaded. Multiple screws are the rule, since they allow the application of greater power in shallow draft and also provide the superior steering characteristrcs essential in river navigation.

Barges appear on the rivers as the hodge-podge or mixed tows and the more common specialized tow. One towboat will handle 20 barges, 4 barges wide and 5 long, putting them through a 600-ft. lock in 2 lockages. By such means traffic on the Ohio was increased from 5,000,000 ton-mi. in 1946 to 16,000,000 in 1956.

Coal and coke make up 55% of the Ohio's tonnage and petroleum and its products 20%; the rest is iron and steel, chemicals, sand and gravel, sulfur, automobiles and miscellaneous products. There is little grain.

There is no authorized program for the development of hydroelectric power in the Ohio basin proper, but during and after World War II the Ohio valley has experienced a marked increase in industrialization. Aluminum, chemicals, steel, atomic energy and electric power plants are important examples of this growth. To a river already badly polluted by factories, coal mines and raw sewage, these industries aggravate the problem. One important step to alleviate this situation has been the eight-state ratification (1948) of the Ohio River Valley Water Sanitation compact passed by the U.S. congress in 1940.

See TENNESSEE RIVER; MISSISSIPPI RIVER.

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(A. J. WT.)

OHIO STATE UNIVERSITY, a state-supported, coeducational institution of higher learning. founded by statute in 1870 and opened at Columbus, O., in 1873. *See* OHIO: *Education.*

ÖHLENSCHLÄGER, ADAM GOTTLOB (1779–1850), Danish poet, was born in Vesterbro, a suburb of Copenhagen, on Nov. 14, 1779. His father, a Schlesn-iger by birth, was at that time organist, and later became keeper, of the royal palace of Frederiksberg. Through Edvard Storm, Adam received a nomination to the college called "Posterity's High School." of ahich Storm mas the principal. Storm himself taught the class of Scandinavian mythology, and thus Ohlenschlager received his earliest bias towards the traditions of his ancestors. His studies were interrupted first by the death of his mother, and by the English attack on Copenhagen in April 1801, which, however, inspired a dramatic sketch *(April the Second 1801)*.

In the summer of 1802, when ~hlenschlagerhad an old Scandinavian romance, as uell as a volume of lyrics, in the press, the young Norse philosopher. Henrik Steffens, came back to Copenhagen after a long visit to Schelling in Germany, full of new romantic ideas. His lectures at the university, in which Goethe and Schiller were for the first time revealed to the Danish public, created a great sensation. Steffens and Ohlenschlager met, and after a conversation of sixteen hours the latter went home and wrote at a sitting hi's splendid poem *Guldhornene,* in a manner totally new to Danish literature. A volume of poems in the romantic style is now chiefly remembered as containing the lovely piece called *Sanct-Hansaften-Spil.* The next two years saw the production of the epic of *Thors Reise til Jotunheim,* the charming poem in hexameters called *Langelandsreisen,* and fantasy *Aladdin's Lampe* (1805).

At the age of twenty-six Ohlenschlager was universally recognized, even by the opponents of the romantic revival. as the leading poet of Denmark. He now collected his *Poetzcal Writings* in two volumes. He obtained a grant for foreign travel from the government, and joined Steffens at Halle in August 1805. Here he wrote the first of his great historical tragedies, *Hakon Jarl.* In the spring of 1806 he ment on to Weimar, where he spent several months in daily intercourse with Goethe. The autumn of the same year he spent with Tieck in Dresden, and proceeded in December to Paris. Here he resided eighteen months, and wrote his three famous masterpieces, *Baldur hin Gode* (1808), *Palnatoke* (1809) and *Axel og Valborg* (1810). In the spring of 1809 ~hlenschlagerwent to Rome to visit Thorwaldsen, and in his house wrote (in German) his tragedy of *Correggio.*

He returned to Denmark in the spring of 1810 to take the chair of aesthetics at the University of Copenhagen. In 1811 he published the Oriental tale of *Ali og Gulhyndi,* and in 1812 the last of his great tragedies. *Staerkodder.* His talent culminated in the cycle of verse-romances called *Helge,* published in 1814. The tragedy of *Hagbarth og Signe,* 181j, showed a distinct falling-off in style. In 1817 he went back to Paris. and published *Hroars Sagu* and the tragedy of *Fostbrodrene.* In 1818 he was again in Copenhagen, and wrote the idyll of *Den lille Hyrdedreng* and the Eddaic cycle called *Nordens Guder.* His next productions were the tragedies of *Erik og Abel* (1820) and *Vaeringerne i Miklagaard* (1826), and the epic of *Hrolf Krake* (1829).

In 1829 Ohlenschlager was publicly crowned with laurel in front of the high altar in Lund cathedral by Bishop Esaias Tegnér, as the "Scandinavian King of Song." His last volumes were *Tordenskjold* (1833), *Dronning Margrethe* (1833), *Sokrates* (1835), *Olaf den Hellige* (1836), *Knud den Store* (1838), *Dina* (1842), *Erik Glipping* (1843) and *Kiartan og Gudrun* (1847). On his seventieth birthday, Nov. 14, 1849, a public festival was arranged in his honour, and he was decorated by the king of Denmark. He died on Jan. 20, 1850, and was buried in the cemetery of Frederiksberg. Immediately after his death his *Erindringer* ("Recollections") were published in two volumes.

With the exception of Holberg, there has been no Danish writer who has exercised so wide an influence as Ohlenschlager. He awakened in his countrymen an enthusiasm for the poetry and religion of their ancestors, and his name remains to this day synonymous with Scandinavian romance. His plays, partly; no doubt, in consequence of his own early familiarity with acting, fulfilled the stage requirements of the day, and were popular beyond all expectation. The earliest are the best—Öhlenschläger's dramatic masterpiece being, without doubt his first tragedy, *Hakon Jarl.* In his poems and plays alike his style is limpid, elevated, profuse; his flight is sustained at a high pitch without visible excitement. His fluent tenderness and romantic zest have been the secrets of his extreme popularity. Although his inspiration came from Germany. he is not much like a German poet, except when he is consciously following Goethe; his analogy is rather to be found among the English poets, his contemporaries. With all his faults he was a great writer, and one of the principal pioneers of the romantic movement in Europe. (E. G.; X.)

OHM, GEORG SIMON (1787–1854), German physicist whose most important contribution was Ohm's law of electric conduction. was born at Erlangen on March 16. 1787, and was educated at the university there. He became professor of mathematics in the Jesuits' college at Cologne in 1817 and at the polytechnic school of Nürnberg from 1833 to 1849. In 1849 he was appointed professor at Munich. where he died on July 7, 1854. His writings were numerous, but, with one important exception. not of the first order. The exception is his pamphlet, published in Berlin in 1827. with the title *Die galvanische Kette mathematisch bearbeitet.* This work, the germs of which had appeared during the two preceding years in the journals of Schweigger and Poggendorff, exerted a great influence on the theory and applications of current electricity. *(See* ELECTRICITY: *III. Direct-Current Circuits: Ohm's Law.)* The most important part of the pamphlet is summarized in what is now known as Ohm's law. *(See* INSTRUMENTS. ELECTRICAL MEASURING.) This work was so coldly received that Ohm's feelings were hurt. and he resigned his post at Cologne. At this time his work began to be recognized, he was awarded the Copley medal of the Royal society in 1841 and was made a foreign member of that society in 1842.

In addition to a number of papers on mathematical subjects, Ohm wrote a *Text Book of Physics* (1854).

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OHMMETER, an electrical instrument employed for measuring insulation-resistance or other high electrical resistances. The ohmmeter is described in INSTRUMENTS, ELECTRICAL MEASURING: *Resistance Measurements: Ohmmeter.*

OHNET, GEORGES (1848–1918), French novelist and man of letters, was born in Paris on April 3, 1848 . After the war of 1870 he became editor of the *Pays* and the *Constitutionnel* in succession. In collaboration with the engineer and dramatist Louis Denayrouze (b. 1848) he produced the play *Regina Sarpi,* and in 1877 *Marthe.* He was an admirer of George Sand and bitterly opposed to the realistic modern novel. He began a series of novels. *Lrs batailles de la vie.* The series included *Serge Panine* (1881) which was crowned by the Academy; *Le Maître de forges* (1882), *La Grande Marnière* (1885), *Volonté* (1888), *Dernier amour* (1891). hlany of his novels have been dramatized with great success. *Le Maître de forges,* produced at the Gymnase in 1883. holding the stage for a year. He published in 1908 *La route rouge,* and in 1912 *La serre de l'aigle.* His last work was *Journal d'un bourgeois de Paris pendant la guerre de 1914* (1914–18).

OIL-BIRD or **GUACHARO** (*Steatornis caripensis*), the sole member of a family. *Steatornithidae.* As big as a crow, its plumage exhibits blended tint; of chocolate-colour and grey. barred and pencilled with dark-brown or black. and spotted in places with white. The guacharo is nocturnal, slumbering by day in deep and dark caverns. Towards evening it arouses itself and. with croaking and clattering, which has been likened to that of castanets, it approaches the exit of its retreat. In Trinidad the young are esteemed a great delicacy for the table.

OIL CAKE, a feeding stuff of great value, prepared from the residue resulting from the crushing of various oilseeds. For details *see* FEEDS. ANIMAL; COTTOKSEED; LINSEED; COPRA.

OIL CITY, a city of Venango county in northwestern Pennsylvania, U.S., is situated on a bend of the Allegheny river at the mouth of Oil creek, about 75 mi. N. of Pittsburgh. Divided into three hillside parts by the river and creek it is the commercial and industrial centre of a large petroleum and natural gas region. Once the site of a Seneca Indian village, Oil City was founded in 1860. following the drilling of the n-orld's first oil well at Titusville. 16 mi. up Oil creek on Aug. 27, 1859. It was incorporated as a borough in 1362 and as a city in 1871. Along with the Pennsylvania oil industry. it reached its high point between 1860 and 1870 with boats plying the shallow river, taking millions of barrels of oil to Pittsburgh. For many years the city's oil exchange set the world's price of oil. Industries include oil refineries, machine shops and the manufacture of steel drums and tubing, tin cans, bottles, gas engines. pumping machinery, and other oil-well supplies. For comparative population figures *see* table in PEKNSYLVANIA: *Population.* (W. A. C.)

OIL ENGINE: *see* INTERNAL COMBUSTION ENGINES.

OIL HEATING, DOMESTIC: *see* HEATING AND VENTILATION.

OIL PAINTING, TECHNIQUE OF. This article deals with the materials and methods necessary for artistic expression in oil colours. a medium which consists of pigments ground in drying oils. (For discussions of the history of painting, *see* PAINTING; LANDSCAPE PAINTING; PORTRAIT PAINTING; STILL-LIFE PAINTING; MURAL PAINTING; FLOWER PAINTING; for a discussion of the paints that are used to cover interior or exterior surfaces, *see* PAINT; PAINTS, CHEMISTRY OF.)

The practices of the artist are guided by principles that are based on the accumulated experiences of centuries, aided to some extent by research data from the laboratories of the industrial paint field and those of the museum technologists. The artist is prrforce a craftsman. He must be adept in the selection and the specialized use of his materials for more than one reason. He must he able to control his paints so that he can obtain the effects with which he expresses himself. He is profoundly concerned with the permanence of his paintings because a work of art is intended to maintain its original condition as long as is possible. Another of his major concerns is appropriateness: the proper choice or selection of materials, methods and techniques to fulfill his purposes to the best advantage.

Among several accepted, standard methods that have been developed to meet the various requirements for easel painting, oil painting has occupied a pre-eminent position for five centuries. It is universally preferred by artists and their patrons. Other mediums have qualities more appropriate for the expression of particular styles or particular works. Water colour, for instance, has its special working method and its sparkling effects; it lends itself to outdoor sketching because the materials required are simple and portable. Fresco has outstanding mural qualities; tempera. pastel and encaustic have their own special characteristics.

Oil painting. however. combines such a number of advantages that it has retained its outstanding position and has survived through centuries of changing art forms. Most of the paintings in museums. collections and in the everyday world of art are oils; the very word painting implies oil painting. (*See* also ENCAUSTIC PAINTING; FRESCO PAINTING; GOUACHE; PASTEL; TEMPERA; WATER-COLOUR PAINTING.)

TECHNIQUE

The painter has two means of depicting forms in art: line or contour. and tonal masses or colour splotches. Either can dominate his results. or they can be balanced so that they contribute equally. The work of the early tempera painters can be characterized as predominately linear; sometimes this quality is called "dry." Subsequent "juicier" styles of painting have a looser, more spontaneous effect; forms in general are more rotund and flowing and less angular, and tonal masses contribute more to the final effect.

Technically. the artist has two means of applying colour: the opaque brushstroke. in which the paint effectually hides the ground and depends on the direct reflection of light from its surface for its effects; and the transparent glaze, in which an underpainting or ground contributes to the final effect (*see* GRISAILLE). Each technique is valuable to the painter. but the colour effects of one cannot be duplicated by the other. Opaque painting utilizes white pigment for its whites and pale tints. Painting that employs thin, transparent layers uses a paler underpainting or a brilliant. white reflective ground for its pale tints. Glazing consists of placing thin, transparent colour over a dry underpainting; the effect is somewhat as if coloured cellophane were placed over a surface; many variations and delicate manipulations may be achieved with skilled application.

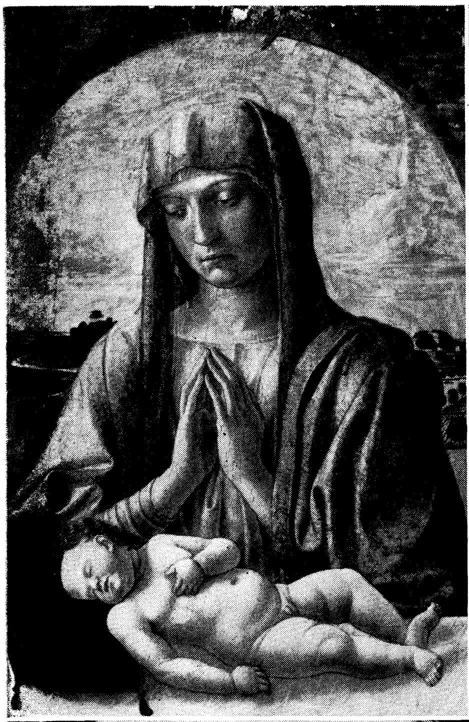
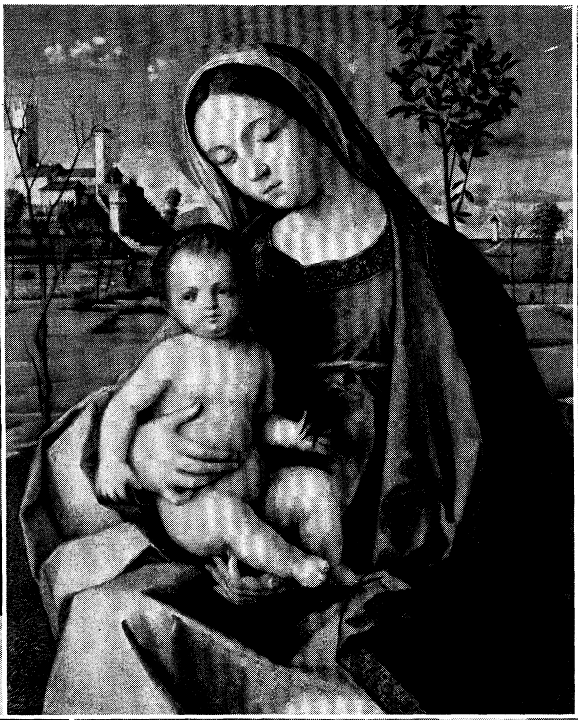
While each painting method may have superlative attributes, oil painting permits virtually every technique to be successfully applied and even combined in the same work. In general, there is no longer an insistence on the degree of excellence in all of the attributes of a painting that was once demanded; no one expects a single picture to have everything. A superlative degree of technical accomplishment is frequently sacrificed for balance or for an aesthetic emphasis.

There are many reasons for the adoption and continued use of oil paints. The outstanding facility with nhich fusion of tones or colour is achieved makes it unique among fluid mediums; at the same time, satisfactory linear treatment and crisp effects are easily obtained. Opaque. transparent and translucent painting all lie within its range. It is unsurpassed for textural variation. the manipulation of smooth and rugged. thick and thin, uniform or varied surfaces. Skill in handling can be acquired after a reasonable amount of training and experience. In painting with the water mediums there is a very definite (and frequently erratic) colour change when the paint dries. but with oil paints. the colour the artist puts down on the canvas is the colour of the finished painting The widest range of styles is possible, from the most simple to the most complex visual effects. Linen canvas is lightweight, it has a desirable texture, and its resilience to brushstrokes appeals to many painters.

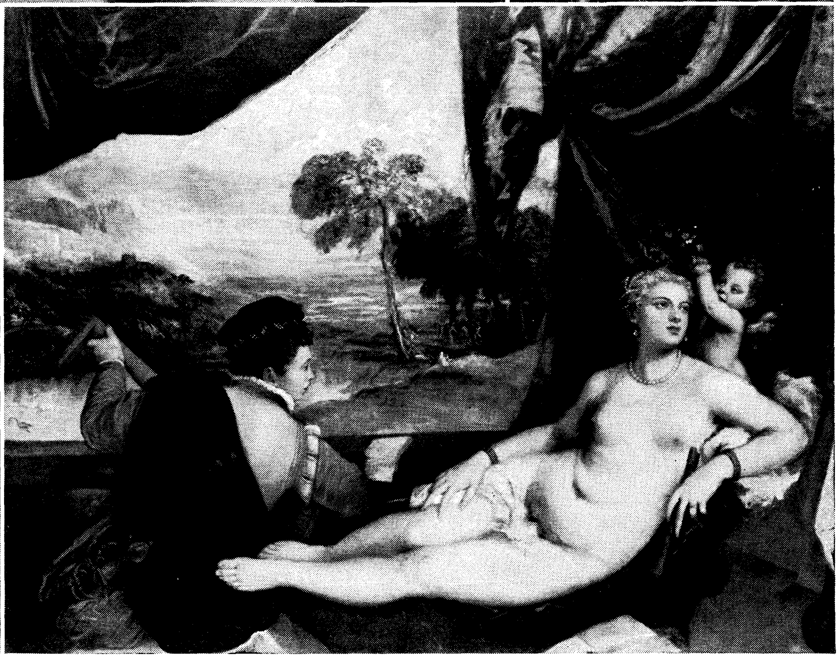
All traditional painting mediums are equally permanent when the pictures are given the care normally given to works of art. However. some are fragile (*e.g.*, pastels) and will not stand wear and tear or abuse as well as oil paintings.

MATERIALS

When painted with bad materials oil paintings on aging will suffer defects and blemishes, such as embrittlement, cracking, darkening or yellowing, nhich can be avoided by observing the rules of correct craftsmanship. Artists' materials have been necessarily of superlative quality prepared with the utmost striving toward perfection. Although a fine painter is not made by fine materials. the artist is nevertheless severely handicapped if his materials are inadequate. The use of substandard materials for





EARLY DEVELOPMENTS IN OIL PAINTING TECHNIQUE

Top left: "Madonna Adoring the Sleeping Child" by Giovanni Bellini (*c.* 1430–1516), Venetian. A straight tempera painting on gesso panel

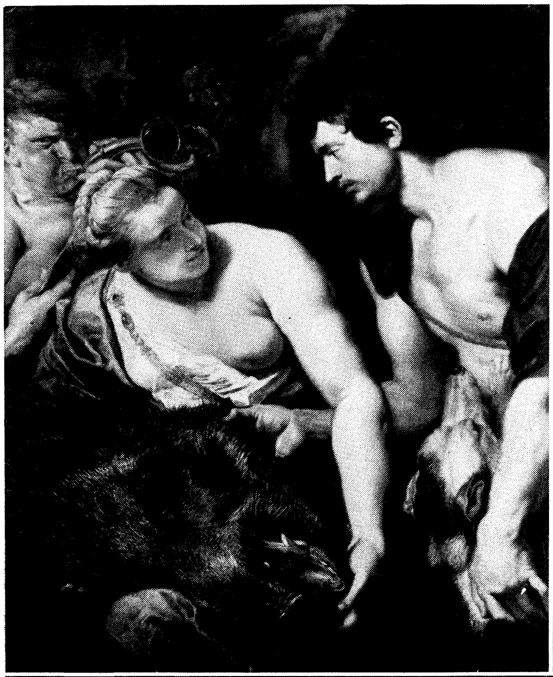
Top centre: "Madonna and Child" by G. Bellini. The beginning of Italian (or Venetian) oil painting, a work begun in tempera and finished with oil or oleoresinous glazes. Oil allows the painter to depart from the extremely dry and linear quality of the earlier work (top left) and move toward more rotund, flowing forms

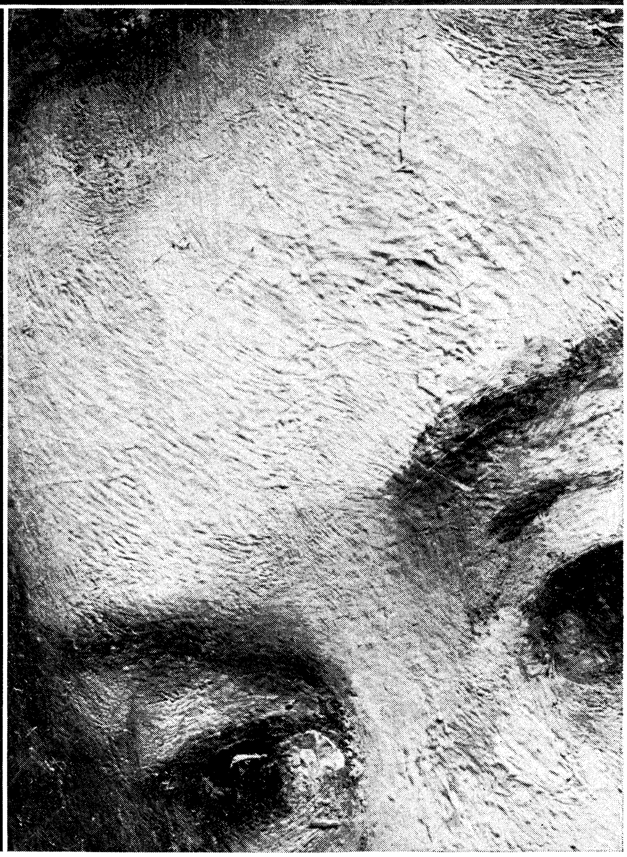
Top ***right:*** Detail from "A Venetian Senator" by Tintoretto (Jacopo Robusti, 1518–94), Venetian. The developing art forms reauired materials and techniques that could emphasize tonal areas or colour masses over the linear elements. The freer use of oil paints continued, with the surface dominating any linear elements or colours that lay below

Centre right: Detail of the hand of Flora from "Primavera" (Spring) by Sandro Botticelli (1444–1510), Florentine. Tempera painting. A completely opposite technique from the Tintoretto (top right). Oil colours, however, are also applicable to the dryer style, and later painters explored the degrees and combinations of these elementary concepts

Bottom left: St. Elizabeth, a detail from "Virgin and Child With Saints and a Donor" by Jan van Eyck (?1385–1441). The Flemish painters developed the oil or varnish-glazed tempera techniques to a level of jewel-like perfection

Bottom right: "Venus and the Lute Player" by Titian (Tiziano Vecellio, c. 1490–1576), Venetian. Oil paints and glazes used extensively, but still influenced by the basic principles of tempera procedure, with its dependence on retention of a meticulous drawing on a brilliant ground and multiple layers of application



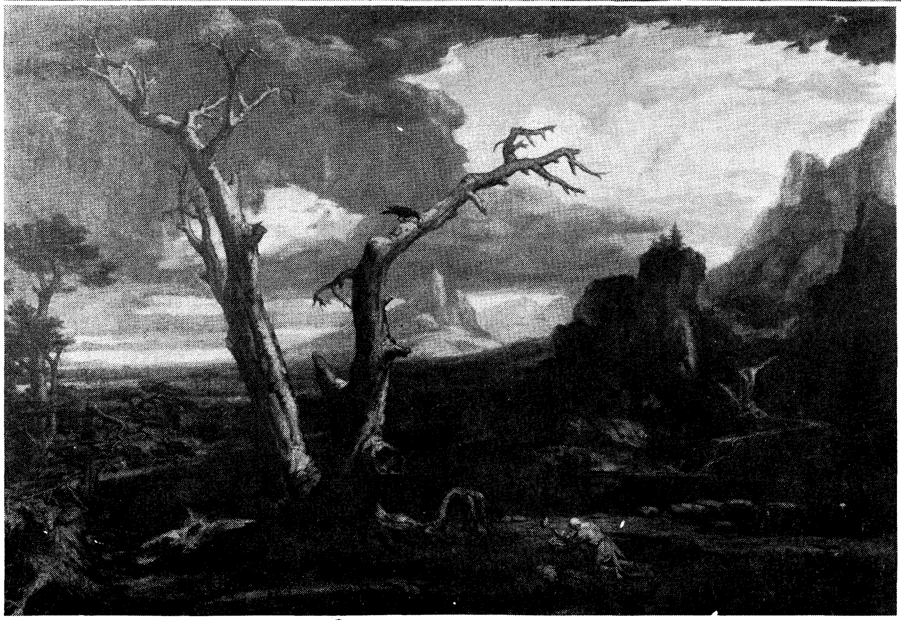
FURTHER DEVELOPMENTS IN OIL PAINTING TECHNIQUE

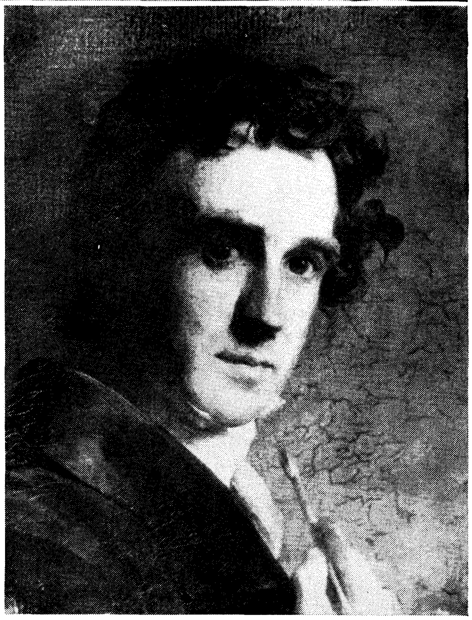
Top left: "Atalanta and Meleager" by Peter Paul Rubens (1577–1640), Flemish. Solidly painted in oil with careful attention to brilliance of effects and longevity of the work, masterly handling of brushwork. Rubens is notable for the play of solidly loaded whites and pale tints against thin, translucent darks

Top right: Detail from "Bear Hunt" by Rubens, an example of his flowing or sketchier style, a partially finished painting which reveals his methods

Bottom left: "Hendrickje Stoffels" by Rembrandt van Rijn (1606–69). Dutch

Bottom right: Detail from "Hendrickje Stoffels." Rembrandt's brush control, his paint quality resulting from use of every technical element inherent in the oil medium, and his characteristic textures are visible in the detail of this portrait





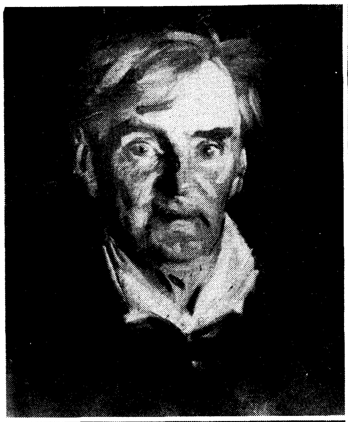
DEVELOPMENTS IN TECHNIQUES IN THE 18TH AND 19TH CENTURIES

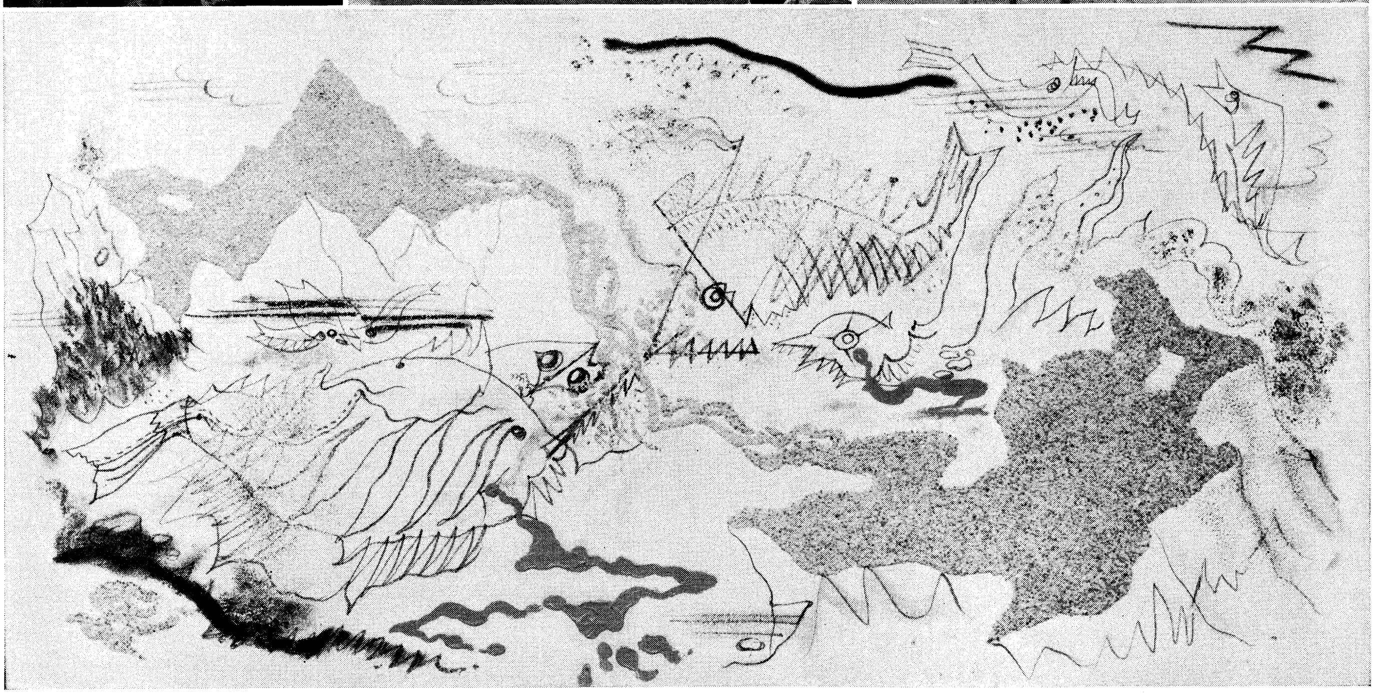
Top left: "Lady Selena Skipwith" by Sir Joshua Reynolds (1723–92), English. Reynolds was among a group of 18th-century painters who became involved in futile and often disastrous searches after the so-called secrets of the old masters' techniques. Although an accomplished and successful representative of the English portrait school, Reynolds' colours and paint layers have frequently deteriorated

Top right: "Mary Edwards" by William Hogarth (1697–1764), English. An extremely well-handled oil painting technique which has survived in fine condition

Bottom left: "Elijah Fed by the Ravens" by Washington Allston (1779–1843), U.S.; and Bottom right: "Self-Portrait" by Thomas Sulley (1783–1872), U.S.

Both of these paintings are documented by their painters as departures from their usual techniques in an effort to emulate the translucent, glowing effects of the earlier painters by underpainting in colours ground in skimmed milk and completing the picture with oil and varnish overpainting and glazes. There are two of the earliest U.S. experimental paintings of record, presaging the 20th-century revivals of older techniques





BY COURTESY OF (TOP CENTRE) WHITNEY MUSEUM OF AMERICAN ART, N.Y., (TOP RIGHT) VIRGINIA D. H. PIERCE, (CENTRE LEFT) THE METROPOLITAN MUSEUM OF ART, N.Y.; PURCHASE, 1871, (BOTTOM) COLLECTION, THE MUSEUM OF MODERN ART, N.Y.; PURCHASE FUND

DEPARTURES FROM THE TRADITIONAL USE OF OIL PAINT

Top left: Portrait sketch of Joseph Jefferson by John Singer Sargent (1856–1925), U.S. Sargent was a brilliant and popular painter in the technical manner of Velázquez, but his almost complete disregard of the limitations of oil paint and its correct handling resulted in a number of his paintings cracking badly

Centre left: Detail of the head from "Malle Babbe" by Frans Hals (1580?–1666), Dutch. The same bold, splashy, bravura brushstroke sought after by Sargent can survive brilliantly for hundreds of years in fine condition if properly handled

Top centre: Detail from "Fantasia in Blue" by Hans Hofmann (1880–), U.S. A not uncommon practice among mid-20th-century painters was the use of oil colours in such enormously exaggerated impasto that the overhanging edges, points and ridges are almost sculptural in effect, far beyond the limits of what was traditionally deemed safe practice

Top *right:* Detail from an untitled painting by Lee Hersch (1896–1953), U.S. An exploration of the plasticity and mobility of paint by exploiting its natural flow when dashed or dropped against a surface without the intervening guidance of a brush or other implement coming in contact with it. The method permits a limited degree of control, the colours do not mix or blend with each other; completely opaque paints may thus be used to produce multiple lacy veils of colour that have textural or tactile value and which allow what is below to show through. There is no foreseeable reason to doubt its permanence if standard, time-tested paints are used in normal thickness

Bottom: "The Battle of the Fishes" by André Masson (1896–), French. The areas of sand on the surface are an innovation of an unknown degree of permanence. The use of oil colour areas surrounded by the unpainted white canvas has so far resulted in a very noticeable yellow staining where clear oil has seeped out of the red blood colour of the fishes at several points economic reasons has been since ancient times a temptation that artists have had to overcome.

Artists' oil colours are made by mixing dry powder pigments with selected refined linseed oil to a stiff paste consistency and grinding it by strong friction in steel roller mills. The action of the mills is squeezing, not crushing; the object is to disperse the tiny individual pigment particles throughout the oil, rather than to grind them down in size, since for the most part they are sufficiently fine at the start. The consistency of the colour is important: the universal use of tube colours demands that they be uniform within well established limits. The standard is a smooth. buttery or short paste, not stringy or long or tacky. When a more flowing or mobile quality is required by the artist, a fluid painting medium must be mixed with it. It is important that this be a time-tested. reliable material, for many 18th- and 19th-century paintings have deteriorated because of the use of facile but improper additives.

Traditional practice is based on the use of pure linseed oil colours judiciously thinned with a little turpentine. Technical practices degenerated decidedly during the 18th century; the older traditions of craftsmanship declined with the end of the apprentice system. the new availability of ready-made materials (even though their ingredients were generally of better quality than the older ones) and the new conceptions of artistic purposes. The necessity for improvement became urgent. Sound traditional practices continued, but many painters who desired to emulate the techniques of admired painters of the past. falsely believed that such effects were due to secret recipes that had become lost. The search for the secrets of the old masters led to the adoption of a number of complex painting mediums, mixtures of cooked varnishes. oils and driers, mostly of 18th-century origin taken from the practices of craft or trade painters and decorators. The most prominent of these was a jellylike medium with the strange name of megilp, which conferred the most facile and versatile brushing qualities to oil colour, Others of equal infamy were the asphalts or bitumens and certain unsound pigments, such as Vandyke brown and emerald green. Unfortunately. cracking, darkening and subsequent ruination was the fate of every area of a painting where these materials were used; they were responsible for much of what conservators call "inherent vice" in a decrepit painting.

Authoritative opinion holds that technical secrets could not have been the sole property of any individual; all of his colleagues, students and helpers would be acquainted with them. The performances of the great masters were largely dependent upon personal attributes that cannot be duplicated by anything that comes out of the varnishmaker's kettle. (See also PAINTS, CHEMISTRY OF.)

PIGMENTS

A pigment is a finely pulverized, insoluble material used to impart its colour effect to another substance. The same materials are used as pigments in all sorts of paints. For artists' use. pigments must conform to rigid requirements. They must possess the highest degree of colour stability under all conditions to which a work of art may be exposed; they must be brilliant, pure, chemically true to type, smooth and fine. Paint pigments do not dissolve in their liquid vehicles but remain suspended in them. Soluble colouring matters are called dyes; these impart their colour effects to materials by staining them or being imbibed by them. Dyes no longer have much use in oil paints; formerly the list of approved pigments contained many lake colours. which were made by fixing dyes on colourless powders. There is a class of white or almost white powders that become colourless or nearly so when mixed with oils, such as chalk. whiting, clay, alumina hydrate and blanc fixe (precipitated barium sulfate). They are called inert pigments. a term that refers to their lack of colouring power. not their chemical stability. Besides being used as extenders or adulterants they also have a fen useful purposes in some paints. Formerly artists used many organic pigments of vegetal and animal origin. Now only two organic pigments are approved for permanent painting, alizarin and phthalocyanine. both of synthetic origin. All other approved colours are inorganic or "mineral" colours.

Pigments are either processed from coloured ores, earths or rocks, or they are manufactured by chemical means from raw materials which are not in themselves colouring matters. The approved palette for oil painting consists of:

Reds: Indian red, light red, alizarin crimson, and cadmium light, cadmium medium, cadmium deep and cadmium maroon.

Blues: ultramarine, cobalt, cerulean, manganese and phthalocyanine.

Yellows: cadmium light, cadmium medium. cadmium deep, cadmium orange, ochre, raw sienna, Mars, Naples, cobalt and strontium.

Greens: green earth, viridian, cobalt and chromium oxide.

Browns: raw and burnt umber, burnt sienna and burnt green earth (transparent brown).

Violets: Mars! cobalt and manganese.

Blacks: Mars, ivory and lampblack.

Whites: flake, zinc and titanium.

Unlike some of the other painting materials, there are few difficulties or unsolved problems in regard to pigments. Their history is well documented; it goes far back and it may be followed through Greek. Roman, medieval, Renaissance and modern times. The brilliance, permanence and other qualities of pigments have steadily improved; most modern pigments are superior to the older ones. However, artists in every age have had to select a permanent palette and to resist the temptation to use superbrilliant colours with fugitive results.

The written history of pigments includes, besides many brief references in nontechnical writings, some specialized accounts. The *History of Stones* of Theophrastus (*c.* 300 B.C.) tells how cinnabar (native vermilion) is obtained from inaccessible cliffs by shooting arrows to dislodge it, and how roasting red earth alters its shade, a recent discovery at that time. Another classical source is the *Natural History* of Pliny, an encyclopaedic work of the first century, which contains a good deal about pigments, Some of it was written from personal observation but much of it was compiled from various sources including literal translations of some of Theophrastus' chapters. Some of Pliny's technical descriptions are models of accuracy, some are vague and ambiguous, and some are fantastic tales. He describes perfectly the manufacture of white lead (flake white). one of the first synthetic pigments, a process still in use. He admonishes artists to return to the simple palette of the Greeks whose paintings were so superior. and he deplores the Roman tendency to use such novelties as "the slime of India's rivers (indigo) and the corrupt blood of her dragons and elephants." Dragon's blood is a colour obtained from the fruit of an Asiatic tree. Pliny solemnly said it was the blood of the dragon mingled with that of the elephant: whenever they met they engaged in mutually mortal combat, the dragon crushing the elephant in its coils and being crushed in turn as the elephant fell.

The medieval period saw the introduction of vermilion. an improved synthetic counterpart of the ancient cinnabar. The fabulous *azzuro oltremarino* ("blue from beyond the sea") or ultramarine blue was obtained by a lengthy and complex processing of lapis lazuli. a semiprecious stone that came by trade routes from Afghanistan. Lapis ultramarine was the most. costly of medieval and Renaissance materials; it was worth well over its weight in gold. For fine work it replaced all the inferior blues: princes and popes doled it out to their painters and there are tales of how lavishly the artists washed their brushes, subsequently to reclaim a pinch of the precious stuff from the wash water for their own use.

Less desirable blues served everyday purposes until the second quarter of the 19th century when a process for the manufacture of ultramarine was developed. Its discovery began with the casual observation of a blue deposit on the soda furnaces in a French chemical plant. and soon thereafter a process was worked out so that this once treasured rarity became a mass-produced item. the standard blue of commerce and the arts.

In the early years of the 18th century. prussian blue was accidentally discovered when a colour chemist who had been given a wrong chemical for an experiment on a red pigment, poured the unsuccessful batch onto other waste material. Prussian blue is notable as the first completely documented pigment; its date and place of discovery, discoverer and development are all covered in contemporary scientific journals. Prussian blue has several shortcomings, but it is relatively cheap and still survives in industrial use. Despite its poor qualities, artists used it until an accidental blue product was obtained in England in 1935 from the production of alkyd resins. It was soon developed into the useful, permanent phthalocyanine blue, a perfect replacement for Prussian blue in colour and physical characteristics. The painter's palette is enriched from time to time when a pigment with known good qualities. because of its commercial usefulness, becomes economically feasible to produce.

In 1942, after conferences held in New York between artists' colour manufacturers and artists' groups, the national bureau of standards promulgated a voluntary agreement known as Commercial Standard CS 98–42 for Artists' Oil Paints. This set of specifications, based on research done by the then-existing Federal Art project, established standards and provided tests for physical and colour properties, performance and composition. Its official pigment nomenclature alone brought order to a previously confused and chaotic situation that had plagued artists for centuries and had resisted all former proposals for reform. A single pigment used to be known under as many as a half-dozen names, and entirely different pigments went by the same name. Whimsical names were in wide circulation. Since the agreement, artists' tube colours which are guaranteed to meet or exceed the requirements cf CS 98–42 are so labeled. (Copies of the Standard may be procured from the superintendent of documents, Washington, D.C.) (See also COLOUR.)

Vehicles, Mediums and Thinners. — A vehicle is the liquid component of a prepared paint; it serves to bind the pigment into a durable paint film, to cause it to adhere to the canvas and to allow manipulation of the paint with the painter's brush. A painting medium is a liquid with binding and adhesive properties similar to those of the vehicle. The medium is added to a paint to alter its brushing or manipulative properties. A thinner is a completely volatile liquid whose sole function is to dilute a paint to a more fluid consistency so that it may be spread out more thinly. The thinners used with artists' oil paints are pure gum turpentine and its perfectly acceptable petroleum substitute, mineral spirit.

In order to accelerate drying, a siccative or liquid drier is sometimes used. The one universally approved siccative is cobalt drier, used sparingly in minimum amounts; it replaces the old lead and manganese siccatives.

The vegetable drying oils do not dry like water paints, which lose the bulk of their volume by evaporation. On exposure to air these oils solidify without appreciable loss in volume by chemical changes (oxidation and polymerization) ; afterward they cannot be reliquified by any means.

Modern fine tube colours are carefully compounded with a minimum oil content; excess oil is one cause of afteryellowing and structurally defective paint films. Furthermore, it will not perform like the blended mediums; hence, straight oil is not used as a painting medium. Poppy, walnut and other drying oils are no longer used in oil colours, except for a small percentage of poppy oil sometimes added by manufacturers in grinding certain pigments to improve consistencies. Mastic and copal varnishes have likewise been outmoded for some time. Megilp, previously mentioned, consists of mastic varnish mixed with oil cooked with lead driers.

The standard technique for best results in regard to permanence has always been to use straight oil colours with the occasional use of a little thinner. But for thin glazes and for special techniques which require a more fluid, mobile consistency and an especially facile handling, mediums are added. There are quite a few on the market but many artists prefer to mix their own. A good recipe is: one fluid ounce of stand oil, one fluid ounce of damar varnish, five fluid ounces of pure gum turpentine and a small amount (about ten drops) of cobalt drier. Stand oil is a traditional material, a nonyellowing, heat-thickened (polymerized) linseed oil.

The aim in the formulation of such materials is to produce a liquid which will overcome the natural buttery quality of the colour, permit it to be manipulated in the desired manner and leave the final paint film no weaker nor less flexible than the original paint. (See OILS, FATS AND WAXES.)

Brushes. — The brush is the item of the artist's equipment in which inferior materials are least likely to produce desired results. Brushmaking is a highly skilled craft that has come through ages of development. In the midst of mechanized production it survives as a handicraft industry. Each brush is made with careful attention.

The top-grade brushes are made in two types: red sable. made from the tail hairs of the kolinsky or red Tartar marten; and bristle, made from a superlative grade of bleached white hog's bristles. Since the early 1940s supplies of the best bristles, which come from eastern European and north Asiatic sources, have been difficult to maintain, although there has been no lowering of workmanship. Very good bristle brushes are not common.

The tips of hairs and bristles are never cut; all trimming and shaping is done from the other end. Red sable hair has a minute bulge in the middle and tapers to a very sharp point. The hog's bristle is forked or branched at the tip; this is called the flag. Bristle brushes come in numbered sizes in each of four regular shapes: round (pointed), flat, bright (flat shape but shorter and less supple) and oval (flat but bluntly pointed). A poor flat brush will splay like a broom; a good one yields a controllable line and maintains its shape in use because it is skillfully constructed, with incurving bristles set at its edges. Round brushes are generally associated with the earlier painters; flat ones with the more recent past. Red sable brushes are widely used for the smoother, less robust type of brush stroking; they also come in corresponding shapes. Artists also use some supplementary styles, especially for the manipulation of paint after it has been brushed on; for example, the badger-hair blender, which looks something like a shaving brush, is tapped, clean and dry. perpendicularly against the wet surface. A different grade red sable brush, with ox-hair mixed with the sable. is sometimes chosen when very springy, resilient stroking is required. The water-colour brush, a short-handled, round, pointed red sable brush of special construction. is sometimes also useful in small sizes for small. precise work in oil. The painting knife, a finely tempered. thin, limber version of the artist's palette knife, is a convenient tool for applying oil colours in a robust manner. It did not come into wide use until the 19th century, but had a forerunner in the cestrum used in encaustic painting (*q.v.*). Artists have learned how to use the painting knife to obtain a number of textural effects, both rough and smooth. keeping the thickness of the paint within safe limits, so that it will survive without cracking. (See also BRUSH.)

Painting Grounds. — The surface on which the artist paints and the support or backing for it must be selected with care. The survival of the work, the ease of its execution and the final visual effect are all profoundly involved in this selection. The standard ground for oil painting is a canvas made of pure European linen, of strong, close weave. It is coated with a white oil priming and stretched on a wooden stretcher frame or chassis. Modern stretchers are machine made so that the tongue and groove mitred corners of the strips are interchangeable. The inner corners are provided with slots for wooden wedges, which, when tapped with a hammer, tighten the canvas. For larger sizes. extra-heavy custom-made stretchers of more sturdy construction are available, with crossbars if desired.

Stretchers are beveled slightly to prevent their inner edges from being noticeable through the canvas. In France, the chassis (assembled stretcher), stretched canvases and picture frames are available by number in 57 stock sizes: 19 lengths in three different proportional widths, figure, *paysage* and marine. For example, number 20F, roughly equivalent to the popular 24 × 30, is 73 X 60 cm , 20P is 73 × 54 and 20M is 73 × 50. In the U.S. and Great Britain it is customary to sell stretcher bars separately and canvas by the roll.

When the artist makes his own canvas he tacks the linen to the stretcher and then sizes it with a weak solution of hide glue to protect it from the oil. It has been known from earliest times that linen in direct contact with oil will decompose on aging. A white lead-in-oil priming is then applied, in one or two coats. When, as is more often the case, the canvas is bought ready-made by the roll the quality of the linen and priming should be carefully examined.

If rigidity and smoothness are preferred to springiness and texture, a wooden panel may be used with an oil priming or a gesso ground. Gesso. a mixture of chalk and glue is too inflexible for use on cloth The panel may be a well-made maple or birch plywood or a wallboard with the trade-marked name of Standard Presdwood, which has the advantage of uniformity of structure. Many other supports, textile and metal. have been tried, but fen of these are in general use or have wide approval. Cotton canvas, often used by art students, has several shortcomings and is definitely inferior to linen in every requirement.

Varnish.—A coat of picture varnish is usually given to a finished oil painting. This is necessary to protect the painting from atmospheric attacks. from minor abrasions and an injurious accumulation of dirt. It also brings the surface to a uniform lustre, and brings the tonal depth and colour intensity to those originally created by the artist with wet paint. A correctly painted oil painting should be moderately glossy. Formerly, a highly reflectant gloss was considered in good taste, but, except in very low-keyed works. in dark intense paintings or in revarnishing old paintings that have large areas of blackish tones, a glassy shine is no longer widely admired.

When a layer of dust and dirt accumulates on a painting it becomes powerfully adhesive and behaves much as though it were adsorbed into the surface. If the surface is simply oil paint, the removal of this embedded grime presents a serious problem and its effect is sometimes ruinous. If the painting is protected by a coating of picture varnish, cleaning by the removal of part or all of the varnish film is a relatively safe and easy procedure. (See PAINTINGS, CONSERVATION OF)

Some 20th-century painters. especially those who do not favour the deep, intense type of colouring, have wanted a mat or lustreless finish in oil paintings, but this seems unobtainable by any means if the longevity of the painting is to he considered It is well known in the industrial paint and enamel field that lustreless finishes are obtained only at a definite sacrifice of durability.

An acceptable, mat varnish for permanent easel painting has not been invented, although there are some that are adequate for decorative work or other purposes for which permanence is a secondary consideration. Oil painting in the past mas never intended to be other than glossy; admiration for this quality was one of the attributes which contributed to its adoption. Other types of painting, water colour. gouache, tempera, casein, fresco and pastel, have dead mat or semimat finishes. The aqueous paints in comparison to oil have powerful, gluelike binders; their chief ingredient (water) evaporates. leaving no surplus vehicle to surround or encase the pigment in a transparent pellicule or film. as oil paint does. They therefore have a different optical effect on the pigments. The gloss of an oil painting is a natural function of the medium.

The two approved varnishes which come nearest to fulfilling most of the ideal requirements for a picture varnish are. damar (a solution of a pale East Indian resin in turpentine) and acrylic. (a solution of a nater-white synthetic resin). Two outmoded picture varnishes still in circulation are mastic !made from a resin from the Mediterranean countries) and copal (a cooked linseed oil varnish containing a very hard African resin) Both of the latter are relatively dark in colour and turn bronn or brownish-yellow upon aging. Copal has the additional disadvantages of cracking nith age and of becoming difficult to remove when it needs replacement Besides picture varnish the artist may use a very dilute resin solution knonn as retouch varnish This is not a finish; it is employed as an extremely weak or attenuated covering to bring out the natural wet gloss and colour effect when work is resumed on a painting that has dried and become sunken-in. It is intended to be used for this one purpose and is not supposed to form an appreciable film or layer. or to give permanent finish or protection.

Paintings are varnished as soon as they are completely and thoroughly dry When thick, glassy coats of mastic or copal were in vogue, artists waited for months before varnishing to avoid any physical injury to the soft paint layers by the contraction of the varnish. (See also VARNISH.)

HISTORY

The practice of easel painting with oil colours stems directly from 15th-century tempera painting techniques; its development can be followed without interruption. Oils, varnishes and oil colours were known and used for several decorative and protective purposes long before their adoption by artists. Drying oils are described in manuscripts by ancient and medieval writers; oil as a painting medium is mentioned in the treatise of Theophilus (11th century).

Well known to all students of early painting methods is the book of Cennino Cennini (see TEMPERA), a 14th-century painter whose practices descend directly frorn Giotto's studio; there are several references to the preparation of oil painting materials and the methods used for various purposes. One chapter (no 89) is titled "How to work in oil on a wall, on a panel, on iron or uherever you please." Numerous other references are found in old expense accounts. for instance: "The King to his treasurer and chamberlains. Pay from our treasury to Odo the goldsmith and Edward his son one hundred and seventeen shillings and tenpence for oil, varnish and colours bought, and for pictures executed in the Queen's Chamber at Westminster . . . May 25th to June 11, 1239."

Basic improvements in the refinement of linseed oil and the availability of volatile solvents or thinners for varnishes and oil paints after 1400 coincided with a need for some other medium than pure egg-yolk tempera to meet the changing requirements of the Renaissance. The new demands were particularly exemplified in Venetian painting. Painting developed away from the dry. linear effects that had prevailed; the new materials allowed new techniques of handling colour, tonal masses and depth of colour. At first oil paints and varnishes were used to glaze tempera panels, painted with their traditional linear draftsmanship. The work of Antonello da Messina, Domenico Veneziano, and the technically brilliant jenellike portraits of the 15th-century Flemish painters were done this way. Among the earliest of these oil-glazed tempera paintings were the works of Jan van Eyck of Bruges (1385?–1441) and his brother Hubert. In 1550 Giorgio Vasari published his Lives of *the* Painters, in which he credited "Giovanni da Bruggia" with the "invention" of oil painting. This statement made such a strong impression, on Flemish and Dutch historians in particular, that the belief that 'the Van Eycks were the first artists to discover that one could make paint with linseed oil, persisted for centuries. Scholars since 1781 have shown that although Jan van Eyck, one of the great masters of all time, was important in the history of painting, oil painting was neither his invention nor that of any individual, but was the result of a long, gradual development. In the lives of the painters who lived nearer his oan day and in his technical chapters "The Three Arts of Design." Vasari records information of great value; his direct. factual statements about 16th-century technical practices refute those who hold that there are lost secrets of the old masters.

In the 16th century oil colour emerged as the basic painting material in Venice. Artists had to learn gradually how to assure themselves of permanent results and how to develop fluent control. Since their traditions developed from tempera painting, they first relied on glazes and on carefully and deliberately planned cartoons and underpaintings. retaining many of the cardinal principles of the older technique. This type of painting utilized the effects of the drawing and underpainting which were never entirely obscured.

The emphasis on the oil glazes increased until the overpaintings gradually became more solid and direct, and the dry or linear character gave way to a more balanced combination of line and tonal effects. the latter obtained by use of directly applied, opaque colour areas or splotches. This progression can be followed in the lifetime of one artist. Giovanni Bellini (1430–1516), who worked at first in pure egg tempera, then passed through an intermediate stage in which he must have used some oily ingredient. then covered his works with thin oily glazes and finally employed heavier oil coatings.

The work of Titian (c. 1490–1576) and Tintoretto (1518–94) carried on the development and during the 16th and 17th centuries, most of the technical possibilities of oil painting were explored, at least in principle. Later investigations that were made into specific recipes for the oily mediums used by the masters of this period. brought about very involved, confused and contradictory interpretations, discussions and arguments, in the 18th and 19th centuries.

In the early years of oil painting, so many mixtures of oils and varnishes were tried and recorded in manuscripts, so many were subsequently discarded when their lack of permanence was established and so many recipes designed for trade or decorative uses later passed as artists' mediums that it is doubtful whether anyone can make any really authoritative statements or generalizations on exactly nho used what and when.

By the end of the 16th century. artists had become proficient in the exploitation of the basic characteristics of oil painting; the means of expressing personal techniques, while ensuring longevity. had been learned. Linen canvas. after a long period of development, replaced wooden panels as the most logical and popular support. Cennini discusses the use of colours on linen and hempen cloth on wooden stretchers. and on banners. standards and trappings. It was adopted for easel paintings, because oil paint has sufficient elasticity to give permanent results when properly applied upon it.

Velázquez (1599–1660), who can be said to represent the culmination of the Venetian tradition, is usually cited as the first master whose technique can be copied by simple, direct oil painting, as it was later practised. His direct uncomplicated use of colour and his bold, bravura brushstrokes have frequently been emulated, especially in portraiture. Peter Paul Rubens (1577–1640). who represents the culmination of the Flemish school. was a prodigious painter of the very highest personal attainments. His studio has been called a picture factory because of his output and because he employed so many colleagues and students as assistants. He charged a higher fee for paintings entirely esecuted by his own hand, but boasted that no painting left his possession without being gone over by himself, at least in its salient points. Much is known of his manner of working and his basic techniques, some of it from his own writings. The technical significance of Rubens as an influence on later painters is the manner in which he loaded or piled up his whites and pale colours. opaquely. in juxtaposition to thin. transparent darks and shadows. He is also admired for another and sketchier style of handling. Over a brilliant, reflective white ground, he laid a cool, gray transparent film of paint (*imprimatura*); on this he painted a fully modeled monochromatic underpainting in a thin. translucent brown. Brilliant colours were then stroked in with a light, sure touch. Painters of this period sometimes employed coloured grounds, particularly in earth reds, but Rubens' combination of the reflective white and a transparent veil of colour utilized the technical advantages of both.

A third great master of oil painting technique of this period is Rembrandt (1606–69) who can be considered to represent the culmination of the Dutch school. His technical effects had perhaps the most profound influence of all on later painters, particularly his brushwork, his handling of paint textures and surfaces, and his paint quality and visual effects. A single brushstroke sometimes reveals an effective depiction of rotundity of form and a textural depth combining the rough and the smooth and the thick and the thin. The system of loaded whites and transparent darks. so pronounced in Rubens. is enriched by further touches of broken opaque strokes, which do not obscure the underlying colours, in addition to glazed effects and blendings. Rembrandt left no record of his materials, but he is presumed to have used much stand oil, a heat-processed or polymerized linseed oil for which the Dutch have long been famous.

Other basic influences on the techniques of later easel painting are the smooth, thinly painted, deliberately planned, tighter styles of painting. These were never discarded; they have continued to have their followers in every generation. Bold. crisp brushstrokes and any areas or spots raised considerably above the level of surrounding colour are called impasto. A great many admired works were executed with smooth gradations and blends of tones to achieve rotund forms and subtle colour variation. The paintings of Jan Vermeer (1632–75) may be cited as examples. His direct painting is combined with restrained and subtle blends without diminishing the forcefulness of the work.

An interesting effect seen in some old paintings is called pentimento ("repentance"). Because of changes in the refractive index of linseed oil films after aging, it is possible for thinly painted layers to become transparent, revealing forms that had been covered over.

There are numerous examples in galleries, in which the artist had used thin overpaintings of paler colour to obliterate dark forms that in time became visible in a ghostly manner. Examples are found among the thinly painted Dutch panels of the 17th century, especially where the checkerboard marble floors they mere so fond of depicting have come through thinly overpainted figures and objects. Painters have learned to avoid *pentimenti* by scraping away dark markings before overpainting with paler colours or by making the overpainting sufficiently opaque to preclude this occurrence.

Painting in the 20th century has created many technical problems. In addition to traditional art forms, many new schools have arisen. The technical requirements of some of these are well served by the materials and technical means of the past; others cannot be realized by the use of paints that were developed specifically for the craftsmanship and painterly qualities associated with traditional techniques.

The demands of French Impressionist painting had coincided with improvements in paint-grinding machinery that permitted the manufacture of artists' oil colours to a more buttery or less mobile consistency. Some abstract painters, and to some extent contemporary painters in traditional styles, have expressed a need for an entirely different plastic flow or viscosity than can be had with oil paint and its conventional additives. Some require a greater range of thick and thin application and a more rapid speed of dry. Some artists have used the traditional materials in unorthodox ways, such as mixing coarsely grained materials with their colours to create ne textures; some have used oil paints in enormously heavier thickness than has been considered safe. Abandoned techniques have been revived to cope with such problems and experimental paints based on synthetic resins have been tried. See also PAINTINGS, CONSERVATION OF.

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OIL PALM, a genus of palms (*Elaeis*) botanically allied to the coconut palm (Cocos). The more widely known of the two species belonging to the genus *Elaeis*, E. *guineensis*, is indigenous to tropical west Africa, where it has attained considerable economic importance as a source of palm oil and palm kernels. but it is also cultivated as a plantation crop in Indonesia and the Malay peninsula and, on a small scale, in some Central and South American countries. The oil palm in Africa is confined mainly to a 300-mi -wide region along the coast from the Gambia to Angola, although it is also found in the forest regions of the middle Congo and Kenya. It is a light-demanding species but grows well on a variety of deep. well-drained. neutral or alkaline soils. In maturity it may attain a height of Go ft. but normally has a stem of no more than 30 ft., which bears at the summit an irregular crown of feathery leaves, each of from 10 ft. to 15 ft. in length and pinnately divided into 50 or more lance-shaped leaflets. The numerous flowers are crowded on a short spadix and develop into a large ovate fruit cluster which may contain more than 1,000 drupes. varying in colour from a deep yellow to a dark red-brown. Mature palms bear from two to six bunches of fruit, each normally weighing between 10 lb. and 35 lb., approximately one-third of which consists of stems or bracts.

The individual fruit is between one and two inches in length and three-fourths and one inch in diameter, its weight varying from 3 g. to 25 g. The fibrous pericarp, or outer fleshy portion of the fruit, consists, as to between 30% and 70% of its weight, of palm oil, while the kernels in the endocarp are approximately 50% by weight of palm kernel oil.

The weight ratio of pericarp to kernels varies considerably but the *dura* and *tenera* varieties cultivated in Malay peninsula and Indonesia consist largely of pericarp, unlike the wild palms (var. *macrocaryaj* of west Africa; production of palm oil in the Asian countries is consequently of much greater importance than that of palm kernels (*see* PALM OIL AND PALM-KERNEL OIL). Research into the improvement of E. *guineensis* strains has been concentrated mainly upon the thick pericarp varieties and. in particular, upon dwarf varieties which facilitate harvesting of the fruit.

See West African Institute for Oil Palm Research, *Quarterly Progress Report* (1953). (*H* F. C. *G.)*

OIL PLANTS. Oil has been obtained from plants since the beginnings of recorded history. Its first uses were probably for illumination, anointing and cooking. The discovery that linseed oil would mix with pigments to make an excellent artist's paint undoubtedly encouraged the tremendous increase in painting during the Renaissance. Castor oil was used before the petroleum era as a lubricant for wheels of carts and wagons. Margarine as a butter substitute was developed in France in the 19th century. By the second half of the 20th century annual world production of vegetable oils was more than 32,000,000,000 lb. (in the U.S., more than 1,000,000,000 lb. being used for margarine alone).

This article identifies the sources of oil in plants and the important oil plants and plants from which oil is extracted as a by-product, and discusses uses of oils and oil plant by-products, improvements in oil plants and trends in production. Additional information on uses will be found in separate articles on products, as MARGARINE; PAINT, etc., and by-products. as COTTONSEED; FEEDS. ANIMAL; etc. *See* also TROPICAL AGRICULTURE and articles on individual trees and plants, as OIL PALM; SOYBEAN; etc.

Sources of Oil in Plants. — All living plant cells contain some oil. This is true not only of the higher plants but also such primitive plants as bacteria, algae and fungi. When oil is present in large amounts in tissue it usually functions as a food reserve. Oil will produce about two and one-half times more calories than the same weight of carbohydrate.

Oil in large amounts is found usually in the seeds of plants. and occasionally in the fleshy part of the fruit, as in the olive and oil palm. Seeds may contain from 1% to over 60% oil, most species having rather large amounts. The oil functions as a reserve of high-energy food for use by the germinating seed (starch has a similar function in starch-storing species such as wheat and corn). In seeds large amounts of oil are associated with large amounts of protein, which makes oilseeds an important source of protein for livestock feeds. (*See* also NUT.)

Roots are not normally a site of oil storage, the oil content rarely going about 10% on a dry-weight basis. One exception is the sedge, *Cyperus esculentus,* native to southern Europe and Africa. This plant produces small tubers or underground stems which, when dry, may contain 20% to 36% oil. This oil is similar to rice-bran oil or olive oil. Other vegetative (as opposed to reproductive) parts of plants usually have leas than 5% oil on a dry-weight basis. The vegetative parts of some plants, however, are important sources of volatile or aromatic oils used in perfumes or flavours. (*See* ESSENTIAL OILS.)

Some fungi produce large numbers of fat globules, the amount reaching as high as 50% on a dry-weight basis. During World Wars I and II. when fats were scarce in many countries, there was considerable interest in fungi as a source of oil. Research in Germany indicated that a species of *Fusarium* would produce an oil similar to olive and peanut oils.

Important Oil Plants. — Many plant families have contributed species, ranging in size from the palms to small herbaceous types such as flax, that have been used as a source of oil. An exception is the large and important grass family, which has contributed no species grown primarily for its oil. Oil crops include plants over a wide range of domestication. At one extreme are babassu, oiticica and the species that yield mowrah and shea butter; these grow only in the wild state. The oil palm and castor bean grow wild and are also cultivated. The coconut, many trees such as tung and olive and all herbs utilized for their oil are cultivated. In fact very few of the herbs in their present form would survive in the wild.

Most of the more important oil crops are found in tropical and semitropical areas. Actually one-half to one-third of the vegetable oils for export have come from the tropical areas of west and central Africa and the area of Indonesia, the Philippine Islands and Malaya. In cool temperate areas the oil crops are flax, rape, mustards and sunflower. These crops of cool temperate areas are often used in hot and semitropical areas also, where they may be grown during the cooler part of the year. For example, rape is grown in Canada and northern Europe, and is at the same time one of the important oil crops of India.

The oil palm produces the highest oil yields of any crop, 2,880 lb. of oil per year per acre having been obtained in Sumatra (by way of contrast the average yield of linseed oil and soybean oil in the United States is less than 250 lb. per acre). Heavy investments, however, are necessary to establish palm plantations, and they do not bear for at least four or five years after planting. They also require much hand labour.

The production of other oil crops from trees, such as tung and olive, present some of the same advantages and disadvantages as the palms. Tung and olive trees are slow to get established, but once in production they require little upkeep. They are not readily adapted to mechanical harvesting, though some equipment is available to remove olives from the trees. Castor beans may be grown as a perennial tree in the tropics but as an annual in temperate areas.

Most of the herbs are adapted to production with mechanical equipment. Perilla, sesame, rape and the mustards tend to shatter their seed at harvest time, and have not been harvested too successfully with combine harvesters. For some. such as the castor bean, specially designed harvesters have been developed.

Oils as By-products. — Several of the oils are by-products. The most important of these is cottonseed oil, obtained by processing cottonseed (*q.v.*). Soybean oil might also be considered a by-product of the production of the seed for the protein meal; certainly the crop usually could not be grown profitably for its oil alone. Mustards are grown primarily as a condiment; the oil is a by-product. Corn oil is obtained as a by-product of industries using corn for its starch, and rice oil is recovered from the bran after its removal from the seed in the production of polished rice. Oil is often taken from the seeds of grapes in the wine industry and from the seeds of fruits such as peaches. apricots and cherries in the canning industry. Even weed seeds removed from cereal grain in large terminal elevators may be processed for the oil that some of them contain — the seeds of wild radish and wild mustard are examples.

Tall oil. a by-product of the manufacture of kraft (sulfate) process paper from wood pulp, has been used in paints. linoleum, soaps and emulsifiers. The yield of oil totals about 70 lb. for every ton of pulp produced, but the amount is influenced by the species of pine and the method of pulp manufacture.

Uses. — Vegetable oils are used principally for food. for soap and detergents, for paint and related products and for a variety of industrial items. The iodine value of the oil is usually a measure of its utilization; a low iodine value is characteristic of oils used for food and soap, and a high iodine value of oil that is employed in paint and industrial products. Oils with intermediate iodine values. such as soybean and sunflower oil, are more flexible in their use. (See also OILS, FATS AND WAXES.)

Among food products that contain large amounts of vegetable oil are shortening, margarines and salad and cooking oils. The availability and price of oils will determine which is used; soybean oil and cottonseed oil are used extensively in the United States, sunflower oil in the U.S.S.R. and Argentina and coconut oil in many countries. Even linseed oil may be used as a food oil if supplies of the more common food oils are scarce. With the increased use of coal-tar- or petroleum-derived detergents, the volume of vegetable oil used in soaps decreased in the late 1950s. Large amounts of detergents, however, were made from coconut oil Linseed oil has long been an important ingredient of paint and varnish (*qq.v.*), though its tendency to yellow with age has discouraged its use in light-coloured paints and clear varnishes. Soybean oil, tung oil and dehydrated castor oil are used in many paint products. Rubber-base paints are easier to apply in many situations and have tended to displace in part those made from oil. Other products made from vegetable-oil products are linoleum, oil cloth, printing inks and plastics. Sebacic acid, important in the manufacture of nylon, is made from castor oil. Castor oil when sulfonated is used in tht textile-dyeing industry. Palm oil is extensively used in tin-plating

Technology has expanded the utilization of oil crops. Hydrogenation. the addition of hydrogen ions to saturate the carbon chain structure of oils, permitted the hardening of liquid oils into solid fats. Dehydration of castor oil enabled its utilization in the making of paint products. Fractionation permitted the division of oils into two or more components, each useful for specific purposes. But while technology extended the utilization of vegetable oils, it also developed competing nonvegetable products.

Some vegetable oils are interchangeable, and in the second half of the 20th century a rapidly expanding technology was making them even more so. Cottonseed oil may be substituted for coconut oil or soybean oil in many products, and safflower oil may be substituted for linseed oil. Dehydrated castor oil may function in place of tung oil in some paint mixtures. The effect of similarities in oils and of technological developments is to keep the prices of oils more or less the same, unless one is needed for a specific product.

In addition to their use as sources of oil, most of the oil crops have other commercial uses. Peanuts may be grown for their edible oil or they may be roasted and used as nuts or made into peanut butter. (*See* PEANUT.) Sunflower seeds often serve for similar purposes. The coconut is a staple food in many tropical areas. Soybeans may be grown as a vegetable, as a hay or as a soil-improvement crop. Flaxseed may be a by-product of the culture of flax for its fibre; the flax (linseed) varieties grown for oil are too short to give a satisfactory fibre for linen, but they are used in paper manufacture The dried and highly coloured blossoms of safflower are used in some areas as a source of dye to colour cloth and foods Sesame and poppy seeds are used for decoration and flavour in bakery products.

By-products.—The most important by-product of oilseeds is the residual meal or cake remaining after the extraction of the oil. Indeed, the value of the meal frequently determines the agricultural and commercial success of an oil crop. Usually the meal is used as a protein concentrate in feeding livestock and poultry. As a consequence the value of the meal is frequently measured by the protein content and quality. Where the residual meal is poisonous to animals. as it is with castor beans and tung nuts, it can be used only as an organic fertilizer. Considerable amounts of oilseed protein are also used for industrial purposes. Soybean meal is used in plywood adhesives, and an increasing amount of protein is utilized in the manufacture of synthetic fibres.

Improvements in Oil Plants.—Plant breeders are aiding the advance of some oil crops toward domestication. Castor beans, essentially a wild plant of tropical and semitropical areas after 1940 rapidly moved toward the status of a cultivated crop; varieties that have nonshattering capsules. that are uniform for plant and seed size and that are much shorter than the wild types were developed. Improved sesame varieties that do not shatter also became available.

The area of adaptation of oil crops was in the meantime being extended. In the United States, for example, the area of soybean production increased in 20 years from about 1,500,000 ac. in 1924 to more than 18,500,000 ac. in 1954, mostly because adapted varieties were developed for many areas. The development of safflower varieties with high oil content and high yield permitted the establishment of this crop in the United States. Earlier maturity was developed in several oil crops, which promised to extend the area of production—a particularly important development for countries having a cool temperate climate.

Among the established oil crops seed yield and oil content were being increased to permit higher yields of oil per unit area. Where diseases became a problem, which was inevitable when large areas were grown to a single crop, efforts were required to develop resistant varieties. More attention was given to the fatty acid components in the oil of different varieties, since markets were becoming more specific in their requirements.

Trends in Production.—Production of vegetable oils increased about 50% between 1920 and 1950, much of this increase following the introduction of the plantation system in the Netherlands East Indies and the use of better varieties of oil palm. The production of peanut oil increased from about 2,000,000,000 lb. in 1910 to 4,000,000,000 lb. in 1930.

There is a tendency for nations to try to become self-sufficient in their supply of vegetable oils. This tendency encouraged the increase in acreages of rape, sunflower and soybeans in Canada after World War II. Sunflowers became an important oil crop in Argentina and Chile. After 1930 the United States became increasingly self-sufficient in its supply of soybean and linseed oils. As tropical countries develop higher standards of living the supply of oil for export will decrease unless the acreages of oil crops are extended. In the late 1950s it appeared likely, however. that the tropics mould remain an important source of oils for export; yields of oil were high. and there were large areas of land in the tropics that could still be developed agriculturally.

See also agriculture sections of articles on individual producing countries.

World Production and Trade.—World production and trade in oils. oilseeds and fats on an equivalent oil basis at mid-20th century are shown in the table.

Commodity	World production 000 lb.	World trade 000 lb.
Edible vegetable oils:		
Cottonseed	3,878	671
Peanut	4,024	1,587
Soybean	5,066	1,361
Sunflower	2,098	TOO
Rapeseed	2,212	141
Sesame	1,444	127
Olive oil	2,088	117
Total	20,810	4,104
Palm oils:		
Coconut	4,468	2,660
Palm kernels	916	856
Palm	2,722	1,216
Babassu kernels	90	3
Total	8,196	4,735
Industrial oils:		
Linseed	2,254	1,023
Castor bean	438	268
Oiticica	24	16
Tung	232	102
Perilla	10	*
Total	2,958	1,409
Total veeetable oils	11.464	10.218
Total animal fats	22,520	3,262
Total marine animal fats	2,032	1,450
World total all oils	56,516	14,960

*Less than 500,000 lb.

Source: U.S. Department of Agriculture, Foreign Agricultural Service, *Foreign Crops* and *Markets* (Sept. 25,1958, and Jan. 29, 1959). Figures are averages for five years, 1953–57. Data for oil from seed of corn, rice, Chinese tallow tree, cocoa, mowrah and shea butter, poppy, hemp, safflower and mineral and essential oils not included.

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OIL REFINING: *see* PETROLEUM.

OIL **RESERVES SCANDALS (U.S.).** Certain oil-bearing lands in the state of California—reserve no. 1 (Elk Hills) and reserve no. 2 (Buena Vista)—had been designated by the U.S. government in 1912 as naval oil reserves. Three years later reserve no. 3 (Teapot Dome, Wyo.) was established.

The navy department was authorized in 1920 to exploit and use those lands on the reserves on which there were no prior claims pending. Although the navy department retained the right to set general policy, jurisdiction over the reserves was later transferred by executive order to the department of the interior.

In 1922 the secretary of the interior. Albert H. Fall, and the secretary of the navy leased the Elk Hills reserve to Edward L. Doheny of the Pan American Petroleum company, and the Teapot Dome reserve to Harry F. Sinclair of the Mammoth Oil company.

The negotiations were carried on in secrecy on the advice of the navy department, which held that military plans and security were involved since the construction of oil tanks at Pearl Harbor, T.H., and other strategic matters were part of the agreements.

Senate investigating committees, however, discovered that Fall had received a "loan" of $100,000 from Doheny and was further involved in financial dealings with Sinclair.

A joint resolution was passed by the C.S. congress on Feb. 8, 1924, directing the president "to institute and prosecute suits to cancel certain leases of oil lands and incidental contracts, and for other purposes."

The resolution stated: ". . . the said leases and contract are against the public interest and . . . the lands embraced therein should be recovered and held for the purpose to which they were dedicated."

It was further resolved that "the President of the United States be, and he hereby is, authorized and directed immediately to cause suit to be instituted and prosecuted for the annulment and cancellation of the said leases and contract and all contracts incidental or supplemental thereto, to enjoin further extraction of oil from the said reserves under said leases or from the territory covered by the same. to secure any further appropriate incidental relief, and to prosecute such other actions or proceedings, civil and criminal, as may be warranted by the facts in relation to the making of the said leases and contract." After a great deal of litigation, the courts held the leases invalid In criminal actions Doheny and Sinclair were acquitted of charges of bribery and conspiracy, but Fall was convicted and served a prison term.

See also SECRET SERVICE, U.S.; UNITED STATES (OF AMERICA): *History.*

OILS, FATS AND WAXES. The term oils is loosely used as a generic term for substances having the common property of being greasy or oily fluids at ordinary temperatures. Used alone the term could refer to the fatty or fixed oils such as olive or soybean oils. to the hydrocarbon or mineral oils and derivatives such as petroleum. shale oils. oils from low-temperature distillation of coal, fuel oils and lubricating oils, and to the odoriferous ethereal oils usually called essential oils, such as oil of cloves. The collective expression "oils, fats and waxes" refers to water-insoluble, oily or greasy substances that can be separated from plant and animal tissues. These are the products which will be described in this discussion. The mineral or hydrocarbon oils *(see* COAL TAR; PARAFFIN; PETROLEUM) and the volatile oils *(see* ESSENTIAL OILS) do not come within the scope of this article.

The substances considered here may be divided into two large classes: (1) oils and fats and (2) waxes. The distinction between the two classes is based on their chemical differences. The oils and fats consist primarily of glycerides which are the esters (*q.v.*) formed by the union of three molecules of fatty acids with one molecule of glycerol (a trihydric alcohol). Oils are usually liquid at ordinary temperatures, such as 25° C. Fats are solid at this temperature. Houever, there is no basis for chemical distinction between the two. The difference is one of physical state reversible merely by changing the surrounding environment. Waxes consist of the esters formed by the combination of one molecule of fatty acid with one molecule of a monohydric alcohol. such as cetyl alcohol or cholesterol.

Use of the word fat to include both fats and oils is becoming common. especially among chemists. Thus, both soybean oil and tallow would be considered fats. This terminology avoids confusion with other nonfatty oils. There can be no sharp distinction between fats and oils. because at sufficiently low temperatures all oils will solidify and at even moderately elevated temperatures all fats will liquefy. Moreover, a fat is never entirely solid except under unique circumstances. A. E. Bailey pointed out that fats are usually plastic solids consisting of a mixture of crystalline particles and liquid oil.

Lipide (lipid) is a much broader term which may be used to include all the ether-soluble, water-insoluble substances obtainable from plant and animal sources. W. R. Bloor's proposed definition (1943) of lipides has been accepted generally in the United States. A modified and abbreviated form follows: (1) Simple lipides are esters of fatty acids and various alcohols, classified as (a) fats and oils (glycerides), fatty acid esters of glycerol; and (b) waxes, fatty acid esters of alcohols other than glycerol. (2) Compound lipides are esters of fatty acids and alcohols containing additional groups, divided into (a) phospholipides (phosphatides), fatty acid esters containing a phosphoric acid group (they also usually contain a nitrogenous group); (b) glycolipides, compounds in which are combined fatty acids, a carbohydrate and a nitrogen-containing compound (no phosphoric acid group); and (c) others, such as sulfolipides and aminolipides. (3) Derived lipides are compounds derived from the preceding groups and having the general properties of the lipides, classified as (a) fatty acids; (b) alcohols including glycerol, sterols and the long chain alcohols from the waxes; and (c) others. such as some hydrocarbons like squalene found in fish livers, and nitrogenous bases from the phosphatides. This classification of lipides does not always find expression in common parlance. Thus, Japan wax is a glyceride and should be more correctly called Japan tallow. However, sperm oil is, chemically speaking. a liquid wax.

The fats comprise one of the three great classes of inaterials which are the main building blocks of living organisms. Nearly all cells contain protein, carbohydrates and fat. These three materials are the main classes of food for all animals. Fat is sometimes called nature's storehouse of energy because it contains more than twice as much energy as an equal weight of carbohydrate or protein. It is probably in this role of concentrated energy that fats appear in plant reproductive organs such as pollen grains and seeds. This makes possible man's recovery of fats for food and industry. The fat content of the nonreproductive tissue of plants is usually so low that practical recovery would be impossible. Yet much of man's dietary fat comes from natural foodstuffs without being separated from the other plant materials with which it occurs. The proportion of fat in these foodstuffs varies from .2% in white potatoes to 70% in some nut kernels.

The fats generally referred to in a general discussion are those which can be separated profitably from the tissues in which they were formed. More than 90% of the recovered fat in the world is obtained from a score or so of the thousands of species of plants and animals. Most of this separated fat in turn finds its way into human food. Consequently, fat technology deals largely with the separation and processing of fats into forms acceptable to the various dietary customs in the countries in which they are to be used. The nonfood uses also have been important from the time man first found that bear grease or tallow on an axle made the wheel turn easier or that oil from flax could be applied to wooden surfaces to protect them from the weather.

History.—Man has used many natural fats since prehistoric times. In addition to early uses for food! man gradually through observation of physical properties and their effects under a variety of circumstances utilized fats in many everyday functions, accumulating empirical knowledge in fat technology. The Egyptians. for example, used olive oil as a lubricant to aid the moving of heavy building materials. They also made axle greases from fat and lime mixed with other materials for use on chariots as early as 1400 B.C.

George Sarton in *Introduction to the History of Science* (1931) gives many examples of the early use of fats up to the middle ages. Homer mentioned oil as an aid to weaving and Pliny talked about hard and soft soaps. Candles and lamps using oil, tallow or beeswax have been used for thousands of years.

Waxes and oils which dried to hard films were used in protective or decorative coatings on walls and mummy cases, and as waterproofing agents on ships at early dates. The form of painting known as encaustic employed a mixture of pigments in natural waxes. Tempera, another early form of painting, might be considered a forerunner of the modern emulsion paints. It was a water emulsion of wax or oil and pigments stabilized with vegetable gums or egg yolk.

Apparently the first mention of the use of a drying oil as a protective coating was made by Aetius in about the 6th century A.D., when he commented that certain nut oils dry to form a protective coating. Following that period, the art grew rapidly. Transparent varnishes were made of linseed oil and natural resins. However, chemical driers were not used until much later when Hubert and Jan van Eyck reportedly used them in the early 15th century.

The primary basic uses of fats for nonedible purposes remain much the same as the applications of centuries ago. The efficiencies and proficiencies of use have improved. In addition, the advent of a more complete understanding of the chemical nature of fats has expanded their uses to many diverse commercial applications. K. W. Scheele discovered in 1779 that glycerol could be obtained from olive oil by heating with litharge, but it was not until about 1815 that M. E. Chevreul proved the true chemical nature of fats and oils, which he described in his classical work, *Recherches sur les corps gras d'origine animale* (1823, reprinted 1889). At about the same time (1819) J. J. E. Poutet isomerized oleic acid to elaidic acid and C. A. Gusserow (1828) separated unsaturated liquid acids from the solid acids.

Organic chemists did little more experimenting with fats until after 1900. Lack of suitable experimental methods and equipment together with difficulties of preparation in pure form discouraged work on fats which had been in such intimate use for centuries. It was not until after World War I that extensive knowledge first of fatty acid compositions and then of glyceride compositions of fats was gained. Growth of the chemical industry stimulated simultaneous expansion of the use of fats as raw materials and as intermediates for scores of new chemicals. Modern application of most organic chemical reactions to fats and fatty acids formed the foundation of a new and rapidly growing fatty chemicals industry.

Physiology of the Fats and Waxes.—The universality of fats in plant and animal tissues suggests physiological roles which go beyond their purpose as a fuel supply for the cells. The most evident function of fats in animal organisms is that of food reserve to supply (through subsequent enzymatic oxidation) energy for the growing and working tissues. The storage of fat in vegetable seeds can be similarly explained on the basis that it is a food reserve for the embryo. However: it is not so easy to account for the presence of large quantities of fat in the pericarp of such fruits as olives. avocados, and palms which is probably destroyed before germination of the seed.

Fats, and especially the waxes, do fulfil other valuable functions in plants and animals. Subcutaneous deposits of fat protect animals from the cold because of the low heat transfer rate of fat, a function especially important for those animals living in cold waters or climates, *e.g.*, whales, walruses and bears. Beeswax prevents dilution or contamination of concentrated sugar solutions in the comb. Waxes. and in some cases fats, secreted on the surface of plant leaves preserve the underlying tissues from loss of or access of water. Apples, citrus fruits and melons have a natural protective wax coating.

Fats which have been separated from tissues always contain minor quantities of closely associated nonglyceride lipides such as phosphatides, sterols, vitamins A, D and E, and various carotenes and carotenoids. Many of these substances have in themselves vital physiological functions as emulsifying agents or growth factors These minor constituents probably are present in the fats as a result of their physical solubility. and thus fats serve as carriers for these substances in animal diets. Nevertheless, increased recognition of the attributes of associated substances attaches greater significance to the functions of fats in animal nutrition. Many animals require some fat containing one or more of the essential fatty acids (linoleic, linolenic and arachidonic) to prevent the physical symptoms of essential fatty acid deficiency manifested by skin lesions, scaliness, poor hair growth and low growth rates.

Synthesis and Oxidation of Fats in Living Organisms.— Formation of fats in seeds and fruits occurs late in the ripening process. Sugars and starches predominate in fruits, seeds and sap in the unripe condition. These apparently are converted by enzymatic direction during the maturing process to fatty acids and glycerol which then form glycerides. Studies with radioactive tracer techniques confirmed the synthesis of fats from carbohydrates in both plants and animals. In fact, it was shown by the use of labelled acetate that any food source from which acetate may form as an intermediate metabolite can thus be converted to fatty acids in at least some animal tissues. It was further demonstrated that acetate can be converted to cholesterol in animal tissue. It is noteworthy that, almost without exception, fatty acids occur with only even numbers of carbon atoms in natural fats. These apparently arise from this buildup of two carbon units. Although the preponderance of eighteen-carbon fatty acids had suggested the hypothesis that fats are derived from the C_{18} nucleus of polysaccharides or perhaps from three molecules of glucose, discoveries through tracer studies seem to indicate buildup from the two-carbon acetate units. Since acetate can be formed in oxidative processes from fats, proteins or carbohydrates, it is thus possible for fats to be synthesized indirectly from any of these sources. The formation of double bonds in the fats synthesized from acetate is accomplished by various enzymatic dehydrogenation and hydrogenation systems probably in the liver.

Utilization of stored fat by plant embryos had not been entirely explained by the latter 1950s. However, it was found that in germinating embryos the glycerides are hydrolyzed by lipolytic (fat-splitting) enzymes to glycerol and fatty acids. These may pass through direct two- and four-carbon oxidative processes to intermediate metabolic products which can be oxidized further to carbon dioxide and water or can be converted to carbohydrates which may then pass directly through the many steps of carbohydrate metabolism.

In animal digestive tracts, the fats in foods are emulsified with digestive secretions containing lipase which hydrolyzes at least part of the glycerides. The glycerol, partial glycerol esters, fatty acids and some glycerides then are absorbed through the intestinal epithelium and at least partially recombined to form glycerides and phosphatides. The fat in the form of microscopic droplets, or chylomicrons, is transported in the blood and chyle to points of use or storage. The fat of an individual animal may vary according to the compositions of fat in the food. For instance, body fats of swine that were fed cod-liver oil had soft fats characteristic of the diet, and cows receiving coconut oil or fish oil produced milk fats similar to the dietary sources. Fats used by or stored in animal tissues come from two sources—diet and enzymatic synthesis. Thus, the endogenous fat enzymatically synthesized from carbohydrates or proteins is characteristic of the species of animal; whereas, the exogenous fat resynthesized from the food fats is characteristic of the dietary fat. Mammary glands apparently have enzymatic systems which can produce fats quite different from those stored in adipose tissues. Even so, milk fats still can reflect characteristics of ingested fats.

The manner in which fat reserves are circulated to the organs in which metabolism occurs with liberation of energy is incompletely understood. Radioactive tracer studies provided some insight into this complicated process. It has long been established that, when mobilization of reserve fat takes place, the stream is primarily directed to the liver, where fatty acids may be partially desaturated; *i.e.*, hydrogen is removed from the fatty acid chains to produce unsaturated linkages. This facilitates subsequent oxidation in other tissues. Fatty acids also may be oxidized directly in the various tissues as well as in the liver Fatty acid metabolism is presumed to be by oxidation in successive two- and four-carbon stages. Intermediate products could be acetoacetate and acetate groups. In cases where the mechanism is faulty, acetone is formed and excreted (acetonuria). The final products of normal combustion are carbon dioxide and water.

Chemical Composition of Fats.—Although natural fats consist primarily of glycerides, they contain many other lipides in minor quantities. Thus, for example, oil from corn may contain glycerides plus phosphatides, glycolipides, inositides, many isomers of sitosterol. several tocopherols, vitamin A, dozens of carotenoids and chlorophyll compounds as well as many products of decomposition. hydrolysis, oxidation and polymerization of any of the natural constituents.

Since the glycerides, which make up 90% to 99% of most individual fats or oils of commerce! are esters formed by three fatty acids combining with one molecule of glycerol, they may differ not only in the fatty acids which they contain but also in the arrangement of the fatty acid radicals on the glycerol moiety. Simple triglycerides are those in which each molecule of glycerol is combined with the same acid, *e.g.,* tripalmitin. $C_3H_5(O.CO.C_{15}H_{31})$, the glyceryl ester of palmitic acid. $C_{15}H_{31}COOH$. Few simple glycerides occur in nature; predominantly, they are mixed triglycerides wherein one molecule of glycerol is combined with two or three different fatty acids. Thus, stearodipalmitin, $C_3H_5(O.CO.C_{15}H_{31})_2(O.CO.C_{17}H_{35})$, contains two palmitic acid radicals and one stearic acid radical. Likewise, oleopalmitostearin, $C_3H_5(O.CO.C_{15}H_{31})$ $(O.CO.C_{17}H_{33})$ $(O.CO.C_{17}H_{35})$, contains one radical each of oleic, palmitic and stearic acids. Each mixed triglyceride containing three different acid radicals has three different isomeric forms depending on which acid was linked with the centre carbon (β-position) of the glycerol molecule and which acids consequently went to the outside (α or α') positions. Similarly, each glyceride containing two acid radicals has two isomeric forms.

Monoglycerides and diglycerides have only one or two fatty acid radicals, respectively, and are seldom found in natural fats except as the products of partial hydrolysis. However, they are easily prepared synthetically and have important applications mainly because of their ability to aid in the formation and stabilization of emulsions. As constituents of shortening in baked products they function to increase loaf volumes and to retard staling.

The characteristics of glycerides are determined by their component acids. In considering the composition of a glyceride it is particularly important to distinguish between the saturated acids (such as palmitic or stearic, which are relatively high melting) and the unsaturated acids (such as oleic or linoleic, which are

TABLE I

Oil	Principal sources of raw material	Yield %	Iodine value	Principal applications
Vegetable Oils				
Drying oils				
Perilla	China, Korea, Japan, India	30–50	193–208	Paint, varnish.
Linseed	Argentina, India, N. America, Russia.	35–40	175–205	,, ,, ,linoleum, soft soap.
Tung	China, Japan, U.S.	15–20	160–175	,, ,, .
Hempseed	W. Eurqpe, N. America, India, Japan	30–35	140–175	,, ,, , soft soap.
Semi-drying oils				
Poppyaeed	Levant, India	41–50	123–143	Salad oil, artists' oil, soft soap.
Soyabean	U.S., China, Japan	15–20	125–140	Food, paint, resins.
Maize; corn	U.S., Argentina, Europe	6–10	120–127	,, .
Sunflower	S. America, Russia	22–35	120–130	,, .
Cottonseed	U.S., India, Egypt	30–32	100–116	,, , soap.
Sesame	India, etc., Egypt, Levant	35–55	103–118	,, ,, .
Rape (Colza)	E. India, Europe	33–43	94–102	,, , lubricant.
Nondrying oils				
Almond	S. Europe, N. Africa	45–55	93–100	Perfumery, pharmacy, food.
Arachis (peanut)	India, W. Africa, China, U.S.	43–50	83–100	Edible, soap.
Olive	Mediterranean countries	15–40	79– 88	,, , ,, , perfumery, lubricating, pharmacy.
Castor	E. India, Mediterranean, Brazil	35–55	80– 90	Medicine, soap, lubricant, Turkey-red oil.
Animal Oils				
Marine Animal Oils				
Sardine	West Coast of N. America, Japan	..	170–190	Resins, leather currying, linoleum, paints, food.
Menhaden	Atlantic coast of N. America	..	140–173	
Herring	N. Sea, Japan		120–145	Leather currying, paints, food.
Cod liver.	N. Sea, E. coast N. America.		120–180	Vitamins, leather currying.
Shark liver	Coasts of N. America		100–115	,, ,, ,,
Seal	Arctic and Antarctic seas		127–147	Food, leather currying, soap.
Whale	,, ,, ,, ,,		110–136	,, , soap, fibre dressing, leather currying, greases.
Dolphin, jaw and body oils			33, 99–126	Lubricating oil for delicate machinery.
Porpoise ,, ,, ,, ,,			36, 119	
Terrestrial Animal Oils				
Neat's-foot	U.S., S. America, Europe		65–75	Lubricating, high-grade leather-dressing.
Vegetable Fats				
Mahua (Illipé) butter	India, Malaya	50–60	53–67	Food, soap, candles.
Sheabutter	W. Africa, Sudan	45–55	53–65	,, ,, ,,
Palm oil	W. Africa.	65–72	50–60	Candles, soap, tin-piate industry.
Cacao (cocoa) butter	W. Indies	32–41	32–41	Chocolate, pharmacy, perfumery.
Palm-kernel oil	W. Africa	30–50	13–20	Food, soap.
Coconut oil	Philippine Islands, E. Indies, Ceylon, Oceania, S. American coasts	20–25	8–10	,, ,, , candles.
Japan wax	China, India, Japan	20–30	5–17	Polishes.
Animal Fats				
Lard	U.S., Central Europe	..	50–70	Food, soap, pharmacy, perfumery.
Bone	,, India, Europe	..	46–56	Soap, candles.
Tallow, beef	Argentina, U.S.	..	38–46	Food, soap, candles.
,, mutton	Australasia	..	35–46	,, ,, ,,
Butter	U.S., N.W. Europe, Australasia, Canada	..	26–38	Food.

low melting and chemically much more reactive because of their double bonds).

Glyceride compositions of natural fats tend to follow the rule of even distribution developed by T. P. Hilditch and his associates, who proposed that each of the individual fatty acid radicals in a fat is apportioned evenly among the different glyceride molecules. Consequently. specific acids present in quantities less than one-third of the total acids are inclined to appear singly in the glycerides. and it is necessary to have an acid present to more than two-thirds of the total acids before any simple triglycerides would be present. vegetable seed fats tend to follow this rule much more closely than do animal fats, which often deviate markedly. 'The latter even tend to have their saturated acids closely grouped. Thus, for example, beef tallow may contain 15% of simple fully saturated triglycerides even though it contains only 55% of saturated fatty acids.

Some fats tend to follow the pattern of random distribution of fatty acids in their glycerides. This method is based on the arrangement of the acids among the glycerides as if there were no directing influences and they had organized themselves by chance alone. Fats which have been heated in the presence of certain alkaline catalysts, such as sodium methoxide. "rearrange" themselves to follow more closely the system of random distribution. Physical properties are often significantly altered. Some shortening manufacturers in the United States thus rearrange the molecules in lard in order to make improved shortenings.

Physical and Chemical Properties. — Fats and oils may be divided according to source into animal and vegetable fats. Further. they may be classified according to their degree of unsaturation as measured by their ability to absorb iodine at the ethenoid linkages or double bonds. This degree of unsaturation determines to a large extent the ultimate use of the fat as shown in Table I. Oils having iodine values higher than about 150 are generally called drying oils and are used primarily in protective coatings. Those having iodine values of 100 to 150 are considered as semidrying and may be used either for food or in protective coatings. The nondrying oils have iodine values generally below 100 and are used mainly in foods. soaps, chemicals and specialty products.

Solid vegetable fats melting between 20° C. and 35° C. are found mainly in kernels and seeds of tropical fruits. They have relatively low iodine values and consist of glycerides containing high percentages of saturated acids such as lauric. myristic and palmitic. Fats from fruits of many of the palm family. notably coconut and palm-kernel oils, contain large amounts of combined lauric acid. Most animal fats are solid at ordinary temperatures; milk fats are usually characterized by the presence of short chain fatty acids (butyric, caproic and caprylic).

Specific gravities of oils and fats range from 0.913 (rape oil) to 0.975 (Japan wax. myrtle wax); for most fats the value is 0.915 to 0.945. Some oils which contain acids with asymmetric carbon atoms, notably those of the castor oil and chalmoogra groups, rotate the plane of polarized light.

Fats are practically insoluble in water and, with the exception of castor oil, they are insoluble in cold alcohol and only sparingly soluble in hot alcohol. They are soluble in ether, carbon disulphide. chloroform. carbon tetrachloride, petroleum ether and benzene. Oils and fats have no distinct melting points or solidifying points. because they are such complex mixtures of glycerides having different melting points. Glycerides themselves, further, have several polymorphic forms with different melting or transition points. The freezing points of the oils range from a few degrees above zero to about 30° C. below zero. At low temperatures (*e.g.*, 12° C. for cottonseed oil). solid portions, termed stearine, separate from many oils. The stearine is filtered or settled out; the clear fraction. which will remain limpid at low temperatures, is called winter oil.

Fats can be heated to 200° C. to 250° C. without undergoing significant changes provided prolonged contact with air is avoided. On being heated above this temperature the more unsaturated oils gradually polymerize and increase considerably in viscosity. When this is done commercially in the protective coating industry, it is called bodying. Castor oil, when heated to high temperature or under suitable conditions in the presence of catalysts, loses a molecule of water from each ricinoleic acid radical to form what is called dehydrated castor oil. At more than 300° C. fats may decompose with the formation of acrolein (decomposition product of glycerol) which has the pungent odour of burning fat. Hydrocarbons also may be formed at high temperatures (see PETROLEUM).

On exposure to the air. oils and fats gradually undergo certain changes. The drying oils absorb oxygen (dry) and polymerize readily; thin layers form a skin or protective film. The semidrying oils absorb oxygen more slowly and are less useful as paint oils; still, in the course of time, sufficient oxygen is absorbed to produce distinct thickening and some film formation. Oxidation of the semidrying oils is accelerated by spreading over a large surface, as on greasy cloths. when oxygen absorption may proceed so rapidly that spontaneous combustion ensues. The nondrying oils, of which olive oil is typical, do not oxidize readily on exposure to air. although gradually changes do take place. including slow hydrolysis (splitting to fatty acids and glycerol) and subsequent oxidation. This slow oxidation causes the disagreeable smell and taste described by the term rancidity. The chemical reactions involved in the development of rancidity have been widely studied. Numerous antioxidants such as the tocopherols, butylated hydroxyanisol (BHA), butylated hydroxytoluene (BHT), propyl gallate and nordihydroguaiaretic acid (NDGA) retard oxidation leading to rancidity.

Fats are readily hydrolyzed. This property is extensively used in the manufacture of soaps and in the preparation of fatty acids for industrial applications. Fats are hydrolyzed by treatment with water alone under high pressure (corresponding to a temperature of about 220° C.), or in the presence of water with caustic alkalies, alkaline earths or basic metallic oxides which act as catalysts, at lower pressures. Free fatty acids and glycerol are formed. If sufficient alkali is present to combine with the fatty acids, the corresponding salts or soaps of these acids are formed, such as the sodium salts of fatty acids (hard soap) or potassium salts (soft soaps), salts of the alkaline earths (*e.g.*, lime soap), or of the metallic oxides (*e.g.*, zinc soap). (For detailed descriptions of the methods employed in commercial hydrolysis. see CANDLE; SOAP.)

Extraction. — Recovering fats from the oil-bearing tissues may be done by three general methods with varying degrees of mechanical simplicity: (1) rendering, *i.e.*, boiling with water; (2) pressing with mechanical presses; (3) extraction with volatile solvents.

Rendering. — The crudest method of rendering oil from fruits, still practised in some countries: consists of heaping oleaginous fruits in piles exposed to the sun and collecting the exuded oil. In a somewhat improved form this process is used in the preparation of palm oil; the fresh palm fruits are boiled in water and the oil is skimmed from the surface. Such processes can be applied only to seeds or fruits (such as olive and palm) which contain large quantities of fatty matter that is easily released from the tissue. The rendering process is applied on a large scale to the production of animal fats such as tallow, lard. bone fat and whale oil. It consists of cutting or chopping the fatty tissue into small pieces which are boiled in open vats or cooked in steam digesters. The fat is gradually liberated from the cells and floats to the surface of the water, where it is collected by skimming. The membranous matter (greaves), is separated from the aqueous (gluey) phase by pressing in hydraulic or screw presses. Some further fat is thereby obtained. The residue is used for animal feed or fertilizer.

Pressing.—The rendering process is not applicable to many oil-bearing seeds and nuts because the oil is not so easily liberated from the cellular structures in which it is held. In these cases rupture of the cell walls by grinding, flaking, rolling or pressing under high pressures is necessary to liberate the oil. Many different mechanical devices have been used for this process. The most primitive method of pressing was to crush seed in mortars until the oil exuded. The lever and wedge, used for centuries, is one step more advanced. It is still used in primitive places. The

Romans developed a screw press, which Pliny described. for the production of olive oil. Centuries ago, the Chinese employed the same series of operations followed in the modern pressing mills. viz., bruising or grinding the seeds in stone mills. heating the meal in open pans then pressing out the oil in a wedge press. The Dutch or Stamper press invented in the 17th century was used almost exclusively in Europe for pressing oilseeds until the early part of the 19th century, when the hydraulic press was developed. The modern screw press replaced many of the hydraulic presses because it is a continuous process, has greater capacity, requires less labour and will generally remove more oil.

The general sequence of operations in treating oilseeds, nuts. etc.. follows: (1) remove all tramp iron by passing the seeds over magnetic separators; (2) decorticate where necessary and remove the shells or hulls; (3) convert the kernels or meats to coarse meal by grinding between grooved rollers or with special types of hammer mills; (4) press in hydraulic or screw presses with or without preliminary heating depending on the type of oil-bearing material and the quality of oil desired. Hydraulic presses can develop several hundred atmospheres of pressure on the meal whereas screw presses may exert several times as much pressure. Oil expressed without heating contains the least amount of impurities and is often of edible quality without refining or further processing. Such oils are known as cold-drawn oils, cold-pressed oils or virgin oils. Pressing with the addition of heat removes more oil and also greater quantities of nonglyceride impurities such as phosphatides. colour bodies and unsaponifiable matter. The oil is more highly coloured than cold pressed oils. Residual meals are generally used for cattle feed.

Solvent Extraction.—Cakes obtained by pressing operations still retain 3% to 12% of residual oil. In cases where the value of the oil is considerably greater as oil than as a part of the meal for feed, it is desirable to obtain more complete extraction with solvents. Modern commercial methods of solvent extraction use volatile hydrocarbons, such as benzene and various grades of petroleum ether (commonly known as commercial hexane or heptane). The use of chlorinated solvents mainly to decrease the fire and explosion hazard did not prove satisfactory. Trichloroethylene was used in several plants until it was found that it interreacted with some constituent in soybean meal. for example, to make the meal toxic to some animals. In large scale operations solvent extraction is a more economical means of oil recovery than is pressing by mechanical means. In the Cnited States there are many instances of simple hexane extraction of seeds. mainly soybeans. For seeds or nuts containing a higher oil content than soybeans it became customary to prepress the material before extraction to remove a large proportion of the oil in screw-press expellers. This also ruptures the cellular structures of oil-bearing materials so that most of the residual oil is easily removed by solvents. A typical extraction system consists of (1) removing hulls or cortex in cracking, aspirating or screening operations; (2) cracking or rough grinding the kernels. meats, or prepress cake: (3) flaking the small pieces between smooth flaking rolls; (4) extracting the oil with solvent; (5) separating the meal or marc from the oil-solvent solution called miscella; and (6) desolventizing both the oil and the marc. The marc or meal, may be toasted or pelletized or both, for use in animal feeds. Most extracted meals contain about 1% of residual oil. The amount varies depending upon the absence or extent of prepressing, the type of material being extracted and the efficiency of the extracting system.

An interesting combination of solvent extraction and rendering is the azeotropic rendering process. A chlorinated solvent is mixed with fresh wet tissue, and the mass is heated to the boiling point of the azeotropic mixture of solvent and water. On condensation the azeotrope separates: water is drawn off and the solvent is returned to the extraction system. The resulting product consists of a dry (low moisture) extracted meal and iniscella containing most of the fat. The high cost of chlorinated solvents proved a disadvantage. but the process has promising potentialities because of its ability to prepare extracted animal or fish meals which have not been subjected to high temperatures.

Processing. — The extent of processing applied to fats depends upon their source. quality and ultimate use. Many fats are used for edible purposes with no more than clarification by settling or filtering. Most cold-pressed or virgin oils are used directly in food products, thus. cold-pressed olive, peanut and some coconut oils can be used without further processing. Tremendous quantities of butter and lard are used without particular treatment after churning or rendering. However. the growing demand for bland tasting and stable salad oils and shortenings led to extensive processing techniques. But in less industrialized countries processing often is limited by lack of facilities and added costs.

Refining. — The nonglyceride components contribute practically all of the colour and flavour to fats. In addition. such materials as the free fatty acids. waxes. colour bodies. mucilaginous materials, phosphatides and gossypol compounds (found only in cottonseed oil) contribute other undesirable properties in fats used for edible purposes and to some extent for industrial applications. Many of these can be removed by treatment of fats at 40° to 85° C. with an aqueous solution of caustic soda (NaOH) or soda ash (Na_2CO_3). The refining may be done in a tank (called batch or tank refining) or in a continuous system. In the former system the aqueous emulsion of soaps formed from free fatty acids along with other impurities (soapstock) settles to the bottom and is drawn off. In the continuous system the separation of emulsion is made with centrifuges. After the fat has been refined: it is usually water-washed to remove traces of alkali and soapstock. Oils which have been refined with soda ash or ammonia generally require a light rerefining with caustic to improve colour. After water-washing the oil may be dried by heating in a vacuum or by filtering through a dry filter aid material. The refined oil may be used for industrial purposes or may be processed further to edible oils. Usually, the refined oils are neutral, free of material that separates on heating (break material), lower in colour, less viscous and show less stability to rancidification.

Other refining processes which have been used include the use of sulphuric acid instead of alkaline agents. This technique removes or destroys much of the impurities in the oils without removing the free fatty acids. For industrial oils. such as linseed oil. which are not required to be low in fatty acids. acid refining is sometimes advantageous. Steam refining consisting of blowing clean steam through oil usually at high temperature and under vacuum may sometimes be used on oils, such as coconut oil. which contain little phosphatides or other impurities. This treatment removes most of the free fatty acids. Solvent or miscella refining consists of caustic refining of the fat in a solvent such as hexane. Other refining agents which have been used include ammonia, magnesium and calcium oxides, ion exchange resins and certain organic bases.

Water refining, usually called degumming, consists of treating the natural oil with a small amount of water followed by centrifugal separation. It is applied to many oils which contain phosphatides in significant amounts. Its purpose may be to recover the phosphatides or to degum the oil. or both. Phosphatides from oils such as corn (maize) and soybean oils may be dried (commercially. these products are called lecithin) and used as emulsifiers in such products as margarine, chocolate products and emulsion paints. The degummed oil may be used directly in industrial applications such as in paints or alkyd resins, or refined with alkalies for ultimate edible consumption.

Bleaching. — In cases where further colour removal is desired, the fat may be treated with any of dozens of chemical and physical bleaching agents. Chemical treatments include the use of air and light. sodium dichromate and acid, permanganates, hypochlorites, metallic persalts and peroxides. They are not usually used on products destined for edible purposes. Physical adsorption methods involve treating hot oils with activated carbons, fullers' earths or activated clays. Many impurities including chlorophyll and carotenoids are thus adsorbed onto the agents and removed by filtration. Bleaching by any of these means reduces the stability of oils to rancidity. When many oils are heated to more than 175° C.. a phenomenon known as heat bleaching takes place. Apparently the heat decomposes such coloured compounds as the carotenoids which may be present.

Destearinating or *Winterizing*.—It is often desirable to remove the traces of waxes (prohably by contamination with cuticle wax from seed coats) and the higher melting glycerides from fats. Waxes can generally be removed by rather rapid chilling and filtering. Separation of stearine usually requires very slow cooling in order to form crystals which can be removed by filtration. Thus linseed oil map be winterized to remove traces of waxes which otherwise interfere with its use in paints. Stearine may be removed from fish oils to separate the solid glycerides which would detract from its use in paints and alkyd resins. At the saine time, fish stearine is more suitable than whole oil for edible purposes. Cottonseed and peanut oils may be destearinated to produce salad oils which remain liquid at low temperatures. Tallows and hydrolyzed animal fats may be destearinated for simultaneous production of hard fats (high in stearic acid content for special uses such as in making candles) and of liquid oil called oleo oil.

Fat *Hardening* or Hydrogenation.— For most edible purposes and for some commercial applications it is desirable to have solid fats. Most shortenings and margarines contain as their major ingredients hardened oils. The great development of margarine and shortening products resulted from the invention by Wilhelm Normann of 3 successful method for converting low-melting unsaturated fatty acids and glycerides to much higher melting saturated products. The process consists of the general reaction discovered by P. Sabatier and J. B. Senderens of the addition of hydrogen in the presence of a catalyst to the unsaturated bonds. Thus, oleic or linoleic acid (or acid radicals in glycerides) normally liquid at room temperature can be converted to stearic acid (or radical) by the addition of one or two moles of hydrogen, respectively.

In commercial practice! hydrogenation is usually carried out with vigorous agitation or hydrogen dispersion with a narrow range of catalyst concentration (about 0.05% to 0.10% of finely divided nickel suspended on kieselguhr or diatomaceous earth) in a steel pressure reacting vessel. The ordinary ranges of temperature and pressure are 110° to 200° C. and 0 to 60 lb. per square inch, respectively. These conditions can be controlled to make the hydrogenation reaction somewhat selective; *i.e.,* to add hydrogen to the linolenic (three double bonds) and linoleic (two double bonds) acid radicals before adding to the oleic (one double bond) acid radicals. The most unsaturated fatty acid groups are most easily hydrogenated and thus react first with the hydrogen if conditions are right. In cases where very hard fats with low amounts of unsaturation are desired and selectivity is unimportant. higher temperatures and pressures are used to shorten the reaction time and to make possible use of partially spent catalyst which would otherwise be wasted. After hydrogenation the hot oil is filtered to remove the metallic catalyst for either reuse or recovery.

During the catalytic treatment another reaction also takes place—the isomerization of unsaturated fatty acid radicals to form iso-oleic, iso-linoleic, etc., groups. These isomers have higher melting points than do the natural acids. Thus they contribute to the hardening effect. They can be detected by infrared analysis but not by determination of iodine value.

Applications.— It is virtually impossible to enumerate in detail the many applications of fats. However, in Table I principal uses of some typical oils and fats are given. Most of the high-quality fats can be and are used for edible purposes such as margarine, shortenings, cooking fats and salad oils. The next largest use for fats is for soap. However, after World War II synthetic detergents (syndets) manufactured from petroleum products supplanted much of the soap, especially in the United States. Some hard fats, tallows and stearine are still used in candle manufacture. but there also petroleum waxes took over a large share of production. Considerable quantities of specialty oils and sulfonated oils are used in leather dressing and textile manufacture. Some of the oils have peculiar properties of medicinal values. Thus; castor and curcas oils have a strong purgative action; chalmoogra and allied oils have curative effects on leprosy; fish liver oils (see COD-LIVER OIL) act as sources of vitamins A and D, and others such as lard, olive and almond oils serve as vehicles in pharmaceutical preparations. Linseed, tung and other drying oils and large quantities of soybean oil are used in paints, varnishes, linoleums (linseed, mainly), and alkyd resins. The latex emulsion paints containing products principly derived from petroleum oil began to find widespread acceptance for interior finishes in the U.S. in the latter 1940s. This trend. which was spreading to other countries and beginning to include emulsion paints for outside use in the 1950s, displaced large volumes of the drying oils in protective coatings. Competition of products from petroleum encouraged (and forced) the development of new products and new markets for glyceride oils.

A new industry based on the manufacture of chemicals from fats was started just prior to World War II and grew rapidly after the war. Fats were hydrolyzed to glycerol and their fatty acids fractionated by vacuum distillation, by solvent segregation or by both. This made available commercial quantities of relatively pure single fatty acids. From the fatty acids dozens of products such as long chain alcohols, amines, amides, esters, nitriles and ketones were made. These chemicals could be used for many applications directly or as chemical intermediates in the manufacture of other products such as detergents, plasticizers, special lubricating oils, polyamide resins and special thixotropic paints. Other recent modifications of the glycerides themselves through such chemical reactions as epoxidation, copolymerization, rearrangement; chlorination, vinylation and acetylation promised more new industrial products. Thus fats were established as future sources of organic chemicals.

Commerce.— The principal countries producing various oil-bearing materials (seeds, nuts, etc.) are given in Table I. In many cases the fats are not extracted in the countries of origin; instead, the raw materials are exported. Thus, Marseilles became a centre for coconut oil trade; Liverpool, Hull and Hamburg-Harbourg centres of oilseed expression, etc. However, development of industry in tropical countries and high costs for freight led to increased production of oils and fats in their native countries. Statistics on world productions of oil-bearing materials and extracted oils are sometimes incomplete, but data are available in publications of Frank Fehr and Co. (Annual Review of *Oilseed and* Oil *Markets*), the Congress of International Association of Seed Crushers. the U.S. department of agriculture, the Cnited Nations Food and Agriculture organization and trade returns of various countries.

WAXES

Waxes differ from fats chemically in that they are not esters of glycerol but are fatty acid esters of monohydroxy alcohols. A few exceptions include esters of dihydroxy alcohols. Moreover, the physiological function as a protective coating on cuticles of leaves and fruit appears to be different than that for fats because waxes rarely occur as cell constituents. The waxes are difficult to saponify in contrast with the relative ease of saponification or hydrolysis of glycerides. Many of the waxes are high melting, and they form hard films which can be polished to a high gloss; therefore, they are used in many kinds of polishes. Their other physical properties are similar to those of the fats. They are soluble in the same solvents and leave grease spots on paper.

Fatty acids, which are found as esters in waxes, are almost always completely saturated. They vary from lauric ($C_{11}H_{23}$-COOH) to octatriacontanoic ($C_{37}H_{75}COOH$) acid. The saturated alcohols of the $C_nH_{2N+2}O$ series from dodecanol (lauryl alcohol, C_{12}) to incarnatyl (C_{34}) alcohol have been identified in various waxes. Several dihydric (two hydroxyl groups) alcohols have been separated, but they do not form a large proportion of any wax. Also, several unidentified branched chain fatty acids and alcohols have been found in minor quantities. Several cyclic sterols (cholesterol and analogues) make up major portions of wool wax.

Only a few vegetable waxes are produced in commercial quantities. Carnauba wax, which is very hard and is used in most high-gloss polishes, is probably the most important of these. It is obtained from the surface of the fronds of a species of palm trees native to Brazil. Another similar wax, candelilla wax, also is obtained commercially. Sugar cane wax occurring on the surface of sugar cane leaves and stalks is recovered from the sludges of cane juice processing. It is similar in properties and uses to carnauba wax, but it is normally dark in colour and contains more impurities. Economical production of other waxes such as rice wax and grain sorghum wax proved unsuccessful. Other cuticle waxes occur in trace quantities in vegetable oils such as linseed, soybean, corn (maize) and sesame. They are undesirable because they may precipitate when the oil stands at room temperature. They can be removed by cooling and filtering. The cuticle wax on apples accounts for the beautiful gloss when polished.

Beeswax, the most widely distributed and important animal wax, is softer than the above waxes and finds little use in gloss polishes. However, it is used for its gliding and lubricating properties as well as in waterproofing formulations.

Wool wax, the main constituent of natural wool fat that covers the hair of sheep, is obtained as a by-product in scouring raw wool. When it is purified it is called lanolin and is used as a pharmaceutical or cosmetic base because of its easy assimilation by the skin. Sperm oil and spermaceti, from sperm whales, are liquid at ordinary temperatures and are used mainly as lubricants.

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OIRAT (OIROT) (GORNO-ALTAI), an autonomous *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., created in 1922 and renamed Gorno-Altai autonomous oblast in 1948. It is bounded by Kazakh Soviet Socialist Republic on the south and west, Altay *kray* and Kemerovo *oblast* on the north, Mongolia and Tuva *oblast* on the south arid east. Area 35,753 sq.mi. Pop. (1959) 159,000, of which 129,000 is rural. It lies between 49° 5′ and 52° 4′ N. and 84° and 89° 55′ E. The administrative centre Gorno-Altai is on Katun river. The area is mountainous, lying in the Altai region of west Siberia, which forms part of the Alpine highlands bordering the Mongolian plateau. Within it lies Mount Byelukha, whose summits rise to 14,783 ft. and 14,560 ft. respectively, and on which several glaciers exist. Numerous spurs strike from the Sailughem mountains toward the Siberian plain in all directions, among which are the Yuzhno-Chuya mts., average altitude 9,000 ft., rising to 12,933 ft., and at least 10 glaciers on the northern slope, and the snowclad Katun mts. (14,783 ft.).

The Katun river rises in a glacier in a wild gorge on the southwest slope of Byelukha and, after making a wide curve, pierces the Katun range and flows to the north. The upper course of the Biya, which with the Katun later forms the Ob, lies in the Oirat area. The Biya flows from the beautiful alpine Lake Teletskoye, to the south of which are the high Bashkaus, Chulyshman and Chulcha valleys all draining into the lake. The Kok-su and the Argut are the chief among the numerous tributaries of the Katun.

The climate is severe. average winter −13° to −16° C., summer 16° to 18° C. The maximum rainfall is in the Chernevoi district of the northeast, on the right bank of the Katun river, thickly forested with Siberian cedar and fir. In the northwest the conifers are mixed with birch, poplar and aspen. The Chuya, Kurai and Chulyshman alps lie above the tree limit and have much tundra. The soils are mainly bog, meadow, rubble and forest clays; their poor character, the short vegetation period and the drought of the region under the influence of winds from Mongolia make cultivation difficult. Wheat and oats, with a little barley, rye, millet, flax, hemp, buckwheat and potato are grown, but only a small part of the area is under cultivation.

Forest fires and reckless exploitation early in the 20th century diminished the timber in accessible places and also reduced the number of fur-bearing animals. Squirrel, bear, fox, ermine and sable are the chief fur-bearing animals of the region. The chief traditional occupation of the people west of the Katun river is stock raising, with horses, working and dairy cattle, sheep, goats and pigs being bred. Lumbering and fur trapping are the main occupations east of the Katun river.

Epizootic diseases became prevalent, possibly because of their spread along the road from Mongolia. Milk and meat, with fermented mare's milk (kumiss), form the staple diet of the people. Raw leather and butter from the farms of the Russian settlers were exported to a small extent.

The maral deer, from whose horns a substance called *panty* (used as a medicine in China) was obtained, were kept by the natives.

Over 50% of the inhabitants are Russians, partly descendants of the Old Believers who took refuge there from religious persecution from 1761 onward. Colonization began in the 19th century, the settlers being mainly peasants from the crown lands, but no attempt was made to organize Russian colonization until 1874–1879.

The colonists occupied the areas suitable for cultivation, especially the Uimonsk region. Disputes between the Russian tillers of the soil and the nomad herdsmen of the hills were frequent and sharp before the creation of the *oblast*. The etymology of the word Oirat or Uirad is uncertain.

The Uirads are recorded as living in the region of the "eight rivers," *i.e.*, the sources of the Kem or Upper Yenisei, at the accession of Genghis Khan. Apparently they were Mongols with a Turkish admixture. They submitted to Genghis Khan without any struggle and their chieftain Kara Kiragho was one of the nine famous generals or *orloks* who commanded divisions' of Genghis Khan's army. A long struggle afterward ensued between the Uirads and the Mongols, and in the 15th century the greater part of the western Mongols were under Uirad overlordship. Toward the end of the 16th century the Uirad power decayed and the Mongols recovered their supremacy. The Dzungarians later overran the Uirad territory, but were themselves conquered by the Chinese in the 18th century, when many took refuge with the Kirghiz in Russian territory. The non-Russian population of the Oirat *oblast* is thus composed of the descendants of these various Turkish, Kalmuck and Mongol tribes and includes also some Kirghiz shepherds. These Altai hill tribes are all nomad herdsmen, supplementing their income by hunting and by undertaking transport along the road from Kobdo to Biisk which passes through the Oirat area. It should be noted that the Telengets of the district north of Kusnetsk, lying outside the Oirat area, call themselves Oirat and that their language and poetry is similar to that of the Altaians, Howorth suggests that they may have been closely allied.

Another division of the Uirads in 1296 deserted the Khan of Persia and went to Damascus. Among Altai mountain peoples are the Mountain or Black Forest Tatars, living in the cedar forest region between the Katun and Lake Teletskoye and supplementing their seminomad herding by collecting cedar nuts and roots and hoeing the soil in a primitive way for wheat and barley cultivation. The Kumandins live on both banks of the Biya from the mouth of the Lebed downward and are taking to settled agriculture. Another Tatar group lives along the Lebed shores and is mainly occupied in hunting.

See Henry Howorth, *The History of the Mongols* (1876), and in Russian *Atlas of the U.S.S.R.* (1928).

OISE, a *dkpartement* of northern France, three-fourths of which belonged to Ile-de-France and the rest to Picardy, bounded north by Somme, east by Aisne, south by Seine-et-Marne and Seine-et-Oise, and west by Eure and Seine-Inférieure. Pop. (1954) 435,308; area 2,273 sq.mi. As its name implies, the *département* includes a good deal of the lower basin of the Oise and its tributaries, forming a broad basin dissected from the outlying zone of the Eocene deposits. To the southeast of the Oise the Eocene forms a plateau with a considerable amount of forest, especially toward the north. To the northwest of the Oise the Eocene is capped along various southeast–northwest ridges by Pliocene, forming the hills of the Pays de Bray (770 ft.).

Clay for bricks and earthenware, sand and building stone are among the mineral products of Oise, and peat-is also worked. Pierrefonds, Gouvieux, Chantilly and Fontaine Bonneleau have mineral springs. Wheat, oats and other cereals, potatoes and sugar beet are the chief agricultural crops. Cattle are reared especially in the western districts, where dairying is actively carried on. Beekeeping is gèneral. Racing stables are numerous in the neighbourhood of Chantilly and Compiltgne. The chief industries of the department are manufactures of sugar and alcohol from beetroot. The manufacture of furniture, brushes (Beauvais) and other wooden goods and of toys, fancyware, buttons. fans and other articles in mood, ivory, bone or mother-of-pearl are important. There are also woolen and cotton mills, and manufactories of woolen fabrics, blankets, carpets (Beauvais), hosiery and lace (Chantilly and its vicinity). Creil and the neighbouring Montataire form an important metallurgical centre.

There are four *arrondissements*—Beauvais, Clermont, Compiègne and Senlis—with 35 cantons and 698 communes.

OISE, a river of northern France, 188 mi. long, flowing southwest from the Belgian frontier to join the Seine 39 mi. below Paris. It drains the northeastern part of the Paris basin. Rising in Belgium, 5 mi. S.E. of Chimay at a height of 980 ft., the river enters France after a course of little more than 9 mi. It divides below Guise into several arms and is joined by the Serre (left), near La Fère. Thence as far as the Ailette (left) it flows through well-wooded country to Compiltgne, above which it receives the Aisne (left). Skirting the forests of Compiègne, Halatte and Chantilly (all left) and receiving near Creil the Thérain and the Brèche (both right), the river flows past Pontoise to reach the Seine. See SEINE.

ŌITA, Japanese prefecture (ken) of northeastern Kyushu. Area 2,385 sq mi.; pop. (1955) 1,277,199. Its interior is dominated by complex mountainous terrain and most human activity centres on small coastal plains. The long, irregular coast line is marked by deep-cut Beppu bay and the rounded Kunisaki peninsula. Most Oita inhabitants are farmers who raise subsistence and some cash (tobacco, reeds. citrus fruit and cattle) commodities. Forestry (bamboo and cryptomeria) flourishes in the mountains. A little industry is found in the main coastal cities (cotton textiles, metals, cement and chemicals). Beppu is among Japan's most famous hot spring resorts.

Oita, the prefectural capital and largest (pop. [1955] 112,429) city is located on the southern coast of Beppu bay. It reached its greatest fame in the 16th century but declined in the Tokugawa period. It is strictly an administrative, commercial and educational centre, with a few industrial establishments. (J. D. EE.)

OJEDA (HOJEDA), **ALONSO DE** (c. 1468–1515/16) Spanish explorer and adventurer, was born in Cuenca, Spain. He accompanied Columbus on his second voyage (1493–96) during which he explored the Vega Real of Hispaniola and captured a renowned native chief in the Cibao mountains. Back in Spain he heard news of the pearl coast, which he set out to explore with pilot Juan de la Cosa accompanied by Amerigo Vespucci (*q.v.*). They sailed westward from Guiana to the Venezuelan coast.

When Ojeda returned to Spain he found that legal and financial troubles delayed his third voyage until 1505. In 1508 he secured the governorship of Urabá. but his attempts to settle were unsuccessful. He lost his friend. Juan de la Cosa, and when his force was reduced to 60 he left his men to seek help in Hispaniola. He was shipwrecked off Cuba but reached Santo Domingo, only to find himself bankrupt and unable to secure funds.

Ojeda died in a Franciscan convent, according to Las Casas. (U. S. L.)

OJIBWA., an ethnic group of American Indians, speaking an Algonkian language, now found widely dispersed in both Canada and the United States. When first reported in the Jesuit Relations (1640), they occupied a comparatively restricted region near the St. Mary's river and in the upper peninsula of Michigan, but moved west as the fur trade expanded. They fought the Dakota with firearms obtained from the French, driving them from Mille Lacs and occupying the northern part of Minnesota. In Canada some Ojibwa penetrated beyond the woodlands and reached the country west of Lake Winnipeg where they were influenced by the manner of life found in the prairie tribes. Called "Saulters" by the French traders, this name still persists, in the form Saulteaux, in Canada. The meaning of the name Ojibwa, usually rendered "to roast until puckered up," refers to the puckered seam characteristic of their moccasins. The appelation "Chippewa," officially adopted in the publications of the Bureau of American Ethnology, actually is a corruption of Ojibwa.

In the United States the Ojibwa constitute one of the largest remnants of the aboriginal population. They occupy ten reservations in Minnesota, five in Wisconsin, one in North Dakota and one in Montana, while in Michigan there are several thousand nonreservation Ojibwa. Altogether, they probably number more than 30,000, possibly 80% of them being mixbloods. In Canada there are approximately 20.000 Ojibwa, although the number of reservations on which they live in the provinces of Ontario, Manitoba and Saskatchewan outnumber those in the United States five to one.

Originally forest dwellers, hunters and gatherers of wild rice, the Ojibwa have made varying social adjustments to the contemporary world just as they did in their historic past to the different circumstances in which they found themselves. At no time have they been a politically unified nation, their traditional social organization being adapted to group-living in small local bands. Because of the immense popularity of Longfellow's The Song of *Hiawatha* (1855), based on Henry R. Schoolcraft's study of Ojibwa mythology during his residence at Sault Sainte Marie in the early 19th century, the Ojibwa have achieved a romantic fame in American literature, unique among the aboriginal peoples of America. See also ALGONKIN; INDIAN. NORTH AMERICAN. (A. I. H.)

O.K., a colloquial expression used to indicate approval, is probably more widely understood than any other word or phrase in any language. It originated in the United States, but for a full century, despite the popularity and almost universal use of the term, its origin remained obscure. From 1840, which most authorities accepted as the date of its first appearance in print, the term moved rapidly into the everyday language of all the English-speaking peoples. During World War I it became widely known in Europe, at least on the level of vernacular, and in World War II it was carried by U.S. and British troops into practically every part of the world.

Until the 1940s, there were many theories about the origin of O.K. One of the most popular ideas was that it originated in the Choctaw word oke, a term of approval; several dictionaries used this derivation, qualified with "probably." Another popular theory held that the initials represented *oll korrect,* this gross misspelling being attributed to both John Jacob Astor and Andrew Jackson.

The disputes over the origin of O.K. apparently were ended in 1941 when Allen Walker Read shoned that the term derived from the Democratic O.K. club, a political group in New York city supporting Martin Van Buren for the presidency in 1840. The initials came from "Old Kinderhook," a nickname for Van Buren derived from the name of the New York village where he was born. From this beginning as a political rallying cry, O.K. quickly took its place in the language.

QKANOGAN (OKANAGAN in Canada) is an international stream that originates in British Columbia, westernmost province of Canada, and flows 115 mi. S, to join the Columbia river near Brewster, Wash. The Canadian portion includes about 72% of the watershed. 40 mi. of the main river, and all but the last 20 mi. of the Similkameen river. The latter, the principal tributary stream, furnishes about 70% of the Okanogan runoff and empties into the main river 5 mi. S. of the international boundary at Oroville, Wash.

North of the international boundary, the Okanagan is noted for its chain of beautiful lakes, the largest of which, Okanagan lake, is used extensively for water transportation. South of the boundary the river flows 75 mi., and its valley, like that in Canada, is famous for fruit tree production, principally apples. The Okanogan river furnishes essential water supplies for irrigation in both countries. (G. V. SK.)

OKAPI, large animal allied to giraffes, inhabiting the Semliki forest between lakes Albert and Albert Edward in central Africa. First obtained by H. H. Johnston, in 1900, the okapi (*Okapia* *johnstoni*) has shorter legs and neck than the giraffe, standing 5 ft. at the shoulder. In colour it is purplish, with the sides of the face puce and the limbs barred with black and white. The horns, only present in the males, are capped with a small polished tip which alone penetrates the covering skin. The skull is intermediate between that of the giraffe and that of the extinct *Samotherium* of the Lower Pliocene of Europe.

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

MALE OKAPI (OKAPIA JOHNSTONI), FOUND MOSTLY IN THE CONGO DISTRICTS

The okapi dwells in the densest parts of the primeval forest. feeding on leaves of trees. shrubs and epiphytes. Its colouring renders it practically invisible at a short distance.

The okapi belongs to the family Giraffidae (see RUMINANT).

OKAYAMA, Japanese prefecture of western Honshu bordering the Inland sea. Area 2.726 sq.mi.; pop. (1960) 1,670,454. It has a predominantly agricultural economy, and rice, grapes, peaches, rush (for matting) and other cash crops are grown in the southern districts. Farm techniques and the degree of mechanization are among the most advanced in Japan. Life in the interior mountains is poor and largely dependent upon forestry and small-scale cattle raising. Steadily increasing manufacturing is concentrated in such southern cities as Okayama, Kurashiki (synthetic fibres) and Tamano (shipbuilding). Salt fields, used to extract salt from sea water, line the seacoast.

OKAYAMA city, the prefectural capital (pop. [1960] 260,773), is located in the central Okayama plain astride the Asahi river. An old castle town of the Ikeda clan, it dominates prefectural life. A major marketing centre, Okayama has excellent rail connections with cities on the Inland sea, Sea of Japan and Shikoku (via ferry). Since its river port is shallow, it uses Uno, on the Kojima peninsula, as its outport. Industry includes the manufacture of agricultural machinery, cotton and synthetic textiles, and rubber goods.

Okayama university is noted for its medical college. Kōrakuen, laid out in 1786, is one of Japan's three most celebrated public gardens. (J. D. EE.)

OKAZAKI, a textile, manufacturing city and commercial centre of the west Mikawa plain, central Honshu. Japan. Pop. (1960) 166,095. The town developed around Okazaki castle after its construction in 1455. During the Tokugawa period (1600–1876) it prospered as one of the 53 stage towns on the Tokaido. Okazaki refused to allow the Tokaido railway to pass through the city in 1883. For some years the town declined. Later it was connected with Nagoya and Toyohashi by rapid-transit lines and its economy was revived. In the 1960s there were about 300 small spinning mills, 3 large modern textile plants; other factories producing foods. machinery, chemicals and fabricated metals. (R. B. H.)

OKEECHOBEE, LAKE, the second largesl fresh-water lake wholly within the United States, is located 40 mi. W.N.W. of Palm Beach. Fla. Bearing the Seminole Indian word for "big water." it has a shore line of 135 mi., a length of 35 mi., and including three small islands covers an area of 700 sq.mi. The altitude is 12.5 to 15.5 ft. above mean sea level; the mean depth is 7 ft. and the maximum depth 15 ft.

The chief source is the Kissimmee valley watershed. immediately to the north, which drains into a chain of lakes that in turn empties into the Kissimmee river as it flows southward almost roo mi. to Lake Okeechobee. Before the construction of adequate levees and a regulatory outlet system, the overflow produced by the rainy season flooded surrounding areas and spilled over southward into the Everglades (*q.v.*).

First plans for drainage were made in 1881 when Hamilton Disston of Philadelphia purchased from the state 4,000,000 ac., much of it in the Lake Okeechobee area, which he contracted to reclaim. His death in 1896 halted the operations. In 1904 Napoleon B. Broward won the governorship on a spectacular platform of draining the Everglades. Begun by Broward. this undertaking was continued until Sept. 1928, when hurricane winds flooded the area, killing many people and destroying much property. Subsequently the federal government aided the reclamation project. A levee 8j mi, long was constructed along the southern shore and at other low stretches; its height varies but averages about 34 ft.. approximately 20 ft. above the usual lake level. Pumping stations, spillways, hurricane gates and locks also were provided.

In 1937 a 155-mi. cross-state waterway from Stuart on the Atlantic ocean across Lake Okeechobee through the Caloosahatchee river to the Gulf of Mexico was completed. Lake communities include Pahokee, Belle Glade, Lake Harbor, Clewiston, Okeechobee and Canal Point. The region is served by three railroads and numerous highways. A Seminole Indian reservation is located on the northwest shore of the lake.

The Lake Okeechobee region is also a part of the 15,000 sq.mi. area of the Central and Southern Florida Flood Control project. joint undertaking of the corps of engineers, U.S. army, and the state of Florida, designed to provide flood protection and improved water control. Further improvements to the Lake Okeechobee levee system and to its regulatory outlet works are included in the project. (A. J. H.)

OKEFINOKEE (OKEFENOKEE), a famous U.S. primitive swamp and natural wildlife refuge of southeastern Georgia and northern Florida, is a shallow saucer-shaped depression approximately 20 mi. wide and 40 mi. long, covering about 600 sq.mi. The swamp is about 60 mi, inland from the Atlantic coast in Brantley, Clinch, Ware and Charlton counties in southeastern Georgia. and Columbia and Baker counties in northern Florida. Low sandy Trail Ridge forms the eastern swamp boundary and prevents drainage toward the Atlantic. The swamp is partially drained by the Suwannee and St. Marys rivers. Included are low sandy ridges, wet grassy savannas, small islands called "hummocks" surrounded by marshes: and extensive "prairies" or dark water areas covered by thick undergrowth and trees. Narrow channels of open water are interlaced among hummocks, prairies and wet savannas to form a bewildering maze. Vegetation is dense in the swamp. There are giant tupelo and cypress trees festooned with Spanish moss, brush and vines; where sandy soil is above the water, pines predominate. Exotic flowers abound, including kitchen plants, floating hearts, lilies and rare orchids. The swamp is populated with deer, bear, racoons, alligators, snakes and many varieties of fish, turtles and lizards. There are at least 200 different species of birds, including the ibises.

In 1937, 331,900 ac.—including most of the swamp in southeastern Georgia—were set aside as the Okefenokee National Wildlife refuge. The entrance to the refuge is at Waycross, Ga. Boat tours, trestle walks and alligator-hunting boat excursions are among the tourist attractions. (M. C. P.)

OKEGHEM, JOANNES (also OCKEGHEM, OCKENHEIM, OKERGAN, JEAN DE) (early 15th cent.–c. 1495), was born early in the 15th century at Termonde, East Flanders. He was a chorister at Antwerp in 1443 and is generally supposed to have been a pupil of Binchois. The latter part of his life was spent at Tours, where he held the coveted post of treasurer to St. Martin's church under Louis XI. He stands out in the early history of music as one of the greatest of teachers and is by common consent regarded as the founder of the second Netherlands school of contrapuntists, covering the latter half of the 15th century. Josquin des Près and De la Rue were but two among the many famous pupils who carried his teaching into all countries. His skill and ingenuity in counterpoint were considered extraordinary even in that age of elaboration. He wrote. among others, a transposing mass, the Missa *cujusvis toni,* which could be sung in any of the church modes, and a complicated motet for 36 voices. In fugue he introduced the stretto, a now familiar device by which the answer follows the subject at a closer interval than in the original statement. and in addition to the usual form of canon in unison he added the canon at the fourth below. Much of his work was destroyed in the wars, or lost, and he lived too early to see his works in print. The masses and motets were not published until after his death.

O'KELLY (Irish O CEALLAIGH), **SEAN THOMAS** (1882–), Irish statesman, was one of the founders of Sinn Fein. He was born in Dublin on Aug. 25, 1882. His education was partly private, partly at the O'Connell schools, Dublin. Later he was for some years an assistant in the National Library of Ireland. In 190j he became associated with Arthur Griffith (*q.v.*) in the editing of various Irish journals, and acted as honorary secretary of Sinn Fein from 1908 to 1910. He was also a formative influence in the Gaelic league, of which he was general secretary, 1915–20.

From 1913 onward he was active in raising the Irish Volunteers and, during the Easter rising of 1916, fought as a staff captain in the general post office, Dublin. On the collapse of the rising, he was imprisoned until the following year. In the Sinn Fein election of 1918 that swept away the old Irish Nationalist party, he was returned for College Green division (Mid-Dublin). Dublin city, and was subsequently elected speaker of *Ddil Eireann.* From 1918 to 1945 he represented at intervals various divisions of Dublin in *Ddil Eireann.* In 1919 he was accredited by the *Ddil* to the Peace conference in Paris as envoy of the government of the Irish republic; later he acted in the same capacity at Rome and Washington.

In June 1945 he was elected president of Ireland for a term of seven years; and, in May 1952, was re-elected unopposed for a further term of seven years—his unopposed return being a tribute of affection and respect from the Irish people. (D. L. I.)

OKEN, LORENZ (1779–18j1), German naturalist: whose real name was Ockenfuss, was born at Bohlsbach, Baden, on Aug. 1, 1779. He studied at Wurzburg and Gottingen, where he became *Privatdozent* (official but unpaid lecturer), and in 1807 was appointed professor extraordinarius of medical sciences at Jena. His inaugural discourse on the signification of the bones of the skull, based upon a discovery he had made in the previous year, was delivered in the presence of Goethe, as privy councilor and rector of the university, and was published in the same year, with the title, *Ueber die Bedeutung der Schiidelknochen.* In 1816, at Weimar, he began to publish the periodical *Isis, eine encyclopädische Zeitschrift, vorziiglich fur Naturgeschichte, vergleichende Anatornie und Physiologie.* Comments on politics led to his removal from Weimar. He continued to publish the *Isis* at Rudolstadt until 1848. In 1821 Oken promulgated the idea of annual general meetings of German naturalists and medical practitioners, the first meeting being held in Leipzig in 1822. The British Association for the Advancement of Science was organized after the Okenian model.

After teaching at the University of Munich, 1828–32, he transferred to the professorship of natural history at the University of Zurich, where he served until his death, in Zurich, Aug. 11, 1851.

All Oken's writings display his reliance on deductive logic, *i.e.,* of his use of a foregone and assumed principle to explain all the mysteries of nature. For example, he theorized that the head was a repetition of the trunk—a kind of second trunk, with limbs and other appendages. Postulates of this kind prevented his making any real contributions to the science of comparative anatomy.

The homology of the head and trunk mas claimed by Goethe as his own theory in his *Morphologie* (1820). In the controversy that followed Oken has an able statement in reply in *Isis* (1847). (K. P. S.)

OKHBTSK, SEA OF, a part of the western Pacific ocean, lying between the peninsula of Kamchatka, the Kurile Islands. the Japanese Island of Yezo, the Island of Sakhalin, and the Amur province of East Siberia. The Sakhalin gulf and Gulf of Tartary connect it with the Japanese sea on the west of the Island of Sakhalin, and on the south of this island is the La Pérouse strait.

OKI, a group of islands belonging to Japan, lying due north of the prefecture of Shimane. of which they form a part, 36° N. and 133° E. The group consists of one large island called Dogo, and three smaller isles—Chiburi-shima, Nishi-no-shima, and Naka-no-shima—which are collectively known as Dozen. These four islands have a coast line of 223 mi., an area of 134 sq.mi., and a pop. (1955) of 43.814. The Island of Dogo has two high peaks, Dairnanji-mine (1,092 ft.) and Omine-yama (2,185 ft.). The chief town is Saigo in Dogo, distant about 40 mi from the port of Sakai in Shimane. The name Oki-no-shima signifies "islands in the offing," and the place is celebrated in Japanese history not only because the possession of the islands was much disputed in feudal days, but also because a former emperor and an emperor were banished thither by the Hojo regents in the 13th century

OKINAWA, a pre-World War II Japanese prefecture, is composed of the island groups (Nansei Shoto in Japanese; Ryukyu Islands in English) stretching from Japan to Formosa. The Ryukyus came under G.S. control by the 1951 Japanese peace treaty; Japan kept residual sovereignty The northern island groups, Osumi. Tokara and Amami, reverted to Japan by 1954. The southern groups. the Okinawa and the Sakishima islands, remained under U.S. control Three-fourths of the inhabitants are farmers or fishermen. Sweet potatoes and sugar cane are the main crops. The islands suffer from chronic overcrowding. Pop. (19jj) 678,017. The largest (463 sq.mi) island, Okinawa, has 80% of the Ryukyu population. as well as some of the largest U S military bases in the western Pacific. Its principal city, Naha. once the capital of the Japanese Okinawa prefecture, is the seat of the U.S. military government and the native Ryukyu government, a 29-member legislature nith a chief executive appointed by U.S. authorities. For the battle of Okinana. *see* WORLD WAR II: *The War in the Pacific.* (J. D. EE.)

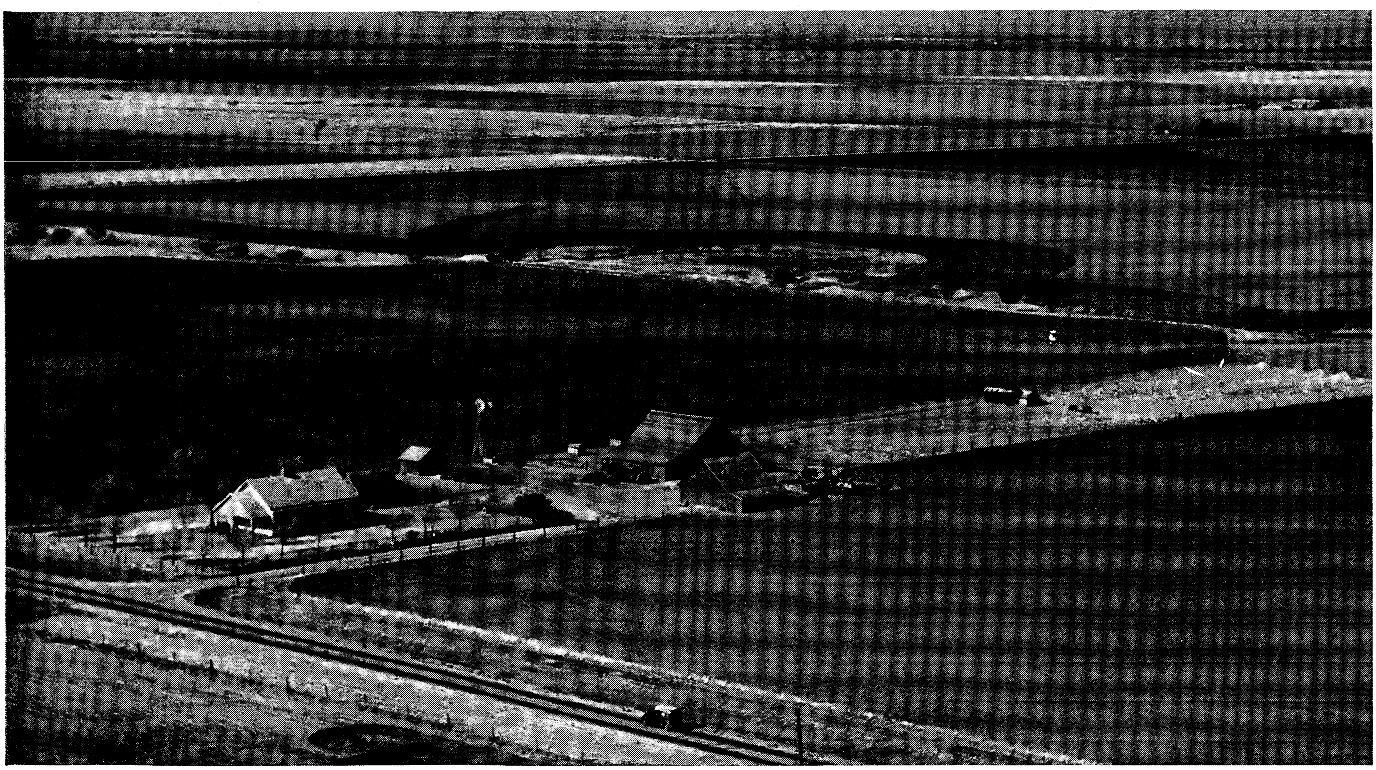
OKLAHOMA, popularly called the "Sooner state," is a west south-central state of the United States. admitted to the union in 1907 as the 46th state. It is bounded on the north by Colorado and Kansas, on the east by Missouri and Arkansas, on the south and west by Texas and on the far west (Panhandle) by New Mexico. The area is 69.919 sq mi, including 1.032 sq mi of water surface (rivers and artificial lakes); it ranks 18th among the states in size. The capital of Oklahoma is Oklahoma City, located in the centre of the state The name Oklahoma. a Choctaw Indian term meaning "red people," was first applied to the Indian Territory in 1866. The popular name "Sooner state" was derived from the term "sooner." referring to a person who entered and staked a claim for land sooner than the law stipulated when the central part of the Indian Territory was opened to homesteading in 1889. The Oklahoma state motto is *Labor omnia vincit* ("Labour Conquers All Things"). The flag has a blue field on which is a design: a circular rawhide shield, superimposed on the face of which is a peace pipe crossed by an olive branch The state floral emblem is the mistletoe, the tree the redbud. the bird the scissor-tailed flycatcher, the song "Oklahoma" (from the musical *Oklahoma!).*

PHYSICAL GEOGRAPHY

Physical Features.—The topographical features of Oklahoma (between approximately 33° 38' and 37° N. lat. and 94° 26' and 103" W. long.) range from wide treeless plains in the west to rugged, heavily wooded mountains in the east. The altitude varies from 4,978 ft. above sea level on the summit of the Black Mesa, a volcanic tableland 700 ft. above the valley floor of the Cimarron river, in the northwestern corner of the Panhandle, to 350 ft. above sea level on the bank of the Red river in the southeastern corner of the state.

There are four mountain regions in the eastern and southern parts of Oklahoma. The western fringe of the Ozark mountains (*q.v.*) in the northeast extends nearly halfway across the state in a chain of low sandstone hills gradually decreasing in height. These hills include such well-known features as Claremore mound, Concharty hills, Council hill, Osage Knob and Shawnee hills. The Ouachita range, crossing the eastern boundary, lies in southeastern Oklahoma; in this region, noted for its scenic beauty, are mountains of appreciable heights, the highest being Rich mountain, 2,950 ft. above sea level, in Le Flore county. The Xrbuckle mountains in the south-central part of the state have summits of moderate altitude. Between the valleys of the Red and Washita rivers west of the 98th meridian are the Wichita mountains, in which, among several well-known peaks, are Mt. Scott (2,464 ft.), Mt. Sheridan and Saddle mountain.

The plains region of western Oklahoma has widely distributed gypsum deposits, and many parts of the area are characterized by



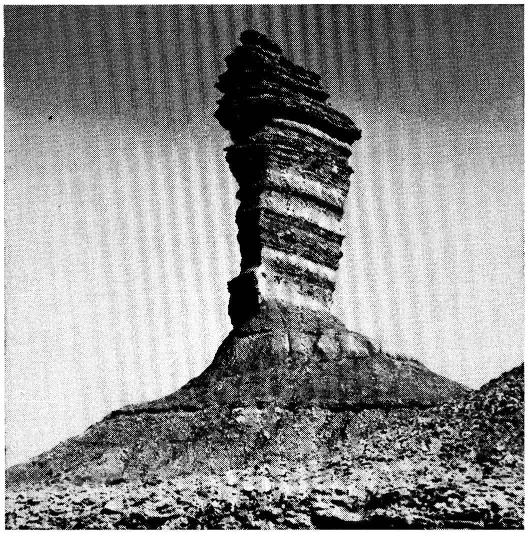
BY COURTESY OF (TOP) OKLAHOMA CITY CHAMBER OF COMMERCE (BOTTOM) STANDARD OIL CO. (N.J.)

Top: Oil wells on the state capitol grounds, Oklahoma City, tap oil from a pool beneath the capitol building

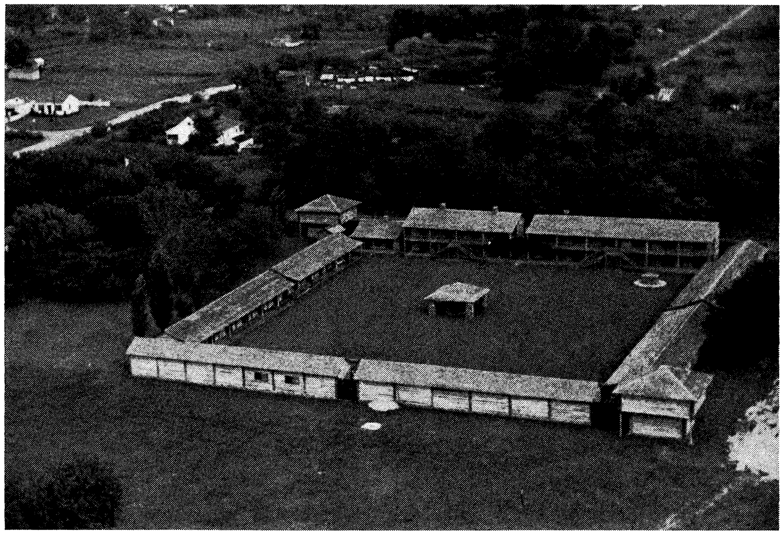
Bottom: Wheat farm west of Oklahoma City. Good soil and favorable climate have combined to make the state one of the leading producers of wheat

OKLAHOMA

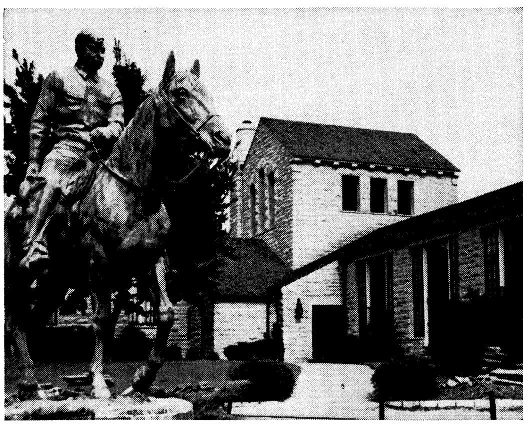
Beginning of the race for homestead sites in Oklahoma at noon, April 22, 1889. An estimated 20,000 persons were at the border of a tract of almost 2,000,000 ac. purchased from the Creek and Seminole Indians. Oklahoma received its nickname, the "Sooner state," from those persons who crossed the border and claimed land "sooner" than those shown in the photograph



Chimney rock, Cedar canyon, near Freedom, in the northwestern part of the state. The area contains several unusual structures created by the erosion of layers of rock, clay and mineral salt deposits



Reconstruction of the stockade and barracks at Ft. Gibson, at one time the principal military base for control of the Indian territory, and an important trading centre throughout the 19th century



Will Rogers Memorial museum, erected by the state at Claremore in 1938. The statue is a duplicate of one in Washington, D.C.

The Municipal building, Oklahoma City, one of four city and county buildings which comprise the civic centre of the state capital

HISTORIC AND MODERN VIEWS OF OKLAHOMA

BY COURTESY OF (TOP) OKLAHOMA HISTORICAL SOCIETY, (CENTRE LEFT, CENTRE RIGHT, BOTTOM LEFT) OKLAHOMA PLANNING AND RESOURCES BOARD; PHOTOGRAPH, (BOTTOM RIGHT) AUTHENTICATED NEWS deeply eroded streams, fantastically weathered outcrops and bold hills. the Glass mountains located near the Cimarron river in Major county being typical of gypsum scenery. A striking feature in the northwest is the Big Salt plain in Woodward county, one of four such plains; it is almost level. varying in width from ½ mi. to 2 mi. and extending 8 mi. along the Cimarron river.

Following the general slope of the land, most of the important streams flow from northwest to southeast. The Arkansas river enters the state near the 97th meridian, flows generally southeast and leaves near the centre of the eastern boundary. Its tributaries from the north and east are small but important streams —Verdigris, Neosho and Illinois; from the west it receives much larger streams — Salt Fork, Cimarron and the Canadian with its numerous tributaries The southern part of the state is drained by the Red river and its tributaries, the North Fork, Washita, Blue. Boggy and Kiamichi.

Climate. — The climate of Oklahoma is of continental type, with wide variations of temperature and humidity. The western and central parts are generally cooler and drier than the eastern section At Boise City. Cimarron county, in the northwest. the average annual daily temperature is 55.3" F. and the annual rainfall is 16.51 in.; while at Idabel. McCurtain county. in the southeast, the average annual daily temperature is 63.5" F. and the annual rainfall is 46.53 in. At Oklahoma City in the centre of the state the average annual daily temperature is 60.4" F. and the average annual rainfall is 30 22 in. The highest temperature recorded in the state was 120° F. in the summer of 1936, in widely separated places; the lowest temperature recorded was −27° F. at Vinita in 1905.

Soil. — The greater part of the soil in Oklahoma is residual, partaking of the character of the rocks from which it mas derived, found in a number of soil areas that in general correspond to the topography of the region. The most fertile soil in the state is the black limestone soil found in abundance in the Ozark and especially the Arbuckle mountzin regions, where the Arbuckle limestone lies 6.000–8,000 ft. thick. one of the heaviest limestone ledges in the world. A stiff clay soil is found in the east where clay and shale characterize the surface rocks of the great coal fields that lie north and south of the Ouachita range. In the central part of the state and its adjoining sections, the soil is highly fertile and of a deep red colour derived from the brick-red shales and clays of the rocks known as red beds.

Vegetation. — Eastern Oklahoma was originally covered with forest growth, with small prairie areas interspersed. Since it is well within the humid region, vegetation is practically identical with that of other states of the central and lower Mississippi valley. Principal trees in this eastern section of the state are several species of oak and hickory (including the pecan), besides walnut, elm, sycamore, gum, ash. bois *d'arc*, red cedar. pine, cypress and many others of less importance. In the central part of the state timber growth is generally limited to narrow fringing belts of a few species of trees along the streams — elm, cottonwood. hackberry, chinaberry, hickory and walnut. Blackjack. post oak. hackberry and hickory grow in the sand-hills region. The distribution of trees is even more limited in the western part of the state, where the thorny mesquite is found along some of the streams and flat prairies. In this semiarid western region. trees tend to be stunted by lack of moisture. and dwarf species of oak, walnut and hackberry are sometimes found.

Wild fruits and berries found in different parts of the state include plum. crab apple, cherry, blackberry, denberry, raspberry, gooseberry, currant, grape, strawberry, huckleberry, persimmon. papaw and others.

There are many species of native grasses in Oklahoma. Grasses grow tall in the eastern and central parts of the state, bunch grass being commonest. Bluestem is scattered widely throughout the prairies. Western Oklahoma was often called the short grass country, for there were found the dwarfish. low-lying buffalo, mesquite and grama grasses Buffalo grass was the commonest native grass in this semiarid region, furnishing excellent pasturage under all range conditions, summer and winter, growing low and thick and forming a heavy sod carpet on the ground.

Animal Life. — Oklahoma was once a great hunting ground. Buffalo were originally found in all parts of the state, and enormous herds roamed over the western plains until a comparatively late date in history. Other important species of animals that were plentiful in the region included elk, deer, antelope, bear, panther or cougar, wildcat, timber wolf, coyote, fox. beaver, otter, muskrat, mink, squirrel, badger, skunk, raccoon, opossum, jack rabbit and prairie dog.

A very large number of birds, resident and migratory, have been found in Oklahoma. The country teemed with wild turkey, prairie chicken and bobwhite quail. Great flocks of the now-extinct passenger pigeon and the Carolina parakeet once were found in this region. Hawks and turkey buzzards are the commonest types of large birds; smaller birds include the mockingbird, robin, meadow lark and cardinal.

The Wichita Mountains Wild Life refuge, established in 1902 as a national preserve of 58,000 ac., is noted for fine herds of buffalo, elk and the now-rare Texas longhorn cattle. The state game and fish commission supervises a number of smaller game preserves over the state, for deer, turkey and quail. The commission in 1930 established the Great Salt Plains Wild Life Refuge in Alfalfa county, where a large salt lake reservoir is a sanctuary for migratory waterfowl.

Parks and Recreation. — The construction of large lakes along streams in the U.S. flood control program and the establishment of state parks in Oklahoma brought great changes in living conditions in the surrounding areas after 1930, with millions of visitors coming to the state annually for fishing and water sports. The largest artificial lakes are Lake Texoma, which extends more than 100 mi. along the Red and Washita rivers; Grand lake (Lake o' the Cherokees), 65 mi. long on the Neosho river; and Lake Tenkiller, 30 mi, long on the Illinois river.

Oklahoma state parks in scenic or historic areas include Alabaster Caverns and Boiling Springs, both parks in Woodward county; Beavers Bend park, a primitive forest area reserve, McCurtain county; Greenleaf Lake park. southeast of Muskogee; Lake Murray park, near Ardmore in the old Chickasaw Nation; Osage Hills park in Osage county, this county comprising the former Osage Indian reservation; Robbers Cave park, Latimer county; Quartz Mountain park at Lake Altus on the north fork of the Red river; Roman Nose park named for a noted Cheyenne warrior, Blaine county; Sequoyah park on Fort Gibson reservoir east of Wagoner; Lake Wister park, Le Flore county; Lake Clayton Recreation Area in the Kiamichi mountains, Pushmataha county; Boggy Depot park, Atoka county. site of a historic town (1837) in the old Choctaw Nation on the first C.S. Overland Mail stage route between St. Louis and San Francisco. Platt National park. famous for medicinal springs, in Murray county, was established in 1906.

HISTORY

The Spanish expedition led by Francisco de Coronado in his exploration of the Great Plains in 1541 followed a direct route southnest across the Oklahoma Panhandle. Three centuries later this route approximated that of the Santa Fe trail (*q.v*), the grass-covered traces of which are visible in Cimarron county. Oklahoma, a part of Louisiana, was under the influence of the French in trade during the 18th century, and many French names of mountains and streams dating from that period may be seen on maps of the state.

Oklahoma east of the 100th meridian became known as the Indian Territory after the act of congress of May 28, 1830, which provided for removal of the Indian tribes living east of the Mississippi river to lands in the west. Five large tribes, later known as the Five Civilized Tribes — Choctaw. Creek (or Muskogee), Seminole, Cherokee and Chickasaw (*qq.v.*)—were removed from the southeastern states to the Indian Territory (1830–42), where they settled on large tracts owned by them under patehts from the government, as provided in different treaties from 1520 to 1837. These tribes established their own governments as nations, with written laws, courts of justice and elected officers. They maintained schools and foste-ed churches, missions and printing presses for newspapers and books in the native languages. The five Indian capitals and dates of establishment, at some of which old buildings stand, were Nanih Waijah (1834), Choctaw Nation, site 2 mi. from the last capitol building, near Tuskahoma (in present Pushmataha county); Tahlequah (1839), Cherokee Nation (in present Cherokee county); Tishomingo (1856), Chickasaw Nation (in present Johnston county); Okmulgee (1867), Creek (or Muskogee) Nation (in present Okmulgee county); and Wewoka (1869), Seminole Nation, this tract comprising Seminole county in the state.

American Civil War.—The people of the Indian nations and their governments were southern in their background and institutions. Some of the Indian leaders were wealthy owners of Negro slaves and plantation properties in the valleys of the Arkansas and Red rivers. But while there was strong feeling for the South and the seceding states, especially in the Choctaw Nation, there also was widespread sentiment for neutrality and staying out of the "white man's war" under such leaders as Chief John Ross of the Cherokee Nation and the venerable Opothleyahola of the Creek Nation. The United States had guaranteed the Indian nations military protection against their enemies; however, at the outbreak of the American Civil War all U.S. troops were withdrawn from the Indian Territory to Kansas, leaving the garrisoned posts open to occupation by Confederate troops from Texas and Arkansas. By Oct. 1861 Albert Pike, appointed commissioner at Richmond, Va., had concluded treaties of alliance between the Five Civilized Tribes and the Confederate states; similar treaties also had been made with other tribal groups in the Indian Territory. During the summer and autumn of 1861, the Indian nations organized their forces for military service in the Confederate army.

Division among the Indian peoples in their sympathies between the northern and southern states began in the Creek Nation under the leadership of Opothleyahola, who refused to recognize the Confederate-Creek treaty. Setting out with about 5,000 followers toward the Kansas line, he was followed and attacked three times by Confederate troops (white and Indian). His forces were defeated in the third fight (battle of Chustenahlah, Dec. 26, 1861), and his followers, including some Seminoles, fled destitute in a winter storm to Kansas, where they became refugees within the Union lines. Confederate Indians from several other tribes soon went over to the Union side and were organized as Indian home guard regiments in the U.S. army.

Ft. Washita with its outpost and commissary at Boggy Depot was the Confederate stronghold during the war. Troops and scouting parties of both armies swept back and forth across the country to the north and in the Arkansas river valley. The Cherokee Nation, particularly, was a scene of desolation at the end of the war. Stand Watie, leader of the Confederate Cherokees, was the only Indian officer commissioned brigadier general, though many others among the Indian officers were cited for bravery and gallantry in action. Gen. Stand Watie surrendered his troops at Doaksville, Choctaw Nation, on June 23, 1865, the last general officer of the Confederate army to do so.

Postwar Period.—After the Civil War, new treaties with the Five Civilized Tribes, demanded by the federal government, were signed at Washington in 1866. While each of these dealt with local conditions and problems as a result of the war within the signatory nations, there were some general provisions common to all: the abolition of slavery; rights of way granted for the building of two railroads (one north to south and one east to west) through the Indian Territory; plans for the organization of the whole territory as a federal commonwealth with a legislative body composed of delegates from each of the Indian nations and tribes within its borders; and the cession of the western tribal lands (western Indian Territory) to the United States, this provision being in retaliation for the recent alignment of the Five Civilized Tribes with the Confederate government. These land cessions, involving millions of acres, meant great changes throughout the region. The five Indian governments continued in greatly reduced areas in eastern Indian Territory, and social conditions changed from a pastoral to the beginnings of an industrial society. Towns and villages sprang up beside the railroads where settlers came to live as owners of stores and other small enterprises.

The ceded lands in western Indian Territory were assigned by the government as reservation tracts for Indian tribes brought there from many parts of the United States. The new reservations bordering the Five Civilized Tribes on the west (now central Oklahoma) were assigned to tribes from Kansas and adjoining states, including Osage, Kaw, Sac and Fox, Shawnee, Potawatomi, Ponca, Pawnee and others. Farther west in the territory were the big reservations assigned the Plains tribes—Comanche, Kiowa, Kiowa-Apache, Cheyenne, Arapaho.

During the first years, some of the leaders of the latter tribes were imbued with the spirit of the Indian wars on the Great Plains, and military campaigns were undertaken against some of the tribal bands. The last of the warring Plains tribes was the Quahadi band of Comanche under Quanah (later noted as Chief Quanah Parker), who came in from the Staked Plains of Texas and surrendered at Ft. Sill in June 1875. From this time, except for some local trouble with part of the Kiowa and the Cheyenne, the tribes of the Great Plains settled down to reservation life that continued until their lands were opened to homesteading and became a part of Oklahoma Territory.

Among several military posts established after the Civil War in western Indian Territory, Ft. Sill (1869) has been continuously garrisoned since, and after World War II it became the largest artillery and missile centre in the United States.

Homesteading.—After the building (1872) of the Missouri, Kansas and Texas, the first railroad through Indian Territory, colonies of "boomers" from the states attempted to establish homesteads on a central tract (1,887,880 ac.) left unassigned for Indian reservation purposes. Boomer colonies for several years were ejected by U.S. troops because delegations of Indian leaders of the Five Civilized Tribes repeatedly went to Washington to point out that their tribal lands and properties remained in jeopardy. Until the government cleared the title of the Creek and Seminole owners of the unassigned land tract by due process of law, no patent to homestead claims could be given. Finally congress granted an appropriation to fulfill the terms of the Creek and Seminole treaties; this was followed within a few weeks by the proclamation of Pres. Benjamin Harrison opening the unassigned land to white settlement by a run for homestead claims to begin at noon on April 22, 1889. Evening of this opening day saw the unassigned land peopled by thousands who had made the run from its borders, and the tent cities of Guthrie and Oklahoma City growing. The region was without a regular system of government until the congressional act of May 2, 1890, provided the organization for the western half of the Indian Territory as Oklahoma Territory with Guthrie as the capital. The Indian Territory throughout its history was never organized under regular territorial government; the eastern half (1890–1907) remained the last Indian Territory, the land owned by the governments of the Five Civilized Tribes except for the northeast Quapaw agency region, which was owned by several remnant tribes including Quapaw, Wyandot, Seneca and allied Indian bands. Members of all Indian tribes were allotted land in severalty, and all Indian reservations and governments were closed by 1906. Millions of acres of surplus Indian reservation lands had been opened to white settlement and organized as part of Oklahoma territory.

Statehood.—When congress authorized the admission of Oklahoma and Indian territories as one state, the people including the Indians voted approval of a constitutional convention (composed of 100 Democrats and 12 Republicans) which met at Guthrie on Nov. 20, 1906. The constitution framed by this body was approved by a vote of the people on Sept. 17, 1907, and the state of Oklahoma was admitted to the union by proclamation of Pres. Theodore Roosevelt on Nov. 16, 1907.

Operation of the coal mines in the McAlester and Lehigh fields had been the leading industrial development for over 30 years until the discovery of oil in 1905, in the Glenn Pool 10 mi. S. of Tulsa. The Glenn Pool touched off development of the great mid-continent field, from which 5,790,759,000 bbl. of crude oil had been removed through 1947. The petroleum industry in the first 50 years of Oklahoma statehood contributed enormous revenue to the state government and its institutions. Very low prices of crude oil and waste in oil production aggravated conditions at the beginning of the nation-wide depression (1933) and brought about enactment of the proration law of April 10, 1933, by the state legislature. This law became a pattern for other states and the federal government.

The federal government's depression emergency program was needed mostly in the eastern and southern parts of the state. It was during this period that John Steinbeck's novel The *Grapes of Wrath* popularized the term "okies," portraying poverty-stricken farm families from the Arkansas river region in eastern Oklahoma on their migration route to California.

The Oklahoma national guard, organized in territorial days, was inducted into active service in the U.S. army, as part of the 8th corps area in the 45th division (Thunderbird division), on Sept. 16. 1940, and served in the European campaigns during World War II. Soldiers from all parts of the United States were trained at Ft. Sill, and approximately 28 army camps and 13 naval bases were established in different parts of the state.

One of the continuing state questions was the prohibition of the sale of liquor, which dated from 1834 when the congressional la regulating trade and intercourse throughout the Indian Territory was passed. Oklahoma Territory had been open for the sale of liquor to 1907, though the territorial enabling act (1890) had provided the continuance of prohibition for 21 years in the Indian Territory and on any Indian reservation tract. Prohibition for the new state had been voted by the people in the election of 1907. The prohibition clause finally was stricken from the state constitution by vote in the election of April 7, 1959. Under a liquor control act of the state legislature, the alcoholic control board set up state regulations for the operation of retail liquor stores.

politics. — Oklahoma has remained consistently Democratic in politics but with a strong Republican minority, Democratic electors having been chosen in nine presidential elections and Republican electors in five; Warren G. Harding carried the state in 1920, Herbert Hoover in 1928. Dwight D. Eisenhower in 1952 and 1956 and Richard M. Nixon in 1960. All U.S. senators from Oklahoma were chosen by the Democratic party except three who won on the Republican ticket in 1920, 1924 and 1942. All governors of the state were elected on the Democratic ticket. The state senate was never controlled by Republicans, and the state house of representatives had a Republican majority only in 1920.

GOVERNMENT

The Oklahoma constitution adopted in 1907 contains many provisions that in older states were left to legislation. Amendments may be submitted through a majority of the members elected to both houses of the legislature or through a petition signed by 15% of the electorate, and a proposed amendment is adopted if it receives a majority of the votes cast at a popular election. General elections are held in even-numbered years; party candidates for state, district, county and municipal offices, and U.S. senators and congressmen are chosen at primary elections.

Executive. — The executive authority of the state is divided among 12 elected officials, including the governor, lieutenant governor, secretary of state, treasurer, auditor, attorney general, superintendent of public instruction, chief mine inspector and commissioner of charities and corrections. They are elected for terms of four years, and the governor, secretary of state, auditor and treasurer are ineligible for election to the succeeding term. Other elected officials are the three members of the corporation commission (one elected every two years for a six-year term), the clerk of the supreme court and four assistant mine inspectors. Administrative work is also done by more than 60 officers, commissions, departments and boards.

Legislative. — The legislative authority is vested in a senate of 44 members and a house of representatives, the membership of which (121 in 1960) varies from 119 to 123 in the decennial legislative period (Nov. 1952–Nov. 1962) by act of the legislature, 1951. One-half of the senators and all representatives are elected every two years, senators by districts and representatives by counties.

Judicial. — For the administration of justice there were established a supreme court, composed of nine justices elected for terms of six years; a supreme court commission, which was discontinued after its work was completed; a criminal court of appeals composed of three justices elected (one each two years) for terms of six years; 31 district courts, each with one or more justices elected for terms of four years; superior courts in certain of the more populous counties, with a judge elected for a term of four years; a county court in each county, with one judge elected for a term of two years; justice of the peace courts held by justices elected for terms of two years; and municipal courts in the cities.

Local Government. — The general management of county affairs is entrusted to three commissioners elected by districts. The other county officers are a sheriff, attorney, judge, clerk, court clerk, treasurer, assessor, surveyor, superintendent of public instruction and public weigher. They are chosen for terms of two years in each of the counties at the general elections.

Finances. — Revenues for state and local purposes are derived almost wholly from separate sources. The greater part of the state's revenue is derived from a gross production tax on minerals, motor vehicle licences, insurance fees. gasoline, inheritance and income taxes and departmental collections. Revenue for local purposes is obtained chiefly from tax levies on personal and real property; there are no state levies on property, tax levies being made only by the counties, townships or cities and towns and school districts. Chief state expenditures are for highways, education, debt amortization and service and penal institutions.

POPULATION

The popuiation of Oklahoma and Indian territories in 1890 was 258,657. A special census gave a population of 1,414,177 in the

*Oklahoma: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900†
Total state	2,328,284	2,233,351	2,336,434	2,028,283	398,331
Ada	14,347	15,995	15,143	8,012	3,257‡
Altus	21,225	9,735	8,593	4,522	1,927‡
Alva	6,258	6,505	5,055	3,913	1,499
Anadarko	6,299	6.184	5,579	3,116	2,190‡
Ardmore	20,184	17,890	16,886	14,181	8,759‡
Bartlesviile	27,893	19,228	16,267	14,417	4,215
Bethany	12,342	5,705	2,590	485	—
Blackwell	9,588	9,199	8,537	7,174	2,283
Broken Arrow	5,928	3,262	2,074	2,086	1,383‡
Chickasha	14,866	15,842	14,111	10,179	7,8623
Claremore	6,639	5,494	4,131	3,435	2,0643
Clinton	9,617	7,555	6,136	2,596	1,2781
Cushing	8,619	8,414	7,703	6,326	226
Del City	12,934	2,504	—	—	—
Duncan	20,009	15,325	9,207	3,463	2,451‡
Durant	10,467	10,541	10,027	7,340	4,510‡
Edmond	8,577	6,086	4,002	2,452	965
Elk City	8,196	7,962	5,021	2,814	2,195‡
El Reno	11,015	10,991	10,078	7,737	3,383
Enid	38,859	36,017	28,081	16,576	3,444
Frederick	5,879	5,467	5,109	3,822	2,036‡
Guthrie	9,502	10,113	10,018	11,757	10,006
Guymon	5,768	4,718	2,290	1,507	839‡
Henryetta	6,551	7,987	6,905	5,889	1,051‡
Hobart	5,132	5,380	5,177	2,936	3,136‡
Holdenville	5,712	6,192	6,632	2,932	1,868‡
Hugo	6,287	5,984	5,909	6,368	2,676‡
Lawton	61,697	34,757	18,055	8,930	5,562‡
McAlester	17,419	17,878	12,401	12,095	8,144‡
Miami	12,869	11,801	8,345	6,802	1,893‡
Midwest City	36,058	10,166	—	—	—
Muskogee	38,059	37,289	32,332	30,277	14,418:
Norman	33,412	27,006	11,429	5,004	2,225
Oklahoma City	324,253	243,504	204,424	91,295	10,037
Okmulgee	15,951	18,317	16,051	17,430	2,322‡
Pauls Valley	6,856	6,896	5,104	3,694	2,157‡
Pawhuska	5,414	5,331	5,443	6,414	2,408‡
Perry	5,210	5,137	5,045	3,154	3,351
Ponca City	24,411	20,180	16,794	7,051	2,528
Pryor Creek	6,476	4,486	2,501	1,767	1,113‡
Sand Springs	7,754	6,994	6,137	4,076	—
Sapulpa	14,282	13,031	12,249	11,634	4,259‡
Seminole	11,464	11,863	11,547	854	206‡
Shawnee	24,326	22,948	22,053	15,348	3,462
Stillwater	23,965	20,238	10,097	4,701	2,431
Tahlequah	5,840	4,750	3,027	2,271	1,916‡
The Village	12,118	—	—	—	—
Tulsa	261,685	182,740	142,157	72,075	7,298‡
Vinita	6,027	5,518	5,685	5,010	3,157‡
Warr Acres	7,135	2,378	—	—	—
Wewoka	5,954	6,747	10,315	1,520	794‡
Woodward	7,747	5,915	5,406	3,849	2,018‡

*Populations are reported as constituted at date of each census. †1900 census figures are for the Territory of Oklahoma. $1907 special census for Territory of Oklahoma, 1900 figures not available.

Note: Dash indicates place did not exist at reported census, or data not available.

new state in 1907. The population in 1910 was 1,657,155; in 1940, 2,336,434; in 1950, 2,233,351 (4.4% less than in 1940; and in 1960, 2.328.284 (4.3% more than in 1950).

The 1960 urban population of Oklahoma comprised 1,464,786 persons, or 62.9% of the total. The state has three standard metropolitan statistical areas. which are Lawton. Oklahoma City and Tulsa. These areas had a total population of 1,021,610 or 43.9% of the total population of the state in 1960.

The population of the state in 1950, distributed by colour and nativity. was 90.2% native white, including a large number of persons of American Indian descent; 0.8% foreign-born white; 6.5% Negro; 2.5% other races, mostly full-blood American Indian.

The number of households in 1950 was 663,262. as compared with 610,481 in 1940; the average population per household had declined from 3.8 in 1940 to 3.4 in 1950. Of the total number of employed males, 25.6% was engaged in agriculture, 6.4% in mining and oil production, 10.1% in construction, 11.0% in manufacturing and 22.4% in transportation and trade.

Oklahoma's population is cosmopolitan in its ethnic origins, with nearly every nationality represented, though the largest number of persons is of American colonial descent. The percentage of American Indians is high, persons of full blood and mixed Indian-white numbering about 400.000. The state's foreign population (largely German) includes families and groups that came to Oklahoma Territory with the opening of new lands (1889–1906); another large foreign element came to the coal mining region along the railroad in eastern Indian Territory in the 1880s. The Negro population in Oklahoma increased after World War II. especially in the urban centres, but basically it consists of descendants of Negro freedmen of the Indian nations, who after the Civil War remained in the country on freedman land allotments under the terms of the treaties of 1866. Groups of Negroes came from the southern states from time to time in the period of railroad building, and others were brought to work in the mines during the coal strikes in the early 1890s. One band of Negroes migrated from southern states, chiefly Louisiana and Texas, soon after the Civil War, and located in the unassigned lands near present Guthrie, where many of their descendants still live.

The decline in the state's population figures seen in 1950 was a result principally of changes in agricultural life; costly mechanization of farming operations, necessity of soil conservation practices in many localities and the reduction of cotton acreage in cotton-growing regions caused families to leave their farms.

EDUCATION

Public Schools.—The public school system in Oklahoma is administered by the state and county superintendents of public instruction. Total annual enrollment (elementary and high schools) was approximately 500,000 in the early 1960s; total expenditures were about $150,000.000.

Higher Education.— The Oklahoma State System of Higher Education, administered by the Oklahoma State Regents for Higher Education. has as members 11 state-owned senior colleges, 1 independent senior college and 7 state-o ned junior colleges.

The University of Oklahoma was established by the first legislative assembly of Oklahoma Territory in 1890, and opened at Norman in 1892. It is governed by a board of seven regents, appointed by the governor and confirmed by the state senate. It includes 9 colleges: arts and sciences (1892), pharmacy (1893), fine arts (1899), engineering (1904), education, graduate, law (1909), business administration (1923), university (1942). and two schools: medicine (1900. Norman; 1910, Oklahoma City) nursing (1911). The University of Oklahoma press established in 1928 is outstanding in the publication of more than 460 books by 1960, covering regional subjects and a variety of offerings including English literature, international biography and linguistics. The university owns and operates an AM and FM radio station. In the late 1950s enrollment approximated 12,000 annually. The university library totals more than 700,000 volumes.

Oklahoma State university at Stillwater was chartered as an agricultural and mechanical college in 1890. It comprises colleges of agriculture, arts and sciences, engineering, education, business, home economics, veterinary medicine and a graduate school. Annual enrollment approaches 10,000.

Other state institutions of higher education include Oklahoma College for Women at Chickasha (1908); Panhandle Agricultural and Mechanical college at Goodwell (1909); Langston university at Langston (founded for Negroes in 1897); and six state-owned senior colleges at Ada, Alva, Edmond, Durant, Tahlequah and Weatherford. Oklahoma Baptist university at Shawnee (1910), independent, also is a member of the state system.

Independent colleges and universities include Oklahoma City university (Methodist. 1904); University of Tulsa (Presbyterian, 1894); Benedictine Heights college, Tulsa (Roman Catholic, 1955, outgrowth from Guthrie, 1917); Phillips university, Enid (Disciples of Christ. 1906); and Bethany-Nazarene college, Bethany (Church of the Nazarene, 1909).

HEALTH, WELFARE AND CORRECTIONS

The state constitution provided for the election of a state commissioner of charities and corrections to supervise and inspect charities and institutions of correction. The state maintains mental hospitals at Norman (with annex at Lexington), Vinita and Supply; sanatoriums for tuberculosis patients at Clinton and Talihina; a state school for the feeble-minded children at Enid; a state school for mentally retarded white children at Pauls Valley; a state hospital and also consolidated Negro institutions for deaf, blind and orphans at Taft.

State penal institutions include a training school for Negro girls (near Taft), "Girls Town" for white girls (Tecumseh) and state training schools for Negro boys (Boley) and for white boys (Helena). Whitaker State home is maintained for neglected and dependent white children (near Pryor). The state penitentiary is located at McAlester and the state reformatory at Granite.

Of the state's 77 counties, about 50 have full-time health departments serving 80% of the state's population; a number of these provide full-time medical service.

The Oklahoma department of public welfare serves dependent children, the disabled, the medical pool fund, the blind, child welfare, crippled children and rehabilitation.

ECONOMY

Agriculture.— Oklahoma was a great cattle country before the first opening of land to white settlement in April 1889, and thereafter agricultural development was rapid, with millions of acres of former Indian lands added to Oklahoma Territory in eight other openings at different times. In 1900 the farm area was 51.1% of the total land surface; in the 1950s it represented 80% of the total land area, nearly two-thirds of farms and ranches being owned by their operators. Oklahoma began its second 50 years of statehood with improved technology that kept agriculture as its most important single pursuit, soil conservation methods contributing largely to this.

Soil erosion, which began to show up even before statehood—because of early, wasteful farming methods on wide grasslands that should never have known a plow—amounted to a blight by the 1930s, aggravated by the great drought. Northwestern and western Oklahoma counties were included in the "dust bowl" region. State conservation laws in 1925 provided for protection of wildlife and promotion of forestry, irrigation and flood control. The program was expanded by the creation of the state soil commission in 1937, to co-operate with farmers in contour cultivation and terracing of farm lands and planting of cover crops to keep the soil from washing away. By 1950 this commission had brought over 95% of the state's area within soil conservation districts under the organization and control of local farmers and ranchers.

Reclamation work to reduce flood damage along the rivers and streams has been a vital part of the water resources program in the state, in which flood control, irrigation and municipal water supply have been combined in one project. By 1957 over 100,000 ac.. principally in western Oklahoma, were irrigated. The sprinkler system of irrigation is used in some parts of eastern Oklahoma for the growing of small fruits and vegetables as well as corn and cotton, and in the Panhandle, largely a livestock-growing region, for feed and forage crops.

Of cash crops, wheat is by far the most important: Oklahoma* is the U S third most Important wheat-producing state Though wheat replaced cotton as the leading crop in the 1930s. cotton growing remains important Other significant crops are hay, oats, peanuts corn. sorghum, rye, pecans and a variety of fruits

The beef cattle industry is the largest source of agricultural wealth in Oklahoma Beef cattle, numbering well over 3,000,000, comprise chiefly Herefords Aberdeen Angus and Shorthorn Grazing is most important in the south-central part of the state and in the Blue Stem Bowl region in Osage county Other livestock. raised in much smaller numbers, include hogs. sheep and horses and mules Chickens number over 5,000 000

Lumber. — Timber is an important resource in southeastern Oklahoma. The lumber and wood products industry (excluding furniture manufacture) is valued at approximately $8,000,000 annually

Minerals.—Oklahoma is widely known as an oil-producing state. and indeed petroleum is by far its most valuable mineral resource, being valued at around $700,000 000 annually (figure includes also natural gas, liquefied petroleum gas and natural gasoline) In cumulative production for 1955–58 Oklahoma ranked third among the states, it also ranks third in number of producing wells Producing regions extend over 66 counties, generally irom the north-central to the southwestern parts of the state, with a large natural gas field in the western part of the Panhandle Tulsa, the oil centre of the state, is situated near the central part of the north-central producing region; Duncan, in Stephens county, is a centre in the oil-producing region of the southwest.

In addition to fuel minerals, Oklahoma also has large reserves of metallic and other nonmetallic minerals. Among those of value to the state are zinc, dolomite, granite, lead, salt, sand and gravel, limestone and sandstone, tripoli, clay, glass sand, bentonite, chat, volcanic ash, sulfur, gypsum, asphalt and ground silica. Mineral industries based on these are an important source of riches. Ada, in Pontotoc county, is noted for its great cement plants and as a centre in a region that produces petroleum, natural-gas liquids, stone, sand and gravel and clay.

Helium is found in the Oklahoma Panhandle. This region, with limited fields extending into the Texas Panhandle and the southern border of Kansas, comprises the only area in the United States and possibly in the world where helium is found in sufficient quantities for commercially profitable extraction. The helium plant at Keyes, Cimarron county, constructed in 1959 for the U.S. bureau of mines, was the second such plant in the United States.

Manufactures. — Manufacturing is a third mainstay in Oklahoma's economy, being based on agricultural and mineral wealth. Agricultural products provide raw materials for meat packing, canning, flour milling, feed manufacturing and textile plants; mineral wealth supplies raw materials and fuels for refining, smelting, glassmaking, petrochemical and other industries. About 90.000 persons are employed in manufacturing, the plants tending to be concentrated in the northeastern and central parts of the state.

Transportation and Communication. — Total railroad mileage approximates 6,000 mi., reaching every part of the state. The State Highway commission is responsible for nearly 12,000 mi, of highway system. The larger cities are served by major airlines. The navigation features of the multiple-purpose Arkansas river project authorized by congress in 1946 were planned to link Oklahoma City and Tulsa with the U.S. inland waterway system. See also references under "Oklahoma" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Brztannica Book of the Year,* American edition. (M. H. W.)

OKLAHOMA CITY, capital of Oklahoma and its largest city, the seat of Oklahoma county, is located on the North Canadian river at the approximate geographic centre of the state, 88 mi. S W of Tulsa and 214 mi N W of Dallas, Tex The 1960 population of the city was 324 253, an increase of 30 4% after 1950; standard metropolitan statistical area (Oklahoma county) was 511 833. an increase of 30 4%.

Oklahoma City's exact location was dictated by the existence of a siding on the Atchison. Topeka and Santa Fe railway, originally intended for military use and known as Oklahoma station (1887) By sundown of the day the area of central Oklahoma (1.887,640 ac known as the Oklahoma country) was opened for settlement (April 22, 1889), approximately 10.000 persons had congregated to stake land claims at a townsite adjoining the railroad stop A provisional town government was instituted by mass meeting in May of 1889 but it was not until May 2, 1890, that formal statutory law came upon the organization of Oklahoma territory. While the name Oklahoma City was in popular use from the earliest day, the U S post office department did not adopt the name until 1923 A council-manager form of government, adopted in 1927, was continued under a new charter approved April 5, 1957

The economy has been based upon agriculture, distribution and industry, and every federal census has shown substantial gains in population (for comparative population figures see table in OKLAHOMA: Population). The first major urban development reached a climax in 1910, the year Oklahoma City was designated the state capital; in the three preceding years the population had doubled. Annual rainfall in the area is 30.22 in. and it is one of the few places where the cotton and wheat belts overlap; the city has long been an important shipping point for both crops and also for cattle. After 1910 state employees increased the population and the city also benefited from the World War I boom. The first meat-packing plants were established about this time and with the coming of additional railroads wholesale trade increased.

The first well in the Oklahoma City oil field came in on Dec 4, 1928. Characteristics of the oil industry there were the productivity of the wells; the enormous gas pressures, resulting in more than one spectacular mid-city fire; and the then unprecedented depths (4.000–7 000 ft) or the wells. Because of the fire hazard city ordinances were passed limiting the drilling zone in the city; it was subsequently enlarged and in 1936 was further expanded to include drilling on the state capitol grounds. In the latter part of the 20th century there were in the metropolitan area about 1,800 producing wells, approximately 1,400 within the city limits.

The city enjoys diversified industry; principal products include aircraft, petroleum refining, oil field and telephone exchange equipment, meat packing and steel fabrication. Oklahoma City is one of the nation's foremost aviation centres, with 'Tinker air force base, a large air material depot and a federal aviation agency centre for the training of students in all phases of department of commerce aviation management and technical skills.

Educational facilities include, in addition to the usual public and parochial schools, Oklahoma City university (Methodist, 1904) and the medical centre of the University of Oklahoma, which includes schools of medicine and nursing, the university hospital, a crippled children's hospital and a speech and hearing clinic. Also on the grounds are a Veterans administration hospital and the Oklahoma Medical Research institute (privately owned and operated) and its adjacent research hospital.

The civic centre includes a modern auditorium which seats 6.000 persons. Residential housing is predominantly ranch and early American in style. The city has a symphony orchestra and is the headquarters ior the state library and the state historical society, which contains an outstanding collection of American Indian archives. The state fair is held there and the city is also the sire of the Cowboy Hall of Fame and Museum. (GE. H. S.)

OKMULGEE, a city of east-central Oklahoma, U.S., is located 37 mi. S. of Tulsa; the seat of Okmulgee county. Capital of the Creek Nation from 1868 until Oklahoma achieved statehood in 1907, Okmulgee. a Creek word meaning "bubbling water," began to be settled by whites in the last decade of the 19th century. In 1904 oil was discovered in the vicinity and with its development, beginning in 1907, the small cattle and agricultural community boomed. Incorporated in 1908. the city adopted a council-manager form of government in 1954. In the second half of the 20th century it was the centre of an important oil-producing area. Agricultural products included beef and dairy cattle, poultry, peanuts, cotton and corn. Manufactures included petroleum and meat products, oil field equipment, glass and furniture.

Located there is the school of technical training, a branch of Oklahoma State university. The Creek Indian council house (1878), now an Indian museum, stands in the heart of the city. For comparative population figures see table in OKLAHOMA: Population. (J. D. Mo.)

OKOVANGO (OKAVANGO, Portuguese CUBANGO), a river in central Africa, about 605 mi. in length, rises in Angola about 10 mi. E. of Vila Nova on the Benguela railway. Near Caiundo, about 200 mi. from the source, the river passes from the ancient crystalline rocks of the Angolan highlands to the Kalahari formation and flows on this formation for most of the remaining 400 mi. of its course. In many places the river has cut several hundred feet into the Kalahari system exposing hard beds of calcrete or silcrete which, as at Runtu, on the Southwest African border, form bluffsor cliffs where they have been undercut by erosion at a bend. Below the Popa falls, about 10 mi. below Andara, the river forms a series of stairlike rapids, falling about 10 to 15 ft.

Between Runtu and Andara the Okovango receives the Cuito, which rises in the Kalahari sand and flows for nearly 450 mi. to join the main stream in an extensive flood plain. On the south side of the river the tributary channels are generally dry courses, the strongest of them being the Omuramba Omatako, which occasionally brings water to the Okovango.

For about 170 mi. below the Popa falls the river has formed a great swamp tract, the first 90 mi. of which is between about 3 and 8 mi. wide, spreading out to form a great delta, about 80 mi. long (from northwest to southeast) and 120 mi. wide (from southwest to northeast). From west to east the main distributaries are: the Taokhe, the Jiao, the Ng-gokha and the Mochaba. These flow into the channel forming the arc of the delta, which stretches from Lake Ngami (*q.v.*) in the southwest along the Ngabe, Tamalakane and Mokhokelo channels to the Mababe depression in the northeast. From the arc of the delta the Botletle river conducts flood water toward the Makarikari depression in the Middle Kalahari, though only during very high floods does water reach the depression. During very high floods, too, water from the head of the delta reaches the Linyanti marshes along the Makwegana (or Selinda) spillway.

At Runtu during the years 1947–54 the flow varied from a minimum of about 480 cu.ft. per second to a maximum of about 20,000 cu.ft. per second. The regimen corresponds closely to the incidence of rainfall in the headwater catchment basin, the lowest flow being in September and the highest in March or April, the maximum flow in the arc of the delta being about five months later than at the head. The annual discharge of the river at the head of the delta is estimated to be about 11,000,000 ac.-ft.

See A. L. Du Toit, *Report of the Kalahari Reconnaissance of 1925* (1925); L. A. Mackenzie, *Report of the Kalahari Expedition, 1945* (1946); A. G Stigand, "Ngamiland," *Geogr. J.*, vol. lxii (1923); C. F. Rey, "Ngamiland and the Kalahari," *Geogr. J.*, vol. lxxx (1332); J. H. Wellington, *Southern Africa*, vol. i (1955). (J. H. Ws.)

OKRA: see GUMBO.

ŌKUBO TOSHIMICHI (1830–1878), one of the Japanese samurai leaders who in 1868 overthrew the shogunate and re-established the government of the emperor (see JAPAN: *History*). Okubo immediately became a dominant member of the new government formed under the emperor. After a brief government mission abroad, he returned convinced of the necessity of Japan's rapid economic development. To this end he supported the establishment of technical schools, the holding of scientific and technical exhibitions, the giving of loans and subsidies to private business, and the building and management of factories by the government.

In 1873 he split with the great Saigo, one of his fellow clansmen of Satsuma, over policy toward Korea. Saigo supported a policy of conquest; Okubo argued that priority should be given to internal reform and development. Okubo's views prevailed and were adhered to until 1894, long after his death. Saigo left the government and returned to his native Satsuma to arouse the clansmen. In the troubles which soon followed the foreign policy split, Okubo was the chief opponent of Saigo, who led the Satsuma rebellion. The suppression of the rebellion brought upon Ōkubo the personal revenge of Saigo's sympathizers, and he was assassinated in 1878 by six clansmen. Thus Okubo, one of Japan's greatest leaders, was in a sense a martyr to his progressive views of government and foreign policy. (T. C. SH.)

OKUMA (SHIGENOBU), MARQUIS (1838–1922), Japanese statesman; was born in the province of Hizen in 1838. His father was an officer in the artillery. He was able to acquire in his youth a knowledge of English and Dutch, and by the help of missionaries he obtained books in those languages on scientific and political subjects. These works effected a complete revolution in his mind. It was his parents' wish that he enter the military profession, but he was determined to devote his energies to the abolition of the existing feudal system and to the establishment of a constitutional government. Though he took no active part in the revolution of 1868, the weight of his opinions was felt in the struggle. Already he was recognized as a coming man and no sooner was the government reorganized, with the mikado as the sole wielder of power, than he was appointed chief assistant in the department of foreign affairs.

In 1869 he succeeded to the post of secretary of the joint departments of the interior and of finance, and for the next 14 years he devoted himself to politics. In 1870 he was made a councillor of state, and a few months later became president of the commission which represented the Japanese government at the Vienna exhibition. In 1872 he was again minister of finance, and was president of the commission appointed to supervise the Formosa campaign of 1874. The Japanese nation had supported him up to a certain point, but opinion now turned against him. When Okuma resigned office in the early '80s he established the Semmon Gakko, or school for special studies, and subsequently other schools.

In 1896–97 he was a member of the Matsukata cabinet. An attempted assassination by bomb necessitated the amputation of one of his legs. On Ito's retirement in 1898 he took office as premier and minister of foreign affairs. He resigned after a few months and retired into private life, cultivating his beautiful garden at Waseda near Tokyo. He emerged from his retirement in 1914 to become prime minister, in which capacity he guided the country through the opening months of World War I. In 1916, Count Okuma retired from office owing to his failing health. In the same year he was raised to a marquessate. He died at Tokyo on Jan. 10, 1922.

OLAF or ANLAF (d. 981?), king of the Danish kingdoms of Northumbria and of Dublin. was a son of Sitric, king of Deira, and was related to the English king Aethelstan. He was of Norse descent, and he married a daughter of Constantine II, king of the Scots. When Sitric died about 927 Aethelstan annexed Deira, and Olaf took refuge in Scotland and in Ireland until 937, when he was one of the leaders of the formidable league of princes which was destroyed by Aethelstan at the famous battle of Brunanburh. Again he sought a home among his kinsfolk in Ireland, but just after Aethelstan's death in 940 he or Olaf Godfreyson was recalled to England by the Xorthumbrians. Both crossed over, and in 941 the new English king, Edmund, gave up Deira to the former. The peace between the English and the Danes did not, however, last long. Wulfstan. archbishop of York. sided with Olaf; but in 944 this king was driven from Northumbria by Edmund, and crossing to Ireland he ruled over the Danish kingdom of Dublin. From 949 to 952 he was again king of Northumbria. until he was expelled once more, and he passed the remainder of his active life in warfare in Ireland. But in 980 his dominion was shattered by the defeat of the Danes at the battle of Tara. He went to Iona, where he died probably in 981, although one account says he was in Dublin in 994. This, however, is unlikely. In the sagas he is known as Olaf the Red.

This Olaf must not be confused with his kinsman and ally. OLAF (d. 941), also king of Northumbria and of Dublin, who was a son of Godfrey, king of Dublin. The latter Olaf became king of Dublin in 934; but he was in England in 937, as he took part in the fight at Brunanburh. After this event he returned to Ireland, but he appears to have acted for a very short time as joint king of Northunibria with Olaf Sitricsson. It is possible that he was the "Olaf of Ireland" who was called by the Northumbrians after Aethelstan's death, but both the Olafs appear to have accepted the invitation. He was killed in 941 at Tyningham near Dunbar.

OLAF I TRYGGVESSÖN (969–1000), king of Norway, was born in 969, and began his career in exile. It is even said that he was bought as a slave in Estonia. After a boyhood spent in Novgorod under the protection of King Valdemar, Olaf fought for the emperor Otto III under the Wendish king Burislav, whose daughter he had married. On her death he raided the coasts of France and the British Isles, until he was converted to Christianity by a hermit in the Scilly Islands, and his marauding expeditions ceased since he would not harry those of his new faith. He married Gyda, sister of Olaf Kvaran, king of Dublin. and administered her property in England and Ireland for some time before he sailed for Norway, then restive under its ruler Earl Haakon. He was unanimously accepted as king of Norway (995), and began the conversion of the country to Christianity. He made overtures of marriage to Sigrid, queen of Sweden, but she clung to her heathen faith. He made an enemy of her, and involved himself in a quarrel with King Sveyn of Denmark by marrying his sister Thyre, who had fled from her heathen husband Burislav. In an expedition (1000) to wrest her lands from Burislav he was waylaid off the island Svold, near Rügen, by the combined Swedish and Danish fleets. together with the ships of Earl Haakon's sons.

The battle ended in the annihilation of the Norwegians. Olaf fought to the last on his great vessel, the "Long Snake." and finally leapt overboard and was seen no more. After his death he remained the hero of his people, who looked for his return. "But however that may be." says the story, "Olaf Tryggvesson never came back to his kingdom in Norway."

OLAF (II) HARALDSSÖN (995–1030), king of Norway, 1016–29, called during his lifetime "the Fat," and afterward known as St. Olaf. was born in 995, the year in which Claf Tryggvesson came to Norway. After several years' absence in England, fighting the Danes, he returned to Norway in 1015 and declared himself king, obtaining the support of the five petty kings of the Uplands. In 1016 he defeated Earl Sveyn, hitherto the virtual ruler of Norway, at the battle of Nesje, and within a few years had won more poner than had been enjoyed by any of his predecessors. He had annihilated the petty kings of the south. had crushed the aristocracy, enforced the acceptance of Christianity throughout the kingdom, asserted his suzerainty in the Orkney Islands. had humbled the king of Sweden and married his daughter in his despite, and had conducted a successful raid on Denmark. But in 1028 the Norwegian nobles. seething with discontent. rallied round the invading Knut the Great, and Olaf fled to Russia. On his return a year later he fell at the battle of Stiklestad. After his death his cunning and cruelty were forgotten, and his services to his church and country remembered. Miracles were worked at his tomb, and in 1164 he was canonized and was declared the patron saint of Norway.

OLANCHO, a large department in southeastern Honduras that includes nearly 22% of the national area. Pop. (1950) 83,910, of which 70% was rural. Juticalpa, the departmental capital and largest town (pop. 3,205 in 1950), is connected with the national capital: Tegucigalpa, by an all-weather road 130 mi. long. The mountainous western third of the department has most of the population; the rest of the area consists mostly of very rainy forested lowlands with no roads and few people. Agricultural production is largely in the mountain valleys; the department ranks first in production of cattle and swine, and third in output of coffee cotton and beans Other significant products are corn rice, potatoes, gold and handicraft articles. (C F J)

ÖLAND, an island in the Baltic sea. next to Gotland the largest belonging to Sweden, stretching for 85 mi. along the east coast of the southern extremity of that country, from which it is separated by Kalmar sound which is from 5 to 15 mi. broad The greatest breadth of the island is 10 mi., and its area 520 sq mi. The only large town is Borgholm, with 2,314 inhabitants in 1950.

For administrative purposes the island of Öland is included in the Kalmar *län*. From the raid of Ragnar Lodbrok's sons in 775 Öland is frequently mentioned in Scandinavian history, and especially as a battleground in the wars between Denmark and the northern kingdoms. In the middle ages it formed a separate legislative and administrative unit. Borgholm was founded in 1817, but the castle. dating at least from the 13th century, was one of the strongest fortresses. and afterward one of the most stately palaces in the country. The inhabitants show considerable diversity of origin in speech, customs and appearance. The island consists mostly of Silurian limestone. Down the west side runs a limestone ridge, rising usually in terraces, but at times in steep cliffs, to a height of 200 ft.; and along the east side there is a parallel ridge of sand, resting on limestone, never exceeding 90 feet. These ridges are connected toward the north and the south by belts of sand and heath, and the hollow between them is occupied by a desolate and almost barren tract. The southern portion, or Alfvar (forming fully half of the southern part of the island), presents a surface of bare red limestone characteristically weathered. The northern portion is covered uith hazel bushes

Outside the ridges, however, Öland is well wooded, while the narrow strip of alluvial coastland is good agricultural country.

OLAUS MAGNUS: *see* MAGNUS, OLAUS.

OLAV V (ALEXANDER EDWARD CHRISTIAN FREDERIK OF SCHLESWIG-HOLSTEIN-SONDERBORG-GLÜCKSBURG) (1903–), king of Norway (born at Appleton house, near Sandringhani, Norfolk, Eng., July 2, 1903), was two years old when his father. Haakon VII, then a Danish prince, was elected king of Norway His mother was Princess Maud, daughter of King Edward VII of Great Britain.

He studied at an Oslo secondary school, then at the Oslo Military academy (1921–24) and later at Oxford. A sportsman. he took part as a skier in the Holmenkollen competitions and also in several regattas; during the Amsterdam Olympic games (1928) he won a gold medal in his six-metre "Norna"—a feat for which he was praised by the cabinet. On March 21, 1929 he married Princess Martha of Sweden (b. Stockholm, March 28, 1901–d. Oslo, April 4, 1954) and there were three children of this marriage, two daughters and Prince Harald (b. Feb. 21, 1937), the heir to the throne

Prince Olav took his military duties seriously and in 1937 became a general and an admiral. When, in June 1940, the Germans invaded Norway he left for Britain together with King Haakon VII and the government.

He returned to Norway on May 13, 1945, as commander in chief of the Norwegian armed forces. He took the oath of allegiance as the new king on Sept. 21, 1957, two hours after the death of his father.

OLBERS, (HEINRICH) WILHELM (MATTHÄUS) (1758–1840), German astronomer, who paid special attention to comets and the minor planets, was born on Oct. 11, 1758, at Arbergen. a village near Bremen, where his father was minister. He studied medicine at Gottingen, 1777–80, attending at the same time Kaestner's mathematical course. In 1779 he devised a new method of calculating cometary orbits. The treatise containing this important invention uas made public by Baron von Zach under the title *Ueber die leichteste und bequemste Methode, die Bahn eines Cometen zu brrrchnen* (1797). A table of 87 calculated orbits was appended, enlarged by Johann Encke in the second edition (1847) to 178 and by Johann Galle in the third (1864) to 242. In 1781 Olbers settled as a physician in Bremen, where he practised until his retirement on Jan. 1. 1823. The greater part of each night was meanwhile devoted to astronomy. the upper portion of his house having been fitted up for use as an observatory.

The comet of 1815 (period 74 years) bears his name in commemoration of its detection by him. He also took a leading part in the discovery of the minor planets, rediscovering Ceres on Jan. 1. 1802. and discovering Pallas on March 28 following. His hypothesis of their origin by the disruption of a primitive large planet (*Monatliche Correspondenz,* vi, 88) seemed to gain confirmation by the finding of Juno by C. L. Harding, and of Vesta by himself in regions indicated by the hypothesis. Olbers' theoretical investigation of the brightness of the sky to be expected on the hypothesis of an infinite static universe of stars is of great importance to modern cosmology. (*See* J. E. Bode, *Astronomisches Jehrbuch,* p. 110, 1826, and H. Bondi, *Cosmology,* pp. 19–26, 1952.) Olbers was deputed by his fellow citizens to assist at the baptism of the king of Rome on June 9, 1811, and he was a member of the *corps législatif* in Paris (1812–13).

Olbers died at Bremen on March 2, 1840. He was twice married, and one son survived him.

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OLD-AGE PENSIONS: *see* PENSIONS; SOCIAL SECURITY.

OLDBURY, a municipal borough (1935) in the Oldbury and Halesowen parliamentary division of Worcestershire, Eng.. 5 mi. W. of Birmingham. Population (1951) 53,887. Area 5.2 sq.mi.

Lying in the south Staffordshire coalfield, coal, iron, glass and bricks were formerly big industries but later it became a residential town with many manufactures, chiefly steel tubes and chemicals.

OLDCASTLE, SIR JOHN (d. 1417), English Lollard leader, son of Sir Richard Oldcastle of Almeley, Herefordshire, served in the expedition to Scotland in 1400. Next year he was in charge of Builth castle in Brecon, and serving all through the Welsh campaigns won the friendship and esteem of Henry, the prince of Wales.

Oldcastle represented Herefordshire in the parliament of 1404. Four years later he married Joan, the heiress of Cobham, and was thereon summoned to parliament as Lord Cobham in her right. Oldcastle held a high command in the expedition which the young Henry sent to France in 1411.

Oldcastle had adopted Lollard opinions before 1410, when the churches on his wife's estates in Kent were laid under interdict for unlicensed preaching. In the convocation which met in March 1413, shortly before the death of Henry IV, Oldcastle was at once accused of heresy. But his friendship with the new king prevented any decisive action till evidence was found in a book belonging to Oldcastle, which was discovered in a shop in Paternoster row.

Oldcastle declared his readiness to submit to the king "all his fortune in this world," but was firm in his religious beliefs, and Henry at last consented to a prosecution. It was only under a royal writ that Oldcastle at last appeared before the ecclesiastical court on Sept. 23. In a confession of his faith he declared his belief in the sacraments and the necessity of penance and true confession; but to put hope, faith or trust in images was the great sin of idolatry. He would not assent to the orthodox doctrine of the sacrament as stated by the bishops, nor admit the necessity of confession to a priest. He was convicted as a heretic Sept. 25. Henry granted a respite of 40 days in the hope of saving his friend.

Before that time had expired Oldcastle escaped from the Tower by the help of one William Fisher, a parchment maker of Smithfield (Riley, *Memorials of London,* 1868). He now put himself at the head of a widespread Lollard conspiracy. The design is said to have included the seizure of the king and his brothers during a Twelfth-night mumming at Eltham. Henry, forewarned, removed to London, and when the Lollards assembled in force in St. Giles's Fields on Jan. 10 they were easily dispersed. Oldcastle himself escaped into Herefordshire, and for nearly four years avoided capture. He took part in several conspiracies. In Nov. 1417 he was captured by the Lord Charlton of Powis. On Dec. 14 he was formally condemned, on the record of his previous conviction, and was hanged that same day in St. Giles's Fields. and burned "gallows and all." Oldcastle died a martyr. At the same time his execution can be justified on political grounds. His opinions and early friendship with Henry V created a traditional scandal which long continued. In the old play *The Famous Victories* of *Henry V,* written before 1588, Oldcastle figures as the prince's boon companion. When Shakespeare adapted that play in *Henry IV,* Oldcastle still appeared; but when the play was printed in 1598 Falstaff's name was substituted, in deference, as it is said, to the then Lord Cobham. Though the fat knight still remains "my old lad of the Castle," the stage character has nothing to do with the Lollard leader.

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OLD CATHOLICS, the sect which took its origin in a group of Roman Catholic opponents to the Vatican council's definition of the dogma of papal infallibility in 1870. Old Catholics characterized the dogma as *new* and as opposed to the rights and the traditional faith of the *old* church which they claimed to represent. Above all other countries, Germany displayed the most marked and intensive opposition. On Aug. 27, 1870, representatives from the Universities of Munich, Bonn, Breslau, Braunsberg and Prague met at Nuernberg under the presidency of Johann J. I. von Dollinger and issued a formal protest in five resolutions against the Vatican decree. On Aug. 30 the Catholic bishops of Germany, assembled in a national synod at Fulda, issued a pastoral letter promulgating the decrees of the Vatican council. In Oct. 1870 the archbishop of Munich requested the views of his theological faculty on the decrees. Johannes Friedrich refused to submit and Dollinger refused to answer. Finally in his "Declaration to the Archbishop of Munich" on March 28, 1871, Dollinger answered that "neither as a Christian, nor as a theologian, nor as an historian, nor as a citizen, could he accept the dogma of papal infallibility." He was excommunicated on April 17, and Friedrich's excommunication followed on April 19.

Opposition now turned to rebellion. Dollinger had the active and energetic support of fellow priests: Reusch, Langen, Knoodt of Bonn, Reinkens of Breslau and Michelis of Braunsberg. Two central committees were formed to organize the rebellion, one in Cologne for the north, the other in Munich for the south of Germany. Michelis toured Germany and Austria fomenting rebellion, while Johann F. von Schulte, formerly professor of canon and German law at the University of Prague and, after his apostasy, appointed by the Prussian government to a professorship at Bonn, became the legal adviser of Old Catholicism and the apologist of the state in its *Kulturkampf* with the Church of Rome.

So well had Schulte organized the rebellious groups that the first Old Catholic congress met at Munich, Sept. 22–24, 1871; 300 representatives convened from Germany, Austria and Switzerland as well as delegates from the English and Russian Churches. A central commission was set up to prepare the way for intercommunion with other Christian churches and for the organization of an independent Old Catholic sect. Dollinger warned the congress not to "raise up altar against altar" and thus to brand themselves as a new sect, but rather to remain, as they claimed to be, members of the Catholic Church. His was the sole vote cast against the formation of a pastorate and parishes.

At the second congress, which met at Cologne, Sept. 20–22, 1872, a committee was appointed to arrange for the election of a bishop. Dollinger held aloof from Old Catholicism as a sect but accepted the chairmanship of the committee for the intercommunion of Christian churches. Resolutions were passed for the organization of parishes. Schulte obtained Bismarck's consent to the election of a bishop and on June 4, 1873, Joseph H. Reinkens was elected bishop. After the death of the Jansenistic Archbishop Loos of Utrecht, who had been invited to perform the consecration, the function was performed at Rotterdam, Aug. 11, 1873, by Bishop Heykamp of Deventer and a bishopric was established at Bonn. Bishop Reinkens then issued a pastoral in which he claimed to be the only legitimate Catholic bishop in Germany. Prussia, Baden and Hesse recognized this claim; and, through the exertions of Schulte, Prussia and Baden granted the Old Catholics many Roman Catholic churches and gave them title to a legal share of Roman Catholic church property.

Old Catholicism modelled its organization on the Protestant churches: annual synods composed of clergy and laymen were prescribed; mixed synodal commissions were appointed; a bishop was elected to ordain the clergy and to confirm. During the course of annual synods radical changes were made in discipline and dogma which completely separated Old Catholicism from Roman Catholicism. In 1874 confession, fasting and holy days were abolished; in 1875, to facilitate intercommunion with Protestant churches, tradition was abandoned and the authority of the deuterocanonical books was questioned, indulgences were rejected, the validity of Anglican orders was recognized and the *Filioque* dropped from the creed. In 1878, despite the warnings of the Jansenists and the Bavarian representatives, a resolution was carried abolishing clerical celibacy. Finally, in 1880 the Latin was supplanted by the vernacular liturgy.

In the hope that Old Catholicism would nationalize the church in Germany. the leaders of the *Kulturkampf* afforded Old Catholics wholehearted support and assistance. However, after the first 15 years the friendly governments recognized that Old Catholicism was no longer a schism but rather another Protestant sect. The number of Old Catholics had rapidly diminished, and as the bitterness of the *Kulturkampf* declined, less interest was displayed by statesmen toward the movement. In 1880 there were about 50,000 adherents in Germany; in 1910 there were 58 parishes and about 20,000 members; this number remained constant until World War II. Post-World War II figures were not available at mid-20th century.

Upon the definition of papal infallibility, the Liberal government in Austria rejected the concordat of 1855 and forbade the publication of the Vatican decrees. Refusing to recognize the jurisdiction of Bishop Reinkens, the Austrian Old Catholics erected a community in Vienna and appointed Aloysius Anton Nittel as pastor (1881–88). At first refused legal recognition by the government, they received on Nov. 8, 1878, through the energy of Schulte, a legal status under the title of Old Catholic Church. In the beginning a bishop was deemed unnecessary; later Amandus Czech (1888–1922) was elected, but not consecrated, bishop, since the government withheld its consent until an adequate episcopal fund was established.

The first bishop was Adalbert Schindelar (1925–26), who was succeeded by Robert Tüchler as overseer (1926–28) and finally as bishop (1928). Although they numbered but 10,000 in the beginning, assisted in Bohemia and Styria by the Los *von Rom* movement, in 1901 Austrian Old Catholics counted 24 parishes and about 16,000 adherents, about .1% of the total Austrian population. Before World War II there were 12 Old Catholic parishes in Austria with 31,000 members, of whom 23,635 resided in Vienna (later figures were not available). Czechoslovakia had 12 parishes and 20,000 members, with Alois Paschek (1928) as their first bishop.

Though Switzerland had previously bitterly opposed the definition of papal infallibility, in 1870 only three priests formally separated from the Roman Catholic communion; viz., Schwind, Egli and Herzog. Hoping that the Old Catholic movement would establish a national church broad enough to embrace all Christian churches, the governments of the Protestant cantons protected the dissident clergy and invoked harsh measures against Roman Catholic priests. The Old Catholic schism was legally recognized April 9, 1874. A committee was appointed on July 29 to establish an Old Catholic faculty of theology at Berne. On Nov. 23, 1874, under the dean, Friedrich. courses opened and eight students attended. Attempts were made to unite all the Old Catholic communities in Switzerland. but the titles "Old Catholic" and "Liberal Catholic" were rejected in an assembly held at Berne in 1874. On Feb. 28, 1875, however, the Old Catholic communities were organized into a "Christian Catholic National Church." In 1876 Eduard Herzog, the bishop-elect, was consecrated by Bishop Reinkens and Berne became his episcopal residence. By 1878 the Roman Catholics were strong enough to outvote the Old Catholics in the election to local church committees and thus regained possession of their former churches.

Geneva was the centre of severe persecutions of Roman Catholics. Refusing to take the prescribed oath, the Roman Catholic clergy were banished from the city and Père Hyacinthe Loyson was appointed pastor of Geneva. In 1876 the Old Catholics of Switzerland abolished confession and clerical celibacy and permitted the vernacular liturgy. Gradually they abandoned Roman Catholic dogma and discipline in the attempted intercommunion with the Protestant churches of England. Scotland and America. Old Catholicism became indistinguishable from other Swiss Protestant sects. Adolf Küry succeeded Bishop Herzog in 1924.

In Italy, Spain and France the attempts to organize Catholic national churches met with little popular sympathy and no church organization. In North America the Old Catholic movement was initiated by Joseph René Vilatte. a Parisian and Roman Catholic by birth. Vilatte apostatized while studying for the priesthood in Canada, and later became a Presbyterian minister and the pastor of a congregation in northern Wisconsin. Dissatisfied, he sought advice from Père Hyacinthe Loyson and was eventually ordained priest by the Old Catholic bishop Eduard Herzog in 1885. Returning to Wisconsin he spread Old Catholicism among the Belgian communities. Refused episcopal consecration by Bishop Herzog through the animosity of the Anglican bishop Grafton, Vilatte was consecrated by F. X. Julius Alvarez, the schismatic archbishop of Ceylon, Goa and India in 1891.

Vilatte attempted to gain the active support of the Polish schismatic priests Anthony Kozlowski of Chicago and S. Kaminski of Buffalo. Kozlowski was consecrated bishop in Nov. 1897 by Bishop Herzog at Berne and became the leader of the North American Old Roman Catholic Church. Vilatte led the Old Roman Catholic Church. Four Old Catholic bodies were registered in the United States: American Catholic Church (founded in May 1927 by James F. A. Lashley); American Old Catholic Church Incorporated (sprung from the Old Catholic Church of Utrecht in the Netherlands); North American Old Roman Catholic Church (founded June 14, 1912, by its first archbishop, De Landas Berghes, who was consecrated Oct. 4, 1916, and was succeeded by his coadjutor, Carmel Carfora, in 1919); and Old Catholic Church in America.

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OLD CHURCH SLAVONIC, one of the southern group of the Slavonic languages (*q.v.*). In 862. Prince Rostislav of the Great Moravian state moved to counter the influence of the German clergy in his domains and appealed to Constantinople for Christian missionaries who could preach to his people in their own tongue and train a native priesthood. The Greeks responded by sending the brothers Constantine (better known by the name Cyril. which he assumed when he was shorn monk) and Methodius. who were natives of Salonika and knew the Slavonic dialect of that region (*see* CYRIL AND METHODIUS, SAINTS). It was doubtless on the basis of that dialect, for which Cyril created a special alphabet, that the brothers undertook the great task of founding the first Slavonic literary language, translating into it the religious texts needed for their mission. Since the oldest extant manuscripts date from more than a century later, none of their writings have survived in their original form, and it is possible to reconstruct only incompletely the language used by them and their immediate disciples—a language which, moreover, quickly adopted varying norms in the early centres of Slavonic literary culture.

The general term "Church Slavonic" (as in "Croatian Church Slavonic" and "Russian Church Slavonic") is used to cover these various developments, through which the Cyrillo-Methodian linguistic tradition has exerted a powerful influence on the modern literary languages of the Orthodox Slavs. The name "Old Church Slavonic" (or, somewhat misleadingly, "Old Slavonic" or "Old Bulgarian") is reserved for the fairly faithful, but not entirely homogeneous, reflection of that tradition found in a small number of South and West Slavonic texts antedating the 12th century. These include translations from a Roman Sacramentary (*Kiev Fragments*), the four Gospels (*Codex Zographensis, Cod. Marianus*), the Evangeliarium or liturgical Gospel readings (*Cod. Assemanianus, Sava Book*), the Psalter (*Psalterium Sinaiticum*), the Euchologium (*Euch. Sinaiticum*), the Menaea (*Cod. Suprasliensis*) and homiletic literature (*Glagolita Clozianus*). Of these most important manuscripts, two (*Sava, Suprasliensis*) are written in Cyrillic, the others being in the glagolitic alphabet.

The fact that Cyril and Methodius could successfully import their language into West Slavonic territory indicates how closely Slavonic linguistic unity was still maintained in the 9th century. Indeed, in many respects Old Church Slavonic coincides with a reconstruction of Common Slavonic. It has, for example. preserved the nasal vowels in their Common Slavonic distribution: *cf.* CS **rǫka, *pętь*, OCS *rǫka, petь*—Russian *ruká, pjat'*, Polish *ręka, pięć*. The jers (ъ, ь)—which have normally, in the modern Slavonic languages, coalesced with other vowels or disappeared, depending on their position—are regularly maintained in all positions in OCS and kept distinct from the other vowels: *cf.* OCS *sъnъ, dьnь*, Russian *son, den'*, Serbo-Croatian *sȁn, din*, Bulgarian *snn, den*. The vowel *jat'* (*ě*) is likewise distinguished from the other vowels: *cf.* OCS *lěto*, P *lato*, S-C *lȅto, ljȅto, lȉto*. In its morphology, the language is equally conservative. At the same time, OCS shares certain characteristic phonological developments with other South Slavonic dialects, notably (1) its treatment of so-called tort-groups (CS *o* or *e* plus following *r* or *1* between consonants), (2) elimination of CS *d* or *t* before *1* and *(3)* palatalization of velars before reflexes of *woi:*

(1) CS **golva, *bergъ;* OCS *glava, bregn;* B *glavá, brjag: cf. R golová, béreg; P głowa, brzeg* and Czech (resembling South Slavonic) *hlava, břeh.*

(2) OCS *moliti sę,* S-C *mòliti se:* cf. *P. modlić się; Cz modliti se* and Russian (resembling South Slavonic) *molít'sja.*

(3) OCS *cvětъ;* S-C *cvêt; cvȉjet, cvit: cf. P. kwiat; Cz květ* and Russian (resembling South Slavonic) *cvet.*

The reflexes of CS *tj* and *dj* are *St* and *id (cf.* Bulgarian), except in the *Kiev Fragments,* which have (along with a few other West Slavonic traits) *c* and *z.* For this feature, therefore, the usage of Cyril and Methodius cannot be reconstructed with certainty. *See* also BULGARIAN LANGUAGE.

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OLDENBARNEVELDT, JOHAN VAN (1547–1619), Dutch statesman, was born at Amersfoort on Sept. 14, 1547. After studying law at Louvain, Bourges and Heidelberg, and traveling in France and Italy, Oldenbarneveldt settled down to practise in the law courts at The Hague. In religion a moderate Calvinist, he became a zealous adherent of William the Silent. He served as a volunteer for the relief of Haarlem (1573) and again at Leyden (1574). In 1j76 he became pensionary of Rotterdam. He was active in promoting the Union of Utrecht (1579) and the acceptance of the countship of Holland and Zeeland by William (1584). On the assassination of William it was at the proposal of Oldenbarneveldt that the youthful Maurice of Nassau was at once elected stadholder, captain general and admiral of Holland. During the governorship of Leicester he was the leader of the strenuous opposition offered by the states to the centralizing policy of the governor.

In 1j86 he was appointed, in succession to Paul Buys, to the post of land's advocate of Holland. Nominally the servant of the states of Holland he made himself politically the personification of the province which bore more than half the entire charge of the union, and as its mouthpiece in the states-general he practically dominated that assembly.

During the two critical years which followed the withdrawal of Leicester, he prevented the disintegration of the United Provinces, which might otherwise have fallen an easy conquest to the army of Alexander of Parma. Fortunately for the Netherlands the attention of Philip of Spain was at that time riveted upon his contemplated invasion of England, and Oldenbarneveldt had time to gather into his own hands the control of administrative affairs. He was wholeheartedly supported by Maurice of Nassau, who, after 1589, held the stadholderate of five provinces, and was likewise captain general and admiral of the union. The first rift between them came in 1600, when Maurice was forced against his will by the states-general, under the advocate's influence, to undertake an expedition into Flanders, which was saved from disaster only by desperate efforts which ended in victory at Nieuwport. In 1598 Oldenbarneveldt took part in special embassies to Henry IV and Elizabeth, and again in 1605 in a special mission sent to congratulate James I on his accession.

The opening of negotiations by Albert and Isabel in 1606 for. a peace or long truce led to a great division of opinion in the Netherlands. The archdukes having consented to treat with the United Provinces "as free provinces and states over which they had no pretensions," Oldenbarneveldt, who had with him the states of Holland and the majority of burgher regents throughout the country, was for peace, provided that liberty of trading was conceded. Maurice and his cousin William Louis, stadholder of Frisia, with the military and naval leaders and the Calvinist clergy, were opposed to it, on the ground that the Spanish king was merely seeking an interval of repose in which to recuperate his strength for a renewed attack on the independence of the Netherlands. For three years the negotiations went on, but at last after endless parleying, on April 9, 1609, a truce for 12 years was concluded. All that the Dutch asked was directly or indirectly granted, and Maurice gave a reluctant assent to the favourable conditions obtained by Oldenbarneveldt.

Religious Differences and the Sequel.—The now "free and independent state" was rent by internal differences between the Remonstrants (Arminians) and Contra-Remonstrants (Gomarists); the states of Holland under the influence of Oldenbarneveldt supported the former, and refused to sanction the summoning of a purely church synod (1613). They likewise (1614) forbade the preachers in the province of Holland to treat of disputed subjects from their pulpits. obedience was difficult to enforce without military help, riots broke out in certain towns, and when Maurice was appealed to, as captain general, he declined to act. He did more, though in no sense a theologian; he declared himself on the side of the Contra-Remonstrants, and established a preacher of that persuasion in a church at The Hague (1617).

The advocate now took a bold step. He proposed that the states of Holland should, on their own authority, as a sovereign province, raise a local force of 4,000 men *(waardgelders)* to keep the peace. The states-general meanwhile by a bare majority (four provinces to three) agreed to the summoning of a national church synod. The states of Holland, also by a narrow majority, refused their assent to this, and passed (Aug. 4, 1617) a strong resolution (*Scherpe Resolutie*) by which all magistrates, officials and soldiers in the pay of the province were required to take an oath of obedience to the states on pain of dismissal, and were to be held accountable not to the ordinary tribunals, but to the states of Holland. It was a declaration of sovereign independence on the part of Holland, and the states-general took up the challenge and determined on decisive action. A commission was appointed with Maurice at its head to compel the disbanding of the *waardgelders*. On July 31, 1618, the stadholder appeared at Utrecht, which had thrown in its lot with Holland, at the head of a body of troops, and at his command the local levies at once laid down their arms. His progress through the towns of Holland met with no opposition. The states party was crushed without a blow being struck. On Aug. 23, by order of the states-general, the advocate and his chief supporters, Hugo Grotius and Hoogerbeets, were arrested.

Oldenbarneveldt was with his friends kept in the strictest confinement until November, and then brought for examination before a commission appointed by the states-general. He appeared more than 60 times before the commissioners, and was, most unjustly, allowed neither to consult papers nor to put his defense in writing. On Feb. 20, 1619, he was arraigned before a special court of 24 members, only half of whom mere Hollanders, and nearly all of them his personal enemies. It was in no sense a legal court, nor had it any jurisdiction over the prisoner, but the protest of the advocate, who claimed his right to be tried by the sovereign province of Holland, whose servant he was, was disregarded. He was allowed no advocates, nor the use of documents, pen or paper. It was in fact not a trial at all, and the packed bench of judges on Sunday, May 12, pronounced sentence of death. On the following day the old statesman, at the age of 71, was beheaded in the Binnenhof at The Hague.

Not a shred of evidence has ever been produced to throw suspicion upon the patriot statesman's conduct. All his private papers fell into the hands of his foes, but not even the bitterest and ablest of his personal enemies, François van Aersens (*q.v.*), could extract from them anything to show that Oldenbarneveldt at any time hetrayed his country's interests. His high-handed course of action in defense of what he conceived to be the sovereign rights of his own province of Holland to decide upon religious questions within its borders may be challenged on the ground of inexpediency, but not of illegality.

The harshness of the treatment meted out by Maurice to his father's old friend, the faithful counsellor and protector of his own early years, leaves a stain upon the stadholder's memory. That the prince should have felt compelled in the last resort to take up arms for the union against the attempt of the province of Holiand to defy the authority of the generality may be justified by the plea *reipublicae salus suprema lex*. To eject the advocate from power was one thing, to execute him as a traitor quite another. The condemnation of Oldenbarneveldt was carried out with Maurice's consent and he cannot be aquitted of a prominent share in what has been pronounced a judicial murder.

Oldenbarneveldt was married in 1575 to Maria van Utrecht. He left two sons, the lords of Groeneveld and Stoutenburg, and two daughters. A conspiracy against the life of Maurice. in which the sons of Oldenbarneveldt took part, was discovered in 1623. Stoutenburg, who was the chief accomplice, made his escape and entered the service of Spain; Groeneveld was executed.

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OLDENBURG, a former *Larzd* of Germany, now an administrative district in Lower Saxony. Pop. (1959 est.) 758,300. Area 2.100 sq.mi. It consisted until 1937 of three widely separated provinces: (1) Oldenburg, (2) Lubeck and (3) Birkenfeld. It had one vote in the German *reichsrat*.

Oldenburg proper was bounded on the north by the North sea and on the other three sides by Hanover, with the exception of a small strip on the east, where it was conterminous with the territory of the free city of Bremen. It formed part of the northwestern German plain lying between the Weser and the Ems. The climate is temperate and humid; the mean temperature of the coldest month at the town of Oldenburg is 26° F., of the warmest 66°. Storms are numerous and fogs and ague are prevalent in the marshlands. The chief rivers are the Hunte, flowing into the Weser, and the Hase and Leda flowing into the Ems. The Weser itself formed the eastern boundary for 42 mi., and internal navigation is facilitated by a canal connecting the Hunte and the Leda. On the north there are several small coast streams conducted through the dikes by sluices. Large tracts of moorland, however, are useful only as producing peat for fuel, or as affording pasture to the flocks of small coarse-woolled Oldenburg sheep. The rich soil of the marshlands produces good crops of wheat, oats, rye, hemp and rape, but is especially adapted for grazing. The mineral wealth of Oldenburg is very small. Woollen and cotton fabrics, stockings, jute and cigars are made at Varel. Delmenhorst and Lohne; cork cutting is extensively practised in some districts, and there are a few iron foundries. Trade is relatively of more importance, chiefly owing to the proximity of Bremen.

Lübeck.—The former principality of Lubeck had an area of 209 sq.mi. and shared in the general physical characteristics of east Holstein, within which it lies. The population was 47,494. In 1937, by an exchange of territories for the sake of administrative simplification, the Lubeck territories enclaved in Oldenburg were annexed to Oldenburg, and the rest of the Lubeck lands, including the Hanseatic city itself, were annexed to the Prussian province of Schleswig-Holstein, which later became the Land of Schlesxvig-Holstein.

Birkenfeld.—The former principality of Birkenfeld, 312 sq.mi. in extent, lies in the *Land* of Rhineland-Palatinate, about 30 mi. W. of the Rhine at Worms and 150 mi. S. of the duchy of Oldenburg. The population was 5j.649.

General Features. — The bulk of the inhabitants are of Saxon stock, but to the north and west of the *Land* there are numerous descendants of the ancient Frisians.

Low German (*Platt-deutsch*) is universally spoken, except in one limited area, where a Frisian dialect has maintained itself.

Oldenburg is mainly a Protestant district. but Roman Catholicism preponderates in the southwestern provinces, which formerly belonged to the bishopric of Münster, and Oldenburg Roman Catholics are under the sway of the bishops of Münster.

The constitution of 1919 provided for a single representative chamber *(landtag)*, elected by universal suffrage and exercising rights of legislation and taxation. The chamber, which consisted of 48 members. was elected every three years.

History. — The descendants of Elimar (d. 1108), the first historical count of Oldenburg, attained the dignity of princes of the empire when the emperor Frederick I dismembered the Saxon territory in 1180. The free city of Bremen and the bishop of Münster were frequently at war with the counts of Oidenburg.

Count Christian, who in 1448 was chosen king of Denmark as Christian I, became king of Norway in 1450 and in 1457 king of Sweden. In 1460 he inherited the duchy of Schleswig and the county of Holstein, an event of high importance for the future history of Oldenburg. In 1454 he handed over Oldenburg to his brother Gerhard (*c.* 1430–99). Count Anton Gunther (1583–1667). who succeeded in 1603, proved himself the wisest prince who had yet ruled Oldenburg. By his prudent neutrality during the Thirty Years' War he secured for his dominions an immunity from the terrible devastations to which nearly all the other states of Germany were exposed. He also obtained from the emperor the right to levy tolls on vessels passing along the Weser, a lucrative grant which soon formed a material addition to his resources. From 1702 to 1773 the county was ruled by the kings of Denmark, this period being on the whole one of peaceful development. In the latter year Frederick Augustus, bishop of Lübeck, a kinsman of the emperor Paul of Russia, became count, and in 1777 the county was raised to the rank of a duchy. In 1815 the title of grand duke was allowed to the reigning duke, in consideration of his services to the allies. but was not taken up till 1829. In 1871 Oldenburg became a state of the new German empire and in 1918 the grand ducal family was expelled by the German revolution.

For the history of Oldenburg *see* Runde, *Oldenburgische Chronik* (Oldenburg, 1863); E. Pleitner, *Oldenburg im 19 Jahrhundert* (Oldenburg, 1899–1900); and *Oldenburgisches Quellenbuch* (Oldenburg, 1903). *See* also the *Jahrbuch fur die Geschichte des Herzogtums Oldenburg (1892 et seq.).*

OLDENBURG, a city in the *Land* of Lower Saxony in the northwestern part of the German Federal Republic, lies between Bremen and Emden on a crossing of the Hunte river about 12 mi. S.W. of its confluence with the Weser. Pop. (1959) 121.680. Area 103 sq km. (39.7 sq.mi.). One of the oldest settlements in the region. first mention of the town was in 1108 Much of the old quarter was destroyed by fire in 1615, but the Lamberti church (1270) on the central market place survives. Formerly the seat of the grand dukes of Oldenburg, the city has a state theatre, museums, art galleries. botanical gardens, a library, academies of engineering, administration and economy. and numerous schools. Oldenburg is the market centre for the surrounding farming district: auctions of cattle and horses are held. Its industries include one of the largest factories for meat products in Europe, shipbuilding, glass and textiles.

Accessible by ships of up to 1,500 tons from the Weser estuary, Oldenburg is linked by inland waterways with the Ruhr and is a rail and road junction. It is the headquarters of an administrative district. (H.-G. Re.)

OLDFIELD, ANNE (1683–1730), English actress, was successful in tragedy, but preferred to play in genteel comedy, where her charm and great beauty could be set off to greater advantage. She was horn in London. She mas apprenticed to a seamstress. but upon the recommendation of George Farquhar was engaged at Drury Lane in 1692. She remained unnoticed there until, in 1704. she uon surprising acclaim in the insignificant role of Leonora in *Sir Courtly Nice.* Colley Cibber immediately wrote *The Careless Husband* expressly for her, and she was soon acknowledged as the best actress of her time. Pope wrote of her:

Engaging Oldfield, who, with grace and ease,
Could join the arts to ruin and to please.

Mrs. Oldfield died on Oct. 23, 1730, and was buried in Westminster abbey. (M. Rs.)

OLDHAM, JOHN (1653–1683), English satirist, son of a Presbyterian minister, was born at Shipton Moyne, near Tetbury, Gloucestershire, on Aug. 9. 1653. He graduated from St. Edmund hall, Oxford, in 1674, and was for three years an usher in Whitgift's school at Croydon. In 1681 he became tutor to the grandsons of Sir Edward Thurland. near Reigate. *Garnet's Ghost* was published as a broadside in 1679, but the other *Satires on the Jesuits,* although written at the same time, were not printed until 1681. His undoubted services to the Country party brought no reward from its leaders. Eventually he became chaplain to William Pierrepont, earl of Kingston. He died at Holme-Pierrepoint, near Nottingham, on Dec. 9, 1683.

Oldham took Juvenal for his model. and in breadth of treatment and power of invective surpassed his English predecessors. Thomas Garnet, who suffered for supposed implication in the Gunpowder plot, rose from the dead to encourage the Jesuits in the first satire, and in the third Ignatius Loyola is represented as dictating his wishes to his disciples from his deathbed. Oldham's verse is rugged. and his rhymes often defective, but he met with a generous appreciation from Dryden.

The best edition of his works is *The Compositions in Prose and Verse of Mr. John Oldham . . .* (1770), with memoir and explanatory notes by Edward Thompson; *see* also *Poems,* ed. with memoir by R. Bell (1891).

OLDHAM, THOMAS (1816–1878), British geologist, was born in Dublin, Ire., on May 4, 1816. He studied at Dublin and Edinburgh, and in 1839 became chief assistant in the geological department of the ordnance survey, where he helped to prepare the *Report on the Geology of Londonderry* (1843). Appointed professor of geology in Dublin university in 1845, he became director of the geological survey of Ireland in 1846, and two years later F.R.S. The fossil named *Oldhamia* was discovered by him in the Cambrian rocks of Bray head in 1849. In 1850 he was put in charge of the geological survey of India, which led him to publish. in 1864, a report on the coal resources of India. He retired in 1876. and died at Rugby on July 17. 1878.

OLDHAM, a municipal. county and parliamentary borough of Lancashire. Eng.. 7 mi. N.E. of Manchester. Pop. (1961) 115,426. Area 8.3 sq.mi. The ton·11. which lies high near the source of the small Medlock river, is a modern industrial ton·n that takes its name from the Oldham family, who. in the middle ages, held Werneth hall as their manor house. From the Oldhams was descended Hugh Oldham. who died bishop of Exeter in 1519. Linen manufacture was introduced in Oldham in 1630. when it was an agricultural ton·n producing wool. hut n·ith the adoption of Richard Arkwright's inventions and the discovery that the climate was extremely suitable for cotton-spinning, the cotton industry grew with great rapidity. Oldham is non· one of the chief cotton-spinning towns in the world. Its second largest industry is engineering of all kinds, chiefly textile engineering, and it also produces cloth of various kinds.

The parish church of St. Mary was a mediaeval chapel rebuilt in 1476, and again in 1833 in the Early English style. Other public buildings and institutions include the town hall. with tetrastyle portico; the central public library. art gallery and museum. opened in 1895; and the county court. The Hulme grammar school was founded in 1606; Henshaw's Bluecoat school was opened in 1834; the Lyceum. which has schools of art and music. was founded in 1839; the Hathershaw Technical High school and Oldham College of Further Education (which superseded the old Technical college) were opened in 1954.

Alexandra park. n·hich covers 60 ac.. stands on a picturesquely undulating and terraced site. Werneth park contains a study centre and natural history museum. There are thrice-n·eekly markets in the town and two of the biggest fairs in the county are held there in June and September. Oldham. incorporated in 1849, became a county borough in 1888. The parliamentary borough has returned two members since 1832.

OLD MAID, a simple card game popular with younger children. Two or more persons may play. One queen is discarded from a regular jz-card pack. The cards then are divided into approximately equal packets for each player; it does not matter if this rough method of "dealing" results in some inequality in the number of cards each receives. Each player examines his hand. pairing up as many cards as possible and discarding the matched pairs face up on the table. There is no need to conceal one's cards while sorting; in fact, players may help one another pick out their pairs.

After all pairs have been discarded, each player mixes his remaining unpaired cards behind his back. To begin play, one player presents his cards face down to the player at his left, who draws one card and adds it to his own hand. If it matches a card he already has, he discards the new pair, shuffles his remaining cards and presents them in turn, face down, to the player at his left. Play continues in this way, each person in turn drawing a card from the player at his right, until only the odd queen remains. The player left with the queen is "Old Maid" and loses the game. (R. L. Fy.)

OLDMIXON, JOHN (1673–1742), English historian, was a son of John Oldmixon of Oldmixon, near Bridgwater. He wrote a number of miscellaneous works, but his most important book is his *Critical History of England* (1724–26), which contains attacks on Clarendon and a defense of Bishop Gilbert Burnet. Its publication led to a controversy between Zachary Grey and the author, who replied to Grey in his *Clarendon and Whitlock compared* (1727). In his *History of England during the Reigns of the Royal House of Stuart* (1730) he charged Bishop Francis Atterbury and other of Clarendon's editors, unjustly, with tampering with the text of the *History.* He completed a continuous history of England by writing the *History of England during the Reigns of William and Mary, Anne and George I* (1735); and the

History of England during the Reigns of Henry VIII, Edward VI, Mary and Elizabeth (1739). Oldmixon died on July 9, 1742.

OLD POINT COMFORT, a spit of land on the southeastern tip of the peninsula between the James and Tork rivers in Virginia, U.S., commanding the entrance to Hampton Roads and the James river. Its strategic importance was apparent to the earliest colonists, who named it Poynt Comfort because of its sheltered harbour and established the first fortifications there in 1608.

Fort Monroe, last of a series of forts on the point, is a moated and stone-walled fort covering 63 ac., built by the government from 1819 to 1834.

During the American Civil War the Confederacy considered Fort Monroe too strong to attack and it served the Union as a base of operations for McClellan's peninsular campaign (1862) and for a series of expeditions against Confederate ports. Following the war, Jefferson Davis was imprisoned there for two years. Long a coast artillery post, Fort Monroe, after World War II, became headquarters for (successively) the army ground forces, the army field forces and the continental army command.

In 1820 a tavern was opened at Old Point to serve the men constructing the fort. The location proved attractive and by 1828 the tavern had been replaced by a hotel. This was the first of a succession of hotels, some very elaborate, that made Old Point Comfort one of Virginia's best-known resorts. (M. Br.)

OLD TESTAMENT: *see* Bible.

OLDYS, WILLIAM (1696–1761), English antiquary and bibliographer, one of the first to discuss earlier English writers critically. Born July 14, 1696, probably in London, he was the natural son of William Oldys, a distinguished lawyer. He lost money in the South Sea Bubble (*q.v.*) and spent some years (1724–30) in Tiorkshire, often as the guest of his friend the earl of Malton.

In 1727 he began to annotate a copy of Gerard Langbaine's *Early Dramatick Poets* (1691) with notes which had been transcribed from the original (preserved in the British museum, London) by many later commentators. In 1731 he sold his collection of books and manuscripts to Edward Harley, earl of Oxford, who became his patron and in 1738 appointed Oldys his literary secretary. Oldys' best work was a *Life of Raleigh* prefixed to his edition of Raleigh's *History of tire World* (1736). In 1738 the *British Librarian*, which lists and comments on a selection of rare and valuable books, appeared.

After the earl's death in 1741, Oldys was a booksellers' hack for 14 years. With Samuel Johnson he edited the *Harleian Miscellany* (1744–46), a collection of tracts and pamphlets from the earl's library; he contributed 22 articles to *Biographica Britannica* (1747–60).

In 1iil Oldys was sent to the Fleet prison for debt, remaining there until 1753, when his debts were discharged by the duke of Norfolk, who appointed him Norroy king-of-arms in May 1755. He was modest, kindly, "critical as well as erudite" and tireless in his researches, writing his notes on slips of paper collected in small bags suspended about his room, thus accumulating much biographical material useful to later authors. His last published work n-as a *Life of Charles Cotton,* prefixed to an edition of the *Compleat Angler* (1760).

Oldys died in London, April 15, 1761.

See I. D'Israeli, *Curiosities of Literature,* "Second Series," vol. iii (1823); J. Yeowell, *A Literary Antiquary (1862).*

OLEACEAE, the olive family, dicotyledonous shrubs and trees of warm, temperate and tropical regions, especially abundant in Indonesia. *Fraxinus* includes the ash (*q.v.*) and flowering ash (F. *ornus*). *Olea* includes the olive (*q.v.*) and the black ironwood tree (*O. laurifolia*).

The family includes also numerous valuable ornamental trees and shrubs, as privet, jasmine, lilac, golden bells and fringe tree. There are 21 genera and about 500 species, approximately 40 of which occur in North America.

OLEAN, a city of Cattaraugus county in southwestern New York, U.S., on the Allegheny river at the mouth of Olean creek, is located 70 mi. S.S.E. of Buffalo near the Pennsylvania border. Settlement of the area began in 1804, and from Olean point during the early years, lumber, shingles and saw logs mere rafted down the river. It was also an embarkation point for settlers bound for the Ohio valley in flatboats. Olean, however, owes its growth largely to the discovery of oil in the area during the 19th century. Incorporated as a village in 1854, Olean became a city in 1833.

Manufactures include petroleum and lumber products, machinery, diesel and gasoline engines, compressors, ceramic tile, cutlery, plastics, electronic devices and animal feeds. St. Bonaventure university (Roman Catholic, 1859) is 3 mi. W. For comparative population figures *see* table in New York: *Population.* (C. C. Ma.)

OLEANDER, the common name for any shrub of the genus *Nerium.* The best known is *N. oleander*, often called rosebay, a native of the Mediterranean region, characterized by its tall shrubby habit and its thick lance-shaped opposite leaves, which exude a poisonous milky juice when punctured. The flowers are borne in terminal clusters and are of a rose colour, rarely white. The hairy anthers adhere to the thickened stigma The fruit or seed vessel consists of two long pods, which liberate a number of seeds, each of which has a tuft of silky hairs. The genus *Nerium* belongs to the family Apocynaceae (*q v.*). The oleander nas known to the Greeks under three names (viz *rhododendron, nerion* and *rhododaphne*) and is well described by Pliny, who mentions its roselike flowers and poisonous qualities. The oleander has long been cultivated in greenhouses, being, as John Gerard says, "a small shrub of a gallant shewe"; numerous varieties, differing in the colour of their flon ers, which are often double, have been introduced In narm countries it is widely grown outdoors


JOHN H. GERARD

OLEANDER (NERIUM OLEANDER)

OLEASTER (*Elaeagnus angustifolia,* family Elaeagnaceae), a handsome deciduous Eurasian tree, 15 to 20 ft high, commonly cultivated for its edible fruit often under the names of Trebizond date or Russian olive. The brown smooth branches are more or less spiny: the narrow leaves have a hoary look from the presence of a dense covering of star-shaped hairs, the small fragrant yellow floners, nhich are borne in the axils of the leaves, are scaly on the outside.

OLEFIN, in organic chemistry, is the generic name given to an unsaturated hydrocarbon containing one or more pairs of doubly linked carbon atoms. The unsaturation is represented by a double bond, C=C, which indicates the point of unsaturation and of reactivity in the molecule. The olefins are classified in either one or both of the following ways: (1) a cyclic, or an acyclic, olefin is one in which the double bond is located between carbon atoms forming part of a cyclic or of an open-chain grouping, respectively; (2) a mono-, di-, tri- or polyolefin is one in which the number of double bonds per molecule is one, two, three or an unspecified number greater than two, respectively.

The diolefins (or tri- or polyolefins) may be classified according to the relative positions of the double bonds as: (*a*) "cumulated" or "contiguous diolefins," or "allenes," containing the two double bonds adjacent to each other as in allene 1,2-propadiene ($CH_2=C=CH_2$); (*b*) "conjugated diolefins," in which the double bonds are separated by one single linkage as in 1,3-butadiene ($CH_2=CH-CH=CH_2$); (*c*) "isolated diolefins," in which the double bonds are separated by at least two single linkages as in 1,4-pentadiene ($CH_2=CH-CH, -CH=CH,$).

The terms aliphatic, aryl. cyclic, etc., are used to indicate the form of the carbon skeleton. The terminations -ene, -diene, -triene, etc., in the systematic Geneva system of nomenclature, identify the individual hydrocarbons of mono-, di- or triolefinic structure. Sometimes the ending -ylene is given to identify a monoolefin, *e.g.*, ethylene, propylene, etc. The position of the double bonds is indicated by a numerical prefix or suffix.

Olefins containing from two to four carbon atoms per molecule are gaseous at ordinary temperatures and pressures; those containing five or more carbon atoms are usually liquid at ordinary temperatures. They are only slightly soluble in water. The physical constants of some aliphatic olefins are given in the following table. In general, the boiling points are very close to those of the saturated hydrocarbons having the same carbon skeleton: the densities are slightly higher.

Name	Formula	Melting point °C.	Boiling point °C.	Density d_4^{20}
Ethylene	$CH_2=CH_2$			
Propene	$CH_3-CH=CH_2$	−169.4	−103.9	
1-Butene	$CH_3-CH_2-CH=CH_2$	−185.2	−47.6	
1-Pentene	$CH_3-(CH_2)_2-CH=CH_2$	−138.0	−6.3	0.6410
1-Hexene	$CH_3-(CH_2)_3-CH=CH_2$	−141.0	63.7	0.6734
1-Heptene	$CH_3-(CH_2)_4-CH=CH_2$	−120.0	92.8	0.6968
1-Octene	$CH_3-(CH_2)_5-CH=CH_2$	−102.1	121.6	0.7150
1-Nonene	$CH_3-(CH_2)_6-CH=CH_2$	−88.0	145	0.7315

Monoolefins (aliphatic) have the general formula C_nH_{2n}; they are not found in nature. They are formed in large quantities during the cracking of petroleum oils to produce gasoline. The olefins thus obtained are mixed with other types of hydrocarbon, from which they are separated either by physical or by chemical means.

Olefins may be prepared by the dehydration of the corresponding alcohols, removal of hydrogen halides from alkyl halides, pyrolysis of the corresponding acetates or by synthetic methods, such as:

$$CH_2=CH-CH_2Br+RMgBr \longrightarrow CH_2=CH-CH_2-R+MgBr_2$$

The principal reactions of olefins are those of the addition of various elements or groups to the two doubly linked carbon atoms. Hydrogen reacts with olefins, under the influence of catalysts such as platinum black or finely divided nickel, to form the corresponding paraffins.

$$\underset{\text{2,4,4-Trimethylpentene}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH_2} + H_2 \xrightarrow{Ni} \underset{\text{2,2,4-Trimethylpentane ("isooctane")}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{CH}-CH_3}$$

Halogens such as chlorine, bromine and iodine add to the doubly linked carbon atoms to yield dihaloparaffins.

$$\underset{\text{Butene-2}}{CH_3-CH=CH-CH_3} + Cl_2 \longrightarrow \underset{\text{2,3-Dichlorobutane}}{CH_3-CHCl-CHCl-CH_3}$$

Hydrogen halides on reaction form monohaloparaffins (alkyl halides).

$$\underset{\text{2-Methyl-2-butene}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}=CH-CHI} + HBr \longrightarrow \underset{\text{2-Methyl-2-bromobutane}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}Br-CH_2-CH_3}$$

Hypochlorous or hypobromous acids combine with olefins to produce the corresponding halohydrins.

$$\underset{\text{Ethylene}}{CH_2=CH_2} + HOCl \longrightarrow \underset{\text{Ethylene chlorohydrin}}{CH_2Cl-CH_2OH}$$

Water reacts with olefins in the presence of catalysts such as sulfuric acid to form alcohols.

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2O \xrightarrow[H_2SO_4]{\text{dilute}} \underset{\text{Isopropyl alcohol}}{CH_3-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_3}$$

Oxidation of olefins with dilute potassium permanganate results in the addition of two hydroxyl groups at the point of unsaturation to form glycols. Under the influence of stronger oxidizing agents or more drastic conditions, the double bond is ruptured and oxygen-containing compounds, such as acids or ketones, are obtained.

$$\underset{\text{2-Methyl-2-butene}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}=CH-CH_3} \xrightarrow[\text{agent}]{\text{oxidizing}} \underset{\text{Acetone}}{CH_3COCH_3} + \underset{\text{Acetic acid}}{CH_3COOH}$$

Ozone reacts with olefins in solution to form an ozonide, which. when isolated in pure form, is explosive; by treatment of the ozonide with water, the originally unsaturated carbon-carbon linkage is ruptured with the formation of aldehydes and ketones.

$$\underset{\text{2-Methyl-2-butene}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}=CH-CH_3} + O_3 \longrightarrow \underset{\text{Ozonide}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle O}{|}}{C}}-O-\underset{\underset{\displaystyle O}{|}}{CH}-CH_3}$$

$$\xrightarrow{H_2O} \underset{\text{Acetone}}{CH_3-CO-CH_3} + \underset{\text{Acetaldehyde}}{CH_3-CHO} + H_2O_2$$

This reaction is employed, in particular, for the determination of the structures of olefins.

In the presence of certain catalysts, two or more molecules of olefin combine to form polymers.

$$\underset{\text{Isobutylene}}{CH_3-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH_2} + \underset{\text{Isobutylene}}{CH_3-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH_2} \xrightarrow{H_3PO_4} \underset{\text{2,4,4-Trimethylpentene "diisobutylene"}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH_2}$$

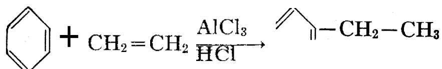
Olefins react in the presence of catalysts with organic compounds such as isoparaffins, aromatic hydrocarbons and phenols to form additional products of great industrial importance, which are used in the manufacture of aviation gasoline, synthetic rubber, detergents and plastics.

Olefins react with carbon monoxide and hydrogen under pressure in the presence of a cobalt catalyst to form aldehydes and alcohols (oxo process).

Ethylene (ethene), $CH_2=CH_2$, is the first member of the olefin series. It is one of the dominant raw materials in organic chemical industry. A large proportion is converted into industrial ethyl alcohol and derivatives thereof.

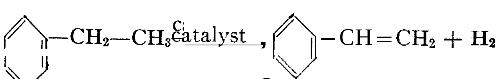
The following are some of the commercial products obtained from ethylene: ethylene glycol (CH_2OH-CH_2OH) is produced via ethylene oxide ($\underset{\diagdown\, O\, \diagup}{CH_2-CH_2}$) by selective oxidation of ethylene. Polyethylene is a plastic material of great commercial use. It can be made either at elevated pressures (1,000 atm.) and temperatures in the presence of minor amounts of peroxides, or at low pressures and low temperatures in the presence of a catalyst composed of titanium tetrachloride and metal alkyls or at medium pressures and temperatures using chromium on silica-alumina base.

Ethylbenzene is a product of interaction of ethylene and benzene;



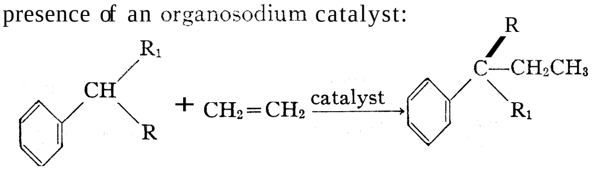
Benzene Ethylene Ethylbenzene

on dehydrogenation, it forms styrene,



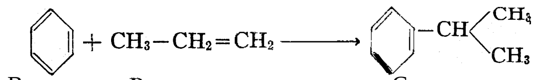
Styrene

one of the important starting materials for both synthetic rubber and various plastics. Ethylene reacts with alkylbenzenes in the presence of an organosodium catalyst:



Ethylene is also used as a general anesthetic and as an agent to hasten the ripening of bananas, citrus fruits, bulbs and potatoes.

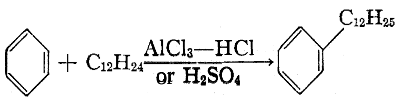
Propene (prop! lene), $CH_3-CH=CH_2$, is used for the synthesis of isopropyl alcohol ($CH_3-CHOH-CH_3$), which on dehydrogenation forms acetone ($CH_3-CO-CH_3$), one of the more important solvents. Propene is made to react with benzene to form cumene,



Benzene Propene Cumene (Isopropylbenzene)

an important intermediate in the commercial manufacture of phenol and acetone.

Propylene is polymerized commercially under pressure in the presence of silicophosphoric acid to form nonenes (C_9H_{18}) and dodecenes ($C_{12}H_{24}$). The nonenes are added to gasoline. The dodecenes are caused to react with benzene in the presence of a catalyst to form dodecylbenzenes:



The dodecylbenzenes are the most common intermediates for the manufacture of household detergents.

Butenes (butylenes) are uied for the synthesis of butyl alcohols (C_4H_9OH). Butylenes react with isobutane in the presence of sulfuric acid or hydrogen fluoride to form octanes; the latter are important constituents in high octane gasolines.

$$i\text{—}C_4H_{10} + C_4H_8 \xrightarrow[\text{or } H_2SO_4]{HF} C_8H_{18}$$

n-Butylenes are dehydrogenated to form butadiene.

$$\underset{\text{1-Butene}}{CH_3\text{—}CH_2\text{—}CH=CH_2} \xrightarrow{\text{catalyst}} \underset{\text{1,3-Butadiene}}{CH_2=CH\text{—}CH=CH_2} + H_2$$

Isobutylene polymerizes at $-78°$ C. in the presence of Friedel-Crafts type catalysts (BF_3, $SnCl_4$ etc.) to a high molecular weight hydrocarbon which is used for the manufacture of butyl rubber from which inner tubes for tires are made.

Olefins containing eight or more carbon atoms are useful for the synthesis of detergents and wetting agents. The sources of the normal chain olefins are animal and vegetable waxes and oils. These are converted into alcohols, from which the corresponding olefins are obtained.

Diolefins (C_nH_{2n-2}) (dienes, alkadienes) containing conjugated double bonds are the most useful members of this series; they undergo reactions similar to those of the monoolefins.

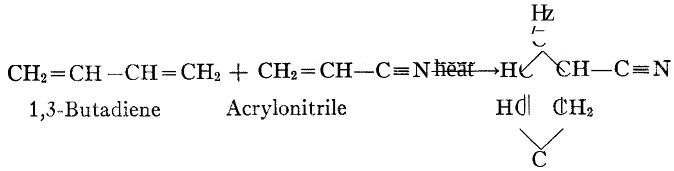
When the addition reaction to conjugated diolefins is carried out stepwise, the addenda are often attached to the first and fourth carbon atoms of the conjugated system rather than to adjacent carbon atoms; such a reaction as this is called 1,4-addition.

$$\underset{\text{1,3-Butadiene}}{CH_2=CH\text{—}CH=CH_2} + Br_2 \longrightarrow \underset{\text{1,4-Dibromo-2-butene}}{BrCH_2\text{—}CH=CH\text{—}CH_2Br}$$

The conjugated dienes react with compounds containing the

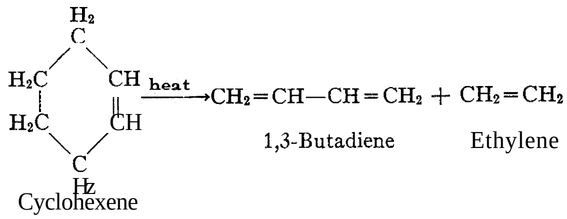
$$\gt C=C \lt \quad \text{(particularly } \gt C=C-\overset{|}{C}=O,\ \gt C=C-C\equiv N\text{, etc.)}$$

group with the formation of cyclic compounds (Diels-Alder reaction), such as:



1,3-Butadiene Acrylonitrile 3-Cyclohexenyl-cyanide

1,3-Butadiene ($CH_2=CH-CH=CH_2$) melts at $-108.7°$ C., boils at $-4.5°$ C.; it can be obtained in the laboratory by cracking of cyclohexene,



Cyclohexene 1,3-Butadiene Ethylene

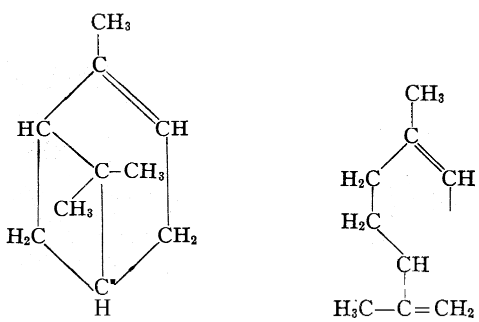
by dehydration of 1,3-butylene glycol,

$$\underset{\text{1,3-Butylene glycol}}{HOCH_2\text{—}CH_2\text{—}CHOH\text{—}CH_3} \xrightarrow{Al_2O_3} \underset{\text{1,3-Butadiene}}{CH_2=CH\text{—}CH=CH_2} + 2H_2O$$

Butadiene is prepared commercially by dehydrogenation of normal butylenes. During World War II a substantial amount of butadiene was also produced by catalytic treatment of ethyl alcohol. Rutadiene in conjunction with styrene is the main component in the manufacture of synthetic rubber.

Isoprene (2-Methyl-1,3-butadiene) ($CH_2=\underset{CH_3}{\underset{|}{C}}-CH=CH_2$) melts at $-146.8°$ C., boils at $34.1°$ C., d_4^{20} *0.6805*. It is *a* building unit for naturally occurring products such as rubber and terpenes; these products, on pyrolysis, yield isoprene. Isoprene changes into rubberlike compounds when heated under pressure, or when treated with sodium or peroxides.

Cyclic Olefins.—Of the cyclic olefins, those belonging to the class of terpenes $C_{10}H_{16}$ are the most abundant in nature. They are divided into (a) bicyclic monoolefins (bicyclic terpenes) of which pinene, the main constituent of turpentine oil, is the most important representative. Pinene is used for the synthesis of camphor, resins and insecticides; (b) monocyclic diolefins (monocyclic terpenes) of which limonene



Pinene Limonene

is one of the most widely distributed terpenes in nature. It is present in the oil obtained from the skin of the fruits of the citrus species. It is used as a solvent and as a raw material for the synthesis of perfumes. (H. Ps.)

OLEG (d. c. A.D. 912), a famous leader of the Vikings (or Varangians) who can be considered the founder of the Russian state A kinsman of the Novgorodian prince Rurik, he left Sovgorod after the latter's death and went down the Dnieper river nith his Varangian retinue. seizing Smolensk and Kiev.

Having made Kiev his capital, Oleg expanded his authority both west and east of the great Volkhov-Dnieper waterway, uniting the local Slavic and Finnish tribes under his rule, and became the undisputed ruler of the great Kievan-Xovgorodian state. He defeated the Khazars and delivered several Slavic tribes from dependence on them. Turning his attention southward, he undertook a well prepared expedition against Constantinople (*c.* 905) and forced the Byzantine government to sue for peace and to pay a large indemnity. In 907 his plenipotentiaries in Constantinople concluded a trade agreement with the imperial government; and in 911 a new treaty was concluded regulating commercial relations between the two states and providing for the legal protection of foreign merchants.

As a result of Oleg's military and diplomatic successes, trade with Byzantium became a permanent factor in Kievan Russia's economic life.

See *The Russian Primary Chronicle,* Eng. trans. by S. H. Cross and O. P. Sherbowitz-Wetzor (1953); G. Vernadsky, *The Origins of Russia* (1959). (S. G. Pu.)

OLEIC ACID, is the most widely distributed of all the fatty acids (see CARBOXYLIC ACIDS) and apparently occurs to some extent in all oils and fats. In oils such as olive. palm, peanut and sunflower-seed it is the principal acid obtained by saponification. Oleic acid, $CH_3(CH_2)_7CH=CH(CH_2)_7CO_2H$, like other fatty acids, does not occur in the free state but is normally found as an ester of glycerol; *i.e.,* as a glyceride or as an ester of a long-chain alcohol.

Oleic acid I	Elaidic acid II
$CH_3(CH_2)_7CH$ ‖ $HO_2C(CH_2)_7CH$	$CH_3(CH_2)_7CH$ ‖ $HC(CH_2)_7CO_2H$

Oleic acid is a solid with a low melting point; two crystalline forms (α-form, melting point 13.4° C. and β-form, melting point. 16.3° C.) are known. It is a long-chain carboxylic acid; its molecule contains one double bond between C_9 and C_{10} with the cis-configuration. The structure of oleic acid (I) may be deduced from the following reactions. Treatment with selenium or oxides of nitrogen partially transforms it into the trans-isomer, elaidic acid (II). The arrangement of its 18 carbon atoms and the position of the double bond is demonstrated by its catalytic hydrogenation to stearic acid, $CH_3(CH_2)_{16}CO_2H$; its oxidative cleavage to nonanoic (pelargonic) acid, $CH_3(CH_2)_7CO_2H$, and azelaic acid, $HO_2C(CH_2)_7CO_2H$. When oleic acid is heated with alkali, migration of the double bond occurs giving the α:β-unsaturated acid. $CH_3(CH_2)_{14}CH=CHCO_2H$, and this on further heating with alkali gives palmitic acid, $CH_3(CH_2)_{14}CO_2H$.

Oleic acid shows the standard reactions of a carboxylic acid and a disubstituted ethylene, including the formation of a dibromide with bromine and a glycol with dilute aqueous potassium permanganate.

See K. S. Markley, *Fatty Acids, Their Chemistry and Physical Properties* (1947); A. E. Bailey, *Industrial Oil and Fat Products* (1945). (W. D. Os.)

OLEN, a legendary poet and prophet, reputed author of certain hymns to Apollo, sung at Delos in historical times. Boio, a Delphic poetess, portrayed him as a Hyperborean (see HYPERBOREANS), founder of the oracular shrine at Delphi, first prophet there and inventor of the hexameter. Herodotus made him a Lycian (as follower of Apollo Lukeios). Whether any real person lies behind these stories is unknown.

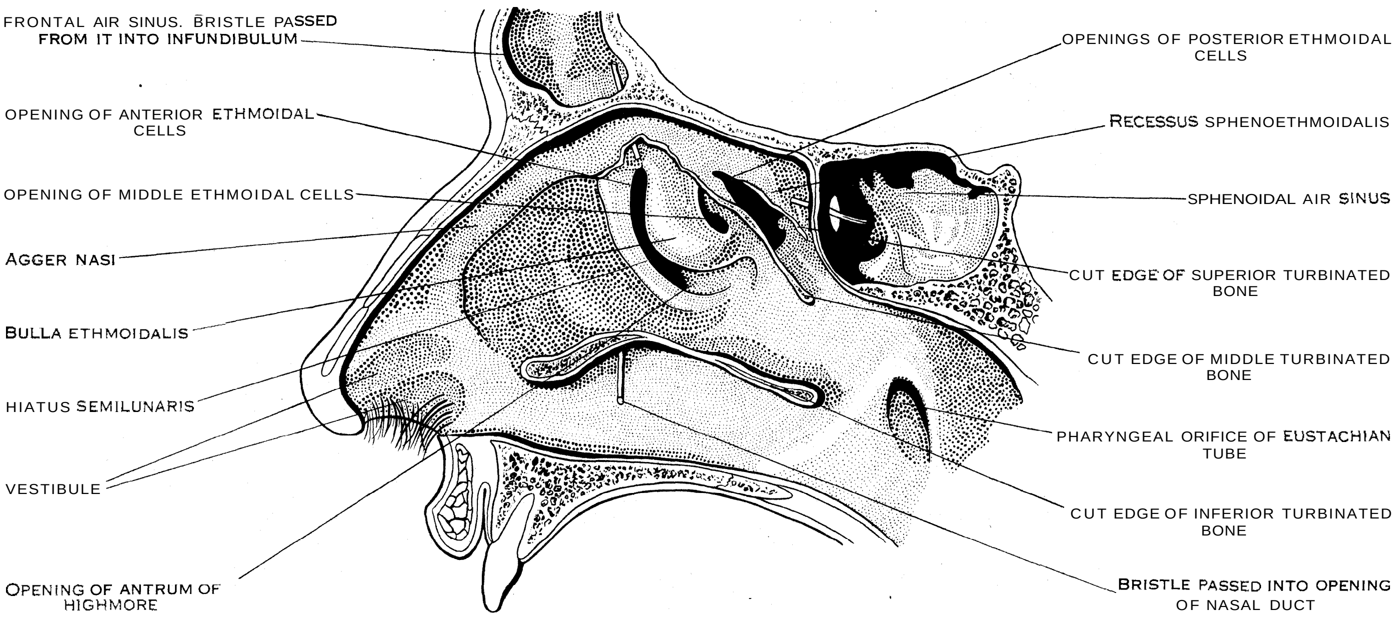
OLEOMARGARINE: see MARGARINE.

OLÉRON, an island lying off the west coast of France, opposite the mouths of the Charente and Seudre, and included in the *département* of Charente-Maritime. Pop. (1954) 13,901. Oléron, the Uliarus Insula of Pliny, formed part of the duchy of Aquitaine and came into the possession of the French crown in 1370. It is about 18 mi. in length from northwest to southeast, and 7 mi. in extreme breadth; area 68 sq.mi.; the strait (Pertuis de Maumusson) separating it from the mainland is at one point less than a mile wide.

The chief places are St. Pierre (pop. 1,336 in 1954), Le Château d'Oléron (1,240) and the watering place of St. Trojan-les-Bains (956).

OLFACTORY SYSTEM, the structures that serve the sense of smell. The system consists of the nose and the nasal cavities, which in their upper parts support the olfactory mucous membrane for the perception of smell. and in their lower parts act as respiratory passages. This article deals with the anatomy of the olfactory system and its nervous pathways; for physiology, see SMELL AND TASTE.

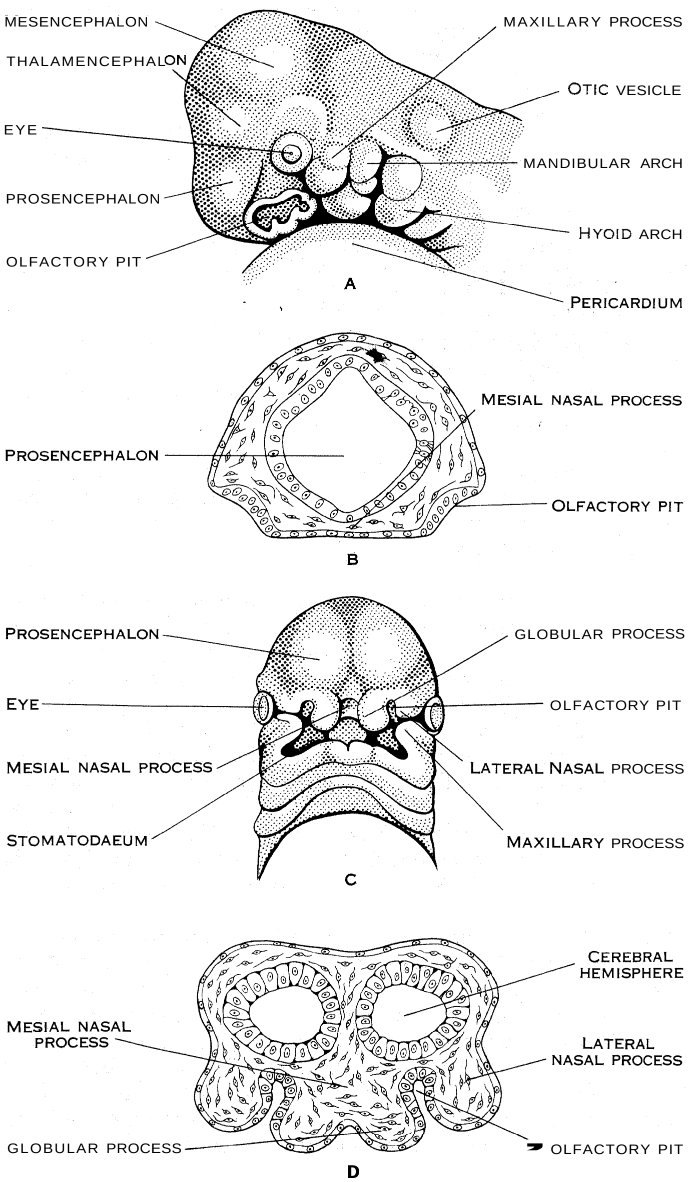
The bony framework of the nose is part of the skull (*q.v.*), but the outer nose is supported only by bone above; lower down its shape is kept by cartilaginous plates. The expanded lower part of the side of the nose, the ala. is formed only of skin, both externally and internally, with fibrofatty tissue between the layers. The nasal cavities are separated by a septum covered in its lower two-thirds by thick, highly vascular mucous membrane composed of columnar ciliated epithelium with masses of acinous glands embedded in it, while in its upper part it is covered by the less vascular but more specialized olfactory membrane. Near the front of the lower part of the septum a slight opening into a short blind tube, which runs upward and backward, may sometimes be found; this is the vestigial remnant of Jacobson's organ. The supporting framework of the septum is made up of ethmoid



FROM R. HOWDEN IN "CUNNINGHAM'S TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 1.—VIEW OF THE OUTER WALL OF THE NOSE. THE TURBINATED BONES HAVING BEEN REMOVED

above. vomer below and the septal cartilage in front. The outer wall of each nasal cavity is divided into three meatuses by the overhanging turbinated bones. Above the superior turbinated bone is a space between it and the roof known as the recessus sphenoethmoidalis. into the back of which the sphenoidal air sinus opens. Between the superior and middle turbinated bones is the superior meatus. containing the openings of the posterior ethmoidal air cells, while between the middle and inferior turbinated bones is the middle meatus, which is the largest of the three and contains a rounded elevation, the bulla ethmoidalis. Above and behind this is often an opening for the middle ethmoidal cells; below and in front runs a deep sickle-shaped gutter, the hiatus semilunaris, which communicates above with the frontal air sinus and below with the opening into the antrum of Highmore or maxillary antrum. The inferior meatus is below the inferior turbinated bone, and, when that is lifted, the valvular opening of the nasal duct (see EYE, HUMAN) is seen. The roof of the



FROM A. H. YOUNG AND H. ROBINSON, IN "CUNNINGHAM'S TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 2.— VIEWS OF THE DEVELOPMENT OF HUMAN EMBRYONIC HEADS

A. Side view of the head of human embryo about 27 days old, showing olfactory pit and visceral arches and clefts. B. Transverse section through head of an embryo, showing relation of olfactory pits to forebrain and to roof of stomatodaeal space. C. Head of human embryo about 29 days old, showing division of lower part of mesial frontal process into two globular processes. D. Transverse section of embryo head, showing deepening of olfactory pits and their relation to hemisphere vesicles of forebrain

nose is narrow, and here the olfactory nerves pass in through the cribriform plate. The floor is wider so that a coronal section through each nasal cavity has roughly the appearance of a right-angled triangle.

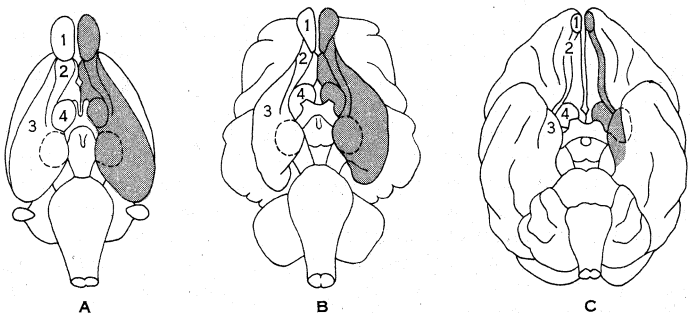
Embryology.— In the third week of intra-uterine life two nasal pits appear on the under side of the front of the head; they are the first appearance of the true olfactory region of the nose, and some of their epithelial lining cells send off axons (see NERVOUS SYSTEM) which arborize with the dendrites of the cells of the olfactory lobe of the brain and so form the olfactory nerves. Between the olfactory pits the broad median fronto-nasal process grows down from the forehead region to form the dorsum of the nose (see fig. 2) and the anterior part of the nasal septum, while outside them the lateral nasal processes grow down and later on meet the maxillary processes from the first visceral arch. In this way the nasal cavities are formed, but are separated from the mouth by a thin bucconasal membrane which eventually is broken through; after this the mouth and nose are one cavity until the formation of the palate in the third month. In the third month Jacobson's organ may be seen as a well-marked tube lined with respiratory mucous membrane; no explanation of the function of Jacobson's organ in man is known, and it is probably entirely atavistic. At birth the nasal cavities are shallow from above downward. but rapidly deepen till the age of puberty.

Comparative Anatomy.— In the lancelet there is a ciliated pit above the anterior end of the central nervous system, which is probably a rudiment of an unpaired olfactory organ. In the Cyclostomata (lampreys and hags) the pit is at first ventral, but later becomes dorsal and shares a common opening with the pituitary invagination. It furthermore becomes divided internally into two lateral halves. In fishes there are also two lateral pits, the nostrils of which open sometimes. as in the sharks and rays, onto the ventral surface of the snout, and sometimes, as in the higher fishes, onto the dorsal surface. Up to this stage the olfactory organs are mere pits, but in the Dipnoi (mudfish) an opening is established from them into the front of the roof of the mouth, and so they serve as respiratory passages and organs for the sense of smell. In the higher Amphibia the nasal organ becomes included in the skull and respiratory and olfactory parts are distinguished. In this class. too, turbinal ingrowths are found, and the nasolachrymal duct appears.

In the lizards. among the Reptilia, the olfactory and respiratory parts are very distinct, the latter being lined only by stratified epithelium unconnected with the olfactory nerves. There is one true turbinal bone growing from the outer wall, and close to this is a large nasal gland. In crocodiles the hard palate is formed. and there is henceforward a considerable distance between the openings of the external and internal nares. In crocodiles. also. air sinuses are first found extending from the olfactory cavities into the skull bones.

The birds' arrangement is very like that of the reptiles; olfactory and respiratory chambers are present, and into the latter projects the true turbinal, though there is a pseudoturbinal in the upper or olfactory chamber. In mammals the olfactory chamber of the nose is variously developed: most of them are macrosmatic, and have a large area of olfactory mucous membrane; some. like the seals. whalebone whales, monkeys and man, are microsmatic. while the toothed whales have the olfactory region practically suppressed in the adult. and are said to be anosmatic. There are generally five turbinal bones in macrosmatic mammals, so that man has a reduced number. The lowest of the series. the maxilloturbinal, is the equivalent of the single true turbinal bone of birds and reptiles, and in most mammals is a double scroll, one leaf turning upward and the other down.

Jacobson's organ first appears in amphibians, where it is found as an anteroposterior gutter in the floor of the nasal cavity. In reptiles the roof of the gutter closes in on each side. and a tube is formed lying below and internal to the nasal cavity. opening anteriorly into the mouth and ending by a blind extremity, posteriorly to which branches of the olfactory and trigeminal nerves are distributed. In the higher reptiles (crocodiles and chelonians) the organ is suppressed in the adult, and the same applies



BY COURTESY OF MEDICAL AUDIO VISUAL DEPT., WALTER REED ARMY INSTITUTE OF RESEARCH

FIG. 3 — BASAL ASPECT OF THE BRAIN OF THE (A) RAT, (B) CAT AND (C) MONKEY

Olfactory structures on the right side of each drawing are indicated by shading; on the left they are numbered as follows: (1) olfactory bulb; (2) olfactory tract; (3) cortex of the piriform lobe; (4) olfactory tubercle. The broken circle indicates the position of the amygdaloid complex, which is covered by the cortex of the piriform lobe. (The three brains have not been drawn on the same scale)

to birds; but in the lower mammals, especially the monotremes, it is very well developed, and is enclosed in a cartilaginous sheath, from which a turbinal process projects into its interior. In other mammals, with the exception of the Primates and perhaps the Chiroptera, the organ is quite distinct, though even in man, as has been shown, its presence can be demonstrated in the embryo. (F. G. P.; P. S.)

Nervous Pathways of Smell. — The pathway of olfactory conduction begins with the olfactory receptors — small, slender nerve cells embedded in large numbers (about 100,000,000 in the rabbit) in the epithelium of the mucous membrane lining the upper part of the nasal cavity. Each olfactory receptor cell emits two processes (projections). One of these is a short peripheral dendrite, which reaches to the surface of the epithelium where it ends in a knob carrying a number of fine, radially placed filaments, the olfactory hairs. The other process is a long and extremely thin axon, the olfactory nerve fibre, which reaches the cranial cavity by passing through one of the openings in the bony roof of the nasal cavity and enters the olfactory bulb of the forebrain (fig. 3). Sensations of smell are experienced when certain chemical substances become dissolved in the thin layer of fluid covering the surface of the mucous membrane, and thus come in contact with the olfactory hairs. It is likely that the receptor cells differ among themselves in their sensitivities to various odorous substances.

In the olfactory bulb. the olfactory nerve fibres end in contact with the antenna-shaped dendrites of the large mitral cells, which represent the second main link in the chain of olfactory conduction. Each mitral cell emits a long axon, many of which enter into the formation of the olfactory tract, a white fibre band extending back from the bulb over the basal surface of the forebrain (fig. 3). The olfactory tract distributes its fibres mainly to the cortex of the piriform lobe, which constitutes the final cortical receiving area of the olfactory pathway. In man, this region corresponds to the uncus of the hippocampal gyrus. A smaller number of fibres of the olfactory tract end in two further olfactory structures; viz.. the olfactory tubercle and the medial part of the amygdaloid complex (the latter lies deep to the olfactory cortex; fig. 3).

In mammals with a highly developed sense of smell (macrosmatic mammals), such as the rodents and carnivores, the olfactory brain structures are relatively large and occupy all or a large part of the basal surface of the forebrain (fig. 3A and B). A marked reduction of all olfactory structures is evident in the microsmatic primates (monkeys: apes and man; fig. 3C), which for, their orientation rely more heavily upon the senses of vision and touch. *See* also BRAIN; NERVE; SMELL AND TASTE. (W. J. H. N.)

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OLGA, wife of Igor, prince of Kiev, and afterward (from 945) regent for Sviatoslav her son, was baptized at Constantinople about 955 and died about 969. She was canonized in the Russian church-; her feast is on July 11.

OLIER, JEAN JACQUES (1608–1657), founder of the Sulpicians and spiritual writer, one of the chief architects of the religious renewal of 17th-century France, was born at Paris on Sept. 20, 1608. Destined by his mother for an ecclesiastical career and at 18 already prior of two monasteries and abbot of a third, he gave himself to a life of pleasure when his theological training at the Sorbonne was over. Converted by a chance remark, in 1631 he proceeded to Rome for further studies. He returned to Paris the following year after having been cured at Loreto of a serious eye ailment and devoted himself wholly to the care and instruction of the poor of the city and to preaching throughout the rural districts. Ordained priest in 1633, he came under the influence of St. Vincent de Paul and Charles de Condren and in 1641 established a seminary for the training of future priests at Vaugirard. The year following he was made pastor of the sprawling, disorganized parish of St. Sulpice in Paris. Thither he transported his seminary and made it and the parish models that would be imitated widely. His writings, in the tradition of Pierre de Bérulle (*q.v.*), are chiefly concerned with the spiritual implications of the Christian priesthood. He died April 2. 1657.

Olier's *Oeuvres complètes* were edited by J. P. Migne (1856).

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OLIGARCHY is the traditional term used to denote the rule of the few when that rule is looked upon with disfavour. Aristotle used it to designate the rule of the few when it was exercised not by the best. but by bad men unjustly. In this sense, it overlaps with the later concept of plutocracy.

It is a recurrent idea that all forms of government are in the final analysis reducible to the rule of a few. Oligarchs will secure effective control whether the formal authority is vested in the people, a monarch, the proletariat or a dictator. Thus, Karl Marx and Friedrich Engels insisted that throughout capitalism, the key capitalists had controlled the government; they coined the famous phrase. "the state is the executive committee of the exploiting class." The Italian political scientist Gaetano Mosca likewise insisted that a "ruling class" always constituted the effective oligarchical control. Vilfredo Pareto elaborated the idea in his doctrine of the "elite." The modern tendency to analyze social patterns in terms of an "elite." although greatly reinforced by Pareto's theory, goes further back than Marx and Engels. who employed the term "elite" to describe the class-conscious communists. the leading group within the proletariat.

To say that all governments are in essence oligarchical may be an exaggeration. Yet a tendency persists in all organizations to evolve a limited group at the centre who, as insiders, "run the show." Political science and sociology are beginning to differentiate more carefully between various types of control and power. The type of power held by a democratic party boss, while overwhelming in relation to any single member of the party, is very different from that wielded by the boss of the single party in a totalitarian and authoritarian pattern. Likewise, the control group within an organization does not occupy the same position under democratic conditions (which provide for the group's being effectively challenged by outsiders at any time) as it does under an authoritarian plan. If effective control changes hands as rapidly as it does in a city of the U.S. or a British trade union, it is doubtful that those exercising it should be spoken of as a "class" or an "elite." The expression "the few" is too abstract to tell us much. Like the other purely numerical concepts of government inherited from Greek philosophy, oligarchy is an outmoded term, because it fails to direct attention to what we really wish to know about a government. (C. J. FR.)

OLIGOCENE, in geology, is the third epoch of the Tertiary period. The name is derived from the Greek *oligos,* "few," and *kainos,* "recent," in reference to the relatively small percentage (about 10%) of living shellfish found as fossils. The Oligocene is the time interval between the older Eocene and the younger Miocene or in the time-rock sense (Oligocene series) it includes the rocks formed during this interval. In those classifications in which it includes the European stages Tongrian, Rupelian and Chattian, it is generally estimated to have a time duration of about 10,000,000 years. The interval was originally included by Sir Charles Lyell in his Older Miocene. The term Oligocene was proposed by H. E. Beyrich in 1854 and again in 1858, being based on rocks in north Germany and their contained fauna. The Oligocene is thus the youngest division of the older, and the middle division of the revised Tertiary (*q.v.*) as indicated on the accompanying geologic time chart.

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	1,000 Years
CENOZOIC ERA			
Quaternary	Recent	Modern man	11
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	70,000
MESOZOIC ERA			
Cretaceous		Extinction of dinosaurs	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	160,000
Triassic		Appearance of dinosaurs	200,000
PALEOZOIC ERA			
Permian		Reptiles developed, conifers abundant	235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
Ordovician		First primitive fishes	400,000
Cambrian		Marine invertebrates	500,000
PRE-CAMBRIAN TIME			
		Few fossils	3,500,000–4,000,000

LIFE OF THE EPOCH

The life of the epoch resembled that of the Eocene more than that of the succeeding Miocene.

Marine. — Foraminifera were abundant; nummulites were still numerous at first but of smaller size, becoming extinct by the close of the epoch. Corals, bryozoans and echinoids were abundant in clear waters of the middle and lower latitudes but were less widely distributed than previously. Shelled cephalopods were few but gastropods and pelecypods assumed more of their present importance.

Terrestrial. — On land the highly varied fauna was composed of a mixture of surviving archaic types and the beginnings of modern families. It is possible to recognize carnivores (Canidae and Felidae), insectivores. rodents, ruminants and camels. Forerunners of the modern rhinoceros, elephant and horse are recognizable. Giant herbivores such as the brontotheres (or titanotheres) were a spectacular element.

See also PALAEONTOLOGY.

For the flora *see* PALAEOBOTANY.

CONDITIONS DURING THE OLIGOCENE

Oligocene deposits are of fresh-water, brackish. marine and terrestrial origins; they include sands, sandstones, grits, marls, shales. limestones, conglomerates, lignites and volcanic materials. The thickness varies from a few hundred feet. as in parts of France, to well over 10,000 ft. as in Oregon-Washington, northern South America and Burma. The deposits were mostly laid down in shallow water or on land, but in places, as in parts of Oregon-Washington. Colombia and Peru, the fossils indicate a deepwater marine environment of several hundreds to perhaps several thousands of feet in depth. Here and there. as in north Germany and the Lake Aral region in western Asia, the sea gained ground that had been unoccupied during the preceding Eocene, but in most areas the seas were less extensive than in the Eocene and the succeeding Miocene epoch. During the late Eocene and early Oligocene important diastrophic changes were in progress. In Europe the Pyrenees and parts of the Alps were uplifted at this time. In the early Oligocene the Bering sea land bridge was elevated, allowing a notable terrestrial faunal migration between the old and new worlds. Near the end of the epoch the ancient Tethys sea started to fragment and marine connections between the Mediterranean and the Indo-Pacific region were broken. In places, as in the Rocky mountains and parts of France, lacustrine or lake and terrestrial deposits were formed. There was extensive vulcanism in the high plains and Rocky mountain areas of the United States and in the northern Andes of South America.

OLIGOCENE STRATIGRAPHY

Neither the lower nor the upper limit of the Oligocene is well defined (*see* TERTIARY), but there is more general agreement on the placement of the boundary with the preceding Eocene than with the succeeding Miocene.

European Stages and Formations. — The epoch is more often considered to include (from oldest to youngest) the European stages identified as Tongrian (Lattorfian, Sannoisian), Rupelian (Stampian) and Chattian (Casselian), but there is little general agreement as to whether or not the Aquitanian stage is younger than, or in part equivalent to the Chattian. Thus the Aquitanian may or may not be included in the Oligocene.

The Tongrian stage (from Tongres. Belg) is represented by marine and fresh-water clays and sands in Belgium, marine sandy glauconitic beds in northern Germany at Latdorf between Magdeburg and Leipzig and the famous series of supragypsiferous marls (Sannoisian) of the Paris basin. At the base of the Sannoisian are blue marls, deposited in salt lagoons, then white marls with fresh-water horizons and finally nidely distributed green marine marls. Contemporaneous marine sands and clays in northern Germany were called Lattorfian. In Britain. classic exposures of Lower Oligocene sediments occur on the Isle of Wight and have been described from base upward as Middle Headon beds (brackish and marine). Upper Headon beds (fresh-water clays. marls and limestones) and Osborne and Bembridge beds (brackish and fresh-water sands, clays and limestones).

The precise correlation of different members of the Tongrian stage in western Europe is still uncertain. Many geologists have considered the molluscan and echinoid faunas of these beds as closely allied to those of the uppermost Eocene of the Paris basin.

The Rupelian stage (from Rupel, a tributary of the Scheldt in Belgium) is the most widely distributed and easily recognized unit of the Oligocene in western Europe. It is represented in Belgium by a thick series of clays. the *argiles de Boom,* and in the Paris basin by the *sables de Fontainebleau* and the underlying Brie limestone (sometimes termed the Stampian). Marine sandstones of equivalent age, called the Septarienton. occur in the Mainz basin and in northern Germany. where they were deposited in a transgressing sea. The Hampstead beds in the Isle of Wight, which consist of marine to brackish clays and marls. were deposited during early Rupelian time

The Chattian stage (from Chattes. an ancient tribe which lived near Cassel, Ger.) is represented in the Mainz basin and northern Germany by glauconitic marine sands and overlying brackish and fresh-water marls and limestones. Equivalent beds are unknown in Britain and Belgium. After the deposition of the Fontainebleau sands the sea left the Paris basin, and its area was occupied by a huge lake within which accumulated the Étampes limestone of which the *meulière de Montmorency* is a lateral equivalent. Above these beds lie the fresh-water Beauce limestones, which in part belong to the Aquitanian stage. Continental Oligocene beds are found in several basins of the central European continent.

Marine and continental Oligocene deposits occur in the Alpine geosyncline of southern and eastern Europe and the Aral-Caspian region. Deposits of the Tethyan seaway, characterized by tropical faunas with nummulites and *Lepidocyclina,* extend from the western Mediterranean to India and even the East Indian region.

Western Hemisphere Correlations and Formations. — Exact correlation of marine Oligocene deposits of the new world with those of western Europe is difficult because of provincial faunas Marine sediments occur in the Gulf and Atlantic coastal plains of the United States. in eastern Mexico, Central America, the West Indies. the northern third of Venezuela and Colombia and in western Ecuador and northwestern Peru. Thick deposits occur in the Coast ranges of California. Oregon, Washington and in southern Alaska and northeastern Asia.

In the eastern United States lower Oligocene sediments occur only in Mississippi and Alabama and are represented by the thin deltaic Forest Hill sand and the Red Bluff clay. Superposed are light-coloured shaly marls and clays of the Vicksburg group. They were deposited during the Middle Oligocene in a widely transgressing sea which extended at times from South Carolina to the coastal plain of Mexico. A slight subsidence of the sea floor during Late Oligocene time was followed by deposition of nearly 100 ft. of the Flint river and Suwanee limestones from South Carolina to northern Florida and by the Chickasawhay marls and shales from Alabama to the Mississippi river. No sediments of Upper Chattian age are exposed unless the sandstones of the lower part of the Catahoula formation extend down into the Oligocene. This formation is thought to have been deposited during the Aquitanian, which is variously included in either the Oligocene or the Miocene (see *European Stages and Formations,* above). Marine limestones and shales of Oligocene age are widely distributed in the West Indies. Costa Rica and Panama.

Marine Oligocene sediments of diverse character occur in northern Venezuela and Colombia. They are mainly blue, brown and gray shales. interbedded sandy shales and sandstones and thick massive sandstones which were deposited in a slowly subsiding trough. These deposits range from 5,000 to 10,000 ft. thick and have been named the Mugrosa, Colorado and Poso series in Colombia and the El Fausto. Icotea. Churuguara, San Luis, Agua Clara. Agua Salada and Carapita formations in Venezuela. The Agua Clara formation is the best known and consists of more than 2,500 ft. of lagoonal gypsiferous shales with marine intercalations. Near the end of the Oligocene the seaway briefly extended south along the eastern front of the Andes in Venezuela. Colombia and Ecuador. These marine deposits are intercalated in the midst of thick continental and lacustrine detrital sediments.

Several thousand feet of marine sandstones and shales occur in the coastal part of northwest Peru and extend through western Ecuador to Colombia. They accumulated in a trough which seemingly connected the Caribbean sea with the Pacific ocean.

During the Oligocene an area more than 100 mi. wide in western Korth America, extending from Vancouver Island to middle Oregon and in California from San Francisco bay to the Transverse ranges was largely occupied by marine embayments.

In Oregon and Washington over 10,000 ft. of marine shale, sandstone, and conglomerate have been classified from top downward as the Blakeley. Lincoln and Keasey formations. Faunal zones *(see* FOSSIL) based on mollusks and foraminifera have been recognized within these deposits but it is uncertain how much of the Keasey formation extends down into the Eocene and how much of the Cpper Blakeley formation ranges into the Miocene. In central California the Oligocene is represented by marine sandstones, sandy shales and deposits of volcanic tuff. In the San Joaquin valley there are deposits of massive and stratified light-gray shale and sand called the Tumey sand and Tumey shale. Other basins in southern California received thick accumulations of terrestrial and lacustrine conglomerate, sandstone and shale which were named the Sespe formation. Locally this formation ranges in age from Upper Eocene to Lower Miocene.

Land-laid deposits of Oligocene age occur throughout much of the Rocky mountains and adjacent areas of the United States. In the eastern Rocky mountains they are represented by the Wind River series, in Montana by the Pipestone Springs and Cook Ranch formations and in Oregon by the lower John Day formation.

Sandstones and shales containing marine fossils similar to those of the Blakeley formation occur in southern Alaska. Sakhalin Island. Kamchatka and in the northern island of Japan (Poronai formation).

New Zealand. — In New Zealand the marine deposits referred to the Oligocene are known as the Kaiatean. Whaingaroan (the two may be combined into the Ototaran), Duntroonian and Waitakian stages. The sediments of this age include mudstones, sandstones, limestones and marls. and attain a thickness of over 3.000 ft.

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QLIGOCHAETA, a class of the Annelida (*q.v.*), comprising the earthworms (*q.v.*), the enchytraeids and several families of small mud-living or aquatic. rarely marine or parasitic, species.

OLIGOCLASE: *see* FELDSPAR.

OLINDA, a city of the northeastern state of Pernambuco, Braz., located on a low hill on the Atlantic coast, about 7 mi. N. of the port city of Recife. Pop. (1950) 38,169. Olinda is noted principally for its ornate churches and monasteries, which date from the 16th and 17th centuries, and other buildings of historical interest. It was founded as the colonial capital in 13'37 by Duarte Coelho Pereira. By 1600 an economy based upon sugar and Negro slave labour had made it a feudal and ecclesiastical stronghold. In 1630 the Dutch captured Olinda and occupied and retained control of Pernambuco until 1654. By that time the city had entered an era of decadence and its place of leadership had passed to Recife which became the capital. The Olinda seminary, founded in 1800 by Bishop José Azeredo Coutinho. won recognition for the liberal thinkers it graduated before independence was achieved. (J. J. J.)

OLIPHANT, LAURENCE (1829–1888), British author, was born at Cape Town. South Africa. His father was then attorney general in Cape Colony. but was soon transferred as chief justice to Ceylon. The boy's education was of the most desultory kind. In 1851 he accompanied Jung Bahadur from Colombo to Nepal and found material for his first book. *A Journey to Khatmandu* (1852). From Nepal he returned to Ceylon, then to England and then to Russia, after which he wrote *The Russian Shores of the Black Sea in the Autumn of 1852, and a Tour through the Country of the Don Cossacks* (1853). Between 1853 and 1861 he was successively secretary to Lord Elgin during the negotiation of the Canada Reciprocity treaty at Washington, D.C., the companion of the duke of Newcastle on a visit to the Circassian coast during the Crimean War, and Lord Elgin's private secretary on his expedition to China. Each of these experiences produced a pleasant book of travel. In 1861 he was appointed first secretary in Japan and might have made a successful diplomatic career if it had not been interrupted, almost at the outset, by a night attack on the legation, in which he nearly lost his life. It. seems probable that he never properiy recovered from this affair. He returned to England and resigned the service and was elected to parliament in 1865 for the Stirling burghs.

Oliphant did not show any conspicuous parliamentary ability, but made a great success by his vivacious and witty novel *Piccadilly: a Fragment of Contemporary Biography* (1870). He fell, however, under the influence of the spiritualist prophet Thomas Lake Harris, who about 1861 had organized a small community, the Brotherhood of the New Life, which at this time was settled at Brocton on Lake Erie where Oliphant spent many years living as a farm labourer. As late as Dec. 1878 he continued to believe that Harris was an incarnation of the Deity.

In 1879 he visited Palestine and in 1881 he crossed again to the United States. On this visit he finally broke with Harris. He and his wife (the former Alice Le Strange) settled at Haifa in Palestine.

There they wrote together the strange book called *Sympneumata: Evolutionary Forces Now Active in Man* (1884), and in the next year Oliphant produced there his novel *Masollam,* which may be taken to contain its author's latest views with regard to the personage whom he long considered as "a new Avatar." One of his cleverest works, *Altiora peto,* had been published in 1883.

In 1886 his wife died of fever. He was persuaded that after death he was in much closer relation with her than when she was still alive and conceived that it was under her influence that he wrote his *Scientific Religion.* In Nov. 1887 he went to England to publish that book. By the Whitsuntide of 1888 he had completed it and started for the U.S. Oliphant married, as his second wife, a granddaughter of Robert Owen. They were starting for Haifa when he died, at Twickenham, on Dec. 23; 1888.

See Margaret Oliphant, *Memoir of the Life of Laurence Oliphant and of Alice Oliphant His Wife* (1892). (M. G. D.; X.)

OLIPHANT, MARGARET OLIPHANT (1828–1897), British novelist and historical writer, daughter of Francis Wilson, was born at Wallyford, near Musselburgh, Midlothian, in 1828. Her childhood was spent at Lasswade (near Dalkeith), Glasgow and Liverpool. She had long been a regular contributor to *Blackwood's* and had written some novels when she married in 1852 her cousin Frank Wilson Oliphant. They settled at Harrington square in London. Her husband was an artist, principally in stained glass. She died at Wimbledon on June 25, 1897. Her *Autobiography* gives a touching picture of her domestic life. Mrs. Oliphant was one of the most popular writers of her time. She wrote more than 120 books. Among the best known are the novels *Adam Graeme* (1852), *Miss Marjoribanks* (1866) and the short stories collected in the *Chronicles of Earlingford.*

OLIPHANT or **OLIFANT,** the large signal horn of the middle ages, made, as its name indicates, from the tusk of an elephant. The oliphant was the instrument of knights and men of high degree.

OLIVARES, GASPAR DE GUZMAN, COUNT OF OLIVARES and DUKE OF SAN LÚCAR (1587–1645), Spanish royal favourite and minister, born in Rome, Jan. 6, 1587. Combining his inherited title of count with that of duke granted him by Philip IV, he became commonly known as *el conde-duque.* Philip III had appointed him to the household of the heir apparent, over whom he obtained such influence that from the beginning of the new reign all papers requiring the royal signature were sent first to the count-duke.

For 22 years, from 1621, Olivares directed the policy of Spain. It was a period of disaster abroad and of rebellion at home, for which the minister was inevitably held responsible, until he became the accepted model of a grasping and incapable favourite. History has modified the harshness of this judgment. A man of great energy and resolve, ambitious less for wealth than for power, he was also a Maecenas of letters and the arts and was much painted by Velazquez.

Most of the errors of Olivares' foreign policy—the renewal of war with the Netherlands in 1621, intervention in the Thirty Years' War. lesser wars in Sicily—were supported by king, church and the country at large. Where his initiative was most personal, and most disastrous, was in his internal policy of consolidating peninsular unity by force, in defiance of regional interests. The resulting revolts which took place in Catalonia and Portugal in 1640 were the immediate cause of his fall, though only in Jan. 1643, and reluctantly, did Philip part with him, under pressure of a strong court intrigue headed by the queen.

Olivares retired to Toro in the province of Zamora, where he composed, or inspired, an able apology which was confiscated by the Inquisition. He died there on July 22, 1645, driven mad by fear that Philip would accede to the persisting demands, chiefly of the Aragonese, for his head.

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OLIVE is a subtropical, broad-leaved evergreen tree (*Olea europaea* L.), grown for the production of its fruit which is utilized for table olives and for the extraction of olive oil. It is a member of the family Oleaceae. which also includes the privet. lilac, ash, forsythia and jasmine. The genus *Olea* contains about 30 other species. none bearing edible fruit. which are native to such parts of the world as South Africa, New Zealand, India and Afghanistan.

The origin of the edible olive. *Olea europaea,* is lost in ancient history. probably first collected wild in the eastern Mediterranean or south central Asia region but undoubtedly it is one of the world's oldest cultivated crops. It was an olive leaf that Noah's dove took back to the Ark.

There is evidence that the olive was grown on the island of Crete about 3500 B.C. and the Semitic peoples apparently cultivated it as early as 3000 B.C. Olive oil was a highly prized luxury for anointing the body in Greece during the time of Homer, about 900 B.C., and it was an important crop of the Romans around 600 B.C. In subsequent times olive growing spread to all the other countries bordering the Mediterranean sea.

In the 20th-century Spain became, by far, the leader in commercial olive production, accounting for about 38% of the world's olive production, followed by Italy with about 20% and Greece with about 13%. Other important olive-producing countries are Portugal. Turkey. Tunisia. France, Morocco. Algeria, Syria, Yugoslavia. Jordan. United States. Cyprus. Israel and Argentina.

Commercial olive production did not begin in the United States —where it is limited to California—until the latter part of the 19th century. The olive mas earlier brought into California, however. from Mexico in 1769 by the Franciscan fathers. In South America and Australia. development of a commercial olive industry is even more recent. starting in the early part of the 20th century.

Olives are grown mainly for the production of olive oil. This is well-illustrated in Spain where about 1.800,000 tons of olives are crushed annually for oil extraction while table olive production amounts to only about 60.000 tons.

The olive tree is relatively slow-growing but very long-lived, some specimens reportedly being over 1,000 years old. It attains a height of 10 to 40 ft. or more. The wood is resistant to decay and if the top dies a new trunk will often grow from the roots. The tree will tolerate drought periods of j or 6 months through the summer, provided winter rainfalls of at least 8 to 10 in. occur. Olive trees will not survive temperatures below about 10° F. (−12.2° C.), being injured at 15° F. (−9.4° C.). To form flowers and fruit the olive seems to require an exposure of several months to inter-chilling conditions. The tree itself will grow satisfactorily in tropical regions of the world but fails to bear fruit due, probably. to a lack of winter chilling. Commercial olive production is generally found to occur in two belts around the world, one between 30° and 45° N. lat., the other between 30° and 45° S. lat. In these areas the necessary climatic requirements for vegetative growth and fruitfulness can be found.

There are hundreds of named varieties of the olive; some such as Picual. Zorzalina, Corregiolo. Leccino and Chemlali are grown primarily for oil extraction. Other varieties. such as Mission, Manzanillo. Sevillano, Ascolano, Karydolia and Amygdalolia, are used principally as table olives.

Propagation.—In propagation, olive varieties do not come true from seed. Seedlings generally produce inferior fruit and must be budded or grafted to one of the named varieties. Olives also can be propagated by cuttings, either by hardwood cuttings set in the nursery row in the spring or by small leafy, softwood cuttings rooted in a glass-covered propagating frame. Either type responds markedly to treatments with root-promoting "hormones."

The nursery trees are planted 2j to 3j ft. apart in irrigated orchards or 40 to 7j ft. apart in unirrigated groves. They start bearing in 4 to 8 years, but full production is not reached until 15 or 20 years, or when dry-farmed, until the trees are 40 to 50 years of age.

In the Mediterranean countries most olive groves are unirrigated. Although remarkably drought resistant. the olive will use just as much water as other trees if it is available. A general misconception is that olives require planting on poor. rocky hillside land and should be unirrigated. Although it will endure such adverse conditions. which would kill most other tree fruits. the olive responds markedly to irrigation, good soil and nitrogen fertilizers.

In California, where many groves are planted on some of the best orchard soils and carefully irrigated through the dry summers, yields of j to 10 times those in the unirrigated orchards of the Mediterranean countries are obtained. In Spain, however, the general belief is that irrigated olives do not pickle as well as those dry-farmed and often the trees are not irrigated even when water is available.

The trees bloom in late spring. Small, inconspicuous flowers are borne on inflorescences which arise in the axils of the leaves and contain 10 to 20 flowers each. Flowers are of two types: (1) perfect, containing both male and female parts. which are capable of developing into the olive fruits; and (2) male, or staminate, which contain only the male, pollen-producing parts. The olive is nind-pollinated, the presence of bees or other insects being unnecessary.

The olive fruit is classed as a drupe, similar to the peach or plum. It consists of the skin (the exocarp), the flesh (the mesocarp). and the pit or stone (the endocarp) Within this is found the seed. usually one, but sometimes two.

Fruit setting in the olive is often erratic; in some areas, especially where irrigation and fertilization are not practised, alternate bearing is the rule. The trees will set a heavy crop one year and not even bloom the next.

FRUITING BRANCH OF THE OLIVE (OLEA EUROPAEA)

Diseases and Pests.—The olive is not subject to many insect or disease pests. The most important. by far, is the olive fly (*Dacus oleae*). which occurs only in the Mediterranean countries, not being found in the olive-producing regions of the western hemisphere nor in Australia. So serious is this pest that in Spain alone it reduces the olive crop by half in some years. There are three to five generations during the groning season, the first starting in late spring. The fly breeds in the flesh of the fruit. forming cavities, making the fruit unfit for consumption and reducing the yield and quality of the oil Trees groun under irrigation seem to be more susceptible to attack than those dry-farmed No completely satisfactory control measures have been developed. Other less troublesome insect pests are black scale (*Saissetia oleae*), olive scale (*Parlatoria oleae*) and the olive kernel borer (*Prays oleae*).

Two diseases attack olives: one is a bacterial disease. called olive knot in California. which is caused by the organism *Bacterium savastanoi*. It causes gall-like growths to develop on the branches .and twigs. There is no satisfactory control for this pest other than pruning out diseased areas as soon as they appear. The second important disease is sometimes termed peacock spot, due to the variegated spots appearing on the leaves in late winter and early spring. This is caused by the fungus (*Cycloconium oleaginum*) which infects leaves during the rainy months of the year, causing them to turn yellow and drop in late spring. Sprays of lime sulfur or Bordeaux mixture applied just before the rainy season starts will generally give control

Harvesting.— Harvesting of the fruit for pickling is done in the autumn, after the fruit has changed from a deep green to a straw or cherry red colour but before it turns black. Harvesting usually continues for about two months. or until the fruit becomes damaged by frost Temperatures of 27° or 28° F. for several hours are likely to injure the tissues so the fruit cannot be used for pickling; such frozen fruits can be alloned to remain on the tree, however, to be harvested later for oil extraction. The table olive harvest is done by hand-picking; ladders are used to climb into the trees.

Processing.— Fresh. unprocessed olives are inedible as they are extremely bitter. This bitter principle is a glucoside which must be neutralized. usually by treatments with a dilute sodium hydroxide solution.

In the Mediterranean countries much of the table olive crop is processed by the green. Spanish style method, in which the fruits are picked when they are a light green to straw colour. They are immediately placed in a dilute sodium hydroxide solution, with the treatment continuing until the lye has penetrated about three-fourths of the distance to the pit. The lye solution is then removed and replaced with several changes of water to wash the lye from the fruit. During treatment and washing, undue exposure to air is avoided, as this results in an undesirable darkening of the fruit.

The fruit is then placed in large wooden barrels and kept there for from one to six months or longer to undergo lactic acid fermentation. During this treatment. the fruits are kept in a 6% to 8% salt solution, and sugar is added after several weeks to maintain the fermentation process. Following this, the olives are packed in barrels or glass containers.

Most of the table olive crop in California is processed as black ripe canned olives. This method is used little or not at all in other olive-producing countries. The olives are picked when straw colour to cherry red. They are usually stored in a 5% to 9% salt solution for several months immediately after picking. where they undergo a lactic acid fermentation. After that, they are treated five or six times with dilute sodium hydroxide. Between treatments they are exposed to air for 24 to 48 hours. which permits oxidation of orthodihydroxy compounds in the fruit, resulting in the black colour of the finished product. The sodium hydroxide is removed by soaking for several days in water which is changed three or four times daily. Following this the fruits are treated with dilute brine for two to five days and are then canned in dilute brine. after which they are sterilized for 60 min. at 240° F.

For oil extraction the fruits are allowed to remain on the tree until midwinter when they become black and reach their maximum oil content. which is 20% to 30% of the fresh weight of the fruit. In harvesting oil olives a common practice. although undesirable, is to beat the trees with long poles. knocking the olives onto sheets spread on the ground under the tree. In many orchards, however, the fruit is hand-picked even for oil extraction.

At the oil mills the fruit is washed by sprays of water to remove soil and leaves before crushing. or it is subjected to a suction fan to remove leaves. The fruit is then coarsely crushed in various types of grinders, after which it is collected in press cloths. These are heavy. folded cloths which hold the fruit in a layer about three inches deep. The cloths are placed in layers between woven metal or heavy wooden racks. Pressure is applied. usually by a hydraulic press, at about joo to 1.000 lb. per square inch. This pressing extracts most of the juice from the fruit and a small proportion of the oil. This oil, called virgin oil. is considered to be of higher quality than that resulting from subsequent pressings and is sometimes kept separate.

In some factories the pomace from the first pressing is again ground, much finer than the first grinding, and pressed once more at about 4.000 lb. per square inch which extracts most of the oil. Sometimes the olive oil is separated from the juice in large settling tanks. In most places the juice and oil are separated continuously by a centrifugal clarifier.

The oil is washed with warm water hy various methods of spraying the oil or water into the other. This removes the bitterness from the oil. Fresh olive oil is not pleasing to the taste. and it is aged in large tanks for a short time. It then may be passed through filter paper, producing a brilliantly clear oil ready for bottling. Most plants filter the oil through diatomaceous earth either in a gravity filter or under pressure. (*See* also OLIVE OIL.)

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OLIVEIRA MARTINS, JOAQUIM PEDRO DE (1845–1894). Portuguese writer, biographer and one of the first Portuguese exponents of socialism. He was born in Lisbon on April 30, 1845. Lack of money made him interrupt his studies and go into a commercial firm. In 1870 he was appointed manager of the

St. Eufémia mine in Spain. He returned to Portugal in 1874 and became administrator of the railway from Oporto to Póvoa. In 1884 he was appointed director of the industrial museum in Oporto. He joined the Progressive party and in 1886 was elected deputy by Viana do Castelo, soon building up a parliamentary reputation. He had a short and ill-starred term of office as minister of finance in 1892 and died at Lisbon on Aug. 23, 1893.

During his early days in Lisbon Martins had been in contact with the most eminent Portuguese intellectuals and, influenced by the literary group of *O Cenáculo* in which Antero do Quental was prominent, he contributed to O *Pensamento,* a socialist paper. His years in Spain and his direct knowledge of the working class broadened his socialist views and gave him the material for two remarkable books—Teoria do Socialismo (1873) and *Portugal* e *o Socialismo* (1873). After his return to Portugal he published a short series of monographs intended to start a campaign of socialist indoctrination. Turning his attention to Portuguese economic history, he wrote a technical study, A *Reorganização* do *Banco* de *Portugal* (1877), to analyze the causes and consequences of the Portuguese financial crisis of 1876. At the same time he sent to the Academy of Sciences in Lisbon a careful analysis of the economic crises of 1846 and 1876—Memdria *sobre* a *circulação fiduciária* (1878). In As *Eleições* (1878) he criticized the existing electoral system and demanded a more democratic representation.

Martins had been interested in history from early youth (he made his literary debut with a historical novel Phebus *Moniz,* 1867) and now, influenced by Proudhon's view that the "theory of socialism is evolution," he embarked on a new venture with *Biblioteca das Ciências Sociais,* in which he attempted to demonstrate the validity of this thesis throughout the great periods of history. His plan begins with a survey of the economic and social structure of primitive societies—As *Raças humanas* e a *civilização primitiva* (1881). *Quadro* das *instituições primitivas* (1883)—and closes with a lively picture of the Roman republic—Histdria da *República Romana* (1885). How-ever, in the course of tracing the development of forms of government, he abandoned Proudhon's rigid concept and adopted the views of the German school of anthropology. He thereby came to believe that as a society grows and develops a spiritual element takes shape under the force of historical circumstances. This element becomes in the end the guiding principle of the social group in the form of the unifying national spirit. Imbued with the idea of Hegelian evolution, Martins interpreted the history of the Hispanic peoples—*História* da *Civilização Ibérica* (1879 j—as the result of a common will sustained by the same ideal, explaining Portuguese independence by mere accidental causes. This theory of the chance incident leaves the door ajar for the role of the "great man," the hero of Thomas Carlyle (*q.v.*). He expounded these views in his biographies *Os filhos* de D. *João I* (1891), *A* Vida de *Nun' Álvares* (1893) and the unfinished O *Príncipe Perfeito* (1896). His psychological insight and human sympathy combined with the clarity of his style made him unsurpassed alike in his biographical portraits and in the grandiose frescoes of a battle or the fall of an empire.

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OLIVE OIL is the oil expressed from the fleshy part of the ripened fruit (pericarp) of the olive tree, which is chiefly cultivated in the countries of the Mediterranean basin. also in California, South America and Australia. The ripe fruit contains from 20% to 30% oil, depending on climatic conditions and care in cultivation. Some varieties contain more oil than others.

The fruit intended for oil production is gathered when fully ripe. Virgin oil. so termed because it is carefully prepared from selected sound fruits in the first pressing, is seldom exported in its natural state but forms the basis of edible export types of the finest qualities. The apparatus used in expressing the oil (crushing) varies from the most primitive Koman presses, consisting of conical stones, hand or mule propelled; to the most modern types of hydraulic presses.

To obtain the best quality edible oil it is essential that the oil be removed from contact with the residual and putrescible pulp as soon as possible; otherwise the consequent formation of free fatty acids may induce rancidity. In practice the residual pulp is subjected to a second pressing with hot water yielding an oil of higher free fatty acid content. called *lampante* after-its primitive use as a fluid for lamps. This oil of second pressing is then subjected to a refining process of decolorization, deacidification and deodorization and is commercially known as refined olive oil. It is largely used to blend with virgin oils for edible export types.

A third type of oil. lowest in quality. is obtained from the residue by a process of extraction with a volatile solvent, usually carbon disulphide. This oil is commercially known as sulfur olive oil or olive oil foots, and is largely used in the production of soap, especially green and mottled laundry soaps.

Edible olive oil should be practically devoid of free fatty acids. The U.S. Pharmacopoeia requires olive oil not to exceed 1.41%; however, most export types do not exceed 17,. It varies in colour from water white (refined) to golden yellow. Certain types, pressed from unripe fruit, will have a greenish tint. Almost every producing country produces oils of varying characteristics and qualities, depending on the districts in which the olive is grown and the degree of the ripeness of the fruit.

Each oil has definite characteristics which generally consist of glycerides made up of saturated or unsaturated fatty acids. The majority of the glycerides are not made up of one fatty acid, but of combinations. The average composition of olive oil is approximately as follows: oleic acid, 70%–85%; linoleic acid, 4%–12%; palmitic acid, 7%–14%; and stearic acid 1%–2%.

Olive oil is sometimes adulterated with other vegetable and seed oils. However, any adulteration that may be used can be detected by chemical tests that are specific for each adulterant.

Pure olive oil is largely used for comestible purposes (cooking, salads, etc.)' and in the preservation of foods (sardine canning, etc.); it is also used in the textile industry (wool combing), in the manufacture of toilet preparations and cosmetics, in the pharmaceutical industry for medicinal purposes and in the manufacture of high-quality Castile soap. (J. M. CN.)

Leading countries in olive oil production in the 1950s were Spain, with an average annual production of about 300,000 metric tons; Italy, about 200.000 tons; Greece. more than 100,000 tons. Other principal producing countries included Portugal, with an average annual production of about 60,000 tons; Turkey, up to 80,000 tons; Tunisia. Algeria, Morocco and Libya in North Africa, together producing from 50,000 to 100,000 tons. World production (excluding the U.S.S.R.), according to the UN Food and Agriculture organization, averaged about 1,000,000 tons annually. ***(See*** also OLIVE.)

OLIVER (OLIVIER), **ISAAC** (d. 1617), English miniature painter, whose work is in the first rank of British miniatures, was born at Rouen, France, of French Huguenot parents who took him to London about 1568. He studied under Nicholas Hilliard, and was in Venice in 1596. Apparently he married Sarah, daughter of Marc Gheeraerts, the portrait painter. in 1602. Besides miniature portraits he painted small religious and classical pictures. His patrons included Queen Elizabeth I, Henry, prince of Wales, Sir Philip Sidney and Anne of Denmark. His earlier miniatures carry on the fine tradition of Hilliard; his later are influenced by the oil painters of that time.

Oliver died. between 50 and 60 years of age, in London, and was buried at St. Anne's, Blackfriars.

His son PETER OLIVER (*c.* 1594–1647) was his pupil and capably carried on his later style. Peter copied Italian pictures in miniature, and his signed and dated portraits range from 1619 to 1646. He is said to have painted landscapes in miniature.

(C. H. C. B.)

OLIVES, MOUNT OF, the ridge, 2,684 ft. above sea level. facing the Temple mount at Jerusalem on the east and separated from it by the Vale of Kidron; Arabic. Jebel et-Tor. Of the four distinct elevations on the ridge the southernmost is the scene of Solomon's idolatrous worship The mount is referred to only four times in the Old Testament. Jesus crossed it on His entry into Jerusalem. The Ascension took place perhaps in one of the secluded ravines of the eastern slope (Luke xxiv, 50). The tradition that the Ascension was from the central eminence of the hill dates from Eusebius Caesarea, and over a sacred cave in that place there was built a succession of sanctuaries. The latest chapel on the site was built by the crusaders and modified by the Moslems, who erected beside the entrance to the *haram* a minaret.

Close by is the grotto of St. Pelagia (d. 457) and a short way down the hill the rock-cut cave called the "Tomb of the Prophets." A tradition of the middle ages identified Olivet with the Mount of Transfiguration. At its foot was the Garden of Gethsemane (*q.v.*).

At the present day there stands on Mt. Scopus. a continuation of the Mt. of Olives, the new Hebrew university opened by Lord Balfour in 192j. The German hospice was opened in 1910. The earthquake of July 11, 1927, was particularly severe in the area of the mount. (E. Ro.)

OLIVETANS, one of the lesser monastic orders following the Benedictine rule, founded by St. Bernard Tolomei. a Sienese nobleman. At the age of 40, when the leading man in Siena, he retired along with two companions to live a hermit's life at Accona, a desert place 1j mi. to the south of Siena, 1313. Soon others joined them, and in 1324 John XXII approved of the formation of an order, the Benedictine rule being taken as the basis of the life.

Partly from the olive trees that abound there, and partly out of devotion to the Passion, Accona was christened Monte Oliveto, whence the order received its name. By the end of the 14th century there were more than 100 monasteries. chiefly in Italy; and in the 18th century there still were 80, one of the most famous being San Miniato at Florence. The Olivetans have a house in Rome and in a few other cities.

OLIVIER, SYDNEY HALDANE OLIVIER, 1ST BARON (1859–1943), British politician, was among those who shaped the early policy of the Labour party. Born April 16, 1859, at Poulshot, Wiltshire, he was educated at Tonbridge school, and at Corpus Christi college, Oxford. He entered the colonial office in 1882, and from 1890 to 1896 was colonial secretary of British Honduras. In 1895 he was appointed auditor general of the Leeward Islands and in 1896 became private secretary to the colonial undersecretary, Lord Selborne.

As colonial secretary of Jamaica, 1899–1904, and as governor, 1907–13, he introduced drastic reforms. On his return to England, he was made secretary to the board of agriculture and fisheries, and in 1917 became assistant comptroller and auditor of the exchequer, retiring in 1920.

As secretary of the Fabian society, 1886–90, Olivier had been influential in planning Labour party policy, and in 1924 he was made secretary of state for India in the first Labour government and raised to the peerage. His publications included *White Capital and Coloured Labour* (1906) and *The Anatomy of African Misery* (1927).

Olivier died at Bognor Regis, Sussex, on Feb. 15, 1943. He had no sons, and his title became extinct.

OLIVINE, an important rock-forming mineral composed mainly of magnesium and ferrous orthosilicate. The name alludes to those common varieties which have an olive-green colour and is often applied incorrectly to other green stones. The transparent varieties used in jewelry are known as precious olivine, chrysolite (not to be confused with chrysotile, a serpentine) and peridot (*see* also GEM). These are obtained chiefly from St. John's Island, Egy., in the Red sea; upper Burma; and Minas Gerais, Braz. The common variety, which is relatively infusible, withstanding temperatures of more than 1,500° C., is used as a refractory brick in special applications.

Olivine is a common constituent of many basic and ultrabasic igneous rocks such as basalt, gabbro, peridotite and dunite, which is an almost pure olivine rock. It also occurs as an accessory constituent of some metamorphosed rocks, particularly the dolomitic marbles and schists. In stony meteorites (*q.v.*) it is a principal constituent, and is occasionally imbedded in iron meteorites. Iron-rich olivine is often found in slag.

The mineral occurs usually as compact or granular masses or as grains and blebs in the rock of which it is a constituent. Faceted crystals are not common. The colour is variable, with shades of green, yellowish-brown, gray and black. Olivine alters readily to a serpentine, chlorite or an amphibole and anhydrous and hydrous iron oxides such as magnetite, hematite, goethite and lepidocrocite. By weathering processes the mineral is altered to carbonates or hydrous iron oxides and silica.

In addition to the magnesium and iron, common olivine contains small amounts of manganese. calcium and, rarely, zinc and lead. When some of these components are dominant the olivine is called forsterite, Mg_2SiO_4; fayalite, Fe_2SiO_4; tephroite, Mn_2SiO_4; and monticellite, $CaMgSiO_4$. These pure end members of the olivine group have been synthesized in the laboratory. Forsterite and fayalite are known to form a complete series of solid solutions or mix crystals.

The hardness of olivine is 6.5 to 7; the specific gravity, 3.22 to 4 32; and it is brittle, breaking with a conchoidal fracture or along two indistinct and inequal cleavages. The mineral is decomposed by hot hydrochloric acid, forming gelatinous silica. Under the microscope it is distinguished by its high index of refraction (1.64–1.88) and its double refraction (birefringence = 0.033–0.051).

All members of the olivine group crystallize in the orthorhombic system and have the same crystal structure as deduced by X-ray diffraction. The general formula is $XYSiO_4$, where X and Y may be magnesium, ferrous iron, manganese, calcium, zinc and lead. Fayalite inverts to a spinel (*q.v.*) structure (cubic) under extreme pressures. (H. S. Y.)

OLLIVIER, OLIVIER ÉMILE (1825–1913), French statesman, was born at Marseilles on July 2, 1825. On the establishment of the second republic his father, DEMOSTHENES OLLIVIER (1799–1844), secured for him the position of commissary general of the *de'partement* of Bouches-du-Rhône. His repression of a Socialist outbreak at Marseilles commended him to Gen. Louis Cavaignac, who made him prefect of the *de'partement.* His removal to the prefecture of Chaumont (Haute-Mame) he ascribed to his father's enemies. He therefore resigned from the civil service to take up practice at the bar.

He re-entered political life in 1857 as deputy for the 3rd circumscription of the Seine. His candidature had been supported by the *Sikcle,* and he joined the constitutional opposition. With Alfred Darimon, Jules Favre, J. L. Hénon and Ernest Picard he formed the group known as Les Cinq, which wrung from Napoleon III some concessions in the direction of constitutional government.

The imperial decree of Nov. 24, permitting the insertion of parliamentary reports in the *Moniteur,* and an address from the *corps législatif* in reply to the speech from the throne were welcomed by him as a first installment of reform. This acquiescence marked a considerable change of attitude, for only a year previously a violent attack on the imperial government, in the course of a defense of Étienne Vacherot, brought to trial for the publication of *La Démocratie,* had resulted in his suspension from the bar for three months. He gradually separated from his old associates, who grouped themselves around Jules Favre, and during the session of 1866–67 Ollivier helped to form a third party, which definitely supported the principle of a liberal empire. This led to a struggle of personal rivalry between Ollivier and Eugène Rouher, the minister of state, who attempted, by the issue of his *senatus-consulte* (July 1866), to uphold the constitution of 1852. On Jan. 19, 1867, an imperial decree was issued, restoring the right of interpellation to the deputies. A promise was also inserted in the *Moniteur* of a relaxation of the stringency of the press laws and of concessions in respect of the right of public meeting. On June 28, 1869, the third party, which consisted of 116 members, with the support of the left, obtained a majority in the chamber for their demand for a responsible ministry "and the right of the Legislative Body to regulate the essential conditions of its own activity."

The emperor prorogued the legislative body on July 13, and on the same day appointed Rouher president of the senate. The *se'natus-consulte* of Sept. 8, 1869, gave the two chambers the ordinary parliamentary rights. On Nov. 29 the chambers again met and on Dec. 28 the emperor was obliged to give in to the third party's demands. He dismissed Rouher and entrusted Ollivier with the formation of a responsible ministry of which Ollivier was really premier, although that office was not nominally recognized by the constitution.

The new cabinet, known as the ministry of Jan. 2, had a hard task before it, complicated a week after its formation by the hostile manifestation following the shooting of Victor Noir by Prince Pierre Bonaparte. Ollivier immediately summoned the high court of justice for the judgment of Prince Bonaparte and Prince Joachim Murat. His ministry included four members of the right centre and four of the left centre. In March his position obliged him to propose a revision of the constitution, and on April 20 a *se'natus-consulte* was issued which accomplished the transformation of the empire into a constitutional monarchy. Ollivier, however, still had to face violent opposition from the Republicans and Socialists. He had arrested Rochefort on Feb. 9 for his presence at the funeral of Victor Noir, and he arrested also the editors of the *Marseille'ien.*

Neither concessions nor firmness sufficed to appease the "Irreconcilable~"of the opposition, who since the relaxation of the press laws were able to influence the electorate. On May 8, however, the amended constitution was submitted to a plebiscite, which resulted in a vote of nearly seven to one in favour of the government. The most distinguished members of the left in his cabinet—L. J. Buffet, Napoléon Daru and Talhouet Roy—resigned in April on the question of the plebiscite. Ollivier himself held the ministry of foreign affairs for a few weeks, until Dam was replaced by the duc de Gramont.

The revival of the candidature of Prince Leopold of Hohenzollern-Sigmaringen for the throne of Spain early in 1870 disconcerted Ollivier's plans. The French government, following Gramont's advice, instructed Benedetti to demand from the king of Prussia a formal disavowal of the Hohenzollern candidature. Ollivier allowed himself to be gained by the war party. The story of Benedetti's reception at Ems and of Bismarck's manipulation of the Ems telegram is told elsewhere. *(See* BISMARCK.) It is unlikely that Ollivier could have prevented the eventual outbreak of war, but he might perhaps have postponed it at that time, if he had taken time to hear Benedetti's account of the incident. He was outmaneuvered by Bismarck, and on July 1j he made a hasty declaration in the chamber that the Prussian government had issued to the powers a note announcing the rebuff received by Benedetti.

He obtained a war vote of 500,000,000 fr., and used the fatal words that he accepted the responsibility of the war "with a light heart," saying that the war had been forced on France. On Aug. 9, with the news of the first disaster, the Ollivier cabinet was driven from office, and its chief sought refuge in Italy. He returned to France in 1873, and occupied himself with writing the apology for his government, *L'Empire libéral* (189j *seq.).*

His first wife, Blandine Liszt, was the daughter of the Abbé Liszt by Mme. d'Agoult (Daniel Stern). She died in 1862, and Ollivier married in 1869 Mlle. Gravier. He died at St. Gervais-les-Bains on Aug. 30, 1913.

His other works include *Démocratie et liberté* (1867), *Le Ministkre du 2 janvier, mes discours* (1875), *Principes et conduite* (1875), *L'Église et l'État au concile du Vatican,* 2 vol. (1879), *Solutions politiques et sociales* (1893) and *Nouveau Manuel du droit ecclésiastique français* (1885).

See M. T. Ollivier, *Emile Ollivier; sa jeunesse d'apres son journal et sa correspondence* (1918).

OLMEDO, JOSÉ JOAQUÍN (1780–1847), Ecuadorian poet and statesman, whose patriotic verse reflects the revolutionary spirit of his time, was born in Guayaquil on March 20, 1780. He studied at the University of San Marcos in Lima, receiving his LL.D. degree in 1805. He was sent to Spain in 1811 to represent Guayaquil in the *Cortes de Cddiz.* After his return in 1816, he participated actively in politics and continued writing poetry. In 1825 he again went to Europe, this time to represent Peru in London and Paris. He returned to Guayaquil in 1828 and when Ecuador became a republic in 1830 he was elected its first vice-president but declined the honour. He died in Guayaquil on Feb. 19, 1847.

As a poet, Olmedo is a neoclassicist. He is best known for his odes *La victoria de Junín: Canto a Bolivar* (1825), the finest example of heroic poetry in the neoclassical style written in Spanish-America, and *Al General Flores, vencedor en Miñarica* (1835), an eloquent composition lamenting the civil wars that were beginning to destroy the unity of South America, so soon after independence from Spain had been achieved.

For his collected poems *see* A. Espinosa-Pólit, *Poesías completas de Jose' Joaquin de Olmedo,* with bibliography (1945; 1947).

See E. C. Hills, ed., *The Odes of Bello, Olmedo and Heredia* (1920). (L. LL.)

OLMSTED, FREDERICK LAW (1822–1903), U.S. landscape architect, was born in Hartford, Conn., on April 27, 1822. He already had an adventurous career when he published his *Journeys and Explorations in the Cotton Kingdom* (1861). which gave a picture of the conditions surrounding American slavery that had great influence on British opinion, and was much quoted in the controversies at the time of the Civil War. During the war he was the untiring secretary of the U.S. sanitary commission.

When Central park, New York city, was projected, he, in conjunction with Vaux, proposed the plan which, in competition with more than 30 others, won first prize. Olmsted was made superintendent to carry out the plan. This was practically the first attempt in the United States to apply art to the improvement or embellishment of nature in a public park; it attracted great attention, and the work was so satisfactorily done that he was engaged thereafter in most of the important works of a similar nature in America—Prospect park, Brooklyn; Fairmount park, Philadelphia; South park, Chicago; Riverside and Morningside parks, New York; Mount Royal park, Montreal; the grounds surrounding the Capitol at Washington, and at Leland Stanford university at Palo Alto, Calif.; and many others.

He developed the bare stretch of lake front at Chicago into the world's fairgrounds, contributing much to the architectural beauty and the success of the exposition. He was greatly interested in the Niagara reservation, made the plans for the park there, and also did much to influence the state of New York to provide the Niagara park.

He was the first commissioner of the national park of the Yosemite and the Mariposa grove, directing the survey and taking charge of the property for the state of California. He also held directing appointments under the cities of New York, Boston, Philadelphia, Baltimore, Wilmington and San Francisco, the joint committee on buildings and grounds of congress, the Niagara Falls Reservation commission, the trustees of Harvard, Yale, Amherst and other colleges and public institutions. After 1886 he was largely occupied in laying out an extensive system of parks and parkways for the city of Boston and the town of Brookline, and on a scheme of landscape improvement of Boston harbour.

Olmsted died on Aug. 28, 1903.

OLMÜTZ: *see* OLOMOUC.

OLNEY, RICHARD (1835–1917), U.S. statesman, was born at Oxford, Mass., on Sept. 15, 1835. He graduated at Brown university, Providence, R.I., in 18j6, and at the law school of Harvard university in 1858. In 1859 he began the practice of law at Boston and attained a high position at the bar. He served in the state house of representatives in 1874, and in March 1893 became attorney general of the United States in the cabinet of Pres. Grover Cleveland. In this position, during the strike of the railway employees in Chicago in 1894, he instructed the district attorneys to secure from the federal courts writs of injunction restraining the strikers from acts of violence, and thus set a precedent for "government by injunction." He also advised the use of federal troops to quell the disturbances in the city, on the ground that the government must prevent interference with its mails and with the general railway transportation between the states.

Upon the death of Secretary W. Q. Gresham (1832–95), Olney succeeded him as secretary of state on June 10, 1895. He became specially prominent in the controversy with Great Britain concerning the boundary dispute between the British and Venezuelan governments, and in his correspondence with Lord Salisbury gave an extended interpretation to the Monroe Doctrine which went considerably beyond previous statements on the subject. In 1897, at the expiration of President Cleveland's term, he returned to the practice of the law.

Olney died in Boston on April 8, 1917.

OLNEY, a market town in the Newport Pagnell urban district of Buckinghamshire, Eng., on the Ouse, 20 mi. N.E. of Buckingham by road. Pop. (1951) 2,337.

Olney is known for its association with William Cowper, the poet, who lived there from 1767 to 1786. John Newton, curate of Olney, had Cowper's assistance in the production of the Olney hymns.

The trade of the town is principally agricultural, but footwear is manufactured there.

OLOMOUC, a town in the Olomouc region, Czech.. at the confluence of the Bystrice and the Morava. Pop. (1957 est.) 73,800. Near the head of a fertile gulf, floored with sandy loam and loess, and having a sheltered climate, it is a market for cereals and cattle and such prepared materials as malt, meal, beer, spirits, starch and sugar.

Until 1640 Olomouc was the recognized capital of Moravia. Originally fortified by Maria Theresa it was. until 1886, one of the strongest fortresses in central Europe and withstood a seven-weeks' attack of Frederick the Great in 1758, but the site of the fortification is now occupied by park, gardens and promenade. Notable buildings are the 14th-century cathedral in Gothic style, with a 328-ft. tower, the 15th-century Mauritius church, also Gothic, and the 15th-century town hall and museum. Olomouc was made the see of a bishop in 1073 and in 1777 was raised to the rank of an archbishopric. It was occupied by Germany in 1939.

OLONA (*Touchardia* latifolia), **a** shrub of the nettle family (Urticaceae), native to the Hawaiian Islands. where it has long been cultivated as a fibre plant. The bast fibre obtained from the young shoots possesses remarkable tensile strength. being three times as strong as that of the finest grades of abaci fibre (*q.v.*). Because of its great pliability olona fibre is readily woven into cloth or made into cordage. Another valuable quality is its unusual durability in water, making it especially suitable for fish nets.

OLONETS, a former government of northwestern Russia (see KARELIA).

OLORON-SAINTE-MARIE, a town of southwestern France. capital of an arrondissement in the *département* of Basses-Pyrénées, 21 mi. S.W. of Pau on a branch of the Southern railway. Pop. (1954) 9,269. It lies at the confluence of the mountain torrents (locally known as gaves) Aspe and Ossau, which: after dividing it into three parts, unite to form the Oloron, a tributary of the Pau.

A Celtiberian and then a Gallo-Roman town, known as Iluro, occupied the hill on which the old feudal town of Sainte-Croix now stands, still surrounded by remnants of its 14th-century ramparts. between the two rivers; Sainte-Marie lies on the left bank of the Aspe, and the new town on the right bank of the Ossau. Oloron is the seat of a subprefect.

The town carries on a thriving trade with Spain by way of the passes of Somport and Anso, chiefly in wool and skins, salt pork and hams. cattle and horses.

OLYBRIUS, Roman emperor of the west from July 11, to Oct. 23, 472, was a member of a noble family and a native of Rome. After the sack of the city by Gaiseric in 455, he fled to Constantinople, where, about 464. he married Placidia, daughter of Valentinian III. This afforded Gaiseric the opportunity of claiming the empire of the west for Olybrius. In 472 Olybrius was sent to Italy by the emperor Leo to assist the emperor Anthemius against his son-in-law Ricimer, but, having entered into negotiations with the latter, was himself proclaimed emperor and on the murder of his rival ascended the throne unopposed.

See Gibbon, ***Decline and Fall, ch.*** **xxxvi**; J. B. Bury, ***Later Roman Empire.***

OLYMPIA, the scene of the Olympic games, is in western Peloponnesos on the north bank of the Alpheus (mod. Ruphia), about 11 mi. E. of modern Pýrgos, where the ancient Cladeus tributary flows in from the north. Olympia is bounded on the west by the Cladeus, on the south by the Alpheus, on the east by the ancient racecourses and on the north by low heights. There a conical hill, about 400 ft. high, cut off by a cleft, descends abruptly on Olympia. This is the Cronion hill sacred to Cronus.

HISTORY

The importance of Olympia in the history of Greece is religious and political. Religious associations date from the prehistoric age, when a centre of worship is attested by house-remains and early votive offerings found beneath the Heraeum. The earliest extant building is the temple of Hera, which may date in its original form from about 1000 B.C. and retained till Pausanias' time one original column of mood. There were various traditions as to the origin of the games. According to one the first race was between Pelops and Oenomaus, who used to challenge the suitors of his daughter Hippodameia and then slay them. Another attributed the festival to Heracles, either the well-known hero or the Idaean Dactyl of that name. In early times the control of the festival belonged to Pisa, but Elis seems to have claimed some share in it. Sixteen women, representing eight towns of Elis and eight of Pisatis, wove the festal robe for the Olympian Hera. Olympia thus became the centre of an amphictyony (*q.v.*), or federal league under religious sanction, for the west coast of Peloponnesos. It suited the interests of Sparta to join this amphictyony; and, before the list of Olympic victors begins in 776 B.C., Sparta had formed an alliance with Elis. Aristotle saw in the temple of Hera a bronze disk, recording the traditional laws of the festival, on which the name of Lycurgus of Sparta stood next to that of Iphitus, king of Elis. Whatever may have been the age of this disk, the relation which it indicates is well attested. Elis and Sparta, making common cause, had no difficulty in excluding the Pisatans from their proper share in the management of the Olympian sanctuary. Pisa had, indeed, a brief success, when Pheidon of Argos celebrated the 28th Olympiad under its presidency. But this festival, from which Eleans and Spartans were excluded, was afterward struck out of the official register. The destruction of Pisa (before 572 B.C.) by Sparta and Elis put an end to the rivalry: Pisatis, and also Triphylia to the south of it, becoming dependent on Elis. On the religious side of the festival the Eleans had unquestioned supremacy. All candidates were tested at Elis, in the gymnasium, before they were admitted to the athletic competitions at Olympia, and training (usually of ten months) at Elis was regarded as the most valuable preparation. Elean officials, who not only adjudged the prizes, but decided who should be admitted to compete, assumed the title of Hellanodicae.

Long before the overthrow of Pisa the list of contests had been so enlarged as to give the celebration a Panhellenic character. Exercises of Spartan type—testing endurance and strength with a special view to war—had almost exclusively formed the earlier program. But as early as the 25th Olympiad the four-horse chariot race was added, an invitation to wealthy competitors from every part of the Hellenic world. and the recognition of a popular spectacular element, as distinct from athletic or military. Horse races were added later. For such contests the hippodrome was set apart. Meanwhile the list of contests on the old racecourse, the stadium, had been enlarged. Besides the original foot race in which the course was traversed once only, there were the double course (*diaulos*) and the "long" foot race (dolichos). Wrestling and boxing were combined in the *pancration;* leaping, quoit throwing, javelin throwing, running and wrestling in the pentathlon. Under the protection of the Spartans. the festival acquired new importance for, having failed in their plans of actual conquest in the Peloponnesos, they sought at least acknowledged predominance. While therefore the Eleans were the religious supervisors of Olympia the Spartans constituted themselves its political protectors, enforcing the sanction which the Olympian Zeus gave to the amphictyones, whose federal bond was symbolized by common worship, and punishing violation of that "sacred truce" which was indispensable if Hellenes from all cities were to have peaceable access to the Olympian festival.

Olympia thus became a recognized Panhellenic institution after the establishment of Elean supremacy in 572 B.C.; and to the last remained a central expression of the Greek ideas that the body of man has a glory as well as his intellect and spirit, that body and mind should alike be disciplined, and that it is by the harmonious discipline of both that men best honour Zeus. The significance of Olympia was larger and higher than the political fortunes of the Greeks who met there, and it survived the overthrow of Greek independence. In the Macedonian and Roman ages the temples and contests of Olympia still interpreted the ideal at which free Greece had aimed. Philip of Macedon and Nero are among those who have record in the Altis. According to Cedrenus, a Greek writer of the 11th century (*Synopsis,* i. 326), the Olympian festival ceased to be held after A.D. 393, the first year of the 293rd Olympiad. The list of Olympian victors, which begins in 776 B.C. with Coroebus of Elis, closes with the name of an Armenian, Varastad, who is said to have belonged to the race of the Arsacidae. In the 5th century desolation had set in. The chrysclephantine statue of the Olympian Zeus, by Pheidias, was carried to Constantinople, and perished in a great fire, A.D. 476. The Temple of Zeus was dismantled, either by Goths or by Christian zeal, in the reign of Theodosius II. (A.D. 402–450). The temple of Zeus, probably thrown down by earthquakes in the 6th century A.D., and the region south of it became a fortress, constructed from materials found among the ancient buildings.

Excavations. — The German excavations were begun in 1875, and completed in 1881. The deposit of earth over the Altis from the overflowing of the Cladeus had an average depth of 16 ft.; it mas also necessary to excavate, especially on the west, the south and the east, several ancient buildings not included within the sacred precinct. Moreover in many places early Greek work had later Greek on top of it, or late Greek work had been overlaid with Roman.

The form of the Altis is not regularly rectangular. The west side is about 215 yd.; the south side is about equally long; the east side. about 200 yd.; the north side, behind the treasure-houses, about 275 yd.

REMAINS WITHIN THE ALTIS

Within the Altis are three main groups of buildings: — (A) chief centres of religious worship; (B) votive buildings; (C) buildings connected with the administration or with the reception of visitors.

A. Chief Centres of Religious Worship. — I. There are traces of an altar near the Heraeum older than the great altar of Zeus, and probably the original centre of worship. The great altar of Zeus was of elliptic form; imposed on this basis, in two tiers, and also, lozenge-shaped, was the famous "ash-altar" at which the Iamidae, the hereditary family of seers, practised rites of divination by fire in virtue of which Olympia is saluted by Pindar as "mistress of truth."

2. The *Pelopium,* to the west of the Altar of Zeus, was a small walled precinct in which sacrifices were offered to the hero Pelops. In the middle was a low tumulus of elliptic form. A Doric gateway with three doors gave access on the south-west side.

The three temples of the Altis were those of Zeus, Hera and the Mother of the gods. All were Doric and completely surrounded by a colonnade.

3. *The Temple* of *Zeus,* south of the Pelopium, stood on a high substructure with three steps. It was probably built about 470 B.C. The colonnades at the east and west ends were of six columns. the north and south sides of thirteen. The cella had a prodomos on the east and an opisthodomos on the west. It was itself divided longitudinally by a double row of columns. The central, and widest, partition was in three sections; the western containing the throne and image of the Olympian Zeus; the middle section, a table and stelae, where, probably, the wreaths were presented to the victors; the eastern was open to the public. On the east pediment was represented in twenty-one colossal figures the moment before the contest between Oenomaus and Pelops; on the western the fight of the Lapithae and Centaurs. The statement of Pausanias that the two pediments were made by Paeonius and Alcamenes is now generally supposed to be an error. On the metopes of the prodomos and opisthodomos were depicted the Twelve Labours of Heracles.

Near this temple was found the statue of a flying goddess of victory — the Nike of Paeonius. (*See* GREEK ART.)

4. *The Temple of Hera* (Heraeum), north of the Pelopium, was on two steps. It is the oldest of extant Greek temples, and may date from about 1000 B.C. 'It was smaller than the temple of Zeus, and of unusual length relatively to its breadth. It has colonnades of six columns at east and west, and of sixteen at north and south. When Pausanias saw it, one of the two columns of the opisthodomos was of wood; and for long, probably, all the columns of this temple had bern wooden, gradually replaced as they decayed in progressively later styles. Only the lower part of the cella wall was of stone, the rest of unbaked brick; the entablature was of wood covered with terra-cotta. The cella — divided, like that of Zeus, by a double row of columns — had four small screens, projecting at right angles from its north and south walls. In the third niche thus formed, from the east, on the north side, was found the Hermes of Praxiteles still preserved in the local museum (*See* GREEK ARCHAEOLOGY.)

5. *The Temple of the Great Mother of the Gods* (Metroum) was smaller than the Heraeum. It stood to the east of it and had a different orientation. It was on three steps, and had six columns east and west by eleven north and south. The cella had prodomos and opisthodomos. It was probably built in the 4th century, and underwent a Roman restoration.

B. Votive Edifices. — These were erected, either by states or by individuals.

1. Twelve *Treasure-houses* on the north side of the Altis, immediately under the Cronion, have the same general character of a Doric temple *in antis*, facing south. Of several the fragments are sufficient for reconstruction. The 2nd and 3rd from the west had been dismantled early for a roadway winding upward towards the Cronion, which is itself older than AD. 157. This explains the fact that, though we can trace twelve, Pausanias names only ten. Each treasure-house was erected by *a* Greek state, either as a thank-offering for Olympian victories gained by its citizens, or as a general mark of homage to Olympian Zeus, and to contain the dedicated gifts in which the wealth of the sanctuary consisted. Temple inventories discovered at Delos and at Lindus in Rhodes illustrate how such possessions accumulated at a shrine of Panhellenic celebrity. The treasure-houses were founded by the following states, in order from the west: 1. Sicyon; 2, 3, unknown; 4, Syracuse (referred by Pausanias to Carthage); 5, Epidamnus; 6, Byzantium; 7, Sybaris; 8, Cyrene; 9, Selinus; 10, Metapontum; 11, Megara; 12, Gela. While the majority are the Greek colonies, from Libya to Sicily, from the Euxine to the Adriatic, Greece proper is represented only by Megara and Sicyon. The dates of the foundations cannot be fixed. The Megarian treasury had pedimental figures of gods fighting with giants; others supplemented stonework with painted terra-cotta.

2. The *Philippeum* near the north-west corner of the Altis was dedicated by Philip of Macedon, after his victory at Chaeronea (338 B.c.), illustrating how his position and power enabled him without risking any revolt of Hellenic feeling to erect a monument of the overthrow of Greek freedom in the very heart of the Panhellenic sanctuary. The building had a circular Ionic colonnade about 15 metres in diameter, raised on three steps enclosing a circular cella, with fourteen Corinthian half-columns. It contained portraits by Eeochares of Philip, Alexander and other members of their family, in gold and ivory.

3. The *Exedra of Herodes Atticus* at the north limit of the Altis by the N.E. angle of the Heraeum consisted of a half-dome of brick (54 ft. diam.), containing twenty-one marble statues, representing the family of Antoninus Pius, of Marcus Aurelius and of the founder. In front was a drinking trough, its ends adorned by very small temples with circular colonnade.

C. **Official Buildings** for the management of the sanctuary or the accommodation of guests.

1. Olympia, besides its religious character, originally was the centre of a political amphictyony. So, like a Greek city, it should have a public hearth, where fire should always burn, and where Olympia should exercise hospitality. The Prytaneum was at the northwest corner of the Altis, close to the Heraeum. It was a square building containing a chapel of Hestia at the front.

2. The Porch of Echo, also called the "Painted Porch," extended 100 yd. along the east Altis wall. A single Doric colonnade, on three steps, open toward the Altis, afforded a place from which to view processions and the sacrifices at the great altar. Built in the Macedonian period, it replaced an earlier portico. In front were pedestals for votive offerings.

3. The Agora was that part of the Altis which had the Porch of Echo on the east, the altar of Zeus on the west, the Metroum on the north, and the precinct of the temple of Zeus on the southwest. There stood altars of Zeus Agoraios and Artemis Agoraia.

4. The Zanes were bronze images of Zeus, erected out of the fines exacted for breaches of the rules of the contests. They stood at the north side of the Agora, in a row, from the Metroum to the gate of the private entrance into the stadium. Sixteen pedestals were there discovered in situ.

REMAINS OUTSIDE THE ALTIS

A. West Side.—The wall bounding the Altis of the time of Nero has two gates, at its north and south ends. Each had on the west a portico of four columns. A smaller gate is nearly opposite the Pelopium.

West of this wall, between the Altis and the Cladeus, the following buildings succeed each other from north to south.

1. The Gymnasium, a large open space, enclosed on two sides at least by Doric colonnades, on the east by a double portico, more than a stadium in length (220 yd.), served as a racecourse for practice in bad weather. At the southeast corner was a Corinthian doorway, leading to the northwest gate of the Altis. The gymnasium was used by competitors during the last month's training.

2. The Palaestra, for wrestlers and boxers, about 70 yd. square, containing rooms of different sizes, and enclosing a building surrounded by a Doric colonnade.

3. A Byzantine Church occupies the site of an older brick building, perhaps the "workshop of Pheidias" seen by Pausanias. Among adjacent structures an inscribed altar marks the *Heroum,* where worship of heroes was practised. The Theocoleon, a large building of Roman age, was probably the house of the priests. A long narrow building south of the church may have been occupied by those alleged "descendants of Pheidias" (Pausanias v, 14) whose privilege it was to keep the statue of Zeus clean. The so-called "workshop of Pheidias" evidently continued to be used for actual work, and a lodging was required for the artists.

4. *The Leonidaeum,* dedicated by an Elean in the 4th century B.C., for the reception of distinguished visitors. Its orientation is from W.S.W. to E.N.E. An outer Ionic colonnade encloses suites of rooms, around a small interior Doric peristyle. In Roman times it was altered to distribute the rooms into four suites. The porticos show traces of much carriage traffic.

B. South Side.—The limits of the Altis toward the Alpheus can only be traced approximately, since architectural changes were numerous down to the latest times.

1. *The Council Hall* (*Bouleuterium*), nearly at the middle of the south wall, comprised two Doric buildings of different date but identical oblong form, divided by a single row of columns, terminating to the west in an apse. In the space between stood a small square building. In front, on the east, a portico covered the front of all three with a large forehall, enclosed by a colonnade.

2. The *South* Colonnade, a late but handsome structure, closed on the north side, with Doric colonnade to southeast and west, and Corinthian columns within, served as a promenade and to view the processions.

3. A Triumphal Gateway of Roman age, with triple entrance, opens on the Altis, a little east of the *Bouleuterium.*

C. East Side.—The line of the east wall can be followed from the northeast corner of the Altis until it breaks off at the remains known as Nero's house.

1. Nero's House is a building of 4th-century date and uncertain purpose, afterward absorbed into a Roman house, to make room for which the south part of the east Altis wall was destroyed. A leaden water pipe bears NER. AVG., and since only a Roman master could have dealt thus with a building within the sacred precinct, it cannot be doubted that the Roman house—from which three doors gave access to the Altis—was that occupied by Nero when he visited Olympia. Later the building, further enlarged, may have been occupied by Roman officials.

2. The Stadium extends east of the Altis from W.S.W. to E.N.E., and is entered from the northeast angle. This position was due simply to the curve of the slopes which bound the valley. The stadium is only cleared so far as was necessary for ascertainment of essential points. Low embankments had been built on west, east and south, the north boundary being formed by the natural slope. The space thus defined was about 234 yd. long by 35 broad. There were no artificial seats. From 40,000 to 45,000 spectators could have found sitting room. The exact length of the stadium itself—which was primarily the course for the foot race—was 192.27 m. (about 210 yd.), and consequently the Olympian foot was 0.3204 m. or 1.05 English foot. In thk Heraeum, however, the unit adopted was not this Olympian foot, but an older one of 0.297 m., and in the temple of Zeus an Attic foot of 1.08 English foot. The starting point and the goal in the stadium were marked by limestone thresholds. Drainage was by a marginal channel. The stadium was used not only for foot races, but for boxing, wrestling, leaping, quoit throwing and javelin throwing. The entrance from the northeast corner of the Altis was reserved for the judges, competitors and heralds. It was a vaulted tunnel, 100 Olympian feet in length, probably constructed in Roman times. To the west the Altis was entered by a gateway and vestibule.

3. The Hippodrome, in which chariot races and horse races were held, can no longer be accurately traced, owing to the overflowings of the Alpheus. But it is clear that it lay south and southeast of the stadium, parallel with it, though stretching beyond it to the east. Its length was probably 770 m. or 4 Olympic stadia.

D. North Side.—A wall running east-west immediately north of the treasuries protects them from landslides off the Hill of Cronus, and carries the water channel of Herodes Atticus. Further west it is doubtful whether the Altis was ever marked off from the "Hill of Cronus," which is associated with the oldest worship there.

BIBLIOGRAPHY.—K. Boetticher, *Olympia* (1890); Daremberg-Saglio iv, *s.v.* (1904–05); E. N. Gardiner, *Olympia, its History and Remains* (1925).

OLYMPIA, the capital city of Washington, U.S., and the seat of Thurston county, at the extreme southern end of Puget sound, is located 60 mi. S.S.W. of Seattle. The city is surrounded on the landward sides by low green hills. On the south the Deschutes river flows through a rocky canyon into Deschutes basin. a fresh-water lake that is part of the capitol grounds, with an outlet to Puget sound. To the north are the snow-capped Olympics, and to the east rises Mt. Rainier in the Cascades. On a promontory jutting into the sound stand the white sandstone state government buildings, of classic design.

The trade of the port of Olympia, averaging about 500.000 tons per year. consists of logs, lumber, plywood, forest products of all types. ores, petroleum products, aluminum and steel products, beverages and military supplies and other products from local industries, including processed foods. It is a centre of oyster culture, producing both the large Pacific oysters and the small, Olympia oysters. Olympia is headquarters of the Olympic National Forest service. Three miles south of the city's centre is St. Martin's college (Roman Catholic. 1895) for men.

The first American settlement on Puget sound was made in 1845 at the falls of the Deschutes river, on the site of Tumwater, 1 mi. S. of Olympia, under the leadership of Michael T. Simmons from Kentucky. In 1849 Tumwater was practically deserted when the men left for the California gold fields, but in 1850 a town was laid out on the site of some homesteads where Olympia now stands. At first called Smithfield, after one of the early settlers, the town was renamed shortly for the Olympic mountains. In 1851 congress authorized the establishment of a customhouse, making Olympia the first port of entry on Puget sound. In 1852 the first newspaper north of the Columbia river in Oregon territory was established there (the *Columbian*). In 1853 Olympia became the capital of the newly created Washington territory, upon the arrival of the first governor, Isaac I. Stevens. It was chartered as a city in 1859. A monument in Capitol park marks the terminus of the Old Oregon trail. For comparative population figures ***see*** table in WASHINGTON (STATE): *Population*. (R. E. Bc.)

OLYMPIAS, daughter of Neoptolemus, king of Epirus, wife of Philip II of Macedon and mother of Alexander the Great. The marriage took place in 359 B.C., shortly after Philip's accession, and Alexander was born in 356. Philip married a new wife, Cleopatra, in 337, and Olympias and Alexander withdrew into Epirus, from which they both returned in the following year, after the assassination of Philip, which Olympias is said to have countenanced. During the absence of Alexander, with whom she regularly corresponded on public as well as domestic affairs, she had great influence, and on Alexander's death in 323 withdrew to Epirus, because of her hostility to Antipater the regent. In 319 she allied herself with Polyperchon, Antipater's successor, and became ruler of Macedonia. Cassander, Antipater's son, hastened from Peloponnesus, and, after an obstinate siege, compelled the surrender of Pydna, where she had taken refuge. One of the terms of the capitulation had been that her life should be spared: but she was brought to trial for the numerous executions which she had ordered during her reign. Condemned without a hearing, she was put to death in 316 by the friends of those she had slain, the promise to spare her life being disregarded.

BIBLIOGRAPHY.—Plutarch, *Alexander*, 9, 39, 68; Justin, vii, 6, ix, 7, xiv. 5, 6; Arrian, *Anab.*, vii, 12; Diod. Sic., xviii, 49–65, xix, 11–51. *See* also the articles ALEXANDER III THE GREAT; MACEDONIAN EMPIRE.

OLYMPIC GAMES. While the origin of the Olympic games is not known exactly, there is a historical record of the ancient games beginning in 776 B.C. Thereafter they were held at four-year intervals until A.D. 394, when they were abolished by the Roman emperor Theodosius after Greece had lost its independence. Few enterprises created by man have lasted so long. At first the program was confined to one day and consisted only of a single event, a race the length of the stadium. Afterward additional races, the discus throw, the javelin throw, the broad jump, boxing, wrestling, the pentathlon, chariot racing and other events were added, and the duration, including the religious ceremonies, was extended to seven days. The games were restricted to Greeks, but competitors came from all the Greek colonies around the Mediterranean. A sacred truce was declared and enforced to permit participants to travel unmolested to the games. Women were not allowed as competitors or, except for the priestesses of Demeter, as spectators. Before the contests opened all the competitors and their families, the trainers and the judges swore a solemn oath to keep the competition clean and fair and to give just decisions.

The games occupied such an important position in the life of Greece that time was measured by the four-year interval between them — an "Olympiad." The greatest honour then to be attained by any Greek was the winning of the simple branch of wild olive given to a victor in the games. Kings competed alongside commoners; even the Roman emperor Nero sought Olympic honours. Winners became national heroes, musicians sang their praise and sculptors preserved their strength and beauty in marble. Their feats of skill and courage were recorded by the poets and writers of the time. The gracefulness and sportsmanship of the contestant and the method of winning were esteemed equally with the victory itself.

It was through the efforts of the Baron Pierre de Coubertin (1863–1937) of France, a brilliant educator and scholar but not an athlete, that the Olympic games were revived. Having decided that at least one of the reasons for the glory of the Golden Age of Greece was the emphasis placed on physical culture and frequent athletic festivals, he concluded that nothing but good could result if the athletes of all countries of the world were brought together once every four years on the friendly fields of amateur sport, unmindful of national rivalries, jealousies and differences of all kinds and with all considerations of politics, race, religion, wealth and social status eliminated. He summoned an international conference at the Sorbonne, Paris, in 1894, which was attended by the representatives of nine different nations.

The games of the I Olympiad of the modern cycle were held under the royal patronage of the king of Greece in 1896 in a new marble stadium constructed in Athens for the purpose. Subsequent games were held in Paris (1900), St. Louis (1904), London (1908), Stockholm (1912), Antwerp (1920), Paris (1924), Amsterdam (1928), Los Angeles (1932), Berlin (1936), London (1948), Helsinki (1952), Melbourne (1956) and Rome (1960). The XVIII Olympiad was awarded to Tokyo for 1964. The games of the VI, XII and XIII Olympiads scheduled, respectively, for Berlin (1916), Tokyo then Helsinki (1940) and London (1944), were not held because of war. In 1906 a set of games was held in Athens, but these were not considered as part of the official series.

A separate cycle of winter games was initiated in 1924 at Chamonix, France; subsequent games were held at St. Moritz, Switz. (1928), Lake Placid, N.Y. (1932), Garmisch-Partenkirchen, Ger. (1936), St. Moritz (1948), Oslo (1952), Cortina d'Ampezzo, Italy (1956), and Squaw Valley, Calif. (1960). The IX winter Olympic games were scheduled for Innsbruck, Aus., in 1964.

The direction of the Olympic movement and the regulation of the games is vested in the Comité International Olympique, with headquarters at Mon Repos, Lausanne, Switz. The committee elects its members for life after a thorough investigation. The C.I.O. is a unique organization in that its members do not represent their countries but are delegates from the committee to their countries. No country may have more than three members. Members must not accept from other organizations or from their governments any instructions that may bind them or interfere with the independence of their votes. In 1952 the committee numbered 72 from 47 countries. Baron Pierre de Coubertin headed the committee until he retired in 1925. He was followed by Count Henry de Baillet Latour of Belgium, who served until his death in 1942. The next president was J. Sigfrid Edstrom of Sweden, who was succeeded in 1952 by Avery Brundage of the United States.

Contestants in the Olympic games must be amateurs. The Olympic definition is as follows:

> An amateur is one who participates and always has participated in sport solely for pleasure and for the physical, mental or social benefits he derives therefrom, and to whom participation in sport is nothing more than recreation without material gain direct or indirect and in accordance with the rules of the International Frderation concerned.

One of the features of the Olympic games introduced successfully for the first time at the Los Angeles games is the Olympic Village. This is special housing provided so that all the competitors from the different countries can live in the same compound.

At the Berlin games in 1936 the sacred Olympic flame, which burns in the stadium throughout the games, was ignited by a torch carried from Olympia, Greece, the site of the ancient games, through the intervening countries by relays of runners. This procedure was repeated at the following games.

The Comité International Olympique awards the following various cups and diplomas annually:

The Olympic cup is awarded to an institution or organization for outstanding service to amateur sport or the Olympic movement.

The Olympic diploma is awarded for the same reasons to an individual.

The Taher Pacha cup is awarded to an athlete who merits special recognition.

The Fearnley cup is awarded to an amateur sport club or local association for merit.

The C.I.O. has granted its patronage to certain regional games which contribute to the development of amateur sports in the areas where they are organized. These are the Far Eastern–Mediterranean games; Asiatic games; Juegos Deportivos Pan Americanos; Juegos Deportivos Bolivarianos; and Juegos Deportivos Centroamericanos y del Caribe.

Participation in the Olympic games is organized by the national

Olympic committees, of which 81 were recognized by the C.I.O. in the latter 1950s. National Olympic committees must include representatives of all the national governing bodies whose sports are included in the Olympic program. They must be independent and autonomous and must avoid any political, commercial or religious interference. Only national Olympic committees can enter competitors in the games, and they must certify to their amateur standing.

Each Olympic sport is governed by international federations composed of national federations in each participating country. Competitors must belong to these national federations. The international federations write the rules governing their sports, and the events in the Olympic games are under their direction subject only to the Olympic regulations.

Ceremonies. — The opening ceremony of the games, staged in the principal stadium, is impressive. The monarch or president of the country where the games are held is received at the entrance of the stadium by the president of the Comité International Olympique and the president of the organizing committee! who escort him to a box where he is greeted with the national anthem of his country. The parade of the competitors then takes place. Each national contingent, dressed in its official uniform, preceded by a shield bearing the name of its country and its national flag. enters the stadium in alphabetical order, except that Greece heads the parade and the organizing country appears last. Each contingent after completing its march around the stadium lines up on the centre of the grounds in a column. behind its shield and flag, facing the tribune of honour. The president of the organizing committee delivers a brief speech of welcome and asks the monarch or president to proclaim the games open. Immediately a fanfare of trumpets is sounded and the Olympic flag is slowly hoisted; pigeons are released, followed by an artillery salute. At this moment the Olympic flame arrives in the stadium and the sacred fire is lit, A benediction is pronounced and the Olympic hymn is sung. Immediately afterward a contestant from the country where the games are taking place mounts the tribune and pronounces the following oath on behalf of all the assembled athletes:

> We swear that we will take part in the Olympic Games in fair competition, respecting the regulations which govern them and with the desire to participate in the true spirit of sportsmanship for the honour of our country and for the glory of sport.

The choir sings the national anthem and the competitors leave the stadium. The ceremony thus comes to an end and the competitions may begin. The closing ceremony, equally impressive, is concluded by the president of the C.I.O., who calls the youth of the world to assemble in four years to celebrate the games of the next Olympiad. "May they display cheerfulness and concord so that the Olympic torch may be carried on with ever greater eagerness, courage and honour for the good of humanity throughout the ages." The trumpet sounds, the Olympic fire is extinguished. the Olympic flag is lowered, there is a salute of five guns and the choir sings the final anthem.

Modern Olympiads. — After 1896, interest in each of the Olympic games centred in the sport of track and field, though at times the program ranged from archery through yachting.

In 1896, 13 nations were represented at Athens and this number dwindled to 11 at St. Louis in 1904. There was steady progress after that (see Table I). The modern Olympiads fall roughly into three eras: (1) 1896–1912; (2) 1920–32; (3) 1936 on. The first era attracted chiefly athletes from the United States, the British empire and the European continent. The second, after World War I, saw entries from the other continents increase rapidly. The third. which began with the great spectacle at Berlin in 1936, saw the games become a truly global affair.

There also has been continual progress in athletic proficiency, with each Olympiad seeing records broken in almost every sport (see Table II). No Olympiad was ever celebrated without the establishment of at least one new world's record in track and field.

The program for the Olympic games usually includes the compulsory events: athletics (track and field), gymnastics, boxing, fencing, shooting, wrestling. rowing, swimming, equestrian, modern pentathlon, cycling, weight lifting and yachting; as well as optional events such as soccer football, water polo, field hockey, basketball, canoeing and an exhibition of fine arts. The winter games normally include skiing, skating, ice hockey and bobsled. Women compete in athletics, fencing, gymnastics, canoeing, swimming. yachting and fine arts and, at the winter games, in skiing and skating.

In addition to the amateur code, major Olympic rules include: no minimum or maximum age limit; only nationals may represent a country; there may be no more than three entries from any country in each event (four in the winter games); no contestant may be disqualified on grounds of religion, colour or politics; the games must be completed within 16 days; no point score may be kept in the games. which are contests between individuals and teams and not between nations (groups not connected with the C.I.O., however, often keep an unofficial point score based on 10 points for a first place, 5 for second: 4 for third, 3 for fourth, 2 for fifth and 1 for sixth in each event); the games are entrusted to a city, not a country; the games must be held in the first year of the Olympiad.

History of **Track** and Field. — Athens, 1896. — James Connolly of Boston became the first modern Olympic champion when he won the hop, step and jump. His U.S. teammates Thomas Burke, Ellery Clark and Robert Garrett scored two victories each, as did Edwin Flack of Australia. Fittingly enough, a Greek, Spyros Louis. won the marathon race.

Paris, 1900. — Held in conjunction with the Paris exhibition, the II Olympiad was another triumph for the United States. Ray Ewry began his unequaled Olympic career with three wins in the standing jumps, Alvin Kraenzlein earned four gold medals and in all track and field events, 17 went to'the U.S. A. E. Tysoe, C. Bennett and J. Rimmer scored for Great Britain.

St. Louis, 1904. — This was almost a private affair for the U.S., with few entries from other countries and only one other gold medalist. Étienne Desmarteau of Canada. Emry again mas a triple winner, as were Archie Hahn, James Lightbody and Harry Hillman.

London, 1908. — The most acrimonious of modern Olympiads, this was also the last monopolized by the U.S. and the British empire, who divided 22 of the 26 track and field gold medals. Ewry completed his career with a double victory to bring his gold medal total to eight. Mel Sheppard and Martin Sheridan of the U.S.

TABLE I.—*Participation* ***in the*** *Olympic* ***Games****

(Official, demonstration and optional sports included)						Winter games (Demonstration events included)					
Location		Sports	Events	Participants (women included)	Participating notions	Location	Date	Sports	Events	Participants (women included)	Participating nations
Athens	1896	10	42	285 —	13					—	
Paris	1900	17	60	1,066 (6 women)	20						
St. Louis	1904	16	67	496 —	11						
London	1908	26	104	2,059 (36 women)	22						
Stockholm	1912	18	106	2,541 (57 women)	28						
Antwerp	1920	24	154	2,606 (63 women)	29						
Paris	1924	24	137	3,092 (136 women)	44	Chamonix	1924	8	16	293 (13 women)	16
Amsterdam	1928	23	120	3,015 (290 women)	46	St, Moritz	1928	7	15	491 (27 women)	25
Los Angeles	1932	21	124	1,408 (127 women)	37	Lake Placid	1932	9	19	307 (30 women)	17
Berlin	1936	27	142	4,069 (328 women)	49	Garmisch-Partenkirchen	1936	10	21	756 (76 women)	28
London	1948	25	138	4,468 (438 women)	59	St. Moritz	1948	11	24	878 (90 women)	28
Helsinki	1952	26	149	4,925 (518 women)	69	Oslo	1952	7	23	732 (108 women)	30
Melbourne	1956	26	149	3,539 (353 women)	67	Cortina d'Ampezzo	1956	7	24	923 (146 women)	32
Rome	1960	18	150	5,902 (651 women)	83	Squaw Valley	1960	7	26	693 (159 women)	30

*Figures supplied by U.S. Olympic committee.

TABLE 11.—Olympic Track and Field Records—,$fen

Event	Location	Year	Holder	Country	Time or distance
100-m. dash	Rome	1960	A. Hary	Germany	10.2 sec.
200-m. dash	Rome	1960	L. Berruti	Italy	20.5 sec.
400-m. run	Rome	1960	O. Davis	United States	44.9 sec.
800-m. run	Rome	1960	P. Snell	New Zealand	1 min. 46.3 sec.
1,500-m. run	Rome	1960	H. Elliott	Australia	3 min. 35.6 sec.
3,000-m. steeplechase	Rome	1960	Z. Krzyszkowiak	Poland	8 min. 34.2 sec.
5,000-m. run	Melbourne	1956	V. Kuts	C.S.S.R.	13 min. 39.6 sec.
10,000-m. run	Rome	1960	P. Bolotnikov	U.S.S.R.	28 min. 32.2 sec.
Marathon (unofficial)	Rome	1960	B. Abebe	Ethiopia	2 hr. 15 min. 16.2 sec.
110-m. hurdles	Melbourne	1956	L. Calhoun	United States	13.5 sec.
400-m. hurdles	Rome	1960	G. Davis	United States	49.3 sec.
20-km. walk	Melbourne	1956	L. Spirin	U.S.S.R.	1 hr. 31 min. 27 sec.
50-km. walk	Rome	1960	D. Thompson	Great Britain	4 hr. 25 min. 30 sec.
400-m. relay	Melbourne	1956	—	United States	39.5 sec.
	Rome	1960	—	Germany	39.5, sec.
1,600-m. relay	Rome	1960	—	United States	3 min. 2.2 sec.
High jump	Rome	1960	R. Shavlakadze	U.S.S.R.	2.16 m.
Broad jump	Rome	1960	R. Boston	United States	8.12 m.
Hop, step and jump	Rome	1960	J. Schmidt	Poland	16.81 m.
Pole vault	Rome	1960	D. Bragg	United States	4.70 m.
Shot-put	Rome	1960	W. Nieder	United States	19.68 m.
Hammer throw	Rome	1960	V. Rudenhov	U.S.S.R.	67.10 m.
Javelin throw	Melbourne	1956	E. Danielsen	Norway	85.71 m.
Discus throw	Rome	1960	A. Oerter	United States	59.18 m.
Decathlon	Rome	1960	R. Johnson	United States	8,392 pt.

were also double winners, as were George Larner of Great Britain and E. Lemming of Sweden, the first Scandinavian champion. John Hayes of the U.S. in the marathon and Wyndham Halswelle of Great Britain, in the 400-m. run, scored disputed victories.

Stockholm, 1912.—The name of the greatest athlete in the V Olympiad appears in no record books. He was Jim Thorpe, American Indian, who won the pentathlon and decathlon, but was later disqualified for professionalism. Even without Thorpe's victories, the U.S. was still dominant, with Ralph Craig taking the sprints, schoolboy James "Ted" Meredith setting a world's record in the 800-m. run and Ralph Rose, Patrick McDonald and Matthew McGrath monopolizing the weight events. Finland earned its first gold medals, six all told. with three of them going to Hannes Kolehmainen in the distance runs.

Antwerp, 1920.—After an eight-year hiatus, the Olympics resumed in war-torn Belgium with the largest program to that date. These games saw the debut of Finland's Paavo Nurmi, destined to be second only to Ewry in Olympic track and field victories. Nurmi won the 10,000-m. run and cross-country races; Kolehmainen took the marathon; five other Finnish victories in field events enabled the small Nordic nation to tie the U.S. in track and field events with nine gold medals apiece. Sprinters Charles Paddock and Allen Woodring led the U.S. team: which had no double winner like Nurmi. Twin triumphs were scored by A. G. Hill of Great Britain in the middle distances and Ugo Frigerio of Italy in the walks.

Paris, *1924.*—For the first time. a modern Olympiad was completely dominated by one man—Nurmi. In one afternoon, within two hours, Nurmi won and set Olympic records in the 1,500-m. and 5,000-m. runs. Later he added the 10,000-m. cross-country title and also won an unofficial 3,000-m. team race. With Ville Ritola winning the other distance races, Finland surpassed its 1920 record with 10 gold medals. The U.S., however, had 12 this time. with Harold Osborn winning the high jump and decathlon and Clarence Houser taking the shot-put and discus. Harold Abrahams in the 100-m. dash, Eric Liddell in the 400-m. run and Douglas Lowe in the goo-m, run gave Great Britain three individual victories on the track, while the United States had only one such winner, Jackson Scholz in the zoo-m. dash.

Amsterdam, 1928.—Nurmi bowed out of Olympic history with his sixth gold medal in the 10,000-m. run, but the continuance of Finnish domination of the distance races was assured when Harri Larva won the 1,500-m. run, Ritola took the 5,000-m. run and Toivo Loukola captured the 3,000-m. steeplechase. A 19-year-old Canadian schoolboy, Percy Williams, was the surprise winner in the sprints. Veteran British stars Douglas Lowe and David, Lord Burghley took the 800-m. run and 400-m. hurdles, respectively. The U.S. was saved from a shutout on the track when Ray Barbutt won the 400-m. run, but did score heavily in the relays and field events. Asia appeared in the gold medal list for the first time when Mikio Oda of Japan won the hop, step and jump. Women participated for the first time in track and field events.

Los Angeles, 1932.—The great distances involved in travel and a world-wide depression cut the entries in half, but the introduction of the Olympic Village marked the X Olympiad as another advance toward Baron de Coubertin's dream. After its embarrassments of the 1920s, the U.S. made a strong comeback on native soil as records were set in almost every event. Eddie Tolan won and set new marks in both sprints. William Carr set a world's record in the 400-m. run after a duel with another U.S. runner, Ben Eastman. George Saling in the hurdles, William Miller in the pole vault, Edward Gordon in the broad jump, Lee Sexton in the shot-put, John Anderson in the discus and James Bausch in the decathlon were other U.S. champions. British schoolmaster Thomas Nampson set a world's record in the 800-m. run and his teammate Thomas Green won the jo-km. walk. Both relays. 400-m. and 1,600-m., went to the U.S. in world's record times. Lauri Lehtinen and Volmari Iso-Hollo gave Finland two distance victories, but Luigi Beccali of Italy and Janusz Kusocinski of Poland prevented any sweep like those recorded in the 1920s by the Finns, as they won the 1,500-m. and 10.000-m. runs, respectively.

Berlin, 1936.—The role which Nurmi played at Paris in 1924 fell to Jesse Owens, an American Negro, in the XI Olympiad, under quite dramatic conditions. Adolf Hitler attempted to turn the Berlin spectacle into a glorification of his Nazi state and the result was that a strong movement developed in the United States against participation in the games. The movement failed of its purpose, however, and Owens was one of seven U.S. Negro stars to win gold medals in track and field. Owens won four gold medals, set two Olympic records, tied a third and was part of a 400-m. relay team which set a world's record. Other Negro stars were Archie Williams, who won the 400-m. run; John Woodruff. who took the goo-m. run; Cornelius Johnson, who won the high jump; and Ralph Metcalfe, who ran with Owens on the relay team. Other U.S. champions were Earle Meadows in the pole vault. Kenneth Carpenter in the discus and Glenn Morris with a world's record in the decathlon. Harold Whitlock was Great Britain's only individual winner in the jo-km. walk, but John Lovelock of New Zealand set a world's record as he won the 1,500-m. run and the British team of Frederick Wolff, A. G. K. Brown, Godfrey Rampling and William Roberts defeated the U.S. in the 1,600-m. relay. Finland swept the distance races with Gunnar Hockert, Ilmari Salminen and Iso-Hollo. while Germany was limited to weight victories by Hans Woellke, Karl Hein and Gerhard Stock.

London, 1948.—To White City stadium for the XIV Olympiad came the victorious nations of World War II (except the C.S.S.R.) and the neutrals. Germany and Japan, growing athletic powers of the 1930s, were absent, but were to be present in 1952 at Helsinki. It mas predicted that only neutral Sweden would be able to challenge C.S. athletes in track and field and so it proved, with no other nation having more than one gold medalist. The U.S. champions of 1936 were gone, but new names replaced them. Hurdler Harrison Dillard failed to qualify in his own event, but went on to qualify for and win the 100-m. dash. Melvin Patton won the 200-m. dash. Mal Whitfield the goo-m. run and William Porter and Roy Cochran the hurdles. In the field events; Owen Guinn Smith, Willie Steele and Wilbur Thompson scored easy victories. A 17-year-old California schoolboy. Robert Mathias, won the grueling decathlon test and the two U.S. relay teams scored

TABLE III.—*Olympic Champions, 1896–1912*

Event	1896	1900	1904	1908	1912
TRICK AND FIELD—;\SEN					
60-m. dash	—	A. Kraenzlein; U.S. (7.0 sec.)	A. Hahn; U.S. (7 sec.)	—	—
100-m. dash	T. Burke; U.S. (12.0 sec.)	F. Jarvis; U.S. (10.8 sec.)	A. Hahn; U.S. (11 sec.)	R. Walker; S.Af. (10.8 sec.)	R. Craig; U.S. (10.8 sec.)
200-m. dash	—	J. Tewksbury; U.S. (22.2 sec.)	A. Hahn; U.S. (21.6 sec.)	R. Kerr; Can. (22.6 sec.)	R. Craig; U.S. (21.7 sec.)
400-m. run	T. Burke; U.S. ij4.2 sec.)	If. Long; U.S. (49.4 sec.)	H. Hillman; U.S. (49.2 sec.)	W. Halswelle; Gt.Brit. (50 sec.; walkover)	C. Reidpath; U.S. (48.2 sec.)
800-m. run	E. Flack; Austr. (2 min. 11 sec.)	A. Tysoe; Gt.Brit. (2 min. 1.4 sec.)	J. Lightbody; U.S. (1 min. 56 sec.)	32. Sheppnrd; U.S. (1 min. 52.8 sec.)	J. Meredith; U.S. (1 min. 51.9 sec.)
1,500-m. run	E. Flack; Austr. (4 min. 33.2 sec.)	C. Bennett; Gt.Brit. (4 min. 6 sec.)	J. Lightbody; U.S. (4 min. 5.4 sec.)	M. Sheppard; U.S. (4 min. 3.4 sec.)	A. Jackson; Gt.Brit. (3 min. j6.8 sec.)
5,000-m. run	—	—	—	—	H. Kolehmainen; Fin. (14 min. 36.6 sec.)
10,000-m. run	—	—	—	E. Voigt; Gt.Brit. (25 min. 11.2 sec.)*	H. Kolehmainen; Fin. (31 min. 20.8 sec.)
Marathon	S. Louis; Gr. (2 hr. 58 min. 50 sec.)	M. Theato; Fr. (2 hr. 59 min. 45 sec.)	T. Hicks; U.S. (3 hr. 28 min. 53 sec.)	J. Hayes; U.S. 12 hr. 55 min. 18.4 sec.)	K. McArthur; S.Af. (2 hr. 36 min. 54.8 sec.)
110-m. hurdles	'T. Curtis; U.S. (17.6 sec.)	A. Kraenzlein; U.S. (15.4 sec.)	F. Schule; U.S. (16 sec.)	F. Smithson; U.S. (15 sec.)	F. Kelly; U.S. (15.1 sec.)
zoo-m. hurdles	—	A. Kraenzlein; U.S. (25.4 sec.)	H. Hillman; U.S. (24.6 sec.)	—	—
400-m. hurdles	—	J. Tewksbury; U.S. (57.6 sec.)	H. Hillman; U.S. (53 sec.)	C. Bacon; G.S. (55 sec.)	—
z,joo-m. steeplechase	—	G. Orton; U.S. (7 min. 34 sec.)	J. Lightbody; U.S. (7 min. 39.6 sec.)	A. Russell; Gt.Brit. (10 min. 47.8 sec.)†	—
4,000-m. steepiechase	—	J. Rimmer; Gt.Brit. (12 min. 58.4 sec.)	—	—	—
10-km. walk	—	—	—	G. Larner; Gt.Brit. (1 hr. 15 min. 57.4 sec.)‡	G. Goulding; Can. (46 min. 28.4 sec.)
3,500-m. walk	—	—	—	G. Larner; Gt.Brit. (14 min. 5j sec.)	—
400-m. relay	—	—	—	—	Great Britain (42.4 sec.)
1,600-m. relay	—	—	—	United States (3 min. 29.4 sec.)	United States 13 min. 16.6 sec.)
Team races	—	Gt.Brit. (5,000 m.)	United States (4 mi.)	Great Britain (3 mi.)	United States (3,000 m.)
8,000-m. cross country (team)	—	—	—	—	Sweden
8,000-m. cross country (indiv.)	—	—	—	—	H. Kolehmainen; Fin. (45 min. 11.6 sec.)
Standing high jump	—	R. Ewry; U.S. (5 ft. 4 15/16 in.)	R. Ewry; U.S. (4 ft. 10 15/16 in.)	R. Ewry; U.S. (5 ft. 1 13/16 in.)	P. .\dams; U.S. (5 it. 4 1/8 in.)
Running high jump	E. Clark; U.S. (5 ft. 11 2/9 in.)	I. Barter; U.S. (6 ft. 2¾ in.)	S. Jones; U.S. (5 ft. 10 15/16 in.)	H. Porter; U.S. (6 ft. 2 13/16 in.)	A. Richards; U.S. (6 it. 3 15/16 in.)
Standing broad jump	—	R. Ewry; U.S. (10 it. 6 3/8 in.)	R. Ewry; U.S. (11 ft. 4 7/8 in.)	R. Ewry; U.S. (10 ft. 11 1/4 in.)	C. Tsiklitiras; Gr. (11 ft. 1 1/16 in.)
Running broad jump	E. Clark; U.S. (20 ft. 10 in.)	A. Kraenzlein; U.S. (23 ft. 6 7/8 in.)	M. Prinstein; U.S. (24 ft. 1 3/8 in.)	F. Irons; U.S. (24 ft. 6½ in.)	A. Gutterson; U.S. (24 ft. 11 3/16 in.)
Pole vault	W. Hoyt; U.S. (10 ft. 9 7/8 in.)	I. Baxter; U.S. (10 ft. 9 7/8 in.)	C. Dvorak; U.S. (11 ft. 6 in.)	E. Cooke; U.S. A. Gilbert; U.S. (tied) (12 ft. 2 1/16 in.)	H. Babcock; U.S. (12 ft. 11½ in.)
Standing hop, step and jump	—	R. Ewry; U.S. (34 it. 8¼ in.)	R. Ewry; U.S. (34 ft. 7 3/16 in.)	—	—
Running hop, step and jump	J. Connolly; U.S. (44 ft. 11¾ in.)	M. Prinstein; U.S. (47 ft. 4% in.)	M. Prinstein; U.S. (47 it.)	T. Ahearne; Gt.Brit. (48 ft. 11 3/8 in.)	G. Lindhlom; Swed. (48 ft. 5 1/16 in.)
16-lb. shot-put	R. Garrett; U.S. (36 ft. 9¾ in.)	R. Sheldon; U.S. (46 ft. 3 1/8 in.)	R. Rose; U.S. (48 ft. 7 in.)	R. Rose; U.S. (46 ft. 7 1/16 in.)	P. McDonald; U.S. (50 ft. 3 15/16 in.)
Special shot-put	—	—	E. Desmartean; Can. (34 ft. 3 15/16 in.)§	—	R. Rose; U.S. (go ft. 10 9/16 in.)‖
Discus throw (free style)	R. Garrett; U.S. (95 ft. 7 3/8 in.)	R. Bauer; Hung. (118 ft. 2 7/8 in.)	M. Sheridan; U.S. (128 ft. 10 1/2 in.)	M. Sheridan; U.S. (134 ft. 1 13/16 in.)	A. Taipale; Fin. (145 ft. 9/16 in.)
Discus throw (special styles)	—	—	—	M. Sheridan; U.S. (124 ft. 7 11/16 in.)¶	A. Taipale; Fin. (271 ft. 10 9/16 in.)‖
Javelin throw (free style)	—	—	—	E. Lemming; Swed. (178 ft. 7½ in.)	E. Lemming; Smed. (198 ft. 11 3/8 in.)
Javelin throw ispecial styles)	—	—	—	E. Lemming; Smed. (179 ft. 10 3/8 in.)¶	J. Saaristo; Fin. (358 it. 11 7/8 in.)‖
16-lb. hammer throw	—	J. Flanagan; U.S. (167 ft. 3% in.)	J. Flanagan; U.S. (168 ft. 1 5/16 in.)	J. Flanagan; U.S. (170 ft. 4 1/16 in.)	M. McGrath; U.S. (179 ft. 7 1/8 in.)
All-around championship	—	—	T. Kiely; Gt.Brit.	—	H. Wieslander; Swed. ♀
Pentathlon	—	—	—	—	F. Bie; Nor.
Tug of war	—	Sweden-Denmark	United States	Great Britain	Sweden
SWIMMING—MEN					
so-yd. free style	—	—	Z. Halmay; Hung. (28 sec.)	—	—
100-m. free style	A. Hajós (Guttmann); Hung. (1 min. 22.2 sec.)	—	Z. Halmay; Hung. (1 min. 2.8 sec.)♁	C. Daniels; U.S. (1 min. 5.6 sec.)	D, Kahanamoku; U.S. (1 min. 3.4 sec.)
100-m. free style (sailors)	J. Malokinis; Gr (2 min. 20.4 sec.)	—	—	—	—
zoo-m. free style	—	F. Lane; Austr. (2 min. 25.2 sec.)	C. Daniels; U.S. (2 min. 44.2 sec.)□	—	—
400-m. free style	P. Neumann; Aus. (8 min. 12.6 sec.)°	—	C. Daniels; U.S. (6 min. 16.2 sec.)▲	H. Taylor; Gt.Brit. (5 min. 36.8 sec.)	G. Hodgson; Can. (5 min. 24.4 sec.)
1,000-m. free style	A. Hajós (Guttmann); Hung. (18 min. 22.2 sec.)+	J. Jarvis; Gt.Brit. (13 min. 40.2 sec.)	E. Rausch; Ger. (13 min. 11.4 sec.)⊕	—	—
1,joo-m. free style	—	—	E. Rausch; Ger. (27 min. 18.2 sec.)**	H. Taylor; Gt.Brit. (22 min. 48.4 sec.)	G. Hodgson; Can. (22 min.)
4,000-m. free style	—	J. Jarvis; Gt.Brit. (58 min. 24 sec.)	—	—	—
100-m. backstroke	—	E. Hoppenberg; Ger. (2 min. 47 sec.)††	W. Brack; Ger. (1 min. 16.8 sec.)♁	A. Bieberstein; Ger. (1 min. 24.6 sec.)	H. Hebner; U.S. (1 min. 21.2 sec.)
zoo-m. breast stroke	—	—	—	F. Holman; Gt.Brit. (3 min. 9.2 sec.)	W. Bathe; Ger. (3 min. 1.8 sec.)
400-m. breast stroke	—	—	G. Zacharias; Ger. (7 min. 23.6 sec.)▲	—	W. Bathe; Ger. (6 min. 29.6 sec.)
zoo-m. obstacle swim	—	F. Lane; Austr. 12 min. 38.4 aec.)	—	—	—
60-m. underwater swim	—	W. de Vaudeville; Fr. (1 min. j3.4 sec.)	—	—	—
zoo-yd. relay	—	Germany (time not given)††	United States (2 min. 4.6 sec.)	—	—
800-m. relay	—	—	—	Great Britain (10 min. 55.6 sec.)	Australia-Sew Zealand (10 min. 11.2 sec.)
Plunge for distance	—	—	W. Dickey; U.S. (62 ft. 6 in.)	—	—
High diving	—	—	G. Sheldon; U.S.	H. Johansson; Swed.	E. Adlerz; Smed. (two events)
Springboard diving	—	—	—	A. Zurner; Ger.	P. Günther; Ger.

*5 mi. ~~, zmo ‡10 mi. §56-lb. weight. ‖Both hands. ¶Greek style. ♀Decathlon. ♁100 yd. □220 yd. °500 m. ▲440 yd. +~,zom. ⊕880 yd. **1 mi. ††200 m.

TABLE III.—*Olympic Champions, 1896–1912* (Continued)

Event	1896	1900	1904	1908	1912
		SWIMMING—WOMEN			
100-m. free style	—	—	—	—	F. Durack; Austr.-N.Z. (1 min. 22.2 sec.)
400-m. relay	—	—	—	—	Great Britain (5 min. 52.8 sec.)
High diving	—	—	—	—	G. Johansson; Swed.
		BOXING			
Flyweight	—	—	G. Finnegan; U.S.	—	—
Bantamweight	—	—	O. ~~Kirk~~ U.S.	H. Thomas; Gt.Brit.	—
Featherweight	—	—	O. Kirk; U.S.	R. Gunn; Gt.Brit.	—
Lightweight	—	—	H. Spanger; U.S.	F. Grace; Gt.Brit.	—
Welterweight	—	—	A. Young; U.S.	—	—
Middleweight	—	—	C. Mayer; U.S.	J. Douglas; Gt.Brit.	—
Heavyweight	—	—	S. Berger; U.S.	A. Oldman; Gt.Brit.	—
		WRESTLING (CATCH-AS-CATCH-CAN)			
Flyweight	—	—	R. Curry; U.S.	—	—
Bantamweight		—	G. Mehnert; U.S.	G. Mehnert; U.S.	—
Featherweight	K. Schuhmann; Ger.‡‡	—	I. Niflot; U.S.	G. Dole; U.S.	—
Lightweight	—	—	B. Bradshaw; U.S.	G. Relwyskow; Gt.Brit.	—
Welterweight	—	—	O. Roem; U.S.	—	—
Middleweight	—	—	C. Erickson; U.S.	S. Bacon; Gt.Brit.	—
Heavyweight	—	—	B. Hansen; U.S.	G. O'Kelly; Gt.Brit.	—
		WRESTLING (GRECO-ROMAN)			
Featherweight	—	—	—	—	K. Koskelo; Fin.
Lightweight	—	—	—	E. Porro; It.	E. Väre; Fin.
Middleweight	—	—	—	F. Martenson; Swed.	C. Johansson; Swed.
Light heavyweight	—	—	—	V. Weckman; Fin.	—
Heavyweight	—	—	—	R. Weisz; Hung.	Y. Saarela; Fin.
		WEIGHT LIFTING			
One hand	L. Elliot; Gt. Brit.		O. Osthoff; U.S.	—	—
Two hands	V. Jensen; Den.	—	P. Kakousis; Gr.	—	—
		CYCLING			
Road race (indiv.)	A. Konstantinidis; Gr.			V. Johnson; Gt.Brit.	R. Lewis; S.Af.
Road race (team)	—	—	—	—	Sweden
1,000-m scratch	P. Masson; Fr.§§	G. Taillandier; Fr.	M. Hurley; U.S.‖‖	(race declared void)	—
2,000-m tandem race	—	—	—	M. Schilles; Fr. A. Auffray; Fr.	—
Team pursuit	—	United States (1,500 m.)	—	Great Britain (1⅜ mi.)	—
Time trials	P. Masson; Fr (333.3 m.)	W. Johnson; Gt.Brit. (⅜ mi.)	—	—	—
440-yd. race	—	—	M. Hurley; U.S.	—	—
⅓-mi. race	—	—	Sf. Hurley; U S.	—	—
1-mi. race	—	—	M. Hurley; U.S.	—	—
5,000-m. race	—	—	B. Downing; U.S.¶¶	B. Jones; Gt.Brit.	—
10-km. race	P. Masson; Fr.	—	C. Schlee; U.S.♀♀	C. Kingsbury; Gt.Brit.♂♂	—
100-km. race	L. Flameng; Fr.	—	—	C. Bartlett; Gt.Brit.	—
25-mi. race	—	—	B. Downing; U.S.	—	—
12-hr. race	F. Schmal; Aus.	—	—	—	—
		EQUESTRIAN EVENTS			
Prize jumping (indiv.)	—	Haegeman; Belg.	—	—	J. Cariou; Fr.
Prize jumping (team)	—	—	—	—	Sweden
High jump	—	Gardère; Fr. G. Triesino; It. (tied)	—	—	—
Long jump	—	Van Langendonck; Belg.	—	—	—
3-day military event (indiv.)	—	—	—	—	A. Nordlander; Swed.
3-day military event (team)	—	—	—	—	Sweden
Dressage (indiv.)	—	—	—	—	C. Bonde; Swed.
		FENCING			
Indiv. foil (amateur)	E. Gravelotte; Fr.	C. Coste; Fr.	R. Fonst; Cuba	—	N. Nadi; It.
Indiv. foil (professional)	L. Pyrgos; Gr.	L. Merignac; Fr.	—	—	—
Indiv. foil (junior)	—	—	A. Fox; U.S.	—	—
Team foil	—	—	Cuba	—	—
Indiv. sabre (amateur)	J. Georgiadis; Gr.	G. de la Falaise; Fr.	M. Diaz; Cuba	J. Fuchs; Hung.	J. Fuchs; Hung.
Indiv. sabre (professional)	—	A. Conte; It.	—	—	—
Team sabre	—	—	—	Hungary	Hungary
Indiv. épée (amateur)	—	R. Fonst; Cuba	R. Fonst; Cuba	G. Alibert; Fr.	P. Anspach; Belg.
Indiv. épée (professional)	—	A. Ayat; Fr.	—	—	—
Indiv. épée (open)	—	A. Ayat; Fr.	—	—	—
Team épée ...	—	—	—	France	Belgium
Singlestick	—		A. Van Zo Post; Cuba	—	—
		GYMNASTICS			
All-around indiv.	—	S. Sandras; Fr.	J. Lenhardt; U.S.	A. Braglia; It.	A. Braglia; It.
Parallel bars (indiv.)	A. Flatow; Ger.	—	G. Eyser; U.S.	—	—
Parallel bars (team)	Germany	—	—	—	—
Horizontal bar (indiv.)	H. Weingärtner; Ger.	—	A. Heida; U.S. E. Hennig; U.S. (tied)	—	—
Horizontal bar (team)	Germany	—	—	—	—
Side horse	L. Zutter; Switz.	—	A. Heida; U.S.	—	—
Flying rings	J. Mitropoulos; Gr.	—	H. Glass; U.S.	—	—
Long horse (vaults)	K. Schuhmann; Ger.	—	A. Heida; U.S. G. Eyser; U.S. (tied)	—	—
Rope climb	N. Andriakopoulos; Gr.	—	G. Eyser; U.S.	—	—
Indian clubs	—	—	E. Hennig; U.S.	—	—
3-event competition (indiv.)	—	—	A. Spinnler; Ger.	—	—
Triathlon	—	—	M. Emmerich; U.S.	—	—
7-event competition (indiv.)	—	—	A. Heida; U.S.	—	—
Team (Swedish system)	—	—	—	—	Sweden
Team (optional exercises)	—	—	—	—	Norway
Team (prescribed apparatus)	—	—	United States	Sweden	Italy
		ROWING			
Single sculls (senior)	—	H. Barrelet; Fr.	F. Greer; U.S.	H. Blackstaffe; Gt.Brit.	W. Kinnear; Gt.Brit. (skiff)
Single sculls (assn. senior)	—	—	D. Duffield; U.S.	—	—
Single sculls (intermediate)	—	—	F. Shepherd; U.S.	—	—
Double sculls	—	—	United States (2 events)	—	—
Pairs (without coxswain)	—	Belgium	United States (2 events)	Great Britain	—
Pairs (with coxswain)	—	Netherlands	—	—	—
Fours (without coxswain)	—	France (2 events)	United States (3 events)	Great Britain	Germany (outrigger)
Fours (with coxswain)	—	Germany	—	—	Denmark
Eights	—	United States	United States	Great Britain	Great Britain

‡‡All competitors wrestled in one group regardless of weight. §§2,000 m. ‖‖880 yd. ¶¶2 mi. ♀♀5 mi. ♂♂20 km.

TABLE 111.—*Olympic Champions, 1896–1912 (Continued)*

Event	1896	1900	1904	1908	1912
		YACHTING			
Over 10-m. class	—	"Esterel"; Fr.	—	"Hera"; Gt.Brit.□□	"Magda IX"; Nor.□□
10-m. class	—	"Aschenbrödel"; Ger.	—	—	"Kitty"; Swed.
8-m. class	—	"Olle"; Gt.Brit.°°	—	"Cobweb"; Gt.Brit.	"Taifun"; Nor.
7-m. class	—	—	—	"Heroine"; Gt.Brit.	—
6-m. class	—	"Lerina"; Switz.▲▲	—	"Dormy"; Gt.Brit.	"Mac Miche"; Fr.
		MOTOR BOATING			
A class	—	—	—	E. Thubron Fr.	—
B class (under 60 ft.)	—	—	—	T. Thornycroft; Gt.Brit.	—
C class (6.5—8-m.)	—	—	—	T. Thornycroft; Gt.Brit.	—
		SHOOTING			
Army gun (indiv., 200 m.)	P. Rarasevdas; Gr.	—	—	—	—
Army gun (indiv., 300 m.)	G. Orphanidis; Gr.	A. Helgerad; U.S.	—	—	S. Prokopp; Hung.
Army gun (indiv., 600 m.)	—	—	—	—	P. Colas; Fr.
Army gun (indiv., 1 000 yd.)	—	—	—	J. Millner; Gt.Brit.	—
Army gun (indiv., all-around)	—	J. Millner; U.S.	—	—	—
Army gun (team 300 m.)	—	Norway	—	—	—
Army gun (team: all-around)	—	United States	—	United States	United States
Full-bore rifle (300 m., standing)	—	L. Madsen; Den.	—	—	—
Full-bore rifle (300 m., kneeling)	—	K. Staeheli; Switz.	—	—	—
Full-bore rifle (300 m., prone)	—	A. Paroche; Fr.	—	—	—
Free rifle (indiv., 300 m.)	—	E.Kellenberger;Switz.++	—	A. Helgerud; Nor.	P. Colas; Fr.
Free rifle (team, 300 m.)	—	Switzerland++	—	Norway	Sweden
6 mm. small gun (open rear sight)	—	C. Grosett; Fr.	—	—	—
Small-bore rifle	—	A. Carnell; Gt.Brit.	—	A. Carnell; Gt.Brit.	F. Hird; U.S.
Small-bore rifle (team)	—	Great Britain	—	Great Britain	Great Britain
Small-bore rifle (vanishing target)		W. Styles; Gt.Brit.	—	W. Styles; Gt.Brit.	V. Carlberg; Swed.
Small-bore (team, vanishing target)	—	—	—	—	Sweden
Small-bore rifle (moving target)	—	A. Fleming; Gt.Brit.	—	A. Fleming; Gt.Brit.	—
Pistol (25-m.)	J. Phrangudis; Gr.	—	—		—
Pistol (30-m.)	S. Paine; U.S.	—	—	—	—
Service revolver	J. Paine; U.S.	M. Larrouy; Fr.	—	—	—
Revolver (team)	—	Switzerland	—	—	—
Free revolver	—	K. Röderer; Switz.	—	—	—
Revolver and pistol	—	P. Van Asbrock; Belg.	—	P. Van Asbrock; Belg.	A. Lane; U.S.
Revolver and pistol (team)	—	United States	—	United States	United States
Dueling pistol	—	—	—	—	A. Lane; U.S.
Dueling pistol (team)	—	—	—	—	Sweden
Running deer (single shot)	—	O. Swahn; Swed.	—	O. Swahn; Swed.	A. Swahn; Swed.
Running deer (double shot)	—	W. Winans; U.S.	—	W. Winans; U.S.	A. Lundeberg; Swed.
Running deer (team)	—	Sweden	—	Sweden	Sweden
Wild boar target (moving)	—	L. Debray; Fr.	—	—	—
Live pigeon	—	L. Bon de Lunden; Belg.	—	—	—
Live pigeon (hunting gun)	—	R. de Barbarin; Fr.	—	—	—
Clay pigeon	—	W. Ewing; Can.	—	W. Ewing; Can.	J. Graham; U.S.
Clay pigeon (team)	—	Great Britain	—	Great Britain	United States
		ARCHERY			
Game shooting	—	Mackintosh; Austr.	—	—	—
Cordon doré (50 in.)	—	Hcrouin; Fr.	—	—	—
Chapelet	—	Mougin; Fr.	—	—	—
Cordon doré perche (33 m.)	—	H. Van Innis; Belg.	—	—	—
À la perche	—	Foulon; Fr.	—	—	—
Au chapelet (33 m.)	—	H. Van Innis; Belg.	—	—	—
American round (men)	—	—	H. Taylor; U.S.	—	—
York round (men)	—	—	P. Bryant; U.S.	W. Dod; Gt.Brit.	—
Team competition (men)	—	—	United States	—	—
Continental style (men)	—	—	—	E. Grizot; Fr.	—
Columbia round (women)	—	—	M. Howell; U.S.	—	—
National round (women)	—	—	M. Howell; U.S.	Q. Newall; Gt.Brit.	—
Team competition (women)	—	—	United States	—	—
		TENNIS AND LAWN TENNIS			
Lawn tennis (men's singles)	J. Boland; Gt.Brit.	L. Doherty; Gt.Brit.	B. Wright; U.S.	M. Ritchie; Gt.Brit.	C. Winslow; S.Af.
Lawn tennis (men's doubles)	J. Boland; Gt.Brit. F. Thraun; Ger.	R. Doherty; Gt.Brit. L. Doherty; Gt.Brit.	E. Leonard; U.S. B. Wright; U.S.	G. Hillyard; Gt.Brit. R. Doherty; Gt.Brit.	H. Kitson; S.Af. C. Winslow; S.Af.
Lawn tennis (women's singles)	—	C. Cooper; Gt.Brit.	—	D. Chambers-Lambert, Gt.Brit.	M. Broquedis; Fr.
Lawn tennis (mixed doubles)	—	C. Cooper; Gt.Brit. R. Doherty; Gt.Brit.	—	—	D. Köring; Ger. H. Schomburgk; Ger.
Tennis (men's singles)	—	—	—	A. Gore, Gt.Brit.	A. Gobert; Fr.
Tennis (men's doubles)	—	—	—	H. Roper-Barrett and A. Gore; Gt.Brit.	M. Germot; Fr. A. Gobert; Fr.
Tennis (women's singles)	—	—	—	G. Eastlake-Smith; Gt.Brit.	E. Hannam; Gt.Brit.
Tennis (mixed doubles)	—	—	—	—	E. Hannam; Gt.Brit. C. Dixon; Gt.Brit.
Tennis, English rules (*jeu de paume*)	—	—	—	J. Gould; U.S.	—
		TEAM SPORTS			
Polo	—	—	—	Great Britain	—
Water polo	—	Great Britain	United States	Great Britain	Great Britain
Association football (soccer)	—	Great Britain	Canada	Great Britain	Great Britain
Rugby football	—	France	—	Australia-New Zealand	—
Basketball	—	—	United States	—	—
Field hockey	—	—	—	England	—
Baseball	—	—	—	—	United States
Lacrosse	—	—	Canada	Canada	—
		MISCELLANEOUS SPORTS			
Figure skating (men)	—	—	—	U. Salchow; Swed.	—
Figure skating (women)	—	—	—	M. Syers; Gt.Brit.	—
Figure skating (pairs)	—	—	—	A. Hübler; Ger. H. Burger; Ger.	—
Special figures	—	—	—	N. Kolomenkin; Russ.	—
Golf (men)	—	C. Sands; U.S.	G. Lyon; Can.	—	—
Golf (women)	—	M. Abbot; U.S.	—	—	—
Roque	—	—	C. Jacobus; U.S.	—	—
Racquets (singles)	—	—	—	E. Noel; Gt.Brit.	—
Racquets (doubles)	—	—	—	V. Pennel; Gt.Brit. J. Astor; Gt.Brit.	—
Glima (Icelandic) wrestling	—	—	—	—	Iceland
Modern pentathlon	—	—	—	—	G. Lilliehöök; Swed.
		ART CONTESTS			
Architecture	—	—	—	—	H. Monod; Switz. A. Laverrière; Switz.
Literature	—	—	—	—	P. de Coubertin; Fr.⊕⊕
Music	—	—	—	—	R. Barthelemy; It.
Painting	—	—	—	—	W. Winans; U.S.

□□12-m. boat. °°Also classed as a 3-ton boat. ▲▲Also classed as a 2-ton boat. ++Full-bore rifle. ⊕⊕Father of the modern Olympics.

Table IV.—*Olympic Champions, 1920–36*

Event	1920	1924	1928	1932	1936
			Track and Field—Men		
100-m. dash	C. Paddock; U.S. (10.8 sec.)	H. Abrahams; Gt.Brit. (10.6 sec.)	P. Williams; Can. (10 8 sec.)	E. Tolan; U.S. (10.3 sec.)	J. Owens; U.S. (10.3 sec.)
200-m. dash	A. Woodring; U.S. (22 sec.)	J. Scholz; U.S. (21.6 sec.)	P. Williams; Can. (21.8 sec.)	E. Tolan; U.S. (21.2 sec.)	J. Owens; U.S. (20.7 sec.)
400-m. run	B. Rudd; S.Af. (49.6 sec.)	E. Liddell; Gt.Brit. (47.6 sec.)	R. Barbutti: U.S. (47.8 sec.)	W. Carr: U.S. (46.2 sec.)	A. Williams; U.S. (46.5 sec.)
800-m. run	A. Hill: Gt.Brit. (1 min. 53.4 sec.)	D. Lowe; Gt.Brit. (1 min. 52.4 sec.)	D. Lowe; Gt.Brit. (1 min. 51.8 sec.)	T. Hampson; Gt.Brit. (1 min. 49.8 sec.)	J. Woodruff; U.S. (1 min. 52.9 sec.)
1,500-m. run	.4. Hill; Gt.Brit. (4 min. 1.8 sec.)	P. Nurmi; Fin. (3 min. j3.6 sec.)	H. Larva; Fin. (3 min. 53.2 sec.)	L. Beccali; It. (3 min. 51.2 sec.)	J. Lovelock; N.Z. (3 min. 47.8 sec.)
5,000-m. run	J. Guillemot; Fr. (14 min. 5j.6 sec.)	P. Nurmi; Fin. (14 min. 31.2 sec.)	V. Ritola; Fin. (14 min. 38 sec.)	L. Lehtinen: Fin. (14 min. 30 sec.)	G. Höckert; Fin. (14 min. 22.2 sec.)
10,000-m. run	P. Nurmi; Fin. (31 min. 45.8 sec.)	V. Ritola; Fin. (30 min. 23.2 sec.)	P. Nurmi; Fin. (30 min. 18.8 sec.)	J. Kusocinski: Pol (30 min. 11.4 sec.)	I. Salminen; Fin. (30 min. 15.4 sec.)
Marathon	H. Kolehmainen: Fin. (2 hr. 32 min. 35.8 sec.)	A. Stenroos; Fin. (2 hr. 41 min. 22.6 sec.)	A. El Ouafi; Fr. (2 hr. 32 min. 57 sec.)	J. Zabala; Arg. (2 hr. 31 min. 36 sec.)	K. Son; Jap. (2 hr. 29 min. 19.2 sec.)
110-m. hurdles	E. Thompson; Can. (14.8 sec.)	D. Kinsey; U.S. (15 sec.)	S. Atkinson; S.Af. (14.8 sec.)	G. Saling; U.S. (14.6 sec.)	F. Towns; U.S. (14.2 sec.)
qoo-m. hurdles	F. Loomis; U.S. (54 sec.)	M. Taylor; U.S. (j2.6 sec.)	Lord Burghley; Gt.Brit. (53.4 sec.)	R. Tisdall; Eire (51.8 sec.)	G. Hardin; U.S. (52.4 sec.)
3,000-m. steeplechase	P. Hodges; Gt.Brit. (10 min. 0.4 sec.)	V. Ritola; Fin. (9 min. 33.6 sec.)	T. Loukola; Fin. (9 min. 21.8 sec.)	V. Iso-Hollo; Fin. (10 min. 33.4 sec.)*	V. Iso-Hollo; Fin. (9 min. 3.8 sec.)
3,000-m. team race	United States	Finland	—	—	—
10,000-m. cross country	P. Nurmi: Fin. (27 min. 1j sec.)†	P. Nurmi; Fin. (32 min. 54.8 sec.)	—	—	—
10,000-m. cross country (team)	Finland	Finland		—	
400-m. relay	United States (42 2 sec.)	United States (41 sec.)	United States (41 sec.)	United States (40 sec.)	United States (39.8 sec.)
1,600-m. relay	Great Britain (3 min. 22.2 sec.)	United States (3 min. 16 sec.)	United States (3 min. 14.2 sec.)	United States (3 min. 8.2 sec.)	Great Britain (3 min. g sec.)
3,000-m. walk	U. Fneerio: It. (13 min. 14.2 sec.)	—			
ro-km. walk	U. Frigerio; It. (48 min. 6.2 sec.)	U. Frigerio; It. (47 min. 49 sec.)			
50-km. walk		—		T. Green; Gt.Brit. (4 hr. 50 min. 10 sec.)	H. Whitlock; Gt.Brit. (4 hr. 30 min. 41.4 sec.
High jump	R. Landon; U.S. (6 it. 4 3/16 in.)	H. Osborn; U.S. (6 ft. 5 15/16 in.)	R. King; U.S. (6 ft. 4 3/8 in.)	D. McNaughton; Can. (6 ft. 5 9/16 in.)	C. Johnspn; U.S. (6 ft. 8 in.)
Broad jump	W. Pettersson; Swed. (23 ft. 5 1/2 in.)	H. De Huhbard; U.S. (24 ft. 5 1/8 in.)	E. Hamm; U.S. (25 ft. 4 5/16 in.)	E. Gordon; U.S. (25 ft. 3/4 in.)	J. Omens; U.S. (26 ft. 5 5/16 in.)
Pole vault	F. Foss; U.S. (12 ft. 5 9/16 in.)	L. Barnes; U.S. (12 ft. 11 1/2 in.)	S. Carr; U.S. (13 ft. 9 3/8 in.)	W. Miller; U.S. (14 ft. 1 7/8 in.)	E. Meadows; U.S. (14 ft. 3 1/4 in.)
Hop, step and jump	V. Tuulos; Fin. (47 it. 7 1/16 in.)	A. Winter; Austr. (50 ft. 11 1/4 in.)	M. Oda; Jap. (49 ft. 10 13/16 in.)	C. Nambu; Jap. (51 ft. 6 7/8 in.)	N. Tajima; Jap. (52 ft. 5 15/16 in.)
16-lb. shot-put	V. Pdrhola; Fin. (48 ft. 7 1/16 in.)	C. Houser; U.S. (49 it. 294 in.)	J. Kuck; U.S. (52 ft. 13/16 in.)	L. Sexton; U.S. (52 it. 5 15/16 in.)	H. Woellke; Ger. (53 it. 1 3/4 in.)
56-lb. weight throw	P. MacDonald; U.S. (36 ft. 11 1/2 in.)	—	—	—	
Discus throw	E. Niklander; Fin. (146 it. 7 1/16 in.)	C. Houner; U.S. (151 it. 5 5/16 in.)	C. Houser; U.S. (155 ft. 3 in.)	J. Anderson; U.S. (162 ft. 4% in:)	K. Carpenter; U.S. (165 ft. 7 3/8 in.)
Javelin throw	J. Myrrä; Fin. (215 ft. 9 3/4 in.)	J. Myrrä; Fin. (206 ft. 6 3/4 in.)	E. Lundquist; Swed. (218 ft. 6 1/16 in.)	M. Järvinen; Fin. (238 ft. 6 9/16 in.)	G. Stock: Ger. (235 ft. 8 5/16 in.)
Hammerthrow	P. Ryan; U.S. (173 ft. 5 11/16 in.)	F Tootell; U.S. (174 ft. 10 1/4 in.)	P. O'Callaghan; Eire (168 ft. 7%′ in.)	P. O'Callaghan; Eire (176 ft. 10 13/16 in.)	K. Hein; Ger. (185 ft. 4 in.)
Tug-of-war	Great Britain	—	—	—	—
Pentathlon	E. Lehtonen; Fin.	E. Lehtonen; Fin.	—	—	—
Decathlon	H. Lövland; Nor.	H. Osborn; U.S.	P. Yrjölä; Fin.	J. Bausch; U.S.	G. Morris; U.S.
			Track and Field—Women		
roo-m. dash	—	—	E. Robinson; U.S. (12.2 sec.)	S. Walasiewicz; Pol. (11.9 sec.)	H. Stephens; U.S. (11.5 sec.)
800-m. run	—	—	L. Kadke-Batschauer; Ger. (2 min. 16.8 sec.)	—	—
80-m. hurdles	—	—	—	M. Didrikson; U.S. (11.7 sec.)	T. Valla; It. (11.7 sec.)
400-m. relay	—	—	Canada (48.4 sec.)	United States (47 sec.)	United States (46.9 sec.)
High jump	—	—	E. Catherwood; Can. (5 ft. 2 9/16 in.)	J. Shiley; U.S. (5 ft. 4 15/16 in.)	I: Csák; Hung. (5 ft. 2 15/16 in.)
Discus throw	—	—	H. Konopacka; Pol. (129 ft. 11 13/16 in.)	L. Copeland; U.S. (133 it. 1 5/8 in.)	G. Mauermayer; Ger. (156 ft. 3 3/16 in.)
Javelin throw	—	—	—	M. Didrikson; U.S. (143 ft. 3 11/16 in.)	T. Fleischer; Ger. (148 ft. 234 in.)
			Swimming—Men		
100-m. free style	D. Kahanamoku; U.S. (1 min 0.4 sec.)	J. Weissmüller; U.S. (jg sec.)	J. Weissmüller; U.S. (58.6 sec.)	Y. Miyazaki; Jap. (58.2 sec.)	F. Csik; Hung. (57.6 sec.)
400-m. free style	N. Ross; U.S. (5 min. 26.8 sec.)	J. Weissmüller; U.S. (5 min. 4.2 sec.)	A. Zorilla; Arg. (5 min. 1.6 sec.)	C. Crabbe; U.S. (4 min. 48.4 sec.)	J. Medica; U.S. (4 min. 44.5 sec.)
1,500-m. free style	N. Ross, U.S. (22 min. 23.2 sec.)	A. Charlton; Austr. (20 min. 6.6 sec.)	A. Borg; Swed. (19 min. 51.8 sec.)	K. Kitamura; Jap. (19 min. 12.4 sec.)	N. Terada; Jap. (19 min. 13.7 sec.)
roo-m. backstroke	W. Kealoha; U.S. (1 min. 15.2 sec)	W. Kealoha; U.S. (1 min. 13.2 sec.)	G. Kojac; U.S. (1 min. 8.2 sec.)	M. Kiyokawa; Jap. (1 min. 8.6 sec.)	A. Kiefer; U.S. (1 min. 5.9 sec.)
zoo-m. breast stroke	H. Malmroth; Swed. (3 min. 4.4 sec.)	R. Skelton; U.S. (2 min. 56.6 sec.)	Y. Tsuruta; Jap. (2 min. 48.8 sec.)	Y. Tsuruta; Jap. (2 min. 45.4 sec.)	T. Hamuro; Jap. (2 min. 42.5 sec.)
400-m. breast stroke	H. Malmroth; Swed. (6 min. 31.8 sec.)	—	—	—	—
800-m. relay	United States (10 min. 4.4 sec.)	United States (9 min. 53.4 sec.)	United States (9 min. 36.2 sec.)	Japan (8 min. 58.4 sec.)	Japan (8 min 51.5 sec.)
High diving	A. Wallman; Swed.	R. Eve; Austr.	P. Desjardins; U.S.	H. Smith; U.S.	M. Wayne; U.S.
Artistic diving	C. Pinkston; U.S.	A. White; U.S.	—	—	
Springboard diving	L. Kuehn; U.S.	4. White; U.S.	P. Desjardins; U.S.	M. Galitzen; U.S.	R. Degener; U.S.
			Swimming—Women		
100-m. free style	E. Bleibtrey; U.S. (1 min. 13.6 sec.)	E. Lackie; U.S. (1 min. 12.4 sec.)	A. Osipowich; U.S. (1 min. 11 sec.)	H. Madison; U.S. (1 min. 6.8 sec.)	H. Mastenbroek; Neth. (1 min. 5.9 sec.)
400-m. free style	E. Bleibtrey; U.S. (4 min. 34 sec.)‡	M. Norelius; U.S. (6 min. 2.2 sec.)	M. Norelius; U.S. (5 min. 42.8 sec.)	H. Madison; U.S. (5 min. 28.5 sec.)	H. Mastenbroek; Neth. (5 min. 26.4 sec.)
100-m. backstroke	—	S. Bauer; U.S. (1 min. 23.2 sec.)	M. Braun; Neth. (1 min. 22 sec.)	E. Holm; U.S. (1 min. 19.4 sec.)	D. Senff; Neth. (1 min. 18.9 sec.)
200-m. breast stroke	—	L. Morton; Gt.Brit. (3 min. 33.2 sec.)	H. Schrader; Ger. (3 min. 12.6 sec.)	C. Dennis; Austr. (3 min. 6.3 sec.)	H. Maehata; Jap. (3 min. 3.6 sec.)
400-m. relay	United States (5 min. 11.6 sec.)	United States (4 min. 58.8 sec.)	United States (4 min. 47.6 sec.)	United States (4 min. 38 sec.)	Netherlands (4 min. 36 sec.)
Springboard diving	A. Riggin; U.S.	E. Becker; U.S.	H. Meany; U.S.	G. Coleman; U.S.	M. Gestring; U.S.
High diving	S. Fryland Clausen; Den.	C. Smith; U.S.	E. Becker Pinkston; U.S.	D. Poynton; U.S.	D. Poynton-Hill; U.S.

*Ran extra lap by mistake. †Error in distance. ‡300 m.

TABLE IV.—*Olympic Champions, 1920–36* (*Continued*)

Event	1920	1924	1928	1932	1936
BOXING					
Flyweight	F. De Genero; U.S.	F. La Barba; U.S.	A. Kocsis; Hung.	I. Énekes; Hung.	W. Kaiser; Ger.
Bantamweight	C. Walker; S.Af.	W. Smith; S.Af.	V. Tamagnini; It.	H. Gwynne; Can.	U. Sergo; It.
Featherweight	P. Fritsch; Fr.	J. Fields; U.S.	L. van Klaveren; Neth.	C. Robledo; Arg.	O. Casanovas; Arg.
Lightweight	S. Mosberg; U.S.	H. Nielsen; Den.	C. Orlandi; It.	L. Stevens; S.Af.	I. Harangi; Hung.
Welterweight	T. Schneider; Can.	J. Delarge; Belg.	E. Morgan; N.Z.	E. Flynn; U.S.	S. Suvio; Fin.
Middleweight	H. Mallin; Gt.Brit.	H. Mallin; Gt.Brit.	P. Toscani; It.	C. Barth; U.S.	J. Despeaux; Fr.
Light heavyweight	E. Eagan; U.S.	H. Mitchell; Gt.Brit.	V. Avendano; Arg.	D. Carstens; S.Af.	R. Michelot; Fr.
Heavyweight	R. Rawson; U.S.	O. von Porat; Nor.	R. Jurado; Arg.	S. Lovell; Arg.	H. Runge; Ger.
WRESTLING (CATCH-AS-CATCH-CAN)					
Bantamweight	—	K. Pihlajamäki; Fin.	K. Mäkinen; Fin.	R. Pearce; U.S.	O. Zombori; Hung.
Featherweight	C. Ackerly; U.S.	R. Reed; U.S.	A. Morrison; U.S.	H. Pihlajamäki; Fin.	K. Pihlajamäki; Fin.
Lightweight	K. Anttila; Fin.	R. Vis; U.S.	O. Käpp; Est.	C. Pacome; Fr.	K. Kárpáti; Hung.
Welterweight	—	H. Gehri; Switz.	A. Haavisto; Fin.	J. Van Bebber; U.S.	F. Lewis; U.S.
Middleweight	E. Leino; Fin.	F. Haggmann; Switz.	E. Kyburz; Switz.	I. Johansson; Swed.	E. Poilvé; Fr.
Light heavyweight	A. Larsson; Swed.	J. Spellman; U.S.	T. Sjöstedt; Swed.	P. Mehringer; U.S.	K. Fridell; Swed.
Heavyweight	R. Roth; Switz.	H. Steele; U.S.	J. Richthoff; Swed.	J. Richthoff; Swed.	K. Palusalu; Est.
WRESTLING (GRECO-ROMAN)					
Bantamweight	—	E. Pütsep; Est.	C. Leucht; Ger.	J. Brendel; Ger.	M. Lörincz; Hung.
Featherweight	O. Friman; Fin.	K. Anttila; Fin.	V. Väli; Est.	G. Gozzi; It.	Y. Erkan; Turk.
Lightweight	E. Väre; Fin.	O. Friman; Fin.	L. Keresztes; Hung.	E. Malmberg; Swed.	L. Koskela; Fin.
Welterweight	—	E. Vesterlund; Fin.	V. Kokkinen; Fin.	I. Johansson; Swed.	R. Svedberg; Swed.
Middleweight	C. Westergren; Swed.	—	I. Moustafa; Egy.	V. Kokkinen; Fin.	I. Johansson; Swed.
Light heavyweight	C. Johansson; Swed.	C. Westergren; Swed.	—	R. Svensson; Swed.	A. Cadier; Swed.
Heavyweight	A. Lindfors; Fin.	J. Deglane; Fr.	R. Svensson; Swed.	C. Westergren; Swed.	K. Palusalu; Est.
WEIGHT LIFTING					
Featherweight	F. de Haes; Belg.	P. Gabetti; It.	F. Andrysek; Aus.	R. Suvigny; Fr.	A. Terlazzo; U.S.
Lightweight	A. Neyland; Est.	E. Décottignies; Fr.	K. Helbig; Ger.	R. Duverger; Fr.	M. Mesbah; Egy.
Middleweight	B. Gance; Fr.	C. Galimberti; It.	F. Roger; Fr.	R. Ismayr; Ger.	K. El Thouni; Egy.
Light heavyweight	E. Cadine; Fr.	C. Rigoulot; Fr.	S. Nosseir; Egy.	L. Hostiu; Fr.	L. Hostin; Fr.
Heavyweight	F. Bottino; It.	G. Tonaui; It.	J. Strassberger; Ger.	J. Skobla; Czech.	J. Manger; Ger.
CYCLING					
1,000-m. time trial	—	—	W. Falck-Hansen; Den.	E. Gray; Austr.	A. van Vliet; Neth.
1,000-m. sprint	M. Peeters; Neth.	L. Michard; Fr.	R. Beaufrand; Fr.	J. Van Egmond; Neth.	T. Merkens; Ger.
2,000-m. tandem race	H. Ryan; Gt.Brit. T. Lance; Gt.Brit.	J. Cugnot; Fr. L. Choury; Fr.	B. Leene; Neth. D. van Dijk; Neth.	M. Perrin; Fr. L. Chaillot; Fr.	E. Ihbe; Ger. C. Lorenz; Ger.
4,000-m. team pursuit	Italy	Italy	Italy	Italy	France
50-km. race	H. George; Belg.	J. Willems; Neth.	—	—	—
Road race (indiv.)	H. Stenqvist; Swed.	A. Blpnchonnet; Fr.	H. Hansen; Den.	A. Pavesi; It.	R. Charpentier; Fr.
Road race (team)	France	France	Denmark	Italy	France
EQUESTRIAN EVENTS					
50-km. long-distance test	E. Johansen; Nor.	—	—	—	—
20-km. long-distance test	J. Misonna; Belg.	—	—	—	—
3-day event (indiv.)	H. Mörner; Swed.	A, van der Voort van Zijp; Seth.	F. Pahud de Mortanges; Neth.	F. Pahud de Rlortanges; Neth.	L. Stubbendorff; Ger.
3-day event (team)	Sweden	Netherlands	Netherlands	United States	Germany
Dressage (indiv.)	J. Lundhlad; Swed.	E. Linder; Swed.	C. von Langen; Ger.	F. Lesage; Fr.	H. Pollay; Ger.
Dressage (team)	Belgium!	—	Germany	France	Germany
Figure riding	T. Bonckaert; Belg.		—	—	—
Prize jumping (indiv.)	T. Lequio; It.‖	A. Gemuseus; Switz.	F. Ventura; Czech.	T. Nishi; Jap.	K. Hasse; Ger.
Prize jumping (team)	Sweden‖	Sweden	Spain	(all teams disqualified)	Germany
FENCING					
Foil (indiv., men)	N. Kadi; It.	R. Ducret; Fr.	L. Gaudin; Fr.	G. Marzi; It.	G. Gaudini; It.
Foil (indiv., women)	—	E. Osiier; Den.	H. Mayer; Ger.	E. Preis; Aus.	I. Schacherer-Elek; Hung.
Foil (team)	Italy	France	Italy	France	Italy
Épée (indiv.)	A. Massard; Fr.	C. Delporte; Belg.	L. Gaudin; Fr.	C. Coruaggia-Medici; It.	F. Riccardi; It.
Épée (team)	Italy	France	Italy	France	Italy
Sabre (indiv.)	N. Nadi; It.	S. Posta; Hung.	O. Tersztyánszky; Hung.	G. Piller; Hung.	E. Kabos; Hung.
Sabre (team)	Italy	Italy	Hungary	Hungary	Hungary
GYMNASTICS					
All-around indiv.	G. Zampori; It.	L. Stukelj; Yugos.	G. Miez; Switz.	R. Neri; It.	A. Schwarzmann; Ger.
Team (men)	Italy	Italy	Switzerland	Italy	Germany
Team (women)	—	—	Netherlands	—	Germany
Team (Swedish system)	Sweden	—	—	—	—
Team (optional exercises)	Denmark	—	—	United States¶	—
Parallel bars	—	A. Güttinger; Switz.	L. Vácha; Czech.	R. Neri; It.	K. Frey; Ger.
Horizontal bar	—	L. Stukelj; Yugos.	G. Miez; Switz.	D. Bixler; U.S.	A. Saarvala; Fin.
Flying rings	—	F. Martino; It.	L. Stukelj; Yugos.	G. Gulack; U.S.	A. Hudec; Czech.
Long horse (vaults)	—	F. Kriz; U.S.	E. Mack; Switz.	S. Guglielmetti; It.	K. Schwarzmann; Ger.
Side horse	—	J. Wilhelm; Switz.	H. Hänggi; Switz.	—	K. Frey; Ger.
Side horse (vaults)	—	A. Séguin; Fr.	—	I. Pelle; Hung.	—
Rope climb	—	B. Supcik; Czech.	—	R. Bass; U.S.	—
Free-standing exercises	—	—	—	I. Pelle; Hung.¶	G. Miez; Switz.
Tumbling	—	—	—	R. Wolfe; U.S.	—
Indian clubs	—	—	—	G. Roth; U.S.	—
ROWING					
Single sculls	J. Kelly; U.S.	J. Beresford; Gt.Brit.	H. Pearce; Austr.	H. Pearce; Austr.	G. Schäfer; Ger.
Double sculls	United States	United States	United States	United States	Great Britain
Pairs (with coxswain)	—	Switzerland	Switzerland	United States	Germany
Pairs (without coxswain)	Italy	Netherlands	Germany	Great Britain	Germany
Fours (with coxswain)	Switzerland	Switzerland	Italy	Germany	Germany
Fours (without coxswain)	—	Great Britain	Great Britain	Great Britain	Germany
Eights	United States	United States	United States	United States	United States
YACHTING					
40-m. class	"Sif"; Swed.	—	—	—	—
30-m. class	"Kullan"; Swed.	—	—	—	—
12-m. class (old)	"Atalanta"; Nor.	—	—	—	—
12-m. class (new)	"Heira II"; Nor.	—	—	—	—
10-m. class (old)	"Eleda"; Nor.	—	—	—	—
10-m. class (new)	"Mosk II"; Nor.	—	—	—	—
8-m. class (old)	"Irene"; Nor.	—	—	—	—
8-m. class (new)	"Sildra"; Nor.	"Bera"; Nor.	"L'Aile VI"; Fr.	"Angelita"; U.S.	"Italia"; It.
7-m. class (old)	"Ancora"; Gt.Brit.	—	—	—	—
6.5-m. class (new)	"Oranje"; Neth.	—	—	—	—
6-m. class (old)	"Edelweiss II"; Belg.	—	—	—	—
6-m. class (new)	"Io"; Nor.	"Elisabeth V"; Nor.	"Norna"; Nor.	"Bissbi"; Swed.	"Lalage"; Gt.Brit.
12-ft. centreboard boat	"Beatriss III"; Neth.	L. Huybrechts; Belg.	—	—	—
12-ft. dinghy	—	—	S. Thorell; Swed.	—	—
18-ft. centreboard boat	"Brat"; Gt.Brit.	—	—	—	—
Monotype class	—	—	—	J. Lebrun; Fr.	"Nürnberg"; Neth.
Star class	—	—	—	"Jupiter"; U.S.	"Wannsee"; Ger.

§Figure riding. ‖Hunting competition. ¶Calisthenics.

Table IV.—*Olympic Champions, 1920–36 (Continued)*

Event	1920	1924	1928	1932	1936
		CANOEING			
Single kayak (1,000 m.)	—	—	—	—	G. Hradetzky; Aus.
Single kayak (10,000 m.)	—	—	—	—	E. Krebs; Ger.
Canadian single (1,000 m.)	—	—	—	—	F. Amyot; Can.
Single collapsible (10,000 m.)	—	—	—	—	G. Hradetzky; Aus.
Double kayak (1,000 m.)	—	—	—	—	Austria
Double kayak (10,000 m.)	—	—	—	—	Germany
Canadian double (1,000 m.)	—	—	—	—	Czechoslovakia
Canadian double (10,000 m.)	—	—	—	—	Czechoslovakia
Double collapsible (10,000 m.)	—	—	—	—	Sweden
		SHOOTING			
Rifle (300 m., 2 position)	M. Fisher; U.S.	—	—	—	—
Rifle (300 m., standing)	C. Osburn; U.S.	—	—	—	—
Rifle (300 m., prone)	O. Olsen; Nor.	—	—	—	—
Rifle (600 m., prone)	H. Johansson; Swed.	—	—	—	—
Rifle (all-around)	—	M. Fisher; U.S.	—	—	—
Rifle (team, 300 m., 2 position)	United States	—	—	—	—
Rifle (team, 300 m., standing)	Denmark	—	—	—	—
Rifle (team, 300 m., prone)	United States	—	—	—	—
Rifle (team, 600 m., prone)	United States	—	—	—	—
Rifle (team, all-around)	United States	United States	—	—	—
Small-bore rifle (indiv.)	L. Nuesslein; U.S.	C. Coquelin de Lisle; Fr.	—	B. Ronnmark; Swed.	W. Rogeberg; Nor.
Small-bore rifle (team)	United States	France	—	—	—
Pistol (indiv.)	C. Frederick; U.S.	H. Bailey; U.S.	—	—	C. van Oyen; Ger.
Pistol (team)	United States	United States	—	—	—
Pistol or revolver (indiv.)	G. Paraense; Braz.♀	—	—	R. Morigi; It.	T. Ullmann; Swed.♂
Pistol and revolver (team)	United States	—	—	—	—
Running deer (single shot)	O. Olsen; Nor.	J. Boles; U.S.	—	—	—
Running deer (double shot)	O. Lilloe-Olsen; Nor.	O. Lilloe-Olsen; Nor.	—	—	—
Running deer (team, single shot)	Norway	Norway	—	—	—
Running deer (team, double shot)	Norway	Great Britain	—	—	—
Clay pigeon	M. Arie; U.S.	G. Halasy; Hung.	—	—	—
Clay pigeon (team)	United States	United States	—	—	—
		ARCHERY			
Fixed target (team, 2 events)	Belgium	—	—	—	—
Fixed target (indiv., small)	E. van Meer; Belg.	—	—	—	—
Fixed target (indiv., large)	E. Clostens; Belg.	—	—	—	—
Moving target (team, 28 m.)	Netherlands	—	—	—	—
Moving target (team, 33 m.)	Belgium	—	—	—	—
Moving target (team, 50 m.)	Belgium	—	—	—	—
Moving target (indiv., 28 m.)	H. van Innis; Belg.	—	—	—	—
Moving target (indiv., 33 m.)	H. van Innis; Belg.	—	—	—	—
Moving target (indiv. 50 m.)	L. Brulé; Fr.	—	—	—	—
Individual competition (women)	O. Newal; Gt.Brit.	—	—	—	—
		LAWN TENNIS			
Men's singles	L. Raymond; S.Af.	V. Richards; U.S.	—	—	—
Men's doubles	O. Turnbull; Gt.Brit. M. Woosnam; Gt.Brit.	F. Hunter; U.S. V. Richards; U.S.	—	—	—
Women's singles	S. Lenglen; Fr.	H. Wills; U.S.	—	—	—
Women's doubles	H. McNair; Gt.Brit. K. McKane; Gt.Brit.	H. Wightman; U.S. H. Wills; U.S.	—	—	—
Mixed doubles	S. Lenglen; Fr. M. Décugis; Fr.	H. Wightman; U.S. R. Williams; U.S.	—	—	—
		TEAM SPORTS			
Polo	Great Britain	Argentina	—	—	Argentina
Water polo	Great Britain	France	Germany	Hungary	Hungary
Association football (soccer)	Belgium	Uruguay	Uruguay	—	Italy
Rugby football	United States	United States	—	—	—
Field hockey	Great Britain	—	India	India	India
Basketball	—	—	—	—	United States
Handball	—	—	—	—	Germany
Baseball	—	—	—	—	United States
		MISCELLANEOUS SPORTS			
Modern pentathlon	G. Dyrssen; Swed.	B. Lindman; Swed.	S. Thofelt; Swed.	J. Oxenstierna; Swed.	G. Handrick; Ger.
Mountaineering	—	—	—	F. Schmidt; Ger. T. Schmidt; Ger.	—
Gliding	—	—	—	—	H. Schreiber; Ger.
		ART CONTESTS			
Architecture	—	—	J. Wils; Neth. A. Hensel; Ger.	J. Hughes; Gt.Brit. G. Saake; Fr. P. Bailey; Fr. P. Montenot; Fr.	W. March; Ger. H. Kutschera; Aus.
Literature	R. Nicolai; It.	G. Charles; Fr.	K. Wierzynski; Pol. F. Mező; Hung.	P. Bauer; Ger.	F. Dhiinen; Ger. Ti. Karhumaki; Fin.
Music	G. Monier; Belg.	—	—	—	P. Hoffer; Ger. W. Egk; Ger.
Painting	—	J. Jacoby; Luxem.	I. Israels; Neth. J. Jacoby; Luxem. W. Nicholson; Gt.Brit.	D. Wallin; Swed. L. Blair; U.S. J. Webster-Golinken; U.S.	A. Diggelmann; Switz.
Sculpture	A. Collin; Belg.	C. Dimitriadis; Gr.	P. Landowski; Fr. E. Grienauer; Aus.	M. Young; U.S. J. Klukowski; Pol.	F. Vignoli; It. E. Sutor; Ger.
		WINTER SPORTS			
Figure skating (men)	G. Grafstrom; Swed.	G. Grafstrom; Swed.	G. Grafstrom; Swed.	K. Schafer; Aus.	K. Schafer; Aus
Figure skating (women)	M. Mauroy; Saed.	H. Planck-Szabó; Aus.	S. Henie; Nor.	S. Henie; Nor.	S. Henie; Nor.
Figure skating (pairs)	L. Jacobsson; Fin. W. Jacobsson; Fin.	H. Engelmann; Aus. 4. Berger; Aus.	A. Jolp; Fr. P. Brunet; Fr.	A. Brunet; Fr. P. Brunet; Fr.	M. Herber; Ger. E. Baier; Ger.
500-m. speed skating (men)	—	C. Jewtraw; U.S. (44 sec.)	C. Thunberg; Fin. B. Evensen; Nor. (43.4 sec., dead beat)	J. Shea; U.S. (43.4 sec.)	I. Ballangrud; Nor. (43.4 sec.)
500-m. speed skating (women)	—	—	—	J. Wilson; Can. (58 sec.)	—
1,000-m. speed skating (women)	—	—	—	E. Dubois; U.S. (2 min. 4 sec.)	—
1,500-m. speed skating (men)	—	C. Thunberg; Fin. (2 min. 20.8 sec.)	C. Thunberg; Fin. (2 min. 21.1 sec.)	J. She?; U.S. (2 min. 57.5 sec.)	C. Mathisen; Nor. (2 min. 19.2 sec.)
1,500-m. speed skating (women)	—	—	—	K. Klein; U.S. (3 min. 4 sec.)	—
5,000-m. speed skating (men)	—	C. Thunberg; Fin. (8 min. 39 sec.)	I. Ballangrud; Nor. (8 min. 50.5 sec.)	I. Jaffee; U.S. (9 min. 40.8 sec.)	I. Ballangrud; Nor. (8 min. 19.6 sec.)
10,000-m. speed skating (men)	—	J. Skutnabb; Fin. (18 min. 4.8 sec.)	—	I. Jaffee; U.S. (19 min. 13.6 sec.)	I. Ballangrud; Nor. (17 min. 24.3 sec.)
Combined speed skating (men)	—	C. Thunberg; Fin.	—	—	—
Ice hockey	Canada	Canada	Canada	Canada	Great Britain
Cross-country skiing (18 km.)	—	T. Haug; Nor.	J. Gröttumsbraaten; Nor.	S. Utterstrdm; Swed.	E.-A. Larsson; Swed.
Cross-country skiing (50 km.)	—	T. Haug; Nor.	P. Hedlund; Swed.	V. Saarinen; Fin.	E. Viklund; Swed.

♀Revolver. ♂Sport pistol.

TABLE IV.—*Olympic Champions, 1920–36 (Continued)*

Event	1920	1924	1928	1932	1936
WINTER SPORTS (Continued)					
Nordiccombined	—	T. Haug; Nor.	Grottumsbraaten; Nor.	Grottumsbraaten; Nor.	O. Hagen; Nor.
Ski jumping	—	J. Tullin-Thams; Nor.	A. Andersen; Nor.	B. Ruud; Nor.	B. Ruud; Nor.
40-km. skiing relay	—	—	—	—	Finland
Alpine combined (men)	—	—	—	—	F. Pfnur; Ger.
Alpine combined (women)	—	—	—	—	C. Cranz; Ger.
Military ski patrol	—	Switzerland	Norway	—	Italy
Tmo-man bobsled	—	—	J. Heaton; U.S.'	United States	United States
Four-man bobsled	—	Switzerland	United States°	United States	Switzerland
Ice shooting (team)	—	—	—	—	Austria
Distance shooting	—	—	—	—	G. Edenhauser; Aus.
Target shooting	—	—	—	—	I. Reiterer; Aus.
Sled-dog race	—	—		E. Goddard; Can.	—
Curling	—	Great Britain	—	Canada	—

'One-man sled. °Five man sled.

TABLE V.—Olympic Champions, 1948–60

Event	1948	1952	1956	1960
TRACK AND FIELD—MEN				
100-m. dash	H. Dillard; U.S. (10.3 sec.)	L. Remigino; U.S. (10.4 sec.)	R. Morrow; U.S. (10.5 sec.)	A. Hary; Ger. (10.2 sec.)
zoo-m. dash	M. Patton; U.S. (21.1 sec.)	A. Stanfield; U.S. (20.7 sec.)	R. Morrow; U.S. (20.6 sec.)	L. Berruti: It. (20.5 sec.)
400-m. run	A. Wint; Jam. (46.2 sec.)	G. Rhoden; Jam. (45.9 sec.)	C. Jenkins; U.S. (46.7 sec.)	O. Davis; U.S. (44.9 sec.)
800-m. run	M. Whitfield; U.S. (1 min. 49.2 sec.)	M. Whitfield; U.S. (1 min. 49.2 sec.)	T. Courtney; U.S. (1 min. 47.7 sec.)	P. Snell; N.Z. (1 min. 46.3 sec.)
1,500-m. run.	H. Eriksson; Swed. (3 min. 49.8 sec.)	J. Barthel; Luxem. (3 min. 45.2 sec.)	R. Delany; Eire (3 min. 41.2 sec.)	H. Elliott; Austr. (3 min. 35.6 sec.)
5,000-m. run.	G. Reiff; Relg. (14 min. 17.6 sec.)	E. Zatopek; Czech. (14 min. 6.6 sec.)	V. Kuts; G.S.S.R. (13 min. 39.6 sec.)	M. Halberg; N.Z. (13 min. 43.4 sec.)
10,000-m. run	E. Zatopek; Czech. (29 min. 59.6 sec.)	E. Zatopek; Czech. (29 min. 17 sec.)	V. Kuts; U.S.S.R. (28 min. 45.6 sec.)	P. Bolotnikov; U.S.S.R. (28 min. 32.2 sec.)
Marathon	D. Cabrrra; Arg. (2 hr. 34 min. 51.6 sec.)	E. Zatopek; Czech. (2 hr. 23 min. 3.2 sec.)	A. Mimoun; Fr. (2 hr. 25 rnin.)	B. Abebe; Eth. (2 hr. 15 min. 16.2 sec.)
110-m. hurdles	W. Porter: U.S. (13.9 sec.)	H. Dillard: U.S. (13.7 sec.)	L. Calhoun: U.S. (13.5 sec.)	L. Calhoun; U.S. (13.8 sec.)
400-m. hurdles	R. Cochran; U.S. (51.1 sec.)	C. Moore: U.S. (50.8 sec.)	G. Davis: U.S. (50.1 sec.)	G. Davis; U.S. (49.3 sec.)
3,000-m. steeplechase	T. Sjöstrand; Swed (9 min. 4.6 sec.)	H. Ashenfelter; U.S. (8 min. 45.4 sec.)	C. Brasher; Gt.Brit. (8 min. 41.2 sec.)	Z. Krzyszkowiak; Pol. (8 min. 34.2 sec.)
400-m. relay.	United States (40.6 sec.)	United States (40.1 sec.)	United States (39.5 sec.)	Germany (39.5 sec.)
1,600-m. relay	United States (3 min. 10.4 sec.)	Jamaica (3 min. 3.9 sec.)	United States (3 min. 4.8 sec.)	United States (3 min. 2.2 sec.)
20-km. walk	J. Mikaelsson; Swed. (10 km.) (45 min. 13.2 sec.)	J. blikaelsson; Smed. (10 km.) (45 min. 2.8 sec.)	L. Spirine; U.S.S.R. (1 hr. 31 min. 27 sec.)	V. Golubnichy; U.S.S.R. (1 hr. 34 min. 7.2 sec.)
50-km. walk.	J. Ljunggren; Swed. (4 hr. 41 min. 52 sec.)	G. Dordoni; It. (4 hr. 28 min. 7.8 sec.)	N. Read; S.Z. (4 hr. 30 min. 42.8 sec.)	D. Thompson; Gt.Brit. (4 hr. 25 min. 30 sec.)
High jump	J. Winter; Austr. (6 ft. 5 15/16 in.)	W. Davis; U.S. (6 ft. 8% in.)	C. Dumas; U.S. (6 ft. 11 1/16 in.)	R. Shavlakadze; U.S.S.R. (7 ft. 1 1/16 in.)
Broad jump	W. Steele; U.S. (25 ft. 8 1/16 in.)	J. Biffle; U.S. (24 ft. 10 in.)	G. Bell; U.S. (25 ft. 8 1/4 in.)	R. Boston; U.S. (26 ft. 7 11/16 in.)
Pole vault	O. Smith; U.S. (14 ft. 1 5/16 in.)	R. Richards; U.S. (14 ft. 11 1/8 in.)	R. Richards: U.S. (14 it. 11 1/2 in.)	D. Bragg; U.S. (15 ft. 5 1/16 in.)
Hop, step and jump	A. Ahman; Swed. (jo ft. 6 3/16 in.)	A. Ferreira da Silva; Braz. (53 ft. 2 9/16 in.)	A. Ferreira da Silva; Braz. (53 ft. 7 11/16 in.)	J. Schmidt; Pol. (55 ft. 1 13/16 in.)
16-lb. shot-put	W. Thompson; U.S. (j6 ft. 2 in.)	P. O'Brien; U.S. (57 ft. 1 1/16 in.)	P. O'Brien; U.S. (60 ft. 11 1/16 in.)	W. Nieder; U.S. (64 ft. 6 13/16 in.)
Discus throw	A. Consolini; It. (173 ft. 1 15/16 in.)	S. Iness; U.S. (180 ft. 6% in.)	A. Oerter; U.S. (184 it. 10 7/8 in.)	A. Oerter; U.S. (194 ft. 1 7/8 in.)
Javelin throw	T. Rautavaara; Fin. (228 ft. 10 7/8 in.)	C. Young; U.S. (242 ft. 3/4 in.)	E. Danielsen: Nor. (281 ft. 2 3/8 in.)	V. Tsibulenko; U.S.S.R. (277 ft. 8 1/4 in.)
Hammer throw	I. Nimeth; Hung. (183 ft. 11 1/2 in.)	J. Csermák; Hung. (197 it. 11 9/16 in.)	H. Connolly; U.S. (207 ft. 3 3/4 in.)	V. Rudenkov; U.S.S.R. (220 ft. 1 11/16 in.)
Decathlon	R. Mathias; U.S.	R. bfathias; U.S.	M. Campbell; U.S.	R. Johnson; G.S.
TRACK AND FIELD—WOMEN				
100-m. dash	F. Blankers-Koen; Neth. (11.9 sec.)	M. Jackson; Austr. (11.5 sec.)	B. Cuthbert; Austr. (11.5 sec.)	W. Rudolph; U.S. (11 sec.)
zoo-m. dash	F. Blankers-Koen; Neth. (24.4 sec.)	M. Jackson; Austr. (23.7 sec.)	B. Cuthbert; Austr. (23.4 sec.)	W. Rudolph; U.S. (24 sec.)
800-m. run				L. Shevcova; U.S.S.R. (2 min. 4.3 sec.)
80-m. hurdles	F. Blankers-Koen; Neth. (11.2 sec.)	S. Strickland de la Hunty; Austr. (10.9 sec.)	S. Strickland de la Hunty; Austr. (10.7 sec.)	I. Press; U.S.S.R. (10.8 sec.)
400-m. relay.	Netherlands (47.5 sec.)	United States (45.9 sec.)	Australia (44.5 sec.)	United States (44.5 sec.)
High jump	A. Coachman; U.S. (5 ft. 6 1/4 in.)	E. Brand; S.Af. (5 ft. 53.: in.)	M. McDaniel; U.S. (5 ft. 9 5/16 in.)	Y. Balas; Rum. (6 ft. 13/16 in.)
Broad jump	O. Gyarmati; Hung. (18 ft. 8 1/4 in.)	Y. Williams; N.Z. (20 ft. 5 11/16 in.)	E. Krzesinska; Pol. (20 ft. 10 in.)	V. Krepkina; U.S.S.R. (20 ft. 10 13/16 in.)
Shot-put	M. Ostermeyer; Fr. (45 ft. 1 1/2 in.)	G. Zybina; U.S.S.R. (50 ft. 1 5/8 in.)	T. Tgchkevich; U.S.S.R. (54 ft. 5 3/8 in.)	T. Press; U.S.S.R. (56 ft. 9 7/8 in.)
Discus throw	M. Ostermeyer: Fr. (137 ft. 6 3/8 in.)	N. Romaschkova; U.S.S.R. (168 ft. 8 7/16 in.)	O. Fikotova; Czech. (176 ft. 1 3/4 in.)	N. Ponomareva; U.S.S.R. (180 ft. 9 1/4 in.)
Javelin throw	H. Bauma; Aus. (149 ft. 6 in.)	D. Zátopková; Czech. (165 ft. 7 in.)	I. Iaounzem; U.S.S.R. (176 ft. 8 7/16 in.)	E. Ozolina; U.S.S.R. (183 ft. 7 15/16 in.)
SWIMMING—MEN				
100 m. free style	W. Ris; U.S. (57.3 sec.)	C. Scholes; U.S. (57.4 sec.)	J. Henricks; Austr. (55.4 sec.)	J. Devitt; Austr. (55.2 sec.)
zoo-m. butterfly	—	—	W. Yorzyk; U.S. (2 min. 19.3 sec.)	M. Troy; U.S. (2 min. 12.8 sec.)
400-m. free style	W. Smith; U.S. (4 min. 41 sec.)	J. Boiteun; Fr. (4 min. 30.7 sec.)	M. Rose; Austr. (4 min. 27.3 sec.)	M. Rose; Austr. (4 min. 18.3 sec.)
1,500-m. free style	J. McLane; U.S. (19 min. 18.5 sec.)	F. Konno; U.S. (18 min. 30.3 sec.)	M. Rose; Austr. (17 min. 58.9 sec.)	J. Konrads; Austr. (17 min. 19.6 sec.)
100-m. backstroke	A. Stack: U.S. (1 min. 6.4 sec.)	Y. Oyakawa; U.S. (1 min. 5.4 sec.)	D. Theile; Austr. (1 min. 2.2 sec.)	D. Theile; Austr. (1 min. 1.9 sec.)
zoo-m. breast stroke	J. Verdeur; U.S. (2 min. 39.3 sec.)	J. Davies; Austr. (2 min. 34.4 sec.)	M. Furukawa; Jap. (2 min. 34.7 sec.)	W. Mulliken; U.S. (2 min. 37.4 sec.)
400-m. medley relay	—	—	—	United States (4 min. 5.4 sec.)
800-m. relay.	United States (8 min. 46 sec.)	United States (8 min. 31.1 sec.)	Australia (8 min. 23.6 sec.)	United States (8 min. 10.2 sec.)
Springboard dive.	B. Harlan; U.S.	D. Browning; U.S.	R. Clotworthy; U.S.	G. Tobian; U.S.
High dive	S. Lee; U.S.	S. Lee; U.S.	J. Capilla Perez; Mex.	R. Webster; G.S.

Table V.—*Olympic Champions, 1948–60 (Continued)*

Event	1948	1952	1956	1960
		Swimming—Women		
100-m. free style	G. Andersen; Den. (1 min. 6.3 sec.)	K. Szőke; Hung. (1 min. 6.8 sec.)	D. Fraser; Austr. (1 min. 2 sec.)	D. Fraser; Austr. (1 min. 1.2 sec.)
100-m. butterfly	—	—	S. Mann; U.S. (1 min. 11 sec.)	C. Schuler; U.S. (1 min. 9.5 sec.)
400-m. free style	A. Curtis; U.S. (5 min. 17.8 sec.)	V. Gyenge; Hung. (5 min. 12.1 sec.)	L. Crapp; Austr. (4 min. 54.6 sec.)	C. von Saltza; U.S. (4 min. 50.6 sec.)
100-m. backstroke	K. Harup; Den. (1 min. 14.4 sec.)	J. Harrison; S.Af. (1 min. 14.3 sec.)	J. Grinham; Gt.Brit. (1 min. 12.9 sec.)	L. Burke; U.S. (1 min. 9.3 sec.)
200-m. breast stroke	N. van Vliet; Neth. (2 min. 57 sec.)	E. Székely; Hung. (2 min. 51.7 sec.)	U. Happe; Ger. (2 min. 53.1 sec.)	A. Lonsbrough; Gt.Brit. (2 min. 49.5 sec.)
400-m. relay	United States (4 min. 29.2 sec.)	Hungary (4 min. 24.4 sec.)	Australia (4 min. 17.1 sec.)	United States (4 min. 8.9 sec.)
400-m. medley relay		—	—	United States (4 min. 41.1 sec.)
Springboard dive	V. Draves; U.S.	P. McCormick; U.S.	P. McCormick; U.S.	I. Kramer; Ger.
High dive	V. Draves; U.S.	P. McCormick; U.S.	P. McCormick; U.S.	I. Kramer; Ger.
		Boxing		
Flyweight	P. Perez; Arg.	N. Brooks, U.S.	T. Spinks; Gt. Brit.	G. Torok; Hung.
Bantamweight	T. Csik; Hung.	P. Hamalainen; Fin.	W. Behrendt; Ger.	O. Grigoriev; U.S.S.R.
Featherweight	E. Formenti; It.	J. Zachara; Czech.	V. Safronov; U.S.S.R.	F. Musso; It.
Lightweight	G. Dreyer; S.Af.	A. Bolognesi; It.	R. McTaggart; Gt.Brit.	K. Pazdzior; Pol.
Light welterweight	—	C. Adkins; U.S.	V. Enguibarian; U.S.S.R.	B. Nomececk; Czech.
Welterweight	J. Torma; Czech.	Z. Chychla; Pol.	N. Linca; Rum.	G. Beuvenuti; It.
Lightmiddleweight	—	L. Papp; Hung.	L. Papp, Hung.	W. McClure; U.S.
Middleweight	L. Papp; Hung.	F. Patterson; U.S.	G. Chatkov; U.S.S.R.	E. Crook; U.S.
Light heavyweight	G. Hunter; S.Af.	N. Lee; U.S.	J. Boyd; U.S.	C. Clay; U.S.
Heavyweight	R. Iglesias; Arg.	E. Sanders; U.S.	P. Rademacher; U.S.	F. de Piccoli; It.
		Wrestling (Catch-as-Catch-Can)		
Flyweight	L. Viitala; Fin.	H. Gemici; Turk.	M. Tsalkalmanidze; U.S.S.R.	A. Bilek; Turk.
Bantamweight	N. Akar; Turk.	S. Ishii; Jap.	M. Dagistanli; Turk.	T. McCann; U.S.
Featherweight	G. Bilge; Turk.	B. Sit; Turk.	S. Sasahara; Jap.	M. Dagistanli; Turk.
Lightweight	C. Atik; Turk.	O. Anderberg; Swed.	E. Habibi; Iran	S. Wilson; U.S.
Welterweight	J. Dogu; Turk.	W. Smith; U.S.	M. Ikeda; Jap.	D. Blubaugh; U.S.
Middleweight	G. Brand; U.S.	D. Cimakuridze; U.S.S.R.	N. Nikolov; Bulg.	H. Gungor; Turk.
Light heavyweight	H. Wittenberg; U.S.	W. Palm; Swed.	G. Takhti; Iran	1. Atli; Turk.
Heavyweight	G. Bóbis; Hung.	A. Mekokishvili; U.S.S.R.	H. Kaplan; Turk.	W. Dietrich; Ger.
		Wrestling (Greco-Roman)		
Flyweight	P. Lombardi; It.	B. Gurevich; U.S.S.R.	N. Soloviev; U.S.S.R.	D. Pirvulescu; Rum.
Bantamweight	K. Pettersen; Swed.	I. Hódos; Hung.	K. Vyropaev; U.S.S.R.	O. Karavaev; U.S.S.R.
Featherweight	M. Oktav; Turk.	Y. Punkin; U.S.S.R.	R. Mäkinen; Fin.	RI. Sille; Turk.
Lightweight	G. Freij; Swed.	C. Safin; U.S.S.R.	K. Lehtonen; Fin.	A. Koridze; U.S.S.R.
Welterweight	G. Andersson; Swed.	M. Szilvási; Hung.	M. Bayrak; Turk.	M. Bayrak; Turk.
Middleweight	A. Grhnberg; Swed.	A. Grdnberg; Swed.	G. Kartozia; C.S.S.R.	D. Dobrev; Bulg.
Light heavyweight	K. Nilsson; Swed.	K. Grondahl; Fin.	V. Nikolaev; U.S.S.R.	T. Kis; Turk.
Heavyweight	A. Khecci; Turk.	J. Kotkas; U.S.S.R.	A. Parfenov; U.S.S.R.	I. Bogdan; U.S.S.R.
		Weight Lifting		
Bamtamweight	J. De Pietro; U.S.	I. Udodov; U.S.S.R.	C. Vinci; U.S.	C. Vinci; U.S.
Featherweight	M. Fayad; Egy.	R. Chimishkyan; U.S.S.R.	I. Berger; U.S.	Y. Minaev; U.S.S.R.
Lightweight	I. Shams; Egy.	T. Kono; U.S.	I. Rybak; U.S.S.R.	V. Bushuev; U.S.S.R.
Middleweight	F. Spellman; U.S.	P. George; U.S.	F. Bogdanovski; U.S.S.R.	A. Kurynov; U.S.S.R.
Light heavyweight	S. Stanczyk; U.S.	T. Lomakin; U.S.S.R.	T. Kono; U.S.	I. Palinski; Pol.
Middle heavyweight	—	N. Schemansky; U.S.	A. Vorobiev; U.S.S.R.	A. Vorobiev; U.S.S.R.
Heavyweight	J. Davis; U.S.	J. Davis; U.S.	P. Anderson; U.S.	Y. Vlasov; U.S.S.R.
		Cycling		
1,000-m. time trial	J. Dupont; Fr.	R. Mockridge; Austr.	L. Faggin; It.	S. Gaiardoni; It.
1,000-m. sprint	RI. Ghella; It.	E. Sacchi; It.	M. Rousseau; Fr.	S. Gaiardoni; It.
2,000-m. tandem	P. Perona; It. F. Teruzzi; It.	R. Mockridge; Austr. L. Cox; Austr.	J. Browne; Austr. A. Marchant; Austr.	G. Beghetto; It. S. Bianchetto; It.
4,000-m. team pursuit	France	Italy	Italy	Italy
Road race (indiv.)	J. Beyaert; Fr.	4. Noyelle; Belg.	E. Baldini; It.	V. Kapitonov; U.S.S.R.
Road race (team)	Belgium	Belgium	France	Italy
		Equestrian Events		
Dressage (indiv.)	H. Moser; Switz.	H. St. Cyr; Swed.	H. St. Cyr; Swed.	S. Filatov; U.S.S.R.
Dressage (team)	France	Sweden	Sweden	—
3-day event (indiv.)	B. Chevallier; Fr.	H. von Blixen-Finecke; Swed.	P. Kastenman; Swed.	L. Morgan; Austr.
3-day event (team)	United States	Sweden	Great Britain	Australia
Prize jumping (indiv.)	H. Mariles Cortes; Mex.	P. Jonquères d'Oriola; Fr.	H. Winkler; Ger.	R. d'Inzeo; It.
Prize jumping (team)	Mexico	Great Britain	Germany	Germany
		Fencing		
Foil (indiv.)	J. Buhan; Fr.	C. d'Oriola; Fr.	C. d'Oriola; Fr.	V. Zdanovich; U.S.S.R.
Foil (indiv., women)	I. Elek; Hung.	I. Camber; It.	G. Sheen; Gt.Brit.	A. Schmid; Ger.
Foil (team)	France	France	Italy	U.S.S.R.
Foil (team, women)	—	—	—	U.S.S.R.
Épée (indiv.)	L. Cantone; It.	E. Mangiarotti; It.	C. Pavesi; It.	G. Delfino; It.
Épée (team)	France	Italy	Italy	Italy
Sabre (indiv.)	A. Gerevich; Hung.	P. Kovács; Hung.	R. Kárpáti; Hung.	R. Karpati; Hung.
Sabre (team)	Hungary	Hungary	Hungary	Hungary
		Gymnastics—Men		
All-around indiv.	V. Huhtanen; Fin.	V. Chukarin; U.S.S.R.	V. Chukarin; U.S.S.R.	B. Chakhlin; U.S.S.R.
Team	Finland	U.S.S.R.	U.S.S.R.	Japan
Parallel bars	M. Reusch; Switz.	H. Eugster; Switz.	V. Chukarin; U.S.S.R.	B. Chakhlin, U.S.S.R.
Horizontal bar	J. Stalder; Switz.	J. Gunthard; Switz.	T. Ono; Jap.	T. Ono; Jap.
Side horse	P. Aaltonen; Fin. V. Huhtanen; Fin. H. Savolainen; Fin. (tied)	V. Chukarin; U.S.S.R.	B. Chakhlin; U.S.S.R.	B. Chakhlin; U.S.S.R. E. Ekman; Fin. (tied)
Long horse (vaults)	P. Aaltonen; Fin.	V. Chukarin; U.S.S.R.	V. Muratov; U.S.S.R. H. Bantz; Ger. (tied)	B. Chakhlin; U.S.S.R. T. Ono; Jap. (tied)
Flying rings	K. Frei; Switz.	G. Chaguinian; U.S.S.R.	A. Azarian; U.S.S.R.	A. Azarian; U.S.S.R.
Free exercises	F. Pataki; Hung.	K. Thoresson; Swed.	V. Muratov; U.S.S.R.	H. Aihara; Jap.
Mass exercises	—	Finland	—	—
		Gymnastics—Women		
All-around indiv.	—	M. Gorokhovskaya; U.S.S.R.	L. Latynina; U.S.S.R.	L. Latynina; U.S.S.R.
Team	Czechoslovakia	U.S.S.R.	U.S.S.R.	U.S.S.R.
Hand apparatus team	—	Sweden	—	—
Parallel bars	—	M. Korondi; Hung.	A. Keleti; Hung.	P. Astakhova; U.S.S.R.
Horse vaults	—	E. Kalinchuk; U.S.S.R.	L. Latynina; U.S.S.R.	M. Nikolaeva; U.S.S.R.
Beam exercises	—	N. Bocharova; U.S.S.R.	A. Keleti; Hung.	E. Bosakova; Czech.
Free exercises	—	A. Keleti; Hung.	L. Latynina; U.S.S.R. A. Keleti; Hung. (tied)	L. Latynina; C.S.S.R.
Team drill	—	—	Hungary	—

TABLE *V.—Olympic Champions, 1948–60 (Continued)*

Event	1948	1952	1956	1960
		ROWING		
Single sculls	M. Wood; Austr.	Y. Chukalov; U.S.S.R.	V. Ivanov; U.S.S.R.	V. Ivanov; U.S.S.R.
Double sculls	Great Britain	Argentina	U.S.S.R.	Czechoslovakia
Pairs (without coxswain)	Great Britain	United States	Cnited States	U.S.S.R.
Pairs (with coxswain)	Denmark	France	United States	Germany
Fours (without coxswain)	Italy	Yugoslavia	Canada	United States
Fours (with coxswain)	United States	Czechoslovakia	Italy	Germany
Eights	United States	United States	United States	Germany
		CANOEING		
Single kayak (women, goo-m.)	K. Hoff; Den.	S. Saimo; Fin.	E. Dementieva; U.S.S.R.	A. Seredina; U.S.S.R.
Single kayak (1,000 m.)	G. Fredriksson; Swed.	G. Fredriksson; Swed.	G. Fredriksson; Swed.	E. Hansen; Den.
Single kayak (10,000 m.)	G. Fredriksson; Swed.	T. Stromberg; Fin.	G. Fredriksson; Swed.	—
Canadian single (1,000 m.)	J. Holecek; Czech.	J. Holecek; Czech.	L. Rottman; Rum.	G. Parti; Hung.
Canadian single (10,000 m.)	F. Capek; Czech.	F. Havens; U.S.	L. Rottman; Rum.	—
Double kayak (women, 500 m.)	—	—	—	U.S.S.R.
Double kavak (1,000 m.)	Sweden	Finland	Germany	Sweden
Double kayak (10,000 m.)	Sweden	Finland	Hungary	—
Canadian double (1,000 m.)	Czechoslovakia	Denmark	Rumania	U.S.S.R.
Canadian double (10,000 m.)	United States	France	U.S.S.R.	—
Single kayak relay (2,000 m.)	—	—	—	Germany
		YACHTING		
6-m. class	"Llanoria"; U.S.	"Llanoria"; U.S.	—	—
5.5-m. class	—	"Complex II"; U.S.	"Rush V"; Swed.	"Minotaur"; U.S.
Dragon class	"Pan"; Nor.	"Pan"; Nor.	"Slaghoken II"; Swed.	"Nirefs"; Gr.
Star class	"Hilarius"; U.S.	"Merope"; It.	"Kathleen"; U.S.	"Tornado"; U.S.S.R.
Flying Dutchman class		—	—	"Sirene"; Nor.
Swallow class	"Swift"; Gt.Brit.	—	—	—
Firefly class	P. Elvström; Den.	—	—	—
Sharpie class		—	"Jest"; N.Z.	—
Monotype class	—	P. Elvström; Den.	P. Elvström; Den.	P. Elvström; Den.
		SHOOTING		
Riflr	E. Grunig; Switz.	A. Bogdanov; U.S.S.R.	V. Borissov; U.S.S.R.	H. Hammerer; Aus.
Small-bore rifle (prone)	A. Cook; U.S.	I. Sarbu; Rum.	G. Oulette; Can.	P. Kohnke; Ger.
Small-bore rifle (all-around)	—	E. Kongshaug; Nor.	A. Bogdanov; U.S.S.R.	V. Shamburkin; U.S.S.R.
Pistol	K. Takács; Hung.	K. Takács; Hung.	P. Linnosvuo; Fin.	W. McMillan; U.S.
Sport pistol	E. Vásquez Cam; Peru	H. Benner; U.S.	S Petrescu; Rum*	A. Gustchin; C.S.S.R.
Clap pigeon	—	G. Généreux; Can.	G. Rossini; It.	I. Dumitrescu; Rum.
Running deer	—	J. Larsen; Nor.	V. Romanenko; U.S.S.R.	—
		TEAM SPORTS		
Water polo	Italy	I-Iungarp	Hungary	Italy
Association football (soccer)	Sweden	Hungary	U.S.S.R.	Yugoslavia
Field hockey	India	India	India	Pakistan
Basketball	United States	United States	United States	United States
Lacrosse	U.S. v. Gt.Brit. (tie)	—	—	—
Field handball	—	Sweden	—	—
Finnish baseball	—	Finland	—	—
		MISCELLANEOUS SPORTS		
Modern pentathlon (indiv.)	W. Grut; Swed.	L. Hall; Swed.	L. Hall; Swed.	F. Nemeth; Hung.
Modern pentathlon (team)	—	Hungary	U.S.S.R.	Hungary
		ART CONTESTS		
Architecture	Y. Lindegren; Fin. A. Hoch; Aus.	—	—	—
Literature	A. Tynni; Fin. G. Stuparich; It.	—	—	—
Music	Z. Turski; Pol.	—	—	—
Painting and'drawing	A. Thomson; Gt.Brit. A. Decaris; Fr.	—	—	—
Sculpture	G. Nordahl; Swed.	—	—	—
		WINTER SPORTS		
Figure skating (men)	R. Button; U.S.	R. Button; U.S.	H. Jenkins; U.S.	D. Jenkins; U.S.
Figure skating (women)	B. Scott; Can.	J. Altwegg; Gt.Brit.	T. Albright; U.S.	C. Heiss; U.S.
Figure skating (pairs)	M. Lannoy; Belg. P. Baugniet; Belg.	R. Falk; Ger. P. Falk; Ger.	E. Schwarz; Aus. K. Oppelt; Xus.	R. Paul; Can. B. Wagner; Can.
500-m. speed skating (men)	F. Helgesen; Sor. (43.1 sec.)	K. Henry; U.S. (43.2 sec.)	Y. Grishin; U.S.S.R. (40.2 sec.)	Y. Grishin; U.S.S.R. (40.2 sec.)
500-m. speed skating (women)	—	—	—	H. Haase; Ger. (45.9 sec.)
1,000-m. speed skating (women)	—	—	—	K. Guseva; U.S.S.R. (1 min. 34.1 sec.)
1,500-m. speed skating (men)	S. Farstad; Nor. (2 min. 17.6 sec.)	H. Andersen; Nor. (2 min. 20.4 sec.)	Y. Mikhailov; U.S.S.R. Y. Grishin; U.S.S.R. (tied) (2 min. 8.6 sec.)	Y. Grishin; U.S.S.R. R. Aas; Nor. (tied) (2 min. 10.4 sec.)
1,500-m. speed skating (women)	—	—	—	I,. Skoblikova; U.S.S.R. (2 min. 25.2 sec.)
3,000-m. speed skating (women)	—	—	—	L. Skoblikova; U.S.S.R. (5 min. 14.3 sec.)
5,000-m. speed skating (men)	R. Liaklev; Nor. (8 min. 29.4 sec.)	H. Andersen; Nor. (8 min. 10.6 sec.)	B. Shilkov; U.S.S.R. (7 min. 48.7 sec.)	V. Kosichkin; U.S.S.R. (7 min. 51.3 sec.)
10,000-m. speed skating (men)	A. Seyffarth; Swed. (17 min. 26.3 sec.)	H. Andersen; Nor. (16 min. 45.8 sec.)	S. Ericsson; Swed. (16 min. 35.9 sec.)	K. Johamnesen; Nor. (15 min. 46.6 sec.)
Ice hockey	Canada	Canada	U.S.S.R.	United States
Bandy (ice football)	—	Sweden	—	
10-km. cross-country skiing (women)	—	L. Wideman; Fin.	L. Kozyreva; U.S.S.R.	M. Gusakova; U.S.S.R.
15-km. cross-country skiing (men)	M. Lundstrom; Swed.†	H. Brenden; Nor.†	H. Brenden; Nor.	H. Brusveen; Nor.
go-km. cross-country skiing (men)		—	V. Hakulinen; Fin.	S. Jernberg; Swed.
go-km. cross-country skiing (men)	N. Karlsson; Smed.	V. Hakulinen; Fin.	S. Jernberg; Smed.	K. Hamalainen; Fin.
rj-km. skiing relay (women)	—	—	Finland	Sweden
40-km. skiing relay (men)	Sweden	Finland	U.S.S.R.	Finland
Nordic combined (men)	H. Hasu; Fin.	S. Slattvik; Xor.	S. Stenersen; Nor.	G. Thoma; Ger.
Ski jumping (men)	P. Hugsted; Nor.	A. Bergmann; Nor.	A. Hyvärinen; Fin.	H. Recknagel; Ger.
Biathlon (men)		—	—	K. Lestander; Swed.
Slalom (men)	E. Reinalter; Switz.	O. Schneider; Aus.	A. Sailer; Aus.	E. Hinterseer; Aus.
Slalom (women)	G. Frazer; U.S.	A. Lawrence; U.S.	R. Colliard; Switz.	A. Heggtveit; Can.
Giant slalom (men)	—	S. Eriksen; Nor.	A. Sailer; Aus.	R. Staub; Switz.
Giant slalom (women)	—	A. Lawrence; U.S.	O. Reichert; Ger.	Y. Ruegg; Switz.
Downhill ski race (men)	H. Oreiller; Fr.	Z. Colo; It.	A. Sailer; Aus.	J. Vuarnet; Fr.
Downhill ski race (women)	H. Schlunegger; Switz.	T. Jochum-Beiser; Aus.	M. Berthod; Switz.	H. Beibl; Ger.
Alpine combined (men)	H. Oreiller; Fr.		—	—
Alpine combined (women)	T. Beiser; Aus.	—	—	—
Skeleton bobsled	N. Bibbia; It.	—	—	—
Two-man bobsled	Switzerland	Germany	Italy	—
Pour-manbobsled	United States	Germany	Switzerland	—
Military ski patrol	Switzerland	—	—	—
Winter pentathlon	G. Lindh; Swed.	—	—	—

*Silhouette pistol. †18 km.

handily. Great Britain was completely shut out, but Arthur Wint of Jamaica in the 400-m. run and John Winter of Australia in the high jump scored for the British Commonwealth. Swedish gold medals mere earned by Henry Eriksson, Thore Sjostrand, John Llikaelsson, John Ljunggren and Arne Ahman. The 10,000-m. run was won by Czechoslovakian Emil Zatopek, in record time.

Helsinki, 1952.—Paavo Nurmi himself lit the flame to open the XI[T] Olympiad, but the host nation failed to win a gold medal for the first time since 1908. The king of distance runners at Helsinki was the Czech, Zhtopek. whose iron legs carried him to a feat Nurmi never even attempted—a sweep of the 5,000-m. and 10,000-m. runs and the marathon, with Olympic records for all three. To add an extra touch, Zátopek's wife, Dana Zátopková, won the women's javelin throw. The 14 U.S. gold medals for men's track and field did not match the 22 of 1904, but the competition was much keener. There was no double winner for the U.S., but Whitfield and Mathias repeated their 1948 victories, while Dillard snitched back to the hurdles and defeated his teammate Jack Davis by inches. Horace Ashenfelter scored a most unexpected triumph for the C.S. in the 3,000-m. steeplechase and Joseph Barthel claimed Luxembourg's first Olympic gold medal in the 1,500-m. run. World records came in seven events: steeplechase; 50-km. walk; 1,600-m. relay; hop, step and jump; hammer throw; decathlon; and marathon.

Melbourne, 1956.—The years between the XV and XVI Olympiads saw three of man's great goals in track and field achieved. Roger Bannister of Great Britain broke the 4-min. barrier in the mile, Parry O'Brien of the United States surpassed 60 ft, in the shot-put and Charles Dumas of the U.S. qualified for the games by clearing 7 ft. in the high jump. Bannister had retired by 1956, but O'Brien and Dumas were among the 15 U.S. champions in men's track and field at Melbourne. As in the case of the Olympiad at Los Angeles, traveling distances cut down the number of individual entries and six nations also withdrew for various reasons on the eve of the games. However, none of the absentees were track and field powers and the competition was as brilliant as ever. The U S S.R. scored its first victories as Vladimir Kuts won the 5,000-m. and 10,000-m. runs and Leonid Spirine took the 20-km. walk. Egil Danielsen of Norway set a world's record in the javelin throw and A. Ferreira da Silva of Brazil repeated his Helsinki triumph and improved his Olympic record in the hop, step and jump. Alain Mimoun of France, Zhtopek's shadow at London and Helsinki, upset his foe in the marathon and Great Britain's Chris Brasher survived a foul call to win the steeplechase. Othernise, it was a U.S. show. Even the 1,500-m. winner and record setter, Ronald Delany of Ireland, was a college student in the United States. The U.S. stars set records in almost every case: Robert Morrow in the zoo-m. dash, after a nonrecord triumph in the 100-m. dash; Thomas Courtney in the Soo-m. run; Lee Calhoun in the high hurdles; Glenn Davis in the 400-m. hurdles; Robert Richards in the pole vault. Dumas and O'Brien in their specialties; Alan Oerter in the discus; Harold Connolly in the hammer throw; Milton Campbell in the decathlon; and Morrow, Leamon King, Ira Murchison and Walter Thane Baker in the 400-m. relay. In women's track and field events, Mildred McDaniel set a new record for the high jump.

Rome, 1960.—No one person dominated track and field as had Nurmi, Owens. Zátopek or Kuts in the past, when the city of Rome, whence had come the Roman decree abolishing the ancient games more than 1,500 years before, played host to the contests of the XVII Olympiad. Despite this, however, records were broken in 18 of the 24 athletic events, tied in one, and unofficially broken in the marathon, for which no official records are kept. The supremacy of the U S. in men's track and field events slipped in Rome, the U.S. taking only 9 gold medals against 15 at Melbourne in 1956. Rafer Johnson, silver-medal winner at Melbourne behind Milton Campbell, set a new record in the decathlon Lee Calhoun, Glenn Davis and Al Oerter repeated their Melbourne victories in the 110-m. hurdles, the 400-m. hurdles and the discus throw, respectively. Davis and Oerter breaking their onn 1956 record< The oldest unequalled record in the Olympics, Jesse Owens' 1936 broad-jump mark, finally fell after nearly a quarter century to Ralph Boston of the U.S. Other records set by U.S. athletes included those by Don Bragg in the pole vault, Bill Nieder in the shot-put and Otis Davis in the 400-m. run. Both Glenn and Otis Davis became double gold-medal winners by running with the record-breaking U.S. 1,600-m. relay team. The only other double winner in men's track and field was Armin Hary of Germany, whose record victory in the 100-m. dash and participation with the record-tying 400-m. relay team gave Germany its first gold track medals in the modern Olympics. Italy, too, was jubilant over its first gold track medal since 1932, won by Livio Berruti who set a record in the 200-m. dash. The U.S.S.R. increased its harvest of track and field gold medals from 3 in Melbourne to 5 in Rome. Records were set by Pyotr Bolotnikov in the 10,000-m. run, by Robert Shavlakadze in the high jump and by Vasily Rudenkov in the hammer throw. Other winners were Viktor Tsibulenko in the javelin throw and Vladimir Golubnichy in the zo-km. walk. Records were also broken in the Soo-m. run by Peter Snell of New Zealand, in the 1,500-m. run by Herb Elliot* of Australia and by Donald Thompson of Great Britain in the 50-km. walk. Poland took two gold medals, both records, when Zdzislaw Krzyszkowiak took the 3,000-m. steeplechase and Joszef Schmidt won the hop, step and jump. One of the most dramatic victories of the games, reminiscent of Spyros Louis' feat in 1896, came in the marathon, when Bikila Abebe, running barefooted, covered the grueling distance faster than any other modern athlete and thus brought Ethiopia its first Olympic gold medal in history. In women's track and field the 800-m. run, discontinued after the 1928 Olympics because it was too hard on the participants, was revived and won in record time by Ludmila Shevcova of the Soviet Union. Records were also set by Vera Krepkina in the broad jump, by Tamara Press in the shot-put, by Nina Ponomareva in the discus throw and by Elvira Ozolina in the javelin throw as the Soviets took 6 of the 10 events. Yolanda Balas of Rumania set a new record in the high jump. The most outstanding woman athlete and the only triple winner of either sex in track and field was Wilma Rudolph of the U.S. who won the roo- and zoo-m. dashes and anchored the victorious 400-m. relay team.

See' also WINTER SPORTS.

BIBLIOGRAPHY.—An official report is published by the organizing committee for each set of games. National Olympic committees also issue reports. *See* also J. Kieran and A. Daley, *The Story of the Olympic Ganzes, 776 B.C.–1956 A.D.* (1957); F. A. M. Webster, *Olympic Cavalcade* (1948); E. A. Bland (ed.), *Olympic Story* (1948); B. Henry, *Approved History of the Olynzpic Games* (1948); F. Mezö, *The Modern Olympic Ganzes* (1956). (AV. BE.; D. SR.; X.)

OLYMPIC NATIONAL PARK, in the state of Washington, was established in 1938 to protect the Olympic mountains and their incomparable forests and wildlife, as well as a 50-mi. stretch of unspoiled Pacific shore line. It includes 896,599 ac. Mt. Olympus, 7,954 ft., supports active glaciers, and probably more than roo glaciers, presenting some of the finest examples of glaciation in the Gnited States, exist in the park. Frequent warm rain clouds from the Japanese current provide an average annual precipitation of 142 in. on the western slope, producing rain-forest conditions in which native conifers grow to their largest size. Records include western red cedar, 20 ft. in breast-high diameter; Douglas fir, 17 ft. 8 in.; Sitka spruce, 16 ft. 3 in.; and western hemlock, 9 ft. This rain forest extends 12 mi. along the river valleys. In its depths trunks and fallen logs are densely covered with carpeting mosses which impart a golden luminescence, and fungi grow to immense dimensions.

On the eastern slopes, which are less moist, are many forested canyons with quiet lakes and meadows. Six thousand Roosevelt elk range in the park, as do Columbian black-tailed deer, black bear and cougar; 140 species of birds have been recorded. The ocean strip safeguards a wilderness shore of rocky points, sandy beaches, islets and tidal pools, where myriad invertebrate animals live. Three Indian reservations lie in the ocean strip and another adjoins it to the south. The park offers excellent mountain climbing, camping and pack trips, and 500 mi. of trails lead into the wilderness regions. Convenient access is afforded by road, ferry, bus and airline. Lodges, motels and ranches provide accommodation. (F. M. PD.)

OLYMPIODORUS, the name of several ancient Greek writers. The following are noteworthy:

1. Olympiodorus of Thebes (5th century A.D.), a historical writer, came from Thebes in Egypt. He was sent on a mission to Attila by the Western Roman emperor Honorius in 412 and later went to live at the court of the Eastern emperor Theodosius II. His history dealt with events in the west from 407 to 425, in 22 books. An abstract of it is preserved in the *Bibliotlzeca* of Photius.

For the test see C. Muller (ed.), *Fragmenta historicorum graecorum,* iv (Paris, 1851); L. Dindori (ed.), *Historici graeci minores,* i (Leipzig, 1870).

2. The elder Olympiodorus of Alexandria (5th century A.D.). a Peripatetic, lectured on Aristotle in Alexandria and is chiefly remembered as one of the teachers of Proclus.

3. The younger Olympiodorus of Alexandria (6th century A.D.), a Seoplatonist. appears to have maintained the Platonic tradition in Alexandria after the emperor Justinian had suppressed the Athenian school in 529 *(see* ACADEMY, GREEK; and NEOPLATONISM). This seems to be the sense of his remark that the Platonic succession had not been interrupted despite the confiscations that it had endured. His philosophy is in close conformity with that of his Athenian contemporary Damascius (*q.v.*). His works include lucid and valuable commentaries on Plato's *Phaedo* (ed. by W. Norwin [Leipzig, 1913]), *Gorgias* (ed. by W. Norwin, [Leipzig, 1936]), *Philebus* and *Alcibiades I;* a life of Plato; an introduction to Aristotle's philosophy; and commentaries on Aristotle's *Categories* and *Meteora.*

See F. Überweg and K. Praechter, *Die Philosophie des Altertums,* 12th ed. (Berlin, 1926):

4(?). Olympiodorus the alchemist, author of a work On *the Sncsed Art of the Philosopher's Stone* (ed. by M. Berthelot. *Collection des alchimistes grecs* [Paris. 1887–88]), is variously identified by scholars: sometimes with Olympiodorus of Thebes, sometimes with Olympiodorus the Seoplatonist.

OLYMPUS, the name of many mountains in Greece and Asia Minor, and of the fabled home of the gods; also a city name and a personal name.

Of the mountains (1) the most famous is the lofty ridge (mod. Gk. *Elympo*) on the borders of Thessaly and Macedonia; it is nearly 10,000 ft. high and covered with snow for a great part of the year. The great gorge of Tempe close below the southeastern end separates it from Mt. Ossa. Olympus is of massive appearance, rising in precipices broken by ravines, above which is the summit of naked rock concave toward the northwest. The lower parts are densely wooded. (2) The peak of Mt. Lycaeus in the southwest of Arcadia. (3) East of Olympia, on the north bank of the Alpheus. (4) Beside Sellasia in Laconia. The name was even commoner in Asia Minor; it referred to a lofty chain in Mysia (Keshish Dagh) and to a ridge east of Smyrna (Nif Dagh); other mountains in Lycia, in Galatia, in Cilicia and in Cyprus were also all called Olympus.

In the *Iliad* the gods are described as dwelling on a lofty peak, rising high above the clouds of the lower atmosphere into the clear ether; in the *Odyssey* Olympus is more remote and less definite; the notions of later poets vary from a definite mountain to a vague conception of heaven. In literary mythology. though each deity had special haunts, all had residence at the court of Zeus on Olympus; there were their assemblies and feasts.

There was a city in Lycia named Olympus; it was a bishopric in Byzantine times.

OLYNTHUS, an ancient city at the head of the Gulf of Torone, in Chalcidice, near the neck of the peninsula of Pallene, about 60 stadia (7 or 8 mi.) from Potidaea. It may have been a colony of Chalcis, and struck coins early, but the district belonged to a Thracian tribe, the Bottiaeans. who held the town till 479 B.C., when the Persian general Artabazus, on his return irom escorting Xerxes to the Hellespont, suspecting that a revolt from the great king was meditated, slew the inhabitants and handed the town over to Greeks irom Chalcidice.

Olynthus thus became a Greek polis, but it remained insignificant in the lists of the Delian league until 432. Kine Perdiccas of Macedon added to its population the inhabitants oi Chalcidian towns in the neighbourhood (Thucyd. i, 58). Henceforward the chief Hellenic city west of the Strymon, it revolted from Athens, iormed a base for Brasidas' expedition (424) and was never again reduced. In the 4th century it was the head of the Chalcidic league which may be traced back to the peace of Nicias (421), when the Chalcidians acted in common and were enrolled as allies of Argos. The motive ior its iormation is almost certainly to be iound in iear of Athens. Coins of the league can be dated as early as 405; one specimen may go back to 415–420. After the Peloponnesian war the league concluded an important treaty, about 390, with Amyntas, king of Macedon (the father of Philip), and by 382 it had absorbed most of the Greek cities west of the Strymon, and even held Pella, the chief city in Macedonia. But in this year Sparta was induced by an embassy from Acanthus and Apollonia, not yet included by the league, to attack; and Olynthus, after three years of indecisive warfare, formally dissolved the coniederacy (379). Chalcidians, however, appear among the Athenian naval confederacy of 378–377. Twenty years later. in the reign of Philip, the power of Olynthus is asserted by Demosthenes to have been much greater than beiore the Spartan expedition, and the league included 32 cities. When war broke out between Philip and Athens (357), Olynthus was at first in alliance with Philip. Subsequently, it concluded an alliance with Athens; but in spite of all the efforts of the Athenians and their orator. Demosthenes, Philip razed it in 348.

OMAGH, a market town, urban district and county town of County Tyrone. Northern Ireland, on the Strule, 72 mi. W. of Belfast by road. Pop. (1951) 6,757. Area 1.6 sq.mi. The town, picturesquely situated above the river, is a military training centre. Shirts and milk products are the chief manufactures. Local antiquities include the scanty remains of a castle which played a part in the Tudor and Confederation wars.

OMAHA. This Siouan tribe of Nebraska, closely associated with the Ponca, combined agriculture with seasonal buffalo hunting. Since 1829 they have numbered between 1,105 and 1,900. They were organized into moieties and ten patrilineal clans.

OMAHA, largest city in Nebraska, U.S., a port of entry and the seat of Douglas county, is located in the extreme eastern part of the state on the west bank of the Missouri river opposite Council Bluffs. Ia. The population in 1950 was 251,117; in 1960 it was 301,598 by federal census. The population of the Omaha standard metropolitan statistical area, which includes Douglas and Sarpy counties in Sebraska and Pottawattamie county in Iowa, in 1960 was 457,873.

While Omaha had its beginnings shortly after the passage of the Kansas-Nebraska act in 1854, the area had already been visited. Meriwether Lewis and William Clark passed the site in 1804 on their journey of exploration to the Pacific coast and Manuel Lisa (*q.v.*) established a fur-trading post in the vicinity during the War of 1812. The vanguard of the Utah-bound Mormons spent the winter of 1846–47 there at an encampment which they named Winter Quarters, later called Florence and subsequently annexed by Omaha. This remained for several years an important way station for Mormon immigrants on their way to Salt Lake City (*q.v.*).

Omaha, named for a dispossessed Indian tribe, was founded in 1854 by Council Bluffs promoters who were anxious to have the capital of the newly created Nebraska Territory located directly across the river from them. Already there was talk of building a railroad to the Pacific and the location of a territorial capital might influence the builders to lay their tracks through or near it. The plan worked and Omaha was made the capital despite the fact that there were older and larger communities in the territory. A few years later Pres. Abraham Lincoln designated Council Bluffs as the eastern terminus of the first transcontinental railroad, and by the second half of the 20th century Ornaha was one of the largest railroad centres in the U.S.

As the actual starting point for the railroad. Omaha (incorporated as a city in 1867) soon became a focal point for trade and industry and grew rapidly during the early years, although the capital was moved to Lincoln soon after Nebraska became a state. A succession of drought years following the great blizzard of 1888 did much to discredit the entire region. This, added to the panic of 1893, brought population growth to a standstill.

In 1892 Omaha was the site of the Populist party's national convention which nominated James B. Weaver for the presidency. Six years later the Trans-Mississippi and International exposition was held there. The Knights of Ak-Sar-Ben (Nebraska spelled backward), the city's leading civic organization. was formed in 1895. By the time of World War I the city had started to grow again. A number of suburban communities, including South Omaha, site of the Union stockyards, were annexed. In 1946 Ft. Crook, an army post located 8 mi. S. of the city, was transferred to the U.S. air force, renamed Offutt air force base and made the headquarters of the strategic air command.

Most of the citizens of Omaha gain a livelihood from some activity connected with agriculture. Long important for meat packing. Omaha by the second half of the 20th century had become one of the nation's largest livestock markets, meat-packing centres and primary grain markets. In addition to being important as a distribution and food-processing centre, it is called "the Hartford of the midwest" because of the large number of insurance companies located there. Other industries include oil refining, smelting and the manufacture of feed, farm machinery. paints and varnishes, garden tools, ball bearings, telephone equipment and paper boxes.

The needs of higher education are met by the Municipal University of Omaha (1908), Creighton university (Roman Catholic 1878) and the University of Nebraska college of medicine (1883–87; re-established in 1902). There are also two Roman Catholic women's colleges, Duchesne College of the Sacred Heart (1881) and the College of St. Mary (1923). The city has a symphony orchestra and a community playhouse. The Joslyn Art museum attracts large numbers of visitors while a $7,000,000 municipal auditorium offers excellent facilities for conventions and entertainments. In addition to a number of scenic parks within the city, Fontenelle forest, the largest unbroken native forest in the state, is located 1 mi. S. of Omaha: Located 11 mi. W. of the city is Boys Town, site of the internationally famous boys' home established (1917) in Omaha by the Rev. Edward J. Flanagan and later moved to its present location. Incorporated as a village in 1936, the community is run by the boys, who elect their own executives and officials. (F. W. A.)

OMAN, SIR CHARLES WILLIAM CHADWICK (1860–1946), British historian, was born at Mozufferpore, India, on Jan. 12, 1860. Educated at Winchester and at New college, Oxford, he was made a fellow of All Souls in 1883. In 1905 he became Chichele professor of modern history at Oxford and he was chosen a fellow of the British academy in the same year. He was president of the Royal Historical society, 1917–21. In 1919 he was elected M.P. for Oxford university and in 1920 he mas knighted. His most important work was done in military history. He died June 23, 1946.

His works include: History of the Art of *War* in the Middle Ages (1898; new ed., 1924); History of Greece (1890); *A* Short History of England (1895; new ed., 1920); A History of the *Peninsular* War 1807–13 (7 vol., 1902–30); and Napoleonic Studies (1929).

OMAN, a nominally independent state in southeastern Arabia, extending from Ras Musandam, on the Gulf of Oman, to the eastern limits of Hadhramaut at Ras Sajar (lat. 16° 8″ N.) on the Indian ocean. Inland the state is bounded by the Empty Quarter. The population (1954 est.) 550,000, chiefly Arabs. with a strong Negro element in the coastal regions; the area is about 82,008 sq.mi. The prevailing religion is Ibadi Islam.

Oman is a mountainous district forming part of the ancient land mass of Arabia, granite and limestone rocks being most in evidence. The high ground culminates in Jabal Akhdar (10.194 ft.), which is flanked by steps of the old mountain block down to the coast. The lateral valleys between the steps are often fertile and cultivated, especially where a good supply of water is available. The wadis. which cut across the mountainous area to the coast. are merely torrential channels, dry for most of the year and often flowing in narrow precipitous gorges; but provide the only ways to the interior. Of these ways, always difficult, the best known are those by the Wadi Qahza, from the port of Matrah; by the Wadi Hail from the port of Quryat; and by the Sama'il valley, leading into the Wadi Munsab from a point 50 mi. N.W. of Muscat. Northwest of Muscat lies the coastal plain known as Al Batinah; it is fertile, prosperous and well populated.

The climate is tropical, with a mean annual rainfall of less than ten inches and a mean annual temperature of 80° F. or more. The vegetation is, however, abundant: tamarisks, oleanders, euphorbias, the milkbush, rhamus and acacias predominate.

Muscat, the capital and the only important harbour, was in Portuguese hands from 1508 to 1648. In 1741 it was taken by Ahmed ibn Sa'id. a descendant of those Yemenite imams who consolidated Arab power in Zanzibar and on the east African coast. His family has ruled Oman ever since. It was the most powerful state in Arabia during the first half of the 19th century, but subsequent raids by the nomadic tribes of the interior, as in 1913–14, and the opportunities for foreign intervention reduced the country for a time to a dependency of India. A treaty of friendship and commerce between Britain and Sultan Sir Sa'id ibn Taimur (succeeded 1932), signed Feb. 5, 1939, reaffirmed the close ties which had existed for nearly 150 years. (See ARABIA.)

Date cultivation has reached a high level in the interior. Cereals and vegetables, as well as vines, peaches, apricots, oranges, mangoes and melons, are grown with the dates.

Trade is mainly with India. Dates, pomegranates and dried fish are exported, while rice, coffee and cotton goods are the chief imports. Oman's riding camels are considered the best in the world. The little port of Gwadar, on the coast of Baluchistan, the outlet for most of the trade of Makran, is a dependency of Oman.

See Bertram Thomas, *Arab Rule under the Al Bu Sa'id Dynasty* of *Oman, 1741–1937 (1938).*

OMAR (c. 581–644), in full 'OMAR IBN AL-KHAṬṬAB, the second of the Mohammedan caliphs (see CALIPHATE). Belonging to the clan of 'Adi of the Meccan tribe of Koraish (Quraish), Omar at first opposed Mohammed but later became one of his ablest advisers and on his death secured the election of Abu Bekr as his successor. His own reign (634–644) saw the emergence of Islam as an imperial power. The chief events were the defeat of the forces of the Greek emperor Heraclius on the Yarmuk river (636) and that of the Persians at Kadisiya (637); the settlement of Arab garrisons in Syria and Iraq; the conquest of Egypt by 'Amr ibn el-'As (*q.v.*); and the final rout of the Persians at Nehavend (Nihawand, 641), which opened Iran to Arab rule. Omar also laid down principles for the administration of the conquered lands and helped stabilize the legal practice of Islam. He was a man of strong and ascetic character; his justice and authority were held in universal respect. He was assassinated by a Persian slave in 644. Though he lingered several days after the attack he left the selection of his successor to a council of six of the leading Meccan "Companions of the Prophet." (H. A. R. G.)

OMAR KHAYYAM (GHIYATHUDDIN ABULFATH 'OMAR IBN IBRĀHĪM AL-KHAYYĀMĪ), the great Persian mathematician, astronomer, free thinker and epigrammatist, who derived the epithet Khayyam (the tentmaker) most likely from his father's trade, was born in or near Nishapur, where he is said to have died in A.H. 517 (A.D. 1123). His standard work on algebra, written in Arabic, and other treatises of a similar character raised him at once to the foremost rank among the mathematicians of that age, and induced Sultan Malik-Shah to summon him in A.H. 467 (A.D. 1074) to institute astronomical observations on a larger scale, and to aid him in his great enterprise of a thorough reform of the calendar. The results of Omar's research were a revised edition of the *Zij* or astronomical tables, and the introduction of the Ta'rikh-i-Malikshahi, or Jalali; that is, the so-called Jalalian or Seljuk era, which commences in A.H. 471 (March 15, A.D. 1079).

Omar's scientific fame, however, is eclipsed in the west by his still greater poetical renown, which he owes to his *rubā'īs* (made famous in the west by E. FitzGerald's translation, *The Rubáiyát*) or quatrains, a collection of about 500 epigrams. Although some of his quatrains are purely mystic and pantheistic, most of them bear quite another stamp; they are the breviary of a radical freethinker, who protests in the most forcible manner both against the narrowness, bigotry and uncompromising austerity of the orthodox ulemā and the eccentricity, hypocrisy and ravings of advanced Sufis.

BIBLIOGRAPHY.—The Leyden copy of Omar Khayyām's work on algebra was noticed as far back as 1742 by Gerald Meerman in the preface to his *Specimen calculi fluxionalis;* further notices of the same work by Sédillot appeared in the *Nouv. Jour. As.* (1834) and in vol. xiii of the *Notices et extraits des MSS. de la Bibl. roy.* The complete text, together with a French translation (on the basis of the Leyden and Paris copies: the latter first discovered by M. Libri, *see* his *Histoire des sciences mathématiques en Italie,* vol. i, p. 300), was edited by F. Woepcke, *L'Algebrè d'Omar Alkhayyāmi* (1851). Articles on Omar's life and works are found in Reinaud's *Géographie d'Aboulféda,* pref., p. 101; *Notices et extraits,* vol. ix, p. 143 *et seq.;* Garcin de Tassy, *Note sur les Rubā'iyāt de 'Omar Hhaïyām* (1857); Rieu, *Cat. Pers. MSS. in the Br. Mus.,* vol. ii, p. 546; A. Christensen. *Recherches sur les Rubā'iyāt de 'Omar Hayyām* (1905); V. Zhukovski, *'Umar Khayyām and the "Wandering" Quatrains,* translated from the Russian by E. D. Ross in the *Journal of the Royal Asiatic Society,* vol. xxx (1898); E. G. Browne, *Literary History of Persia,* vol. ii, p. 246. The quatrains have been edited at Calcutta (1836) and Tehran (1857 and 1862); in English verse, by Edward FitzGerald (1859, 1872 and 1879). FitzGerald's translation has been edited with commentary by H. M. Batson (1900), and the 2nd ed. of the same (1868) by E. Heron Allen (1908). A new English version was published in Trübner's "Oriental" series (1882) by E. H. Whinfield, and the first critical edition of the text, with translations, by the same (1883). Important later works are N. H. Dole's variorum edition (1896), J. Payne's translation (1898), E. Heron Allen's edition (1898) and the *Life* by J. K. M. Shirazi (1905); but the literature in new translations and imitations has recently multiplied exceedingly. *See* A. G. Potter, *A Bibliography of Printed Editions of the Quatrains* of *Omar Khayyám in Foreign Languages* (1923).

OMBRE, a game of cards. the most fashionable in Europe for many years but now practically obsolete. It has been traced as far back as the 14th century. As late as 1884 Friedrich Anton in a standard manual stated. "Of all games, undoubtedly the most interesting, diversified, and widely known is Ombre." Originally played with the Spanish packs of 40 or 48 cards. it was adapted to the French pack of 52. In the course of time it accreted terms from Spanish, French, Italian and English, as well as a great complexity of rules.

Played for the most part by three players, it generated a variant for four, so-called quadrille, which gained great popularity and was one of the five games treated by Edmond Hoyle (1733). A simplification of quadrille, usually called solo, is still played. (G. Mh.)

OMDURMAN. The largest town in Sudan, on the west bank of the Nile, opposite Khartoum and immediately north of the junction of the White and Blue Niles. Pop. (1956) 113.551 (131 Europeans). Area 17 sq.mi. Most of the houses are built of mud. but the number of brick houses is increasing. Few buildings survive from the time of the mahdi. Among these are the mahdi's tomb. ruined in 1947, the khalifa's house (now a museum), the Beit el Amana, or arsenal (now a football stadium) and part of the old slave market.

In the market trade most of the big transactions are handled by Sudanese merchants, the chief articles of commerce being hides and gum arabic for export, and imported cotton piece goods. There is also an important camel. sheep and cattle market. Many dwellers in Omdurman are employed in government service in the administrative capital, Khartoum, about 5 mi, distant. to which Omdurman is connected by a bridge over the White Nile.

There are many schools. government and private, for both boys and girls. The government maintains a large hospital and medical and educational work is undertaken by various missionary societies. Local services are controlled by an all-Sudanese municipal council.

Omdurman. then an insignificant village. was chosen in 1884 by the mahdi Mahommed Ahmed as his capital and so continued after the fall of Khartoum in Jan. 1885. Its growth was rapid. the khalifa (who succeeded the rnahdi) compelling large numbers of disaffected tribesmen to live in the town under the eye of his soldiery. The European captives of the mahdists—notably Slatin Pasha and Father Ohrwalder—were also imprisoned there. On Sept. 2: 1898. the Anglo-Egyptian army under Lord Kitchener totally defeated the forces of the khalifa at Kerreri, 7 mi. N. of the town.

A marble obelisk marks the spot where the 21st lancers made a charge, in which Winston Churchill took part. (E. H. Mh.)

OMEN, a sign in divination, favourable or unfavourable as the case may be. See Augur; Divination; Oracle.

OMICHUND (d. 1767), an Indian whose name is indelibly associated with the treaty negotiated by Robert Clive before the battle of Plassey in 1757. His real name was Xmir Chand; and he was not a Bengali, as stated by Thomas Macaulay, but a Sikh from the Punjab. It is impossible now to unravel the intrigues in which he may have been engaged, but some facts about his career can be stated. He had long been a resident of Calcutta where he had acquired a large fortune by providing the "investment" for the East India company, and also by acting as intermediary between the English and the native court at Murshidabad. Several houses owned by him in Calcutta are mentioned in connection with the fighting that preceded the tragedy of the Black Hole in 1756 and it is on record that he suffered heavy losses at that time. He had been arrested by the English on suspicion of treachery, but afterward he gave help to the fugitives and also valuable advice. On the recapture of Calcutta he was sent by Clive to accompany Watts as agent at Murshidabad. It seems to have been through his influence that the nawab gave reluctant consent to Clive's attack on Chandernagore. Later, when the treaty with Mir Jafar was being negotiated, he put in a claim for 5% of all the treasure to be recovered under threat of disclosing the plot. To defeat him, two copies of the treaty were drawn up: one, the true treaty, omitting his claim; the other containing it, to be shown to him, which Adm. Charles Watson refused to sign, but Clive directed the admiral's signature to be appended.

When the truth was revealed to Omichund after Plassey. Macaulay states (following Robert Orme) that he sank gradually into idiocy, languished a few months and then died. As a matter of fact, he survived for ten pears, till 1767; and by his will he bequeathed £2,000 to the Foundling hospital (where his name may be seen in the list of benefactors as "a black merchant of Calcutta") and to Magdalen hospital in London. (J. S. Co.)

OMNIBUS. A term often shortened to "bus," signifying a public passenger-carrying vehicle of large seating capacity. It has become synonymous in popular use with the word "motorbus." Horse-drawn and steam-driven omnibuses have been superseded by motor-propelled omnibuses.

In several particulars an omnibus must conform with regulations laid down by public authorities, especially in connection with dimensions and weights. The carried load, consisting of the passengers and the omnibus body, will at most be less than the regulation weight by a figure termed the chassis weight. The proportion borne by the carried load to the total weight is largely determined by the speed, hill climbing and other performances characteristic of the omnibus. Such proportion is always made as large as possible to obtain the maximum earning power. For any specified purpose, designers have in recent years been able to increase this proportion without prejudicing either the reliability of the vehicles or the lowness of their running costs.

Body design aims at making the proportion borne by the passenger load to the carried load as great as possible, and is influenced very greatly by public requirements in the matter of comfort and safety. This proportion tends to become less as more exacting conditions have to be met in the provision of seating, shelter, ventilation and lighting. Passengers may be taken to weigh on an average one-sixteenth of a ton each, but as soon as an omnibus body is provided to carry them, the weight that must be credited to each passenger becomes much greater.

The almost universal practice in omnibus design in 1928 was to employ two axles, the rear wheels being used for driving and braking, the front wheels being used for steering. The weight distribution, as indicated by the front and rear axle weights, must be such as to give the adhesion necessary for rapid acceleration and good braking on normal road surfaces. Skidding and inferior performance are the natural consequences of bad weight distribution. The limit is set to front axle weight by the consideration that the driver must be able to turn the front wheels easily in order to steer the vehicle. This limit is reached before the other, which otherwise would aifect both axles alike (but which, in consequence of the earlier limit on the front axle, affects the rear axle alone), viz. the limiting axle weight tolerated by local authorities.

Low Centre of Gravity.—In the complete omnibus, under all conditions of loading, the centre of gravity must be so low in relation to the width of the vehicle as to render exceedingly remote the possibilities of over-turning. Where conditions permit, the centre of gravity should occupy a position even lower than that which gives the desired stability. All deviations of a 'bus from uniform motion in a straight line will bring about changes in the loading of every wheel, and these changes become smaller as the centre of gravity approaches the plane of the road. With a low centre of gravity, it will be usual to work very close to the adhesion figures calculated for the stationary omnibus, since the greatest acceleration and braking effects that these figures allow, can be actually approached in practice under all conditions. Where the centre of gravity is high, braking is liable to promote skidding at corners, and on cambered surfaces; rapid acceleration will give rise to the same tendency. Since the carried load in a modern omnibus forms the large proportion of the total weight, and since the carried load comprises very nearly everything which is above floor level, it follo s that the problem of making further reductions in the height of the centre of gravity, resolves itself simply into the problem of reducing the floor height.

To obtain the lowest possible floor height, omnibus designers have developed the double reduction driving axle. In this axle, the driving shafts do not transmit the torque direct to the road wheels, but communicate their motion to them through gearing. Each wheel bears a drum coaxial with the brake drum, but of smaller diameter, on which teeth are cut internally. Pinions on the ends of the driving shafts engage with these drums at their lowest points. This arrangement permits the use of full size driving wheels with an axle whose height is considerably less than that of the wheel centres. It permits, moreover, the use of a smaller housing for the right angled drive in the centre of the axle. This drive no longer effects the whole torque multiplication, but only a part of it; whereas the whole multiplication may be nearly 10 to 1, the right angled drive may be called upon to give a multiplication of only 2 to 1, and may therefore be much more compact than one giving the full multiplication.

The centre of gravity is lower in the "N.S." omnibus than in other types. Under the worst conditions, when the upper deck is laden and the lower deck is unladen, the ground may tilt to the extent of 28° beneath the car before over-turning can occur. The best figure obtained with the more usual construction, and without a top cover, was 2j°. With the advent of cross seating, omnibus axle weights became so great as to approach the limit tolerated by road authorities. Rear axle weights, reaching that limit, could no longer be increased, and the need arose, as bigger omnibus weights were required, for throwing the weight forward. To this end the forward drive omnibus was introduced in London, and subsequently in all parts of the world.

The modern 'bus body is continued forward to a point only an inch or two behind the rear cylinder block. The driver sits forward alongside the engine, and is actually in a much more favourable position to steer his vehicle round blind corners than formerly. The drawbacks to the forward drive omnibus, are, firstly, the heaviness of steering consequent upon the increased front axle loading, and secondly, the difficulty of access to the engine on the off-side. Neither of these drawbacks has, however, proved serious. There is a tendency among vehicle builders of six wheelers to return to the conventional driving position of many years ago, but the day cannot long be postponed when forward drive will be forced upon designers of six wheelers, as it has been forced upon designers of four wheelers.

Transmission Problem. — Common to all road vehicles employing the internal combustion engine, is the problem of transmitting the power developed by a relatively inflexible prime mover to the road wheels. In the omnibus, above all other vehicles, this problem is one of great difficulty to which no entirely satisfactory solution has yet been found. The high power weight ratio of an ordinary car makes possible the employment of a lightly constructed clutch and gearbox, since the car will normally run in top or direct gear. Only motoring enthusiasts care for driving on the gears and obtaining thereby a splendid performance out of a small capacity engine. Nevertheless, the omnibus driver is called upon to do this, and in consequence, the transmission must be of great robustness and be simple to manipulate. In addition to the need for gear changing, ever present on undulating roads, with the relatively low powered omnibus there is the constant stopping to let down and take up passengers which also calls for gear manipulation. With the very heavy omnibus used in services necessitating a great many stops, it has become impossible to achieve, without high maintenance costs, the propulsion of the load through the agency of the clutch and gearbox. It is probably only a matter of a year or two before other forms of transmission--electric transmission in particular — will live down their many drawbacks, and show on the whole a saving in costs.

For the right angled drive in an omnibus rear axle, bevel, and other forms of gearing have yet to be proved superior to worm gearing. Within recent years, the old fashioned motion communicating screw and wheel has been developed to tneet modern automobile and industrial requirements, and in its original form it can scarcely claim a relationship with the highly efficient reversible worm gearing of the present day. The difficulties inherent in the many forms of bevel drive are to make them compact and also silent.

Suspension. — The suspension of an omnibus is effected through longitudinally disposed semi-elliptic leaf springs mounted on the axles, supplemented by rubber buffers, steel volute springs, or other energy absorbing devices over the axles. The latter augment the stiffness of the suspension to meet exceptional load or road conditions.

Rear springs are often allowed to take the driving and braking torque reactions of the rear axle. Where this is not permissible, a torque arm is provided, and the rear springs are shackled at both ends. Tractive effects are often communicated to the vehicle through the rear springs also, though, where a torque arm is provided, the springs must, in view of their being shackled at both ends be relieved of this duty. Where it is provided, the torque arm usually swings from a well braced frame cross-member that has sufficient strength to withstand the pushing and tugging in a horizontal plane to which it will be subjected by the driving and braking exertions of the rear axle. Some vehicles are made with a torque tube surrounding the propeller shaft.

No effort is made by designers to produce completely rigid chassis frames for omnibuses. All things carried on the frame are mounted so as to flex with it or be able to take up a new position without strain. Such rigid structures as engine, gearbox and radiator, are mounted on frame attachments or bearers with rubber or other resilient pads interposing and permitting small relative movements. Where severe conditions must be met, the engine and gearbox are mounted on three such bearers only. Three points of support, however, situated,. remain always in a plane, and there can be no distortion from twisting with three point suspension. The drive between units, disposed none too rigidly in relation to one another, is effected by means of shafts bearing flexible couplings or universal joints at their extremities.

The enormous mileages accomplished by the omnibus as compared with the light car, prohibit the adoption by omnibus engineers of light car greasing methods. There is no part of an omnibus which can be packed with grease and left to itself from one year's end to another. Grease nipples and filler caps are provided everywhere in accessible positions, and positive action grease feeding guns which can be relied upon to urge lubricant where lubrication is necessary, are used under service conditions at frequent intervals.

Tiremakers, anticipating the call for higher omnibus speeds which had been heard for some considerable time, developed the pneumatic tire that would carry heavy loads. With higher running speed, better braking must be provided on all vehicles. Rear wheel adhesion becomes insufficient and all four wheels must be fitted nith drums and brake shoes. Four-wheel braking is. in any event, often forced upon designers by the difficulty of accommodating two sets of brake drums on the very small wheel centres that accompany these deep-section tires.

OMRI (in the Douai version of the Bible, Omrai), an Israelite general, chosen by the army as ruler (I Kings xvi, 16) when, during a campaign against the Philistines, reports came that Zimri. a captain of the chariots, had murdered the king, Elah, in the royal city of Tirzah and proclaimed himself king. Omri promptly marched against Zimri and captured Tirzah; Zimri, recognizing the hopelessness of his position, set fire to the palace and perished in the flames. A rival party set up Tibni, with whom the Greek versions associate his brother Joram, as king, but Omri defeated this faction and became undisputed king of Israel c. 884 B.C. The one deed of his reign recorded in I Kings xvi, 24, is his purchase of the hill of Samaria, upon which he founded a new royal city. But Mesha of Moab mentions him as "having afflicted Moab many days." In spite of the fact that he suffered some reverses at the hand of Syria (I Kings xx, 34), he must have been an accomplished statesman who consolidated his kingdom and made it respected, because for generations after his death Israel is known to the cuneiform writers as "House (or Land) of Omri." and the Israelite Jehu as a "son of Omri." He reigned 12 years and was succeeded by his son Ahab (*q.v.*).

OMSK, a town in the Omsk oblast of the Russian Soviet Federated Socialist Republic, U.S.S.R., in latitude 55° N., longitude 73° 38' E., on the right bank of the Irtysh river, where the Om joins it.

It is in the midst of a treeless steppe; violent winds bring snow, often to a depth of six feet. in winter, and sandstorms in summer. The average January temperature is 5° F., July, 68° F. The annual rainfall is 12.4 in. and the altitude is 285 ft. It is on the Trans-Siberian railway, and has a branch linking with Sverdlovsk through Ishim and Tyumen. Steamer routes connect it with the Ob northward along the Irtysh, and southward with the Altai towns and Lake Zaisan. and caravan routes from the central Asian republics and Kazakhstan converge upon it. Its population grew from 37,376 in 1897 to 579,000 in 1959.

Stone buildings have been constructed and the cathedral is built of stone: municipal electricity, water and bus services were set up. Its industries included the making of agricultural and other machinery, distilling, brewing: cloth manufacture and foodstuffs, especially sausage. It became a centre for the collection and export of meat, butter, hides and skins. The Russian Geographical society established a museum there and there is much educational and dramatic activity.

A fort was established there in 1716 to protect the Russian settlers from Kirghiz raids. Later. with the increasing colonization of the area and the coming of the railway, the town developed rapidly and became a military centre, with large barracks. After the 1917 revolution, it was the nucleus of Siberian political activity and various governments rapidly succeeded one another; Adm. Alexander Kolchak declared himself dictator of Siberia at Omsk.

With the advance of the Bolshevik army, refugees from the west crowded into the town and the insanitary conditions resulted in a plague of spotted fever and typhus. On the capture of the town the refugees fled farther eastward carrying infection with them, though many died of cold, hunger and disease.

ŌMUTA, Japanese city of southern Fukuoka prefecture (northern Kyūshū), located on the east coast of Ariake bay. Pop. (1955) 201,737. Ōmuta is a coal-mining centre where some of Japan's finest bituminous coal is extracted from the Miike coal field. Its artificial harbour has modern coal-handling facilities. Omuta has been an important industrial city since 1917, especially in the manufacture of chemicals. Its industries include coke ovens, a zinc refinery, ferroalloy steel mill, fireproof brick works, cotton mill and a large synthetic petroleum plant.

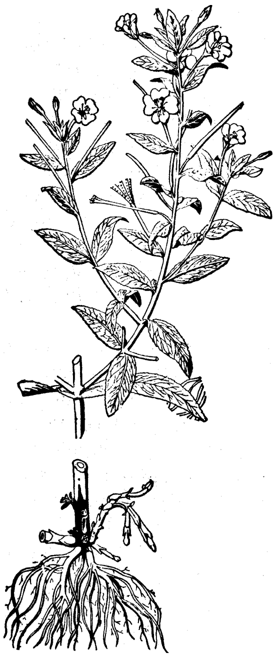
(J. D. EE.)

ONA, an Indian tribe which once occupied the interior of Tierra del Fuego except the southwestern corner, which was uninhabited, and the southeastern corner, where dwelt a related tribe known as the Haush. The Ona in speech, physique and culture were similar to the giant Tehuelche of Patagonia. They subsisted by hunting and were expert archers. Their chief food was the flesh of the guanaco, a wild camel related to the llama. In addition they ate birds, fish, shellfish, berries and fungi. Ona culture was very primitive. Their dress mas a large robe of guanaco fur, moccasins, a petticoat for the women and a fur diadem for the men. In spite of their cold environment they rarely used houses, and habitually slept behind a windbreak of hides. Their manufactures included bows and arrows, short fishing spears, slings, baskets, braided necklaces, wristlets and anklets and a few simple tools. Ona society was organized into hunting groups of relatives. Each group controlled a well-defined territory which it vigorously defended from poachers. As a result blood feuds were common. At times each hunting group assembled to perform initiation ceremonies. Candidates were taught tribal lore, were terrified by masked apparitions and were forced to live in solitude for two years that they might become strong and self-reliant. Ona religion consisted in a fear of certain malevolent spirits and belief in a supreme deity. Ona mythology is rich. The tribe has almost died out.

See S. K. Lothrop, "The Indians of Tierra del Fuego," Museum of the American Indian, Heye Foundation, *Contributions,* vol. x (1928); J. M. Cooper, Analytical and Critical Bibliography—of Tierra *del* Fuego, Bureau of American Ethnology, Bulletin 63 (1917).

(S. K. L.)

ONAGRACEAE or OENOTHERACEAE, a family of dicotyledons belonging to the order Myrtiflorae, to which belongs also the myrtle family, Myrtaceae. It contains about 40 genera and 500 species, and occurs chiefly in the temperate zone of the new world, especially on the Pacific side. It is represented in Britain by several species of Epilobium (willow herb). Circaea (enchanter's nightshade), and Ludwigia (false loosestrife), a small perennial herb very rare in boggy pools in Sussex and Hampshire. In the United States, especially in the Pacific states, the family is well represented, the principal genera being *Oenothera* (containing as a native the evening primrose, now naturalized in certain parts of Europe), *Epilobium* and *Ludwigia.* The plants are generally herbaceous, sometimes annual, as species of Epilobium, Clarkia, Godetia, or biennial, as Oenothera biennis—evening primrose—or sometimes become shrubby or arborescent, as Fuchsia (*q.v.*). The simple leaves are generally entire or inconspicuously toothed, and are alternate, opposite or whorled in arrangement; they are generally exstipulate. The flowers are often solitary in the leaf axils, as in many species of Fuchsia, Clarkia, etc., or associated, as in Epilobium and Oenothera, in large showy terminal spikes or racemes; in Circaea the small white or red flowers are borne in terminal and lateral racemes. The regular flowers have the parts in fours, the typical arrangement as illustrated by *Epilobium, Oeno*thera and Fuchsia being as follows: four sepals, four petals, two alternating whorls of four stamens, and four inferior carpels. The floral receptacle is produced above the ovary into the so-called calyx tube, which is often petaloid, as in *Fuchsia,* and is sharply distinguished from the ovary, from which it separates after flowering.



GREAT HAIRY WILLOW HERB (EPILOBIUM HIRSUTUM)

In Clarkia the inner whorl of stamens is often barren, and in Eucharidium it is absent. In Circaea the flower has its parts in twos. Both sepals and petals are free; the former are valvate in bud, and reflexed in the flower; in *Fuchsia* they are petaloid. The petals are generally convolute in bud; they are entire (Fuchsia) or bilobed (Epilobium); in some species of Fuchsia they are small and scalelike, or absent (F. apetala). The stamens are free, and those of the inner whorl are generally shorter than those of the outer whorl. The flowers of *Lopezia* (Central

America) have only one fertile stamen. The large spherical pollen grains are connected by viscid threads. The typically quadrilocular ovary contains numerous ovules on axile placentas; the one- to two-celled ovary of Circaea has a single ovule in each loculus. The long slender style has a capitate (Fuchsia), four-rayed (*Oenothera, Epilobium*) or four-notched (Circaea) stigma. The flowers, which have generally an attractive corolla and honey secreted by a swollen disk at the base of the style or on the lower part of the calyx tube, are adapted for pollination by insects, chiefly bees and lepidoptera; sometimes by night-flying insects when the flowers are pale and open toward evening, as in evening primrose. The fruit is generally a capsule splitting into four valves and leaving a central column on which the seeds are borne as in Epilobium and Oenothera—in the former the seeds are scattered by aid of a long tuft of silky hairs on the broader end. In Fuchsia the fruit is a berry, which is sometimes edible, and in Circaea a nutlet bearing recurved bristles. The seeds are exalbuminous. Several of the genera are well-known as garden plants; *e.g.,* Fuchsia, Oenothera, Clarkia and Godetia. Evening primrose (Oenothera biennis), a native of North America, occurs apparently wild as a garden escape in Britain. Jussieua, a tropical genus of 50 species of water and marsh herbs, shows a development of well-developed aerating tissue in certain species.

ONATAS, a Greek sculptor of the time of the Persian wars, a member of the flourishing school of Aegina. Many of his works are mentioned by Pausanias; they included a Hermes carrying the ram, and a strange image of the Black Demeter made for the people of Phigaleia; also some groups in bronze at Olympia and Delphi, including a bronze chariot for Hieron I of Syracuse. From Pausanias' descriptions we may assume that the figures on the pediments of Aegina represent his style. They are manly, vigorous, athletic, showing great knowledge of the human form, but somewhat stiff and automatonlike.

ONEGA, the largest lake in Europe next to Ladoga, area, 3.819 sq.mi. and coast line 810 mi. in length. It lies mostly in the Karelian A.S.S.R.. though its southern portion is in the province of Leningrad. The lake basin extends northwest and southeast, the direction characteristic of the lakes of Finland and the line of glacier-scoring observed in that region. The southern coast is comparatively regular and has few islands: but the north is broken into inlets, the largest being Povyenets bay. and is crowded with islands (*e.g.,* Klimetsk) and submerged rocks. The northwestern shore between Petrozavodsk and the mouth of the Lumbosha river consists of dark clay slates, generally arranged in horizontal strata and broken by protruding, parallel ridges of diorite. which extend far into the lake. The eastern shore. as far as the mouth of the Andoma, is for the most part alluvial, with outcroppings of red granite and in one place (the mouth of the Pyalma) diorite and dolomite. To the southeast are sedimentary Devonian rocks. and the general level of the coast is broken by Mt. Andoma and Cape Petropavlovskiy (160 ft. above the lake); to the southwest a quartz sandstone (used as a building and monumental stone in Leningrad) forms a fairly bold rim. Lake Onega lies 108 ft. above the sea. The greatest depths. 318 to 361 ft., occur at the entrance to the double bay of Lizhemsk and Unitsk. On the continuation of this line the depth exceeds 240 ft. in several places. In the middle of the lake the depth is 120 to 282 ft.. and less than 120 ft. in the south. The lake is 154 mi. long, with a maximum breadth of 56 mi. The most important affluents, the Vodka, the Andoma and the Vytegra, come from the east. The Kumsa, a northern tributary, is sometimes represented as if it connected the lake with Lake Seg, but at the present time the latter drains to the White sea. The Onega canal (45 mi. long) was constructed in 1818–51 along the southern shore in order to connect the Svir (and hence Lake Ladoga and the Baltic) with the Vytegra, which connects with the Volga. In 1928 an electric station was constructed on the Svir river. Lake Onega remains free from ice for 209 days in the year (middle of May to second week of December). The water is at its lowest level in the beginning of March; by June it has risen two ft. A considerable population is scattered along the shores of the lake. mainly occupied in the timber trade. fisheries and mining industries. The opening of the Murmansk railway along the western shore in 1917 developed settlement Salmon *palya* (a kind of trout) burbot, pike, pike perch and perch are among the fish caught in the lake.

The Onega river rises in Lake Vozhe, and is navigable for boats and rafts from Kargopol to the Gulf of Onega, an inlet of the White sea. It flows through the provinces of Vologda and Archangel and has no connection with Lake Onega. At the mouth of this river (on the right bank) in 63° 55' N, 38° 55' E.. in the oblast of Archangel R.S F.S.R., C.S S.R., stands the town and port of Onega Pop. (1926) 5,254. It dates from settlements made by the people of Novgorod in the 15th century. known in history as Ustenskaya or Ustyanskaya. It has a sawmilling industry, and has steamer routes to Soroka. Kem and Archangel, but the season is short because of the persistence of land floes and loose pack.

ONEIDA, the only city of Madison county in central New York, U.S. is located 6 mi. S.E. of Oneida lake. about midway between Utica and Syracuse. Founded by Sands Higinbotham in 1829. its future was determined by an agreement he made with the Utica and Syracuse railroad (later part of the New York Central system) to stop all trains there for refreshments in return for a free right of way and land for a depot. Oneida was incorporated as a village in 1848 and as a city in 1901. On the southern edge of the city lies Oneida Castle, the original home of the Oneida Indians, marked by a granite boulder which they held sacred. Nearby is the site of the Oneida community (*q.v.*), an experiment in communal living founded in 1848. In 1880 it nas reorganized as a business corporation which in the second half of the 20th century produced a leading line of silverware. Other manufactures include caskets and burial vaults. furniture, paper and plynood boxes, milking machines and cigars. For comparative population figures *see* table in NEW YORK: Population. (V. C. C.)

ONEIDA (a corruption of their proper name Oneyotka-ono, "people of the stone," in allusion to the Oneida stone, a granite boulder near their former village, which was held sacred by them), a tribe of North American Indians of Iroquoian stock, forming one of the Six Nations. They lived around Oneida lake in New York state, in the region southward to the Susquehanna. They were not loyal to the league's policy of friendliness to the English, but inclined toward the French, and were practically the only Iroquois who fought for the Americans in the War of Independence. As a consequence they were attacked by others of the Iroquois under Joseph Brant and took refuge within the American settlements till the war ended, when the majority returned to their former home, while some migrated to the Thames river district, Ontario. Early in the 19th century they sold their lands, and most of them settled on a reservation at Green Bay, Wis., a few remaining in New York state. In 1926 the Oneidas in the United States numbered 3,238 persons, of whom 2,976 were in Wisconsin and 262 in New York state. They are civilized and prosperous. See NORTH AMERICA: *Anthropology.*

ONEIDA COMMUNITY, a U.S. communistic society at Oneida, N.Y. It was founded at Putney, Vt., in 1842, by John Humphrey Noyes (1811–86), a graduate of Dartmouth college. "Converted" at a revival, he entered Yale Theological seminary. Bible studies convinced him that Christ came a second time in 70 A.D. and absolved Christians from necessity of sin. Called a perfectionist, he barely escaped expulsion from the seminary before graduation, and later was deprived of his licence as a Congregational minister. He and his followers established a commune, eventually pooling all property, renouncing all religious observances and instituting "complex marriage." Monogamy was antagonistic to their ideals. In 1847, dissension having brought them before the courts and their theories and practices before the public, they were forced to leave Putney. They purchased, near Oneida, N.Y., 600 ac. of forestland which proved extremely productive. They planted orchards, lumbered, blacksmithed, farmed and made steel traps—their most profitable industry. In Jan. 1847 their first annual inventory revealed them to be worth about $67,000.

They were mostly New England farmers and mechanics. They had the reputation of being excellent citizens only remarkable for their earnest interest in eugenics. They sought to make practical application of what scientific information they possessed endeavouring by change and experiment to produce the best possible offspring.

Owing to increasing pressure of public sentiment, which had been anticipated though for 25 years it was unexpressed, Noyes, with a few adherents, removed to Canada in 1880 and the community at Oneida voluntarily dissolved as a communistic experiment and formed a stock company known as the Oneida Community, Limited. At that time it manufactured sewing and embroidery silk, steel traps and silverware, and canned large quantities of fruits and vegetables, but has gradually confined itself to the manufacturing of silverware. The present company has "no connection with the old beyond the personnel and traditions which it inherited from its 40 years' experience as a community."

Among the chief writings of J. H. Noyes dealing with the origin, principles and history of the Oneida Community are *The Berean* (1847), a manual for the use of members; *Salvation from Sin the End of Christian Faith* (1869); *History of American Socialisms* (1870); *Honze-Talks* (1875); *Essay on Scientific Propagation* (c. 1875). *See* also *Bible Communism* (1853), a compilation of the community's theories; George Noyes, comp. and ed., *Religious Experiences of John Humphrey Noyes* (1923); Robert A. Parker, *A Yankee Saint* (1935); Pierrepont B. Noyes, *My Father's House* (1937). (P. B. N.)

O'NEILL, the name of an Irish family descended from Niall, king of Ireland in the 5th century, and known as Niall of the Nine Hostages. He is said to have made war against rulers in Ireland, Britain and Gaul, stories of his exploits being related in the Book of Lcinster and the Book of Ballymote. This king had 14 sons, one of whom was Eoghan (Owen), from whom the O'Neills were descended. The descendants of Niall were divided into two main branches, the northern and the southern Hy Neill, to one or other of which nearly all the high-kings (ard-ri) of Ireland from the 5th to the 12th century belonged; the descendants of Eoghan being the chief of the northern Hy Niell[1]. Eoghan was grandfather of Murkertagh (Muircheartach) (d. 533), said to have been the first Christian king of Ireland, whose mother, Eirc or Erca, became by a subsequent marriage the grandmother of St. Columba. Of this monarch, known as Murkertagh MacNeill (Niall), and sometimes by reference to his mother as Murkertagh Mac Erca, the story is told, illustrating an ancient Celtic custom, that he emphasized the inviolability of a treaty with a tribe in Meath by having it written with the blood of both clans mixed in one vessel. Murkertagh was chief of the great north Irish clan, the Cinel Eoghain, and after becoming king of Ireland in 517, he seized a tract in the modern Co. Derry, which remained till the 17th century in the possession of the Cinel Eoghain. The inauguration stone of the Irish kings, the Lia Fail, or Stone of Destiny, fabled to have been the pillow of the patriarch Jacob when he dreamed of the heavenly ladder, was said to have been presented by Murkertagh to the king of Dalriada, by whom it was conveyed to Dunstaffnage castle in Scotland. (See SCONE.) A lineal descendant of Murkertagh was Niall Frassach (*i.e.,* of the showers), who became king of Ireland in 763. His grandson, Niall (791–845), drove back the Vikings who began to infest the coast of Donegal. Niall's son, Aedh (Hugh) Finnlaith, was father of Niall Glundubh (*i.e.,* Niall of the black knee), one of the most famous of the early Irish kings, from whom the family surname of the O'Neills was derived. His brother Domhnall (Donnell) was king of Ailech, a district in Donegal and Derry; the ruined masonry of the royal palace is still to be seen on a hill overlooking loughs Foyle and Swilly. On the death of Domhnall in 911 Niall Glundubh became king of Ailech, and, after defeating the kings of Dalriada and Ulidia he became king of Ireland in 915. To him is attributed the revival of the ancient meeting of Irish clans known as the Fair of Telltown. He fought many battles against the Norsemen, in one of which he was killed in 919 at Kilmashoge, where his place of burial is still to be seen.

His son Murkertagh, who gained a victory over the Norse in 926, is celebrated for his triumphant march round Ireland, the *Moirthimchell Eiream,* when he captured many kings and chieftains. From the dress of his followers in this expedition he was called "Murkertagh of the Leather Cloaks." The exploit was celebrated by Cormacan, the king's bard, and a number of Murkertagh's other exploits are related in the Book of Leinster. He was killed in battle against the Norse in 943, and was succeeded as king of Ailech by his son, Donnell Ua Niall (*i.e.,* O'Neill, grandson of Neill, or Niall, the name O'Neill becoming about this time an hereditary family surname), whose grandson, Flaherty, made a pilgrimage to Rome in 1030.

Aedh (Hugh) O'Neill, chief of the Cinel Eoghain, or lord of Tir-Eoghain (Tir-Owen, Tyrone) at the end of the 12th century, came into conflict with the Anglo-Norman monarchy, whose pretensions he disputed in Ulster. His son (or nephew), Hugh O'Neill, lord of Tyrone, was styled "Head of the liberality and valour of the Irish." Hugh's son, Brian, was inaugurated prince, or lord, of Tyrone in 1291; and his son Henry became lord of the *Clann Aodha Buidhe* (Clanaboy or Clandeboye) early in the 14th century. Henry's son Murkertagh the Strongminded, and his great-grandson Hugh, greatly consolidated the power of the O'Neills. Niall Og O'Neill, one of the four kings of Ireland, accepted knighthood from Richard II.; and his son Eoghan formally acknowledged the supremacy of the English crown, though he afterwards ravaged the Pale, and was inaugurated "the O'Neill" (*i.e.,* chief of the clan) on the death of his kinsman Domhnall Boy O'Neill. He was deposed (1455) by his son Henry, who in 1463 was acknowledged as chief of the Irish kings by Henry VII. Contemporary with him was Neill Mor O'Neill, lord of Clanaboy. From Neill Mor O'Neill's son Brian was descended the branch of the O'Neills who, settling in Portugal in the 18th century, became Portuguese nobles. This branch represents the male line of the ancient Irish kings of the house of O'Neill.

CONN O'NEILL (*c.* 1480–1559), 1st earl of Tyrone, surnamed Bacach (the Lame), grandson of Henry O'Neill mentioned above, was the first of the O'Neills to come to the front as a leader of the Irish against the English in the 16th century. Conn became chief of the Tyrone branch of the O'Neills (Cinel Eoghain) about 1520. Tyrone having been invaded in 1541 by Sir Anthony St. Leger, the lord deputy, Conn delivered up his son as a hostage, attended a parliament held at Trim, and, crossing to England, made his submission at Greenwich to Henry VIII., who created him earl of Tyrone for life. He was also made a privy councillor in Ireland, and received a grant of lands within the Pale. O'Neill's submission to the English king, and his acceptance of an English title were resented by his clansmen and dependents. The earl maintained a feud with his son Shane (John), arising out of his transaction with Henry VIII. The nomination of O'Neill's reputed son Matthew as his heir with the title of baron of Dungannon by the English king conflicted with the Irish custom of tanistry (*q.v.*), which regulated the chieftainship of the Irish clans; moreover, Matthew, if indeed he was O'Neill's son at all, was illegitimate, and Shane, Conn's eldest legitimate son, would not permit any invasion of his rights. The fierce family feud ended in the murder of Matthew by agents of Shane in 1558; Conn dying about a year later.. Conn was twice married, Shane being the son of his first wife, a daughter of Hugh Boy O'Neill of Clanaboy. An illegitimate daughter of Conn married the celebrated Sorley Boy MacDonnell (*q.v.*).

SHANE O'NEILL (*c.* 1530–1567), rejected overtures from the earl of Sussex, the lord deputy, and refused to help the English against the Scottish settlers on the coast of Antrim, allying himself instead with the MacDonnells, the most powerful of these immigrants. Nevertheless Queen Elizabeth was disposed to come to terms with Shane, who after his father's death was de facto chief of the O'Neill clan. She recognized his claims to the chieftainship, thus throwing over Brian O'Neill, son of the murdered Matthew, baron of Dungannon, on terms. O'Neill, however, refused to put himself in the power of Sussex without a guarantee for his safety; and his claims were so exacting that Elizabeth determined to restore Brian. An attempt to incite the O'Donnells against him was frustrated by Shane's capture of Calvagh O'Donnell, whom he

[1]A list of these kings will be found in P. W. Joyce's *A Social History of Ancient Ireland* (London, 1903), vol. i., pp. 70, 71.

kept a prisoner for nearly three years.

Elizabeth, who was not prepared to undertake the subjugation of the Irish chieftain, urgently desired peace aith him, especially when the devastation of his territory by Sussex brought him no nearer to submission. Sussex was not supported by the queen. a h o sent the earl of Kildare to arrange terms with O'Neill. The latter agreed to present himself before Elizabeth. Accompanied by Ormonde and Kildare he reached London on Jan. 4. 1562. Elizabeth temporized; but finding that O'Neill was in danger of becoming a tool in the hands of Spanish intriguers, she permitted him to return to Ireland, recognizing him as "the O'Neill," and chieftain of Tyrone; though a reservation mas made of the rights of Hugh O'Neill, who had succeeded his brother Brian as baron of Dungannon, Brian having been murdered in April 1562 by his kinsman Turlough Luineach O'Neill.

There were at this time three powerful contemporary members of the O'Neill family in Ireland—Shane, Turlough and Hugh, and earl of Tyrone. Turlough had been elected tanist (see TANISTRY) when his cousin Shane was inaugurated the O'Neill, and he schemed to supplant him during Shane's absence in London. The feud did not long survive Shane's return to Ireland. where he re-established his authority and renewed his turbulent tribal warfare. Elizabeth at last authorized Sussex to take the field against Shane, but two expeditions failed. Shane then laid the nhole blame for his lawless conduct on the lord deputy's repeated alleged attempts on his life. Elizabeth consented to treat, and practically all O'Neill's demands were conceded. O'Neill then turned his hand against the MacDonnells, claiming that he was serving the queen of England in harrying the Scots. He fought an indecisive battle with Sorley Boy MacDonnell near Coleraine in 1564. and in 1565 routed the MacDonnells and took Sorley Boy prisoner near Ballycastle. This victory strengthened Shane O'Neill's position, and preparations were made for his subjugation. O'Neill ravaged the Pale. failed in an attempt on Dundalk, made a truce with the MacDonnells and sought help from the earl of Desmond. The English, on the other hand, invaded Donegal and restored O'Donnell. O'Neill was routed by the O Donnells at Letterkenny; and seeking safety in flight, he threw himself on the mercy of his enemies the MacDonnells. Attended by a small body of galloglasses, and taking his prisoner Sorley Boy with him, he presented himself among the MacDonnells near Cushendun, on the Antrim coast. There, on June 2, 1567, he was slain by the MacDonnells.

TURLOUGH LUINEACH O'NEILL (*c.* 1530–95), earl of Clanconnell. was inaugurated chief of Tyrone on Shane's death. He sought to strengthen his position by alliance with the O'Donnells. MacDonnells and MacQuillans. An expedition under the earl of Essex was sent against him, which effected little. and by treaty in 1575 O'Neill received extensive grants of land and permission to employ 300 Scottish mercenaries. In 1578 he was created baron of Clogher and earl of Clanconnell for life; but for the next few years he continued to intrigue against the English authorities. The latter, as a counterpoise to Turlough, supported his cousin Hugh, brother of Brian, whom Turlough had murdered. Eventually Turlough resigned the headship of the clan in favour of Hugh, who was inaugurated the O'Neill in 1593. Turlough died in 1595.

HCGH O'NEILL (c. 1540–1616), 2nd earl (known as the great earl) of Tyrone, was the second son of Matthew, reputed illegitimate son of Conn, 1st earl of Tyrone. He succeeded his brother Brian when the latter was murdered by Turlough in 1562, as baron of Dungannon. He was brought up in London, but returned to Ireland in 1567 after the death of Shane, under the protection of Sir Henry Sidney. He served with the English against the 15th earl of Desmond in Munster in 1580, and assisted Sir John Perrot against the Scots of Ulster in 1584. In the following year he attended parliament as earl of Tyrone, though Conn's title had been for life only, and had not been assumed by Brian. Hugh's constant disputes with Turlough were fomented by the English, but after Hugh's inauguration as the O'Neill on Turlough's resignation in 1593, he was supreme in the north. Having roused the ire of Sir Henry Bagnal (or Bagenal) by eloping nith his sister in 1591, he afterward assisted him in defeating Hugh Maguire at Belleek in 1593; and then again went into opposition and sought aid from Spain and Scotland. Sir John Norris was ordered to Ireland to subdue him in 1595, but Tyrone took the Blackwater fort and Sligo castle before Norris was prepared; he was thereupon proclaimed a traitor of Dundalk. In spite of the traditional enmity between the O Neills and the O'Donnells, Tyrone allied himself with Hugh Roe O'Donnell. nephew of Shane's former enemy Calvagh O'Donnell, and the two chieftains opened communications with Philip II of Spain, their letters to whom were intercepted by the viceroy, Sir William Russell. They presented themselves as champions of the Catholic religion, claiming religious and political liberty for the Irish. In April 1596 Tyrone received promises of help from Spain. He temporized successfully for more thdn two yeara, making professions of loyalty which deceived Sir John Norris and the earl of Ormonde. In 1598 a formal pardon was granted to Tyrone by Elizabeth. Within two months he was again in the field, and on Aug. 14 he destroyed an English force under Bagnal at the Yellow ford on the Blackwater. If the earl had knonn how to profit by this victory, he might then have successfully withstood the English power in Ireland; for in every part of Ireland—and especially in the south, where James Fitzthomas Fitzgerald. with O'Neill's support, was asserting his claim to the earldom of Desmond at the head of the Geraldine clansmen —discontent broke into flame. But Tyrone procrastinated. Eight months after the battle of the Yellow ford, the earl of Essex landed in Ireland. He met Tyrone at a ford on the Lagan on Sept. 7, 1599, when a truce was arranged; but Elizabeth objected to the conditions allowed to the O'Neill and to Essex's treatment of him as an equal. Tyrone then issued a manifesto to the Catholics of Ireland summoning them to join his standard. After an inconclusive campaign in Munster in Jan. 1600, he returned to Donegal where he received supplies from Spain and a token of encouragement from Pope Clement VIII. In May of the same year armies under Sir Henry Docwra and Lord Mountjoy (later earl of Devonshire) compelled O'Neill to retire to Armagh, a large reward having been offered for his capture alive or dead.

The appearance of a Spanish force at Kinsale drew Mountjoy to Munster in 1601; Tyrone followed him, and at Bandon joined forces with O'Donnell and with the Spaniards under Don John d'Aquila. The attack failed. O'Donnell went to Spain. where he died, and Tyrone with a shattered force went to the north, where he renewed his temporizing policy. Early in 1603 Elizabeth instructed Mountjoy to open negotiations; and in March Tyrone, in ignorance of Elizabeth's death, made his submission. In Dublin he heard of the accession of King James, at whose court he presented himself in June accompanied by Rory O'Donnell, who had become chief of the O'Donnells after the departure of his brother Hugh Roe. James confirmed Tyrone in his title and estates, but new disputes arose on his rights over certain of his feudatories, of whom Donnal O'Cahan was the most important. This dispute dragged on until 1607, when Tyrone arranged to go to London to submit the matter to the king Warned, however, that his arrest was imminent, and possibly persuaded by Rory O'Donnell (created earl of Tyrconnel in 1603), Tyrone resolved to fly from the country.

"The flight of the earls," one of the most celebrated episodes in Irish history, occurred on Sept. 14, 1607, when Tyrone and Tyrconnel embarked at midnight at Rathmullen on Lough Swilly, with their wives, families and retainers numbering 99, and sailed for Spain Driven by contrary winds to take shelter in the Seine, the refugees passed the winter in the Netherlands, and in 1608 went to Rome, where they were entertained by Pope Paul V, and where Tyrconnel died the same year. In 1613 Tyrone was outlaned and attainted by the Irish parliament, and he died in Rome on July 20, 1616 He was four times married. and had a large number both of legitimate and illegitimate children.

SIR PHELIM O'NEILL (*c.* 1603–53), a kinsman and younger contemporary of the earl of Tyrone, took a prominent part in the rebellion of 1641. In that year he was elected member of the Irish parliament for Dungannon, and joined the earl of Antrim and other lords in supporting Charles I against the parliament. On Oct. 22, 1641, he surprised and captured Charlemont castle; and having been chosen commander in chief of the Irish in the north, he forged and issued a pretended commission from Charles I sanctioning his proceedings. Phelim and his followers ravaged Ulster on the pretext of reducing the Scots, but failed to take Drogheda, being compelled by the duke of Ormonde to raise the siege in April 1642. During the summer his fortunes ebbed, and he was superseded by his kinsman Owen Roe O'Neill.

OWEN ROE O'NEILL (c. 1590–1649), one of the most celebrated of the O'Neills, the subject of the well-known ballad "The Lament for Owen Roe," was the son of Art O'Neill, a younger brother of Hugh. 2nd earl of Tyrone. Having served with distinction in the Spanish army, he was immediately recognized on his return to Ireland as the leading representative of the O'Neills. Phelim resigned the northern command in his favour, and escorted him from Lough Swilly to Charlemont. But jealousy between the kinsmen was complicated by differences between Owen Roe and the Catholic council which met at Kilkenny in 1642. Owen Roe's real aim was the complete independence of Ireland, while the Anglo-Norman Catholics represented by the council desired to secure religious liberty and an Irish constitution under the English crown. In 1646 a cessation of hostilities was arranged between Ormonde and the Catholics; and O'Neill, furnished with supplies by the papal nuncio Giovanni Rinuccini, turned against the Scottish parliamentary army under General Monro. On June 5, 1646, O'Neill routed Monro at Benburb, on the Blackwater; but, being summoned to the south by Rinuccini, he had to leave Monro unmolested at Carrickfergus. For the next two years confusion reigned, O'Neill supporting the party led by Rinuccini, though continuing to profess loyalty to Ormonde as the king of England's representative. Isolated by the departure of the papal nuncio from Ireland in 1649, he made overtures to Ormonde, and to George Monk (later duke of Albemarle), who had superseded Monro in command of the parliamentarians in the north. O'Neill's chief need was supplies, and failing to obtain them from Monk he turned once more to Ormonde and the Catholic confederates, with whom he prepared to co-operate more earnestly when Oliver Cromwell's arrival in Ireland in Aug. 1649 brought the Catholic party face to face with serious danger. Before anything was accomplished by this combination, however, Owen Roe died on Nov. 6, 1649.

The alliance between Owen Roe and Ormonde had been opposed by Phelim O'Neill, who after his kinsman's death expected to be restored to his former command. In this he was disappointed; but he continued to fight against the parliamentarians until 1652, when a reward was offered for his apprehension. Betrayed by a kinsman while hiding in Tyrone, he was tried for high treason, and executed on March 10, 1653. Phelim married a daughter of the marquis of Huntly, by whom he had a son, Gordon O'Neill, who was member of parliament for Tyrone in 1689; fought for the king at the siege of Derry and at the battles of Aughrim and the Boyne; and afterward commanded an Irish regiment in the French service, and died in 1704.

DANIEL O'NEILL (c. 1612–64), a member of the Clanaboy branch of the family, spent much of his early life at the court of Charles I, and became a Protestant. He commanded a troop of horse in Scotland in 1639; was involved in army plots in 1641, for which he was committed to the Tower, but escaped; and on the outbreak of the Civil War returned to England and served with Prince Rupert, being present at Marston moor, the second battle of Newbury and Naseby. He then went to Ireland to negotiate between Ormonde and his uncle, Owen Roe O'Neill. He was made a major general in 1649, and but for his Protestantism would have succeeded Owen Roe as chief of the O'Neills. He joined Charles II at The Hague, and took part in the expedition to Scotland and the Scottish mvasion of England in 1652.

HUGH O'NEILL (d. c. 1660), son of Owen Roe's brother, Art Oge, and therefore known as Hugh Mac Art, had served with distinction in Spain before he accompanied his uncle, Owen Roe, to Ireland in 1642. After the death of Owen he defended Clonmel in 1650 against Cromwell, on whom he inflicted the latter's most severe defeat in Ireland. In 1647 he so stubbornly resisted Henry Ireton's attack on Limerick that he was excepted from the benefit of the capitulation, and, after being condemned to death and reprieved, was sent as a prisoner to the Tower. He was released in 1652, and died, some time after 1660, probably in Spain.

The Clanaboy (or Clandeboye) branch of the O'Neills descended from the ancient kings through Neill Mor O'Neill, lord of Clanaboy in the time of Henry VIII, ancestor (as mentioned above) of the Portuguese O'Neills. Neill Mor's great-great-grandson, Henry O'Neill, was created baronet of Killeleagh in 1666. His son, Sir Neill O'Neill, fought for James II in Ireland, and died of wounds received at the battle of the Boyne. Through an elder line from Neill Mor was descended Brian Mac Phelim O'Neill, who was treacherously seized in 1573 by the earl of Essex, whom he was entertaining, and executed together with his wife and brother, about 200 of his clan being at the same time massacred by the orders of Essex. (See ESSEX, WALTER DEVEREUX, 1ST EARL OF.) Brian Mac Phelim's son, Shane Mac Brian O'Neill, was the last lord of Clanaboy, and from him the family castle of Edenduffcarrick, on the shore of Lough Neagh in Co. Antrim, was named Shane's castle. He joined the rebellion of his kinsman Hugh, earl of Tyrone, but submitted in 1586.

In the 18th century the commanding importance of the O'Neills in Irish history had come to an end. But John O'Neill (1740–98) took an active part in debate in the Irish parliament, being a strong supporter of Catholic emancipation. He was one of the delegates in 1789 from the Irish parliament to George, prince of Wales, requesting him to assume the regency. In 1793 he was raised to the peerage of Ireland as Baron O'Neill of Shane's Castle, and in 1795 was created a viscount. In defending the town of Antrim against the rebels in 1798 O'Neill received wounds from which he died on June 18, being succeeded as Viscount O'Neill by his son Charles Henry St. John (1779–1841), who in 1800 was created Earl O'Neill. Dying unmarried, when the earldom therefore became extinct, Charles was succeeded as Viscount O'Neill by his brother John Bruce Richard (1780–1855), a general in the British army; on whose death without issue in 1855 the male line in the United Kingdom became extinct. The estates then devolved on William Chichester, great-grandson of Arthur Chichester and his wife Mary, only child and heiress of Henry (d. 1721), eldest son of John O'Neill of Shane's Castle.

WILLIAM CHICHESTER (1813–83), 1st Baron O'Neill, a clergyman, on succeeding to the estates as heir general, assumed by royal licence the surname and arms of O'Neill; and in 1868 was created Baron O'Neill of Shane's Castle. On his death in 1883 he was succeeded by his son Edward, 2nd Baron O'Neill, who was member of parliament for Co. Antrim, 1863–80, and who married in 1873 Louisa, daughter of the 11th earl of Dundonald.

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O'NEILL, EUGENE GLADSTONE (1888–1953), U.S. dramatist, born in New York city on Oct. 16, 1888, was by common consent America's greatest playwright and an artist of international renown. His career divided U.S. theatrical history in two. Before O'Neill, U.S. stages were awash with genteel, sentimentally spurious plays; he pioneered the drama of serious realism and uncompromising honesty.

When Eugene O'Neill took his place on the U.S. literary scene in the 1920s, it was to join a band of iconoclasts. H. L. Mencken was tilting with the "booboisie." Sinclair Lewis was baiting Babbitt. Sherwood Anderson was gingerly lifting the lid off sex. O'Neill ranged over the same themes but he sprayed them with a melancholy that clung like poison gas. Cries a leading character in *The* Great God Brown: "Why am I afraid to dance, I who love music and rhythm and grace and laughter? Why am I afraid to live. I who love life and the beauty of the flesh and the living colors of earth and sky and sea? Why am I afraid of love, I who love love? . . . Why was I born without a skin. O God . . . Or rather Old Greybeard, why the devil was I ever born at all?" (*The* Plays of Eugene O'Neill, 3 vol., New York, Random House, 1946.) O'Neill took this language of failure and flavoured it with the accent of tragedy. It was a convincing performance, in part because failure is often regarded as tragic in America, and in part because O'Neill had a rare mastery of his craft.

He came by a mastery of his craft early. His father, James O'Neill, was a matinee idol of the 1880s, playing for 16 years the count in The Count of Monte Cristo. Barnstorming with his father, young O'Neill soaked up theatrical know-how. In the fall of 1906 he entered Princeton university and flunked out the following spring. In the next few years he married and divorced, prospected for gold, went to sea and sailed the Atlantic from Southampton to South Africa. For O'Neill, the sea was a mystic experience, and some of the best of his 47 plays (e.g., The Moon of *the* Caribbees, The Long Voyage Home) are salty with the tang of the sea and the tongue of lonely, hard-bitten sailormen.

It was not until a mild case of tuberculosis bedded him in a sanitarium in 1913 that Eugene O'Neill thought of becoming a playwright. When the Provincetown (Mass.) Players produced his one-act Bound East for Cardiff in 1916, modem American drama unofficially began. By 1920 O'Neill fashioned a Broadway success and won a Pulitzer prize with his first full-length play, Beyond the Horizon, a bitter domestic tragedy. O'Neill was already felt to be a man of morose views who could be counted on to find the worm in the apple of life. Actually his plays were cardiograms of the outraged heart, poignantly charting the canceled dream, the twisted love, the thwarted hope.

O'Neill won two more Pulitzer prizes with Anna Christie (1922) and Strange Interlude (1928), and in 1936 became the second American (after Sinclair Lewis) to win the Nobel prize for literature. A restless technician, he thrilled theatregoers with tom-toms (Emperor Jones), masks (The Great God Brown), old-fashioned asides (Strange Interlude) and choral chants (*Lazarus* Laughed). A troubled thinker, he tried to pour modern experience into tragic molds.

It has been said that tragedy is the story of man's fate. Greek tragedy is the tragedy of destiny. Man's fate is in his stars. Shakespearean tragedy is the tragedy of character. Man's fate is in his will. Through suffering and death, Greek and Shakespearean tragic heroes appeased the gods and found redemption. O'Neill had to cope with an audience that was almost as suspicious of God, will and destiny as of a flat earth. Bowing to his time. O'Neill wrote the tragedy of personal psychology. Man's fate is in his genes and hormones. But if man is his own fate, there can be no release, only an endless cycle of sin and built. Says Lavinia Mannon at the end of Mourning Becomes Electra: "There's no one left to punish me . . . I've got to punish myself!" (*The* Plays of Eugene O'Neill, ibid.) O'Neill blended the determinism of John Calvin and Sigmund Freud to produce the only kind of tragic hero the 20th century could understand — the victim of circumstance.

The "sickness of today," O'Neill once said, was that the "old God was dead" and a new one was not in sight. To "belong" to the machine age, as O'Neill saw it, man had to be subhuman. an automaton. The instinct to love had been debased by possessiveness. The instinct to believe had atrophied. The best O'Neill could offer was chilly, stoic resignation. As the old barge captain puts it in Anna Christie: "You can't see where you vas going, no. Only dat ole devil, sea — she knows." (The Plays of Eugene O'Neill, ibid.)

O'Neill sometimes handled these themes crudely. He wrote a kind of waterlogged English that never floated memorably across the mind. What he intended for encounters with the inexpressible were simply collisions with the badly expressed. When the juice of life ran low in his characters, he pumped them full of grease paint. His mind was an open manhole; ideas (J. A. Strindberg's, Freud's, C. G. Jung's) tumbled in but were never really absorbed. Yet there is something granitic in O'Neill that refuses to be chipped away — the sweep of his passion and compassion, the hypnotic moods he projects over the footlights and, above all, his probity. He never cheated with his evidence. and his evidence came from the heart. He never consciously wrote a shoddy line.

The coming of World War II sapped O'Neill's will to write; then a muscular disorder made it physically impossible. When he died he left at least three plays in manuscript, including the autobiographical Long Day's Journey Into Night, which was produced in Stockholm in Feb. 1956 and in New York city later that year.

On the world's stages, only G. B. Shaw and Sean O'Casey clearly outrank him among 20th-century dramatists. Yet O'Neill never achieves the Aristotelian catharsis of pity and terror, or climbs to tragedy's classic realm where man's suffering and death stand bare, awesome and ennobling; his heroes wander instead, like eternally lost children through a haunted wood of pathos, futility, self-pity and frustration. But in his dedication to the best in his art form, Eugene O'Neill was a cultural hero, and as such, he left the U.S. theatre the memory of something finer than his best plays.

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ONESICRITUS or ONESICRATES, of Aegina or Astypaleia (probably simply the "old city" of Aegina), one of the writers on Alexander the Great. At an advanced age he became a pupil of Diogenes the Cynic and gained such repute as a student of philosophy that he was selected by Alexander to hold a conference with the Indian Gymnosophists.

When the fleet was constructed on the Hydaspes, Onesicritus was appointed chief pilot (in his vanity he calls himself commander) and in this capacity accompanied Nearchus on the voyage from the mouth of the Indus to the Persian gulf. He wrote a diffuse biography of Alexander which in addition to historical details contained descriptions of the countries visited, especially India. After the king's death Onesicritus appears to have completed his work at the court of Lysirnachus, king of Thrace. Its historical value was considered small. it being avowedly a panegyric, and contemporaries (including even Alexander himself) regarded it as untrustworthy.

Strabo especially takes Onesicritus to task for his exaggeration and love of the marvelous. His *Paraplus* (or description of the coasts of India) probably formed part of the work and incorporated by Juba II of Mauretania with the accounts of coasting voyages by Nearchus and other geographers, and circulated by him under the name of Onesicritus, was largely used by Pliny.

ONION (Allium cepa), a hardy, bulbous, biennial vegetable of the family Liliaceae. The edible part of the onion is the thickened leaf bases arising from the extremely shortened stem, called the stem plate, at the base of the bulb. The upper part of the leaf is cylindrical and hollow. Fibrous, shallow roots emerge in a tuft from the stem plate. In the second season of growth a smooth seedstalk rises two to five feet, topped by a large globose umbel of small whitish flowers. The seeds are small, usually black, irregular and somewhat angular. Two types of onion produce no seeds: those propagated by bulblets formed instead of seeds in the umbel; and those propagated only by division of a vegetative cluster of plants. Most varieties of onions are sensitive to length of day and night. Bulbing varieties adapted to summer culture in high latitudes will not form bulbs during the short days of winter in low latitudes. Certain varieties that form large bulbs during the short days of low latitudes will form only small bulbs during the long days of high latitudes. The Welsh onion (A. *fistulosum*) forms no enlarged bulb.

A. cepa is native to middle Asia, with secondary centres of development in western Asia and the Mediterranean area. A. *fistulosum* is native to China. Onions have been commonly grown since prehistoric times and are now grown the world over, chiefly in the temperate zones.

Varieties grown in the northern U.S. require a mild, cool climate. Varieties of Spanish and Egyptian type tolerate hot days of spring but not the midsummer heat of low latitudes. The latter types are sown in autumn in regions having little or no winter freezing. Northern bulbing varieties typically are firm fleshed, long keeping and very pungent. The Bermuda type. grown in the south for spring harvest, is less firm fleshed, is mild and can be stored several weeks but not several months.

BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

ONION FLOWER HEAD (ALLIUM CEPA)

Discovery of cytoplasmically inherited male sterility in the onion in 1925 led to a commercially feasible method of producing F_1 hybrid seed of onion (1944) and later of certain other plants. Substantial quantities of seed for growing superior F_1 hybrid varieties became commercially available in the U.S. after 1950.

Most onions are grown by sowing seed directly in the field, but large acreages of Bermuda and Spanish onions are grown from transplants. Some onions of the northern type are propagated by planting tiny mature bulbs called sets, which were grown from thickly sown seed the preceding year.

Nonbulbing onions for use in the fresh green state can be harvested at any time after they are large enough. Bulbing kinds sometimes are harvested similarly. before bulbs form. for immediate use. "Green onions" are marketed with the fresh green tops (leaves) attached. Bulb onions are mature enough to harvest soon after the necks weaken and the tops fall to the ground. The bulbs are pulled from the soil and dried in the field until the necks are thoroughly dry. The tops are then removed and the bulbs are bagged for shipment or crated for storage.

Onions keep best in dry, well-ventilated storage at about 32° F. to 34° F. (V. R. B.)

ONION MAGGOT, the larval stage of a small fly Hylemyia *antiqua* of the family Muscidae (Anthomyiidae) order Diptera (*q.v.*), which attacks the roots of onions, garlic and related plants in damp, cool areas of Europe and North America. The eggs are laid on the soil close to the plants; the young larvae, which grow to about one-third of an inch, feed on the roots or attack the bulbs and bases of the leaves. Many other insects are attracted to and feed upon the damaged plants, and bacterial rot often sets in. Species commonly found associated with H. *antiqua* are the lesser bulb fly, Citabaena tuberculatus, and species of *Fannia*.

Treatment consists in watering the plants with a solution of corrosive sublimate, dusting with various chemical powders or spraying with Bordeaux-oil mixtures. See ENTOMOLOGY: Principles of Insect Control. (C. H. CN.; X.)

ONITSHA, a commercial town of Eastern Region, Nigeria, which stands prominently on the eastern bank of the Niger river at its junction with the Anambra river. Pop. (1960 est.) 88,358 (African), predominantly Ibo. The town is virtually divided into two residential areas by the Oguta road, to the east of which lives chiefly the indigenous population. the west side being occupied by people of various tribes. Other main streets in a wide network are the Old Market and New Market roads; Venn, Sokoto and Awka roads; Modebe avenue; and Bright and Nottidge streets. There are no ancient buildings but the Roman Catholic Holy Trinity cathedral (1935) and the Anglican All Saints cathedral (1952) are notable modern buildings. Among many colleges and schools the oldest is the Dennis Memorial grammar school (1925) and others are St. Charles' teachers' training college (1929) and Christ the King college (1933). Onitsha market. built by the town council, is the largest in Nigeria.

Onitsha is served by road and river transport. The inhabitants are engaged largely in farming and trade. The chief export is palm produce. and textiles are the main import. (I. P. N. O.)

ONOMATOPOEIA, the use of a word in poetry whose sound resembles its sense, *e.g.*, as echo: "whirr," "chirp," "roar"; or, suggesting its natural sound: the "murmuring of innumerable bees," in Tennyson's The Princess. Most poets make extensive use of sound symbolism. (G. W. A.)

In philology the term is used to denote the supposed formation of words by imitation of natural sounds; *e.g.*, "hiss," "click" and "hush." Some philologists have held that the term echoism for this alleged process is preferable, since it suggests the imitative repetition of the natural sounds believed to be heard. At one time there was an exaggerated tendency to find in echoism a principal source in the origin of language; it is now recognized, however, that it could have played only a limited part.

Onomatopoeia means literally the making or formation of words. It is derived from the Greek onoma, "name," "word," and poiein, "to make." (J. WH.)

ONONDAGA, meaning "on the mountain," is the name applied to North American Indians of Iroquoian speech; the central fire of the Longhouse of the Five Nations (afterward Six) of the Iroquois league; the aboriginal proprietors of New York state. Flanked by Oneida and Cayuga tribal lands, Onondaga territory extended from the Thousand Islands, their Laurentian homeland, south to the Susquehanna river. First stockaded on the mountain, the capital of Iroquoia later occupied open valley sites along the creek, toward the lake, within the county of that name, moving periodically to plant new gardens, to seek firewood, and to be nearer fish and game. Onondaga castle, now Onondaga reservation, lies just south of Syracuse. A 17th-century visitor counted 140 houses in the main town and 24 in another; he estimated 350 warriors (some 1,700 people); on the intervening two mile clearing grew an abundance of maize for sale to Oneida. In the League of the Iroquois, the Onondagas claimed a total of 14 seats in council; they were "uncles, name bearers, fire keepers"; they furnished the chairman and archivist, who kept the memory of transactions in wampum belts. British colonial representatives attended such congresses in the 18th century, when a sizable faction favouring the French had migrated to Catholic mission settlements on the St. Lawrence. The conservative faction remained loyal to British interest, and with the breakup of their league, after the American Revolution, a small party followed the other Six Nations to the Grand river, Ont.. and the majority returned to their ancestral valley. The resident population of

Onondaga reservation in the second half of the 20th century was nearly 900. See also NORTH AMERICA: Prehistory and Archaeology; IROQUOIS.

See F. W. Hodge (ed.), Handbook of American Indians *North* of *Mexico,* pt. ii (1912); W. N. Fenton, "Problems Arising From the Historic Northwestern Position of the Iroquois," Smithsonian Msc. *Coll.,* vol. 100 (1940). (W. N. F.)

ONTAKE-SAN, Japanese mountain, elevation 10,049 ft., located on the boundary of Gifu and Nagano prefectures (central Honshu). A compound volcano which has a heavy snow mantle in winter, it is second only to Fujiyama in elevation and popular esteem. Crowds of white-robed pilgrims climb to the ancient Shinto shrine on its summit during the height of the summer season. (J. D. EE.)

ONTARIO, a province of Canada, bounded on the east by the province of Quebec and on the west by the province of Manitoba, on the south by the U.S. states of New York, Ohio, Michigan and Minnesota, and on the north by Hudson bay and James bay. It is the second largest Canadian province with a total area of 412,582 sq.mi., 68,490 sq.mi. (17%) of which is fresh water. It is the most populous of Canada's ten provinces with a total population (1961) of 6,236,092, and also the most productive, its varied economic activities accounting for about 40% of Canada's new wealth each year.

This article is divided into the following main divisions:

I. PHYSICAL GEOGRAPHY

Ontario lies in the east central part of North America, stretching from 42° to 57° N., and from 79° 30′ to 95° W. From its southernmost point in Lake Erie to its northernmost point on Hudson bay is a distance of 1,050 mi., while its greatest east to west distance from Quebec to Manitoba is also more than 1.000 mi.

Tradition and its shape divide Ontario into two very unequal parts, the line of division folloming the French and Mattawa river systems from Georgian bay on Lake Huron east-northeast through Lake Nipissing to Mattawa. To the south of this line is southern Ontario, containing less than one-eighth of the total area but having more than seven-eighths of the population and economic activity. To the north of the line, northern Ontario is a vast land of rock and forest, much of which is still relatively untouched.

1. Land Forms. — Ontario has a great length of shore line On James bay and Hudson bay it borders salt water for 680 mi. nhile to the south on the Great Lakes and St. Lawrence, it has a fresh water shore line of 2,362 mi. Ontario is a land of relatively low relief. Large areas near Hudson bay and James bay are not far above sea level. the lowlands along Lake Ontario and the St. Lawrence river are between 150 and 500 ft. above sea level. while most of the southnestern peninsula lies between 500 and 1.000 ft. above sea level. Higher areas from 1.000 to 1,700 ft.. are found in the flat-topped uplands south of Georgian bay, and in the more rugged southern portion of the Canadian shield stretching from the Ottawa river to the Manitoba boundary. The highest points in Ontario are Tip Top hill and Mt. Batchawana, near the northern and eastern shores of Lake Superior, both of which reach over 2,100 ft. above sea level.

The most striking feature in southern Ontario is the Niagara escarpment. From the Niagara river it extends west to Hamilton as a flat-topped ridge about 350 ft. above the level of Lake Ontario. From Hamilton at the western end of the lake, it runs in a northwesterly direction to the Bruce peninsula, reaching its best development in the Blue mountain which stands more than 1.000 ft. above the waters of Georgian bay. Other hilly areas are found in the Oak ridges between Lake Ontario and Lake Simcoe.

2. Geology. — On the basis of bedrock geology, Ontario may be divided into four distinct zones as indicated on fig. 1 (A), (B), (C) and (D):

The Hudson bay lowlands are underlain by Paleozoic rocks (fig. 1[A]). Ranging in age from Ordovician to Devonian, these rocks consist of horizontally bedded limestones, shales and sandstones.

The rocks of the Canadian shield (fig. 1[B]) are Pre-Cambrian in age and among the oldest rocks in the world. They consist of gneisses, granites, greywackes, quartzites, crystalline limestone and many other metamorphosed sedimentary and igneous rocks. (See PRE-CAMBRIAN TIME: The Pve-Cambrian Record.) Many areas are strongly mineralized yielding ores of iron, nickel, copper, gold, silver, cobalt and uranium.

A small area in southeastern Ontario is underlain by Ordovician limestone (fig. 1[C]).

Southwestern Ontario is underlain by Paleozoic rocks ranging in age from Ordovician to Devonian (fig. 1[D]). Petroleum and natural gas, gypsum and salt are found in the rocks of southwestern Ontario. The hard Silurian dolomite which forms the cap rock of the Niagara escarpment is quarried extensively for use as crushed stone, while the red shale beneath it is used for brickmaking.

Ontario was glaciated in the Pleistocene epoch. The surface, nearly everywhere, is composed of unconsolidated rock debris laid down either by the ice itself or by the melt water which issued from the ice front. The minor surface land forms, therefore, are composed of till or boulder clay, and water-worked gravel, sand, silt and clay.

3. Lakes and Rivers. — Numerous lakes and rivers are found in Ontario. The southern part of the province is nearly all tribu-

AFTER THE GEOLOGICAL SURVEY OF CANADA

FIG. 1.—GENERALIZED GEOLOGICAL MAP OF THE PROVINCE OF ONTARIO (see TEXT)

tary to the St. Lawrence while, to the north, a number of river systems, including the Moose, Albany. Attawapiskat, Winisk and Severn drain to Hudson bay. The western margin of the province drains to the Nelson river system of Manitoba.

The surface waters of Ontario include the Canadian portion of four Great Lakes: Superior (11,110 sq.mi.), Huron (13.675 sq.mi.), Erie (5,940 sq.mi.) and Ontario (3,970 sq.mi.). Other notable lakes. wholly or partly in Ontario, are Lake of the Woods, Rainy lake, Lac Seul. Lake Nipigon, Lake Nipissing, Lake Abitibi, Lake Simcoe and Lake St. Clair. In addition, the surface of the Canadian shield is dotted with thousands of smaller lakes.

The rivers of Ontario which flow from the uplands of the Canadian shield are steep and rapid, furnishing numerous power sites. The great volume of the St. Lawrence system makes it an important source of power while with the help of the St. Lawrence, Welland and Sault Ste. Marie canals, the St. Lawrence-Great Lakes system has become a very important inland waterway.

Niagara falls. 158 ft. in height. on the Niagara river between Lakes Erie and Ontario, is one of the scenic wonders of the world and a great tourist attraction (see NIAGARA RIVER AND FALLS). The smaller rivers in the north also have many scenic falls and rapids while the island-dotted waters of Georgian bay, the Muskoka lakes, Lake Timagami, Lake Nipissing, Lake of the Woods and many others provide wonderful vacation areas.

4. Climate. — Because of its large area. Ontario has a considerable range of climate. its temperature range being especially great. Average midwinter temperatures, everywhere. are well below freezing, but they range from less than -15° F. along the shore of Hudson bay to 25° F. along the shore of Lake Erie. Winters in the south are comparatively short, but in the north they are long and cold and the temperature may remain below zero for days at a time. The summer frost free season in the north is less than 60 days while it averages 175 days at the southernmost tip of the province. Average July temperature in the north is about 54° F. on the shore of Hudson bay, while it is 74° F. on Pelee Island in Lake Erie. The waters of the Great Lakes ensure that there is less difference between night and day temperatures along their shores than at inland points.

Mean annual precipitation varies from more than 40 in. to less than 15 in. Greatest precipitation is found along the slopes of the high land east of Lake Superior and on the uplands east and south of Georgian bay. The areas with least precipitation are found in the far north. In general, precipitation is fairly evenly distributed in all months in southern Ontario, but in the north there is more precipitation in summer than in winter. Snowfall is abundant in the areas south and east of Georgian bay which get about 120 in. per winter. On the other hand, the most southerly areas get less than 40 in., while the snow cover is often quite discontinuous. In northern Ontario, snowfall varies from more than 100 in. to less than 60 in., while the ground is snow covered for at least five months of the year.

In general, about half of northern Ontario may be said to have a subarctic climate quite unsuitable to agriculture; the area west of Lake Superior has a mid-continental climate like that of northern Minnesota or southeast Manitoba; a small area of southern Ontario has almost a corn belt climate suitable for corn, sugar beets. tobacco and even grapes and peaches; the southeastern portions are generally suitable for dairy and general farming.

5. Natural Vegetation.——Most of Ontario is naturally a forested region. Only along the shore of Hudson bay is the climate too harsh for tree growth: and there a strip of boggy tundra extends inward a few miles from the coast. Most of northern Ontario is covered with a boreal forest or taiga, composed of white and black spruce, tamarack and jack pine, often intermixed with aspen and birch. This region is noted for its pulpwood resources. The Great Lakes mixed forest stretches from Lake Superior to the Ottawa river. Formerly this area had great stands of white and red pine. and other stands of mixed maple, birch, spruce and hemlock. Most of southern Ontario was occupied by deciduous hardwood forests of sugar maple, beech, yellow birch, white and red oaks, elm, white and black ash, basswood, hickory and, in the extreme south. scarlet oak. chestnut. sassafras and Kentucky coffee tree. There are many poorly drained areas throughout Ontario which are either open bogs or swampy forests.

6. Animal Life.—Among the larger game animals of Ontario may be mentioned the moose: with a range almost coextensive with the forest, the woodland caribou, now rather rare! and the white-tailed deer. which is abundant in the mixed forest belt and may even be found in the hardwood forests of the south. There are many rodents including the porcupine, the red squirrel and the eastern chipmunk. Two larger rodents, much at home in the water, are the beaver and the muskrat. The snowshoe rabbit is found throughout the boreal forest while the cottontail and the imported European hare are common in the south. Common in the south, also, are the black squirrel and the woodchuck. Among the carnivores more common in northern Ontario are the black bear, the timber wolf, the coyote or brush wolf and the red fox. Skunks, minks, bobcats and weasels are also found. Raccoons are plentiful in some parts of southern Ontario, and even the opossum may be found.

With so many lakes, Ontario is a natural home for water birds, including gulls: ducks. geese and herons. Among the uplands game birds are the ruffed grouse and the bobwhite and, in southern Ontario, the imported pheasant. Among the other birds may be mentioned various hawks and owls, ravens, crows and blackbirds, songbirds such as the robin, the cardinal, whippoorwill, bobolink, catbird, meadow lark. swallow and various song sparrows. Two introduced nuisances are the English sparrow and the starling.

There are many species of fish in Ontario waters. Most noted perhaps are the pike, pickerel, lake trout, whitefish, muskellunge,

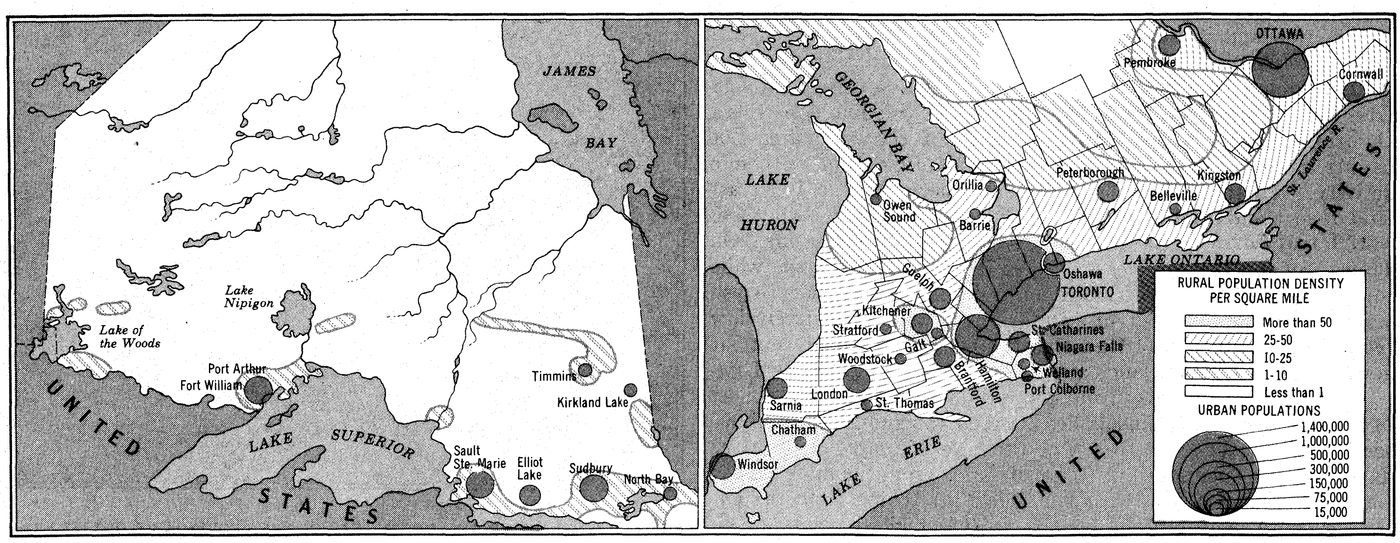
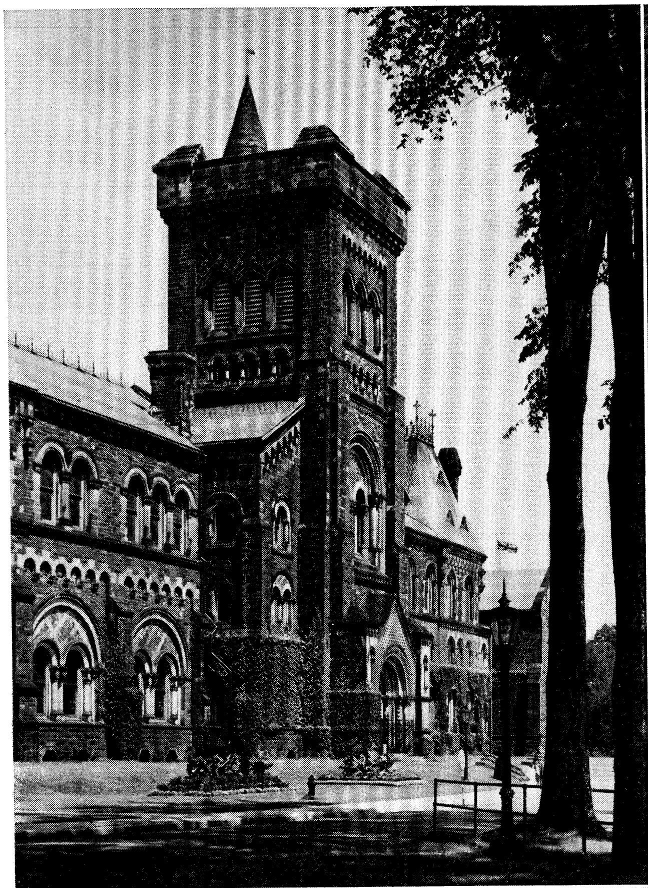
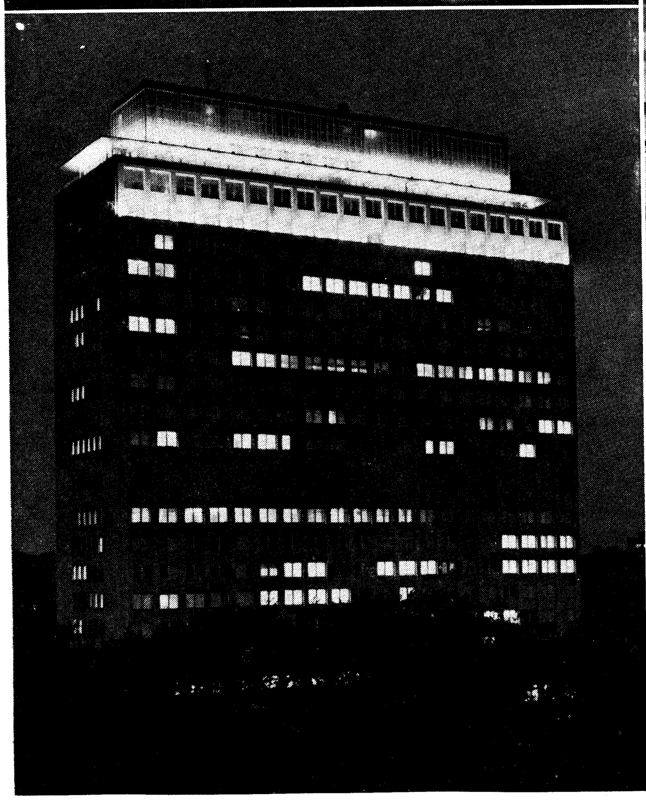


FIG. 2.— MAPSSHOWING THE DISPARITY IN POPULATION DISTRIBUTION BETWEEN (LEFT) NORTHERN ONTARIO AND (RIGHT) SOUTHERN ONTARIO





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TORONTO, AND SCENES OF ONTARIO INDUSTRY

Top left: University college, one of the oldest buildings of the University of Toronto, the provincial university of Ontario

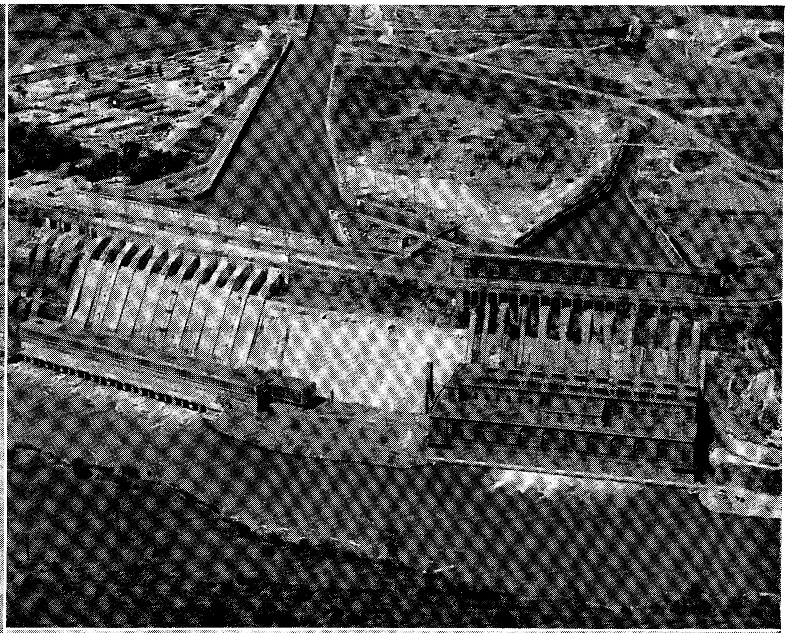
Top right: Tug towing a 5,000 pulpwood boom on Rainy lake, western Ontario

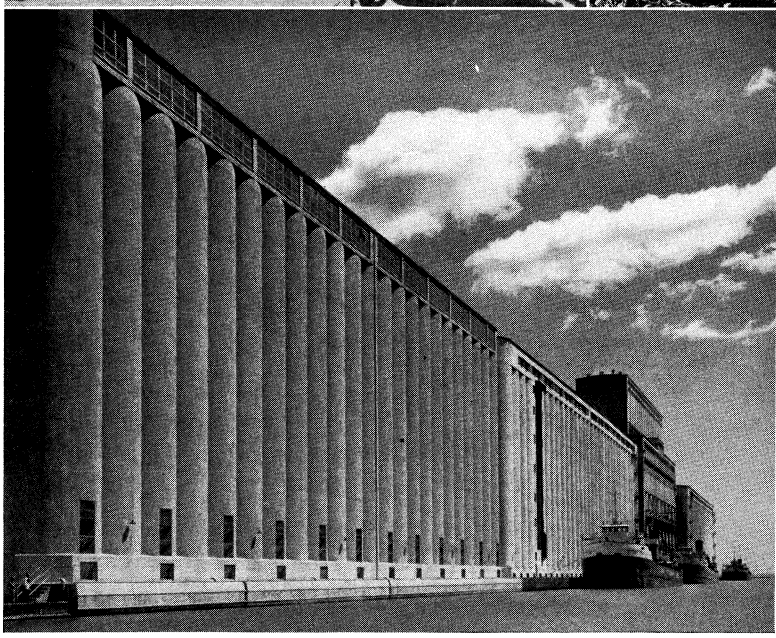
Centre right: Princes' gate at entrance to Exhibition park, Toronto, permanent site of the annual Canadian National exhibition

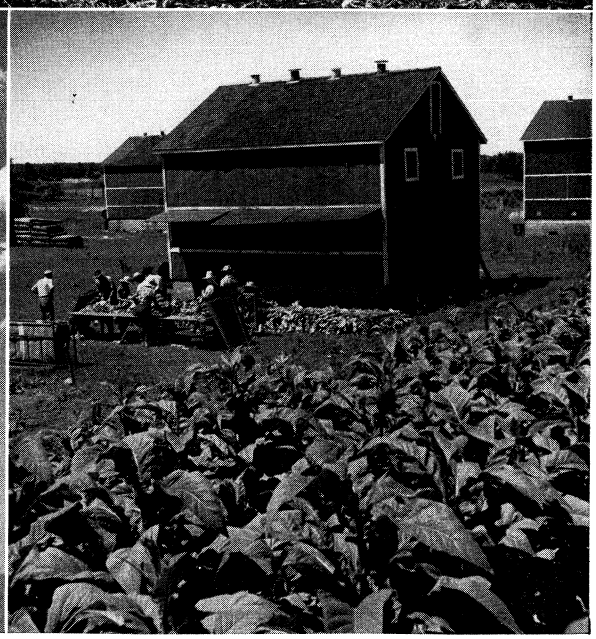
Bottom left: Toronto skyscraper, the Imperial Oil building

Bottom right: Train carrying siderite (iron) ore from a mine north of Sault Ste. Marie

ONTARIO







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SCENES IN ONTARIO

Top left: Peace tower at the parliament buildings, Ottawa
Top right: Power generating stations near Queenston on the Niagara river
Centre right: Onion-picking machine loading onions into boxes on a farm near Bradford, north of Toronto
Bottom left: Lake freighters loading grain at Port Arthur on the northwestern shore of Lake Superior
Bottom right: Grading leaves on a tobacco farm in southern Ontario

TABLE I.—*Population*

Census date	Total population	Rural population						Urban population	
		Total	%	Farm	%	Yon-farm	%	Total	%
1851	952,004	818,541	86.0					133,463	14.0
1871	1,620,851	1,264,854	78.0					355,997	22.0
1901	2,182,947	1,246,969	57.2	979,450	44.9	267,519	12.3	935,978	42.8
1931	3,431,683	1,335,691	38.8	800,960	23.3	534,731	15.5	2,095,992	61.2
1941	3,787,655	1,196,119	31.6	704,420	18.6	491,699	13.0	2,591,536	68.4
1951	4,597,542	1,346,443	29.3	678,043	14.7	668,400	14.6	3,251,099	70.7
1956	5,404,933	1,302,014	94.1	632,153	11.7	669,861	12.4	4,102,919	75.9

Urban and rural data for 1956 bared on 1956 definition; for 1951 based on 1951 definition; for years preceding 1951 the definition in effect.

sturgeon, black bass and brook trout.

The lakes and rivers of Ontario are dotted with cabin resorts which cater to the sport fisherman in spring and summer, and they often remain open to accommodate the fall hunter as well.

7. Soils.—Developed under a forest cover. the soils of Ontario are well leached. In the area west of Lake Superior, the soils resemble those of the forested parts of the Prairie provinces and are usually classed as gray-wooded soils. In much of northern Ontario, true podzols with a markedly leached. gray horizon are to be found on \veil-drained materials. In southern Ontario the soils are normally gray brown podzolics, similar to those of Michigan and New York.

While the soils in well-drained locations exhibit these normal characteristics, there are many old lake plains and other flat areas which have imperfectly drained, immature soils. There are also many areas of hog soils in all parts of the province. Soil drainage has, therefore, been an important problem in the agricultural development of Ontario.

II. HISTORY

The first recorded European to visit Ontario was Etienne Brûlé who explored the Ottawa river in 1613. (For general background and chronology of this as well as later periods see CANADA: *History.)* In 1615, Brûlé and Samuel de Champlain ascended the Ottawa and visited the Indian settlements near Georgian bay. Later. a mission to the Hurons mas established at Fort Ste. Marie, near the present town of Midland. Martyr's shrine, overlooking the restored site, is a memorial to the Jesuit fathers who lost their lives at the hands of the hostile Iroquois war parties who destroyed the settlement in 1649.

The French had fur-trading posts at Fort Frontenac (Kingston), Ft. Rouillé (Toronto), Sault Ste. Marie, Nipigon and Kaministikwia (Ft. William). A small agricultural colony was begun on the banks of the Detroit river. The Hudson's Bay company founded Moose Factory in 1671. and the English were, thereafter, rivals of the French in the fur trade of northern Ontario.

By the peace of Paris in 1763 at the close of the Seven Years' War, Canada was ceded to Great Britain. The Quebec act of 1774 made Ontario part of an extended colony ruled from Quebec. The first settlers were the United Empire Loyalists who came to Canada after the American Revolution, taking up land in the Niagara peninsula, around the Bay of Quinté, and along the north bank of the St. Lawrence river. In 1791, the Constitutional act divided Canada into two provinces. The colonists of Upper Canada (the future Ontario) were guaranteed a development of English law and culture.

1. Upper Canada and Canada West.—The first legislature of Upper Canada met at Newark (now Niagara-on-the-Lake) in 1792 at the summons of the first lieutenant governor, Lt. Col. John Graves Simcoe. In 1793, Simcoe founded the town of York on the shore of Toronto bay and, in 1797, the legislature was moved to the new capital. During the war of 1812, invaders from the United States captured and burned York. Brock's monument at Queenston and the rebuilt Ft. York in Toronto are historic sites commemorating the war.

The treaty of Ghent in 1814 ended the war. The Rush-Bagot agreement of 1817 between Great Britain and the Cnited States (and affirmed by the U.S. senate in 1818) limited the number and size of armed vessels on the Great Lakes and ensured a peaceful future for the frontier. In the next few years many immigrants arrived from the British Isles. The fur trade vanished to be replaced by the square timber trade, and later the trade in sawn lumber. Wheat was also produced for export. By 1837 there were 350,000 people in Upper Canada. Demands for responsible government culminated in an abortive revolt led by William Lyon MacKenzie. The earl of Durham was appointed a special commissioner to make an investigation. His report, in 1839, recommended that responsible government should be granted to the provinces. and that Upper and Lower Canada should be united.

In 1841 the act of union was put into effect. Upper Canada then became known as Canada West. The capital. first established at Kingston. migrated from city to city until it was eventually settled at Ottawa by Queen Victoria in 1858. The principle of responsible government was finally established in 1849.

2. The Province.—In the 1840s and 1850s the economic life of Canada began to quicken. The Welland canal. built in 1829, was enlarged and deepened. and canals were built on the St. Lawrence. Reciprocal trade with the United States was established in 1854, and the Grand Trunk railway from Toronto to Montreal was opened in 1856. There were still many problems, some of which were intensified by the American Civil War. In 1867, the British North America act established the dominion of Canada, with its capital at Ottawa, and Canada West became the province of Ontario. with its capital at Toronto.

In the 1880s farm population reached its greatest expansion in most parts of Ontario. The opening of the Northwest territories to settlement gave opportunity to many young. vigorous Ontarians, while their demands for goods encouraged the development of manufacturing and the growth of towns and cities in Ontario. Further support was given the "National Policy" of the dominion's first premier, John A. MacDonald. which protected Canadian industry from undue outside competition. Railway building also led to the development of mining and forest industry in the north.

After 1900, the economic history of Ontario has been one of expansion and diversification of manufactures. a process greatly accentuated during both World Wars I and II. Agriculture has become more specialized, depending less on export markets and more upon the needs of the expanding cities of the province.

In the federal political field Ontario has fairly consistently supported the Conservative party of Sir John A. MacDonald and the "National Policy." During most of the 20th century also, the Conservatives have been in power in Ontario under the successive leadership of Sir James Whitney, Sir William Hearst, G. Howard Ferguson, G. S. Henry, George Drew, T. L. Kennedy and Leslie Frost. From 1919 to 1923 there was a Farmers' government under E. C. Drury, while from 1933 to 1943 the Liberals under M. F. Hepburn and Gordon Conant formed the government. Regardless of political labels, the policies of Ontario governments have been to promote the use of natural resources, the public development of water power, the expansion of the highway system, an enduring concern over educational matters, and a continued effort to obtain for the province a fair share of federal subsidies.

III. POPULATION

The census of 1961 recorded a population of 6,236,092 in On-

TABLE II.—*Population Distribution**

	Land area sq.mi.	Total population	Density per sq.mi.	Rural population	Density per sq.mi.	Urban population	% urban
Southern Ontario	39,735	4,723,597	104.5	1,068,318	24.0	3,755,279	77.0
Northern Ontario	323,547	681,336	2.0	233,696	0.6	347,640	69.0
Province of Ontario	363,282	5,404,933	14.9	1,302,014	3.6	4,102,919	76.0

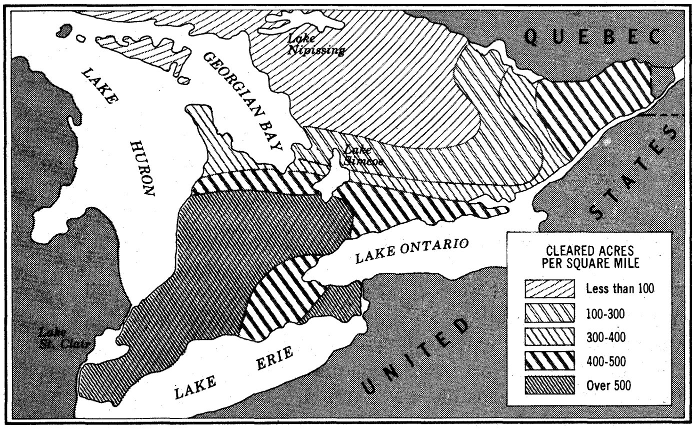

FIG. 3.— MAPSHOWING ACRES CLEARED IN SOUTHERN ONTARIO

tario. This was almost three times the population at the turn of the century and more than three and one-half times its number in 1867, the year of confederation. At that time about 80% of Ontario's people were rural and there were few towns or cities (see Table I).

The great growth of population in Ontario has been largely urban. Farm population has actually declined; there has been a considerable increase in the number of persons residing in rural areas, but not on farms, The population is very unequally distributed between southern and northern Ontario (see fig. 2 and Table II).

The rapid growth after the 1941 census has been attributed to a high birth rate (about 27 per 1,000), a low death rate (9 per 1,000), and the absorption of about 60,000 newcomers each year after the end of World War II. Only about 72% of Ontario residents are native to the province; most of the others have come from other parts of Canada, the United Kingdom or other parts of Europe.

About two-thirds of the people of Ontario are of British origin and about one-tenth are of French descent. Most of the latter, however, are able to speak both French and English. Most new Canadians settling in Ontario learn to speak English.

The religious denominations in Ontario are, roughly, United Church of Canada, 29%; Roman Catholic, 25%; Anglican, 20%; Presbyterian, 9%; Baptist, 4%; Lutheran, 3%; Jewish, 2%; others, 8%. Roman Catholics are most numerous in northeastern and southeastern Ontario, and in the city of Windsor; Anglicans are most strongly represented in metropolitan Toronto. Hamilton, London and the Niagara peninsula. People of Jewish faith are most numerous in Toronto, while Lutherans are concentrated in Kitchener-Waterloo.

The largest cities in southern Ontario are, according to the census of 1961 (metropolitan figures), Toronto (1,618,787), Ottawa (429,750), Hamilton (395,189), Windsor (193,365), and London (186,283). Other important cities in southern Ontario are (municipal figures) St. Catharines (84.472), Kitchener (74.485). Oshawa (62,415), Brantford (55,201). Kingston (53,5261, Sarnia (50,976), Peterborough (47,185), Cornwall (43,639), Guelph (39,838), and Niagara Falls (22,351). The large cities of northern Ontario, of which Fort William-Port Arthur on Lake Superior is the farthest north, are Fort William-Port Arthur (90,490), Sudbury (80,120), Sault Ste. Marie (43,088), Timmins (29.270), and North Bay (23.781). Together these 21 cities contain almost 60% of Ontario's population.

IV. GOVERNMENT

Executive authority in Ontario is vested in the crown represented by the lieutenant governor who is appointed by the government of Canada for a term of five years. His advisors are the cabinet, or executive council, headed by the premier, who remain in power as long as they have the confidence of the legislature. The legislature of 98 members is elected by popular vote for a period not exceeding five years. Government revenues are derived from corporation taxes, sales taxes, licences, royalties on natural resources, profits on the sale of liquor and subsidies from the government of Canada. The largest items of government expense include health and social welfare, highways, education, law enforcement, research and administration of natural resources, general administration and debt charges.

Politically. Ontario is divided into 43 counties, 11 districts and one metropolitan area. The counties and the metropolitan area, each of which is further organized into local municipalities, are all in the southern part of the province. The larger districts in the northern areas contain some local municipalities and a great deal of unorganized wilderness area. Table III shows the area, population and county seat for each of the 5j subdivisions of the province. Local government under the supervision of the Ontario department of municipal affairs is based upon the Municipal act of 1849, as amended from time to time. In addition to the metropolitan area of Toronto there are 30 cities, 8 separated towns, 150 towns, 154 villages and 575 townships. Municipal funds are expended largely on police and fire protection services, schools and public works.

TABLE 111.—Counties and Districts of Ontario

County	Assessed Area† (sq.mi.)	Population (census of 1961)	County seat
	421	83,839	Brantford
	1,659	43,036	Walkerton
Carleton	947	[illegible]	Ottawa
Dufferin	557	16,09j	Orangeville
Elgin	720	62,862	St. Thomas
Essex	707	258 218	Windsor
Frontenac	1,599	[illegible]	Kingston
Grey	1,788	[illegible]	Owen Sound
Haldimand	488	28,197	Cayuga
Haliburton	1,486	8,928	Minden
Halton	363	106,967	Milton
Hastings	2,333	93,377	Belleville
Huron	1,295	53,805	Goderich
Kent	918	89,427	Chatham
Lambton	1,124	102,131	Sarnia
Lanark	1,138	40,313	Perth
Lecdi and Grenville	1,363	69,753	Brockville
Lennox and Addington	1,170	23,717	Napanee
Lincoln	332	126,674	St. Catharines
Middlesex	1,240	221,422	London
Norfolk	634	50,475	Simcoe
Northumberland and Durham	1,363	81,808	Cobourg
Ontario	853	[illegible]	[illegible]
Oxford	765	70,499	Woodstock
Peel	469	111,575	Brampton
Perth	840	57,452	Stratford
Peterborough	1,415	76,375	Peterborough
Prescott and Russell	901	48,118	L'Orignal
Prince Edward	390	21,108	[illegible]
Renfrew	3,009	89,635	Pembroke
[illegible]	1,663	141,271	Barrie
Stormont, Dundas and Glengarry	1,274	[illegible]	Cornwall
	1,348	[illegible]	
	516	176,754	Kitchener
Welland	387	164,741	Welland
Wellington	1,019	84,702	Guelph
[illegible]worth	458	358,837	Hamilton
York*	642	114,321	Newmarket
Metropolitan Area			
Metropolitan Toronto	240	1,618,787	Toronto
District			
Algoma	19,320	111,408	Sault Ste. Marie
Cochrane	53,337	95,666	Cochrane
Kenora	153,220	51,474	Kenora
Manitoulin	1,588	11,176	Gore Bay
Muskoka	1,585	26,705	Bracebridge
Nipissing	7,560	70,568	North Ray
Parry Sound	4,336	29,632	Parry Sound
Rainy River	7,270	26,531	Fort Frances
Sudbury	18,058	16j,862	Sudbury
Thunder Bav	52,471	138,518	Port Arthur
Timiskaming	5,890	50,971	Haileybury
Ontario	363,282	6,236,092	Capital Toronto

*Excluding Metropolitan Toronto.
†Including minor water areas.

V. EDUCATION

Under the British North America act, education was placed under provincial control. It is administered by the Ontario department of education and supported by local taxes and provincial grants. About 21% of the population is in school, at all levels from kindergarten to university postgraduate work.

Attendance at school is compulsory between 6 and 16 years of age. There are 13 grades. 8 in the elementary school and 5 years of high school. Satisfactory graduation from grade 13 is accepted for university entrance.

Institutions of higher learning include the University of Toronto, Queen's university at Kingston, University of Ottawa and Carleton university in Ottawa, McMaster university at Hamilton, University of Western Ontario at London, Assumption University of Windsor, University of Waterloo and University of Sudbury. The Ontario Agricultural college and Ontario Veterinary college are located at Guelph, but the students receive their degrees from the University of Toronto. Ryerson Institute of Technology in Toronto provides technical training in many lines. There are a number of teachers' colleges scattered throughout the province.

The public schools of the province are nondenominational but wherever Roman Catholic ratepayers are sufficiently numerous they may set up separate schools for their own pupils. The Roman Catholic Church supports Ottawa, Assumption and Sudbury universities, as well as St. Michael's which is affiliated with the University of Toronto.

VI. PRODUCTION

Ontario is the most productive province in Canada, normally accounting for 40% of the national income. In the 19th century the economic welfare of the province depended very largely upon the exploitation of natural resources in forestry and agriculture, Since then, despite the growth of mining, the primary industries have been eclipsed by the secondary industries devoted to processing and manufacture.

1. Agriculture. — Farming is still the foremost of the primary industries of Ontario, and, despite great development of other industries, Ontario remains one of the most important agricultural provinces in Canada. There are about 140,000 farms in the province, occupying about 20,000,000 ac. and providing jobs for about 200.000 workers. Normally, Ontario accounts for more than one-quarter of the agricultural wealth of Canada.

Almost nine-tenths of Ontario's agricultural land is found in the southern part of the province where climate, land forms and soils are generally favourable, and city markets lie close at hand, There, over large areas, agricultural settlement is practically continuous while in northern Ontario farms are grouped in small tracts separated by vast areas of almost unbroken forest.

Agricultural production is highly diversified. The leading items contributing to the cash income are cattle, hogs, milk, poultry and eggs, field crops, vegetables, fruits and other special crops. On most Ontario farms such field crops as hay, oats, mixed grains and corn are grown as feed for livestock, and only to a slight extent appear on the market. Wheat, barley, sugar beets, soybeans, tobacco, flax and various canning crops, on the other hand, are usually sold for cash. Most Ontario farms are run as commercial enterprises, but there are a few farms, rather remotely situated, often in northern Ontario, where a pioneer self-sufficing agriculture is carried on. There is also a great deal of part-time farming; many operators of commercial farms have other employment as well.

Within southern Ontario it is possible to distinguish a number of special agricultural areas (see fig. 3). A small district which comprises about ten townships on the south shore of Lake Ontario is known as the Niagara fruit belt. It produces most of the grapes, peaches and other soft fruits of the province. Apple orchards are located along the north shore of Lake Ontario, and on the south shore of Georgian bay. Southwestern Ontario, between Lake Erie and Lake Huron, is the Ontario corn belt, vying with any area in the U.S. middle west both in quality of grain and in yield per acre. This area also produces winter wheat, soybeans, sugar beets, early vegetables and canning crops. Midway along the north shore of Lake Erie, centred in Norfolk county, is the chief tobacco producing area of Canada. The counties which border Lake Huron market a large number of high grade beef cattle. Near such large cities as Toronto, Hamilton and London, there are intensive dairy areas, while in eastern Ontario milk is produced for cheese factories and other processing plants. Southern Ontario has a thriving agriculture, its progress marked by a decreasing farm population and an increasing size of farm, electrification and mechanization, which enables one man to produce much more than ever before.

2. Forest Industry. — A forest inventory showed that about 129,000,000 ac. or 58% of the land area was under forest in the second half of the 20th century. About 98,000,000 ac. or 76% was classed as productive forest. Of the productive forest about 53,000,000 ac. (54%) carries merchantable timber while the remainder is young growth. A small percentage of the wood, mostly in the south, is composed of hardwood species such as sugar maple, yellow birch, elm, white and red oak. In the north are found such softwoods as spruce, balsam fir and jack pine which are useful for pulpwood, and white and red pine which formerly furnished great quantities of logs for the lumber trade. It is estimated that Ontario has about 84,000,000,000 cu.ft. of accessible timber, including 159,000,000,000 bd.ft. of saw timber and 610,000,000 cords of smaller material. Ontario contains slightly less than 20% of the accessible productive forest area of Canada and about 23% of the corresponding economic forest resources.

Most of Ontario's forest stands on crown land and is administered by the Ontario department of lands and forests. It maintains a forest protection and fire ranger service, involving fire towers, a radio communication network and airplane patrols. Most of the cutting operations are carried on by licensees and leaseholders under conditions laid down by the government which collects stumpage and other fees. While it is certain that past history involved a great deal of careless and wasteful forest exploitation, the timber management program of the Ontario government is one of sustained yield forestry. To this end, a forest inventory was made and the province was divided into 120 management units, of which 40 are formed by large timber companies who prepare their own operating plans, while the remainder are planned by the department. The department also has a division of reforestation, a division of research and a division of game and fisheries. The parks division administers a number of forest parks of which the two largest and most noted are Algonquin park, in the highlands southeast of North bay, and Quetico, which lies along the boundary between Ontario and the state of Wisconsin.

3. Fish and Furs. — The fresh-water fisheries of Ontario are exploited mainly in the Great Lakes and in the lakes of northwestern Ontario. The average annual catch is about 45,000,000 lb, and is worth about $7,000,000. Lake Erie is the most important fishing ground; Georgian bay ranks second, with northern inland waters standing third. The most important species are yellow pickerel, whitefish, blue pickerel, perch, lake trout, sturgeon, lake herring and tullibee. Commercial fisheries employ about 3,500 persons, largely on a part-time basis.

The fur trade, once almost the sole source of wealth in Upper Canada, is now the least important of its resources. About 40% of the annual yield is wild fur, the product of the trap line. About 60% is derived from ranch grown pelts. Beaver, muskrat and mink comprise nine-tenths of the trapped fur while various types of mink account for nearly all the production of the fur farms.

4. Mining. — From before 1900 Ontario has been the chief mineral producing province in Canada. In the second half of the 20th century, the value of its minerals averaged more than $600,000,000 per year, or 30% of the national production. Although best known for many years for its gold mines, Ontario produces a long list of other minerals as well. The important metals include nickel, copper, gold, iron ore, cobalt, uranium and silver. Among the nonmetallic minerals are salt, asbestos, nepheline-syenite (used in the manufacture of glass and ceramic products), sulfur and quartz. Natural gas and petroleum are of some importance while structural materials such as sand and gravel, cement, brick, crushed stone and lime are produced in large quantities. Most of the metals and many of the important nonmetallics are won from the Pre-Cambrian rocks of northern Ontario. The Paleozoic rocks of southern Ontario yield salt, gypsum, oil and natural gas; the structural materials are produced mainly in southern Ontario also.

The copper-nickel ores near Sudbury support the oldest and most populous mining community, producing most of the world's supply of nickel. Sudbury also produces platinum metals, gold, silver and iron.

The most important gold mines are in northeastern Ontario near Timmins and Kirkland lake while Cobalt, one of the earliest mining camps, still produces silver and cobalt. Iron ore is mined at Steep Rock lake in the country west of Lake Superior, at Michipicoten Harbour near the northeast corner of Lake Superior, and at Marmora in southeastern Ontario. Manitouwadge is a new field north of Lake Superior producing zinc. copper and silver, while uranium is produced at Elliot Lake, north of Lake Huron, and near Bancroft in southeastern Ontario.

Great quantities of'stone are quarried from the brow of the Niagara escarpment near Hamilton while brick is made from the underlying shale. Much of the natural gas of southwestern Ontario is obtained from wells drilled in the floor of Lake Erie.

5. Electrical Power. — ?*lost of the electrical power used in Ontario is derived from water power. Although second to Quebec in water power installations, Ontario ranks well ahead in the proportion of available power under development. Without the St. Lawrence International power development (in which Ontario has a 1,100,000 h.p. share). the province has 5,500,000 installed h.p., out of a possible 7,300,000 h.p. available, 24-hour power at ordinary six months flow. In addition, there are thermoelectric (steam generator) stations with a capacity of 1,000,000 h.p., while the electrical equivalent of another 1,000,000 h.p. is purchased from Quebec. Almost 90% of the primary electrical power is provided by the Ontario Hydro-Electric Power commission. In terms of kilowatts, the 1960 use of power in Ontario was estimated to be 5,425,000 kw., hydroelectric plants supplying 4,488,000 kw. (82.5%) and steam plants supplying 844,000 kw. (15.5%); the remainder was purchased power.

Public Ownership.—Ontario was a pioneer in public ownership of hydro power. The Ontario Hydro-Electric Power commission was constituted in 1906. At first it merely bought power for distribution from private companies at Niagara. Later, under the guiding genius of Sir Adam Beck as chairman, the commission bought a number of generating stations and built others. In 1922, the first great station at Queenston, now known as the Sir Adam Beck-Niagara generating station no. 1, was built. Since that time a number of large stations have been built on the Ottawa river. The largest projects have been the Sir Adam Beck no. 2 at Queenston, and the Robert H. Saunders-St. Lawrence generating station near Cornwall. A nuclear power demonstration station has also been built near Des Joachims generating station on the Ottawa. Large thermo-electric stations have been located at Windsor, Toronto and Lakeview. In northern Ontario there are large plants on the Abitibi, Mississagi, Nipigon, Aquasabon, English and Winnipeg rivers. Altogether, the Ontario Hydro-Electric commission serves 1,350 municipalities and, through them, more than 1,700,000

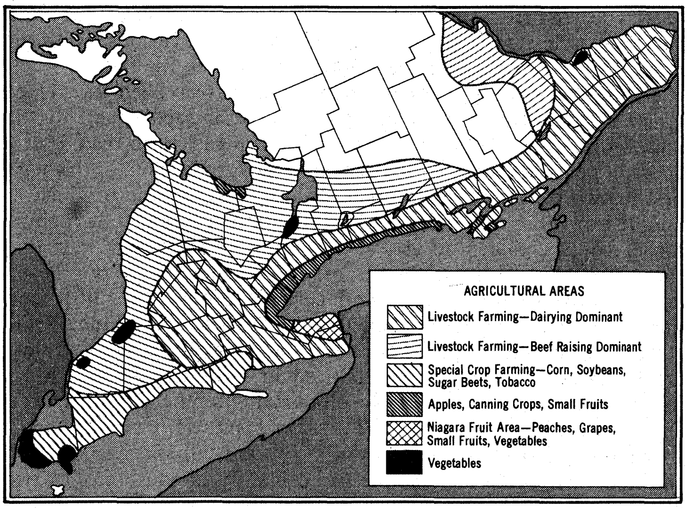

FIG. 4.— MAP OF SOUTHERN ONTARIO SHOWING SPECIAL AGRICULTURAL AREAS AND THEIR DOMINANT CROPS

ultimate customers. Reasonably priced electrical energy is the key to Ontario's industrial expansion. There are few large waterpower sites left undeveloped. Additional needs must be met by building thermal and nuclear power stations.

6. Manufactures. — Ontario has always been the leading manufacturing province in Canada, although, because of the development of industry in other provinces, its share is proportionally less than it once was. Nevertheless, Ontario produces half the manufactured goods of Canada and is one of the leading industrial areas in the world. Most of this industry, in which more than 645,000 persons are employed, is found in southern Ontario, largely in cities situated on or near the shores of the Great Lakes.

Many factors combine to encourage manufacturing. Raw materials from agriculture, forestry and mining are plentiful, abundant power is cheaply and efficiently distributed, the Great Lakes-St. Lawrence waterway provides convenient transportation for bulky raw materials. and there is a large and skillful labour force. Ontario is its own best market; its primary industries are relatively prosperous and this promotes prosperity in other lines. A significant factor is its nearness to the great manufacturing centres of the northeastern United States which have provided much of the capital invested in Ontario industries.

Metropolitan Toronto is by far the largest and most diversified of Ontario's industrial centres. There, slaughtering and meat packing. brewing, distilling. prepared foods, iron and steel products, machinery. aircraft. electrical goods, petroleum products, clothing, and printing and publishing are among the more important lines.

Hamilton is the most important primary iron and steel centre in Canada. Electrical machinery, chemicals and sheet metal products are also made. Windsor has long been noted for motor vehicles and parts. Pharmaceuticals, various steel products and chemicals are also important. Kitchener is noted for meat packing, beverages. leather products, furniture and miscellaneous iron and steel products. London has many of the same industries and is also the site of a diesel-electric locomotive plant.

Ottawa is noted for wood products, pulp and paper, printing and publishing, and food products. St. Catharines and adjoining towns manufacture wines, paper products, iron and steel products. automobile parts and fruit products. There are important shipyards nearby. Sarnia is the largest centre for petroleum refining, petrochemicals and allied products. Brantford is noted for agricultural machinery and miscellaneous iron and steel products. Peterborough manufactures electrical machinery, boats, outboard motors, watches, clocks and cereal products.

A few very special cases may be mentioned; among them are nickel refining at Port Colborne, the refining of radio-active minerals at Port Hope, and the work of the atomic energy corporation at Chalk River.

The extent to which certain industries are centred in Ontario is seen in the fact that Ontario makes 98% of all motor vehicles, 96% of the motor vehicle parts, 93% of the heavy electrical machinery and 92% of all the agricultural machinery made in Canada.

7. Construction. — The construction industry stands next to manufacturing. averaging 15% 'of the annual value of production, and employing over 200.000 workers. New housing is most important, not only in the five largest cities, but in many smaller ones as well. The Ontario Highways and Ontario Hydro-Electric commission each spend more than $200,000,000 per annum in construction. The mining industry has not only undertaken many large projects but has initiated the building of new towns such as Manitouwadge and Elliot Lake. Wherever one goes in Ontario, the building of new industrial and commercial structures serves as a barometer of economic progress.

VII. COMMUNICATIONS

Rivers and lakes provided the transportation for the settlement of Upper Canada, and Ontario still depends upon the water routes. The St. Lawrence and Great Lakes form a navigable route for 1,200 mi. which, with the opening of the new 27 ft. seaway canals in 1959, is open to large ocean ships. Ontario ports handle more than 30,000,000 tons of shipping per year—more than any other province except British Columbia. The chief ports are Toronto, Hamilton. Sarnia, Fort William and Port Arthur.

Ontario has more than 10,500 mi. of railway, most of which is operated by the Canadian National and Canadian Pacific systems.

Branch lines of United States railways also operate in southern Ontario. The Ontario Northland, from North Bay to Moosonee, was built by the Ontario government to open up the mining and forest areas of northeastern Ontario.

By the second half of the 20th century, Ontario had more than 83,000 mi. of road, of which 16,000 mi, were paved and 57,000 mi. surfaced with gravel or crushed stone. Ontario also had more than 1,700,000 motor vehicles, 40% of the Canadian total, one for each 3.2 persons.

Trans-Canada airlines provide several flights daily connecting Montreal, Ottawa, Toronto, London, Windsor, Sault Ste. Marie, the Lakehead and western Canada. Northeastern Ontario is also served. There are many flights to U.S. points. Malton, near Toronto, is the busiest airport.

Ontario is well served with electrical communications; it has over 2 000,000 telephones, nearly half the Canadian total, and Ontario people make more phone calls per capita than any other people in the world. Radio and television are well established, with more than 30 broadcasting stations and 16 television stations in the province.

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ONTARIO, a city of San Bernardino county in southern California, U.S., is located about 36 mi. E. of Los Angeles. The site was settled in 1882 by George and William B. Chaffey who established an agricultural colony and named it for their home province in Canada. A well-designed irrigation system brought water from the nearby San Gabriel mountains. Incorporated in 1891, Ontario became the trading centre for a prosperous agricultural district producing citrus fruits, grapes and olives. Chaffey Agricultural college, established and endowed by George Chaffey, later became a public high school and junior college. About 1940 Ontario began to experience economic diversification with the establishment of industries. Manufactures include aircraft and aircraft parts, wine, tile, steel, plastics and electrical equipment. In 1944 Ontario adopted a council-manager form of government. For comparative population figures, *see* table in California: Population. (J. H. K.)

ONTARIO, LAKE, the smallest and most easterly of the Great Lakes of North America, is bounded on the north by the province of Ontario and on the south by the state of New York.

Lake Ontario, named from an Iroquois Indian term, is roughly elliptical, its major axis, 193 mi. long, lies nearly east and west, and its greatest breadth is 53 mi. The area of its water surface is 7,520 sq.mi. and the total area of its drainage basin, exclusive of lake surface, is 34,800 sq.mi. Its mean surface elevation above mean sea level is 246 ft., which is 326 ft. below the level of Lake Erie. Its greatest depth is 778 ft.; its average depth, much in excess of that of Lake Erie. As a result there are seldom any great fluctuations of level due to wind disturbance, but the lake follows the general rule of the Great Lakes of seasonal and annual variation. There is a general surface current down the lake toward the east, of about 8 mi. a day, which is strongest along the south shore. (For comparison with the other Great Lakes, a discussion of their origins, connections, utilization, etc., see Great Lakes, The.)

History. — Lake Ontario was discovered by Etienne Brûlé, a scout, and viewed by his leader, Samuel de Champlain, in 1615, in the course of their return eastward from Lake Huron. During the next several decades French trading and missionary work developed extensively on the upper Great Lakes, with the route of travel between the Great Lakes and Montreal along the Ottawa river, far to the north of Lake Ontario. The Ontario region was held by the Iroquois Indians, allies of the British. A temporary peace with the Iroquois allowed some French activity along Lake Ontario, and in 1673 Fort Frontenac was built at present day Kingston, Ont. During the next several years Robert Cavelier de la Salle placed a few small sailing vessels on Lake Ontario and he erected a blockhouse at the mouth of the Niagara river in 1679. The French established Fort des Sables at Irondequoit Bay (near the present city of Rochester) about 1720. The first important British settlement on Lake Ontario was at Oswego, in 1722. A permanent Fort Niagara (which is still standing) was built by the French in 1725.

During the French and Indian War the British captured all posts on the lake and in 1763 France ceded the entire Great Lakes territory to the British. During the Revolutionary War military activities in the Lake Ontario region consisted mainly of raids on the American colonists by Indian allies of the British and punitive action by Americans against British Loyalists. The most important action was a battle at Oriskany where General Nicholas Herkimer and his American militia defeated an expeditionary force of British and Indians. The country around Lake Ontario was only lightly settled until after the Revolutionary War. That war probably hastened the development of Ontario by at least a generation, in providing it with Loyalist settlers, garrison trade and improved shipping on the lake. In the War of 1812, as fought on and around Lake Ontario, neither side appeared to make a very determined thrust and the leaders seldom gained their objectives. Both Great Britain and the United States built and maneuvered naval forces on the lake, but they never closed in decisive combat.

Physiography. — On the north side of the lake the land rises gradually from the shore and spreads out into broad plains which are thickly settled by farmers. A marked feature of the topography of the south shore is what is known as the Lake ridge, or Niagara escarpment. This ridge extends, with breaks. from Sodus, about 30 mi. E. of Rochester, west to the Niagara river, and is 3 to 8 mi. distant from the lake. The low ground between it and the shore is a celebrated fruit growing district, covered with vineyards, peach, apple and pear orchards and fruit farms. The Niagara river is the main feeder of the lake; the other largest rivers emptying into the lake are the Genesee, Oswego and Black from the south side, and the Trent, which discharges into the upper end of the bay of Quinte, a picturesque inlet 70 mi. long, on the north shore, between the peninsula of Prince Edward, near the eastern extremity of the lake, and the mainland. The east end of the lake, where it is 30 mi. wide. is crossed by a chain of five islands, and the lake has its outlet near Kingston, where it discharges into the head of the St. Lawrence river between a group of islands. Elsewhere the lake is practically free from islands. The lake never freezes over except near land, but the harbours are closed by ice from about mid-December to mid-April.

Harbours and Commerce. — The principal Canadian ports are Kingston, at the head of the St. Lawrence river; Toronto, where the harbour is formed by an island with improved entrance channels constructed both east and west of it; and Hamilton, at the head of the lake, situated on a landlocked lagoon, connected with the main lake by Burlington channel, an artificial cut. The principal U.S. port is Oswego, N.Y., where a breakwater has been built, making an outer harbour.

The commerce of Lake Ontario is limited in comparison with that of the lakes above Niagara falls, and is in general confined to vessels which can pass the Welland canal and the St. Lawrence canals. (See Welland Ship Canal; St. Lawrence River; St. Lawrence Seaway.) The commerce on the lake is generally confined to coal shipped from Rochester, Sodus bay, Little Sodus bay and Oswego to Canadian ports on the lake and U.S. and Canadian ports on the St. Lawrence river; to coal from Oswego to upper lake ports; to grain and other products shipped from upper lake ports through the Welland canal to the St. Lawrence; and to lumber from Canadian ports. Lake Ontario is connected with the New York State Barge canal at Oswego, N.Y., and it is connected with Georgian bay of Lake Huron by the Trent Valley canal and waterway which accommodates small craft.

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tario (1945). (J. L. Hh.)

ONTENIENTE, a town of eastern Spain, in the province of Valencia; on the right bank of the Clariano or Onteniente, a subtributary of the Júcar, and on the Játiva-Villena railway. Pop. (1950) 14,774 (mun.). Onteniente has a parish church remarkable for its lofty square tower, and a palace of the dukes of Almodovar. Linen and woolen cloth, paper, brandy, furniture and earthennare are manufactured.

ONTOLOGY. The term "ontology" was introduced by the German philosopher Christian Wolff in the 18th century. It was intended to denote a particular branch of philosophy; namely, that branch which deals with the theory of being, for example the theory of what really exists in contrast with what only seems to exist, of what permanently exists in contrast with what only temporarily exists, and of what exists independently and unconditionally in contrast with what exists dependently and conditionally. Ontology therefore coincides with metaphysics (*q.v.*) in one sense; and on the whole little use has been made of Wolff's label.

The adjective "ontological," however, is employed to refer to a particular argument. The ontological argument for the existence of God was used by Descartes and, more disputably, by Anselm (*q.v.;* and see Theism). Whereas other arguments for God's existence rested on factual premisses, the ontological argument rests on the purely conceptual or a priori premisses that "perfection" is part of the meaning of "God" and that "exists" is part of the meaning of "perfect." So there is a logical contradiction in the assertion that God does not exist. This argument was rejected as fallacious by Thomas Xquinas and by Kant; the latter showed that the second premiss pretends that "exists" is a predicate (*i.e.,* stands for an attribute or property) and so can be a part of the definition of a concept, as "quadrilateral" is a part of the definition of "square." But an assertion or denial of the existence of something of a certain description is not the mere unpacking of that description. It asserts or denies that the description applies to something. It says something true or false about the world. Its truth, if it is true, is not a logically necessary, conceptual or analytic truth, but a factual or synthetic truth. (G. R.)

ONYCHOPHORA, a small but unusually interesting group of animals of the phylum Arthropoda (*q.v.*), differing in so many important respects from all other Arthropoda that a special class has been created for them. The class Prototracheata or Onychophora, containing only about 110 species, is equivalent in rank to the classes Crustacea, Insecta, Diplopoda, Chilopoda and Arachnida, although these groups contain thousands of genera and species.

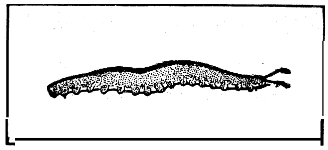
A small group of genera nhich necessitates the creation of a separate class is usually the recipient of particular interest, for it will present highly important indications of the evolutionary relations between other groups of the animal kingdom. It is often to be regarded as the survivor of a group more extensive in range and more numerous in species and individuals in past times.

The Onychophora is such a case. It presents features which are typically arthropod. At the same time it possesses nephridia which recall the segmented worms (Annelida, *q.v.*), the group to which the Arthropoda are structurally most closely related. It may be relict of the evolutionary transition between these groups, as a fossil genus, *Asheaia,* has been discovered in deposits of Cambrian age.

The Onychophora contains only seven genera but these are so much alike that it is still common to use the term Peripatus as the generic name for all. The different species resemble each other externally so closely that, but for the differences in the number of legs, a picture in black and white like fig. 1 would stand for any of them. Notwithstanding this resemblance it appears necessary to restrict the use of the old generic name *Peripatus* to a few species.

The geographical distribution of the group is very wide but discontinuous and very local. Species occur in the West Indies, western Mexico, Central America, northern South America and Chile, South Africa, Malaya, India, Melanesia and Australasia.

Specimens are only met with here and there, even where favourable conditions exist over a wider area. This discontinuity of occurrence coupled with the obviously poor powers of distribution of these creatures is strong evidence to indicate a group on the way to extinction. The distribution of the genera, which form two families, Peripatidae and Peripatopsidae, is as follows: *Peripatus*—America; *Eoperipatus*—Indo-Malaya; *Peripatoides* and *Oöperipatus*—Australia; *Opisthopatus*—Chile and South Africa; *Paraperipatus*—Malaya; *Peripatopsis*—central Africa.



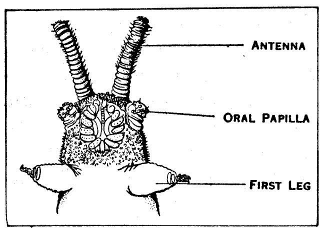
AFTER SEDGWICK

FIG. 1—PERIPATOPSIS CAPENSIS, DRAWN FROM LIFE, LIFE SIZE

Since the present account is a short general summary the term "Peripatus" will be used to include all species of the group. It will be understood, however, that this is for convenience only.

The animal is always found in moist situations (although the district itself may not be moist during the whole year). It is generally found under rotting branches lying on the ground, under stones, under bark and in the crevices of tree stumps. It is extremely sensitive to a dry atmosphere (specimens frequently will not withstand 24 hr. in a dry cardboard box, whereas they will be happy for many days in a small glass tube containing moist soil although the tube may be tightly corked). It never comes out into daylight and in captivity is much more active at night. It is probably carnivorous, feeding on small insects and other small animals in slime which it secretes.

Peripatus is a segmented animal, and at a first glance looks somewhat like a caterpillar; but the long antennae, the peculiar body-surface and the legs soon dispel that view. The actual segmentation is shown externally only by the occurrence of paired legs, one pair to each segment. The surface of the body is marked by ring-like ridges, 12 or 24 to each segment. Some of these are almost continuous round the circumference of the animal (they are all broken by a fine groove down the middle of the dorsal surface), others are less complete and arise between the former. The skin and body wall is highly characteristic, the superficial cuticle being very thin (as in the worms, in contrast to the usual arthropod condition) and raised everywhere on the ridges into delicate microscopic papillae. These close papillae give the skin a velvety appearance and their presence makes it difficult to wet the creature. The colours of these animals are dark gray, olive green, or brown to brick red above, and light, often almost white, on the under surface. Some species are uniformly coloured; others present distinct colour patterns, usually of lozenge-shaped spots. Those of the western hemisphere are usually slightly patterned and the old world species show more contrasting colours.



FROM SEDGWICK IN "TEXTBOOK OF ZOOLOGY" (G. ALLEN & UNWIN)

FIG. 2.—VENTRAL VIEW OF HEAD OF P. CAPENSIS

Both head- and tail-ends taper and there is no distinct head. The anterior end bears two characteristic antennae, very mobile and extensible. In fact the whole animal is remarkably extensible and there is a great difference in length between a living specimen in motion (especially if this is rapid) and one in spirit.

Slightly posterior and ventral to the antennae are two small blunt oral papillae, and between these the buccal cavity is situated (fig. 2). An anal aperture is found at the extreme posterior end of the animal and further forward on the ventral surface between the last pair of legs is the reproductive aperture in both sexes. The males may sometimes be distinguished from the females by slight differences in the

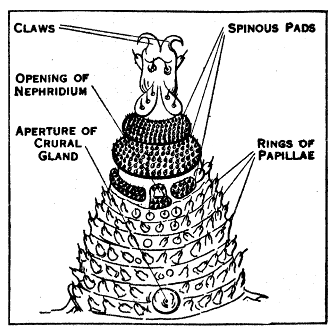


FIG. 3.—FOURTH LEG OF PERIPATOIDES (MALE)

appearance of the genital opening. In many cases, however. the only difference.not always distinct. is the presence of little apertures of crural glands on the legs of the male (fig. 3).

The other apertures on the surface of the body are those of the tracheae (respiratory organs—see below) and the excretory organs. None of the former can be seen with the naked eye and only four of the latter, on the 4th and 5th pairs of legs (fig. 3j.

The limbs of Peripatus are characteristic. Each consists of a cone-like stumpy leg bearing distally a narrower foot which carries two sickle-shaped claws. The skin of the legs bears rings of tiny papillae like those of the body and near the apex there are spinous pads. The structure of the appendages is thus quite unlike the jointed arthropod leg.

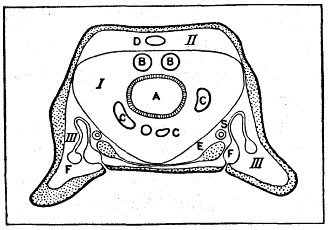
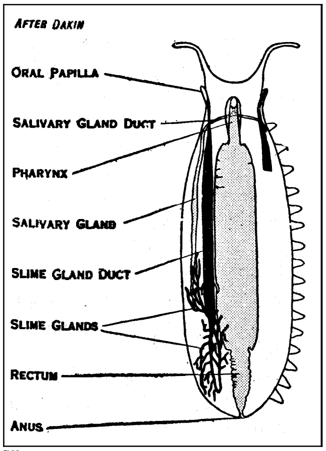


FIG. 4.—DIAGRAM OF TRANSVERSE SECTION THROUGH MIDDLE OF BODY OF PERIPATUS

Internal Structure.—A transverse section through an adult shows clearly how the body cavity, which is a haemocoele, is subdivided by delicate sheets of tissue (fig. 4) into (I.) a large central space extending the whole length and containing the gut (A), slime glands (B) and reproductive organs (cj; (II.) a shallow dorsal space above ehe central cavity, containing the heart (D) ; (III.) two lateral spaces each with a nerve cord (E), nephridia (F), and salivary glands (s). The excretory organs are also found in these compartments, especially in the extensions which exist in the legs.

The Alimentary Canal. The buccal cavity contains a pair of horny jaws (fig. 5) which may just be seen from the exterior. Each consists of two cutting plates lying in contact. These jaws are the only mouth appendages present. The mouth at the posterior end of the buccal cavity leads into a short muscular pharynx and from this a short oesophagus opens into the stomach (fig. j). This forms the greater part of the alimentary canal. It is a straight and wide tube leading almost to the posterior end where a short, narrow rectum opens at the terminal anus.



BY COURTESY OF THE ZOOLOGICAL SOCIETY

FIG. 5.—PERIPATOIDES OCCIDENTALIS, SHOWING PARTS

The only glands connected with the alimentary canal are two salivary glands (fig. 5) which open by a common duct into the buccal cavity. Each gland is a long tubular structure lying in a lateral cavity close to the nerve cord.

The Slime Glands (fig. j) are another peculiar feature. There are two of these, each opening on an oral papilla. Each consists of a long dilated tube which acts as a reservoir and lies over the stomach in the central cavity of the body. This reservoir extends back a considerable distance and then gives off numerous diverticula in which the slime is secreted. These diverticula lie around the posterior part of the stomach, often entangled in the coils of the reproductive organs. When a living specimen is touched the slime is shot out from the oral papillae to a distance of several inches. Contact with the air causes it to congeal into white, sticky threads. It is supposed that the substance is used for offence or defence.

The ***tracheae*** are among the most noteworthy features of the Onychophora because they are characteristic of certain other Arthropoda. They arise in bunches from the bottom of little epidermal pockets, tracheal pits. It is impossible, however, to see these pits externally. From each pit a large or small bunch of parallel tracheae start off, without branching; then they separate and finally branch, when they reach the organs they supply. Since the small single tubes require a high magnification to see them, one can only see readily the little rosettes of tubes where they are bunched at the tracheal pits and then only bv examining the internal surface of the body-wall in fresh specimens.

The tracheal pits are numerous and arranged in definite positions. In the West Australian species there are two main rows, one on each side, between the mid-dorsal line and the level of the legs. There are also four longitudinal series on the ventral surface. E. Gaffron stated that there were about 75 openings to a segment in P. *edwardsi.* The present author has counted 32 without difficulty in *Peripatoides* occidentalis. The tracheal tubes have a spiral thickening in the walls similar to that in other Arthropoda.

The excretory *organs* are probably the most surprising of all the structures found in this animal and at once call to mind the annelid worms, being not at all like the excretory organs of the arthropod groups. They are paired structures. one pair to each pair of legs. With the exception of those of the 4th and 5th pairs, each excretory tube opens on the ventral surface at about the point where its corresponding leg joins the body. The 4th and jth pairs open on papillae near the distal end of the corresponding legs (fig. 3). It is a striking fact that this distinction should be found constantly in the different genera.

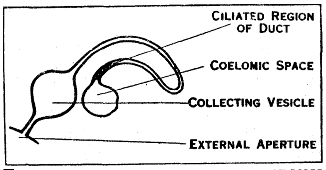


FIG. 6.—DIAGRAM OF NEPHRIDIUM OF PERIPATOIDES OCCIDENTALIS

The excretory organs have been termed nephridia and there is some evidence frorn embryology in support of this. Anatomical study, however, is insufficient to indicate the exact homologies of these organs and the embryological evidence requires confirmation. Each "nephridium" (fig. 63 consists of a tube with an enlargement, the collecting vesicle, near its aperture and another, corresponding to a coelomic cavity, at its internal blind end. In the West Australian *Peripatoides* W. J. Dakin discovered that cilia were present in that part of the tube leading out from the coelomic vesicle. This is the second part of the body where cilia have been found in these animals and since cilia are characteristically absent in the Xrthrapoda, it is a point of importance. Their other site is the reproductive organs of the female.

The blood *system* appears to consist only of a feebly developed dorsal tubular heart.

The *nervous* system consists of a pair of large supraoesophageal ganglia completely united in the middle line and occupying most of the head space, and a pair of cords which run backward. These latter. instead of being close together in the mid-ventral line. are situated at the sides in the lateral cavities of the haemocoele. Numerous commissures, 8–10 between successive pairs of legs. connect the lateral cords. There are indications of ganglia, corresponding to the legs in number, where the lateral cords are slightly thickened. Nerves pass out from the supraoesophageal ganglia to the tentacles, eyes and skin sense organs and also leave the lateral nerve cords.

The only sense organs are the eyes and numerous skin sense organs all of which look alike in structure.

The eyes are moderately well-developed, situated on the head near the base of the antennae. They are simple eyes, not compound like those so characteristic of the Arthropoda. They differ also fundamentally from the arthropod type of simple eye, the ocellus. It is sufficient here to point'out that on the whole the visual organ presents features of a simple type met with in both annelid worms and arthropods, but it has followed its own line of evolution.

The skin sense organs consist of little packets of cells associated with a projecting spine. They look like arid are usually regarded as tactile organs. Peripatus is, however. extremely sensitive to chemical stimuli as well as to vibrations and the presence of a very little chloroform vapour or acetic acid in the air produces a quick reaction.

Reproduction.—The sexes are separate. The reproductive organs consist of a pair of tubular testes in the male and a pair of ovaries in the female. In both sexes the reproductive organs are continuous with the tubes which lead their products to the exterior, opening at the single aperture already described. In the female, part of each duct is differentiated to form a uterus in which the young develop. Slight differences in the arrangement occur in the different species. Almost all produce living young.

One feature of special note is the varying amount of yolk in the eggs and its result. The Australian species have large yolk-laden eggs, and all species come near to laying eggs. At least one species of eastern Australia is actually oviparous and eggs are laid in sculptured shells. In all others the eggs are retained within the female and after a period of several months the young are born.

The South African and Australian species give birth to the young in April–June. Fertilization in one of the latter species takes place in the preceding August or September and the period of gestation would thus be 8–9 months. It has been given as 13 months for the Cape species.

The eggs are fertilized internally and it has been stated that the male of the Cape species deposits its spermatozoa on the surface of the female. Since the uterus is said never to contain spermatozoa, the mode of entrance into the body would be a complete mystery. There can be no doubt that in the Australian species copulation of the two sexes takes place and the spermatozoa pass up the vagina of the female.

The embryology of the Cape species has been worked out and reference should be made to A. Sedgwick (*see* below) for details. Further work is required in this direction and would be of undoubted interest and importance.

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(W. J. D.; X.)

ONYX is a striped agate (*q.v.*), a variety of quartz (*q.v.*), in which white layers alternate with black. When brown or red bands occur instead of black the stone is termed sardonyx. The Romans applied this name originally to a species of marble, now called onyx marble. because of a resemblance between its well-defined white and yellow veins and the shades in the fingernail (Greek onyx, "claw" or "fingernail"). Onyx has always been largely employed in cameo work because the design and background could be cut so as to occur in differently coloured layers. The best cameos are those produced by the ancients, though a revival of the art was occasioned by the discovery in the middle of the 19th century of the South American sources of onyx. Many agates are made suitable for the cutting of cameos by artificially dyeing the layers (see Gem: Colour Improvement). Beads, brooches, ring stones and other small ornaments are frequently made of onyx, and larger pieces are fashioned into cups and vases. Onyx marble is much softer and less precious than true onyx. For varieties and uses see Marble.

The chief localities for onyx are South America and India.
(A. W.; X.)

OÖLITE. Oölites resemble the roe of a fish, hence their name (from the Greek don, "an egg"; and *lithos,* "a stone"). They are a millimetre or less in diameter, are generally ovoid or spherical and most commonly consist of a concentric or radial crystalline deposit of calcium carbonate. Less commonly, oölites are siliceous (SiO_2), sideritic ($FeCO_3$), phosphatic (tricalcium phosphate) or ferruginous (iron silicate or iron oxide).

The term has been applied both to the microspherical concretionary bodies and to the rock composed largely of such structures: to avoid ambiguity these structures have been called ooids, ooliths or ovulites, and the term oolite has been reserved for the rock composed of such bodies. The term is also used in an adjectival sense, such as oolitic limestone, oolitic chert. etc.

False oolites are small spherical or ovoid bodies bearing superficial resemblance to oolites but devoid of a regular internal structure.

The calcareous oolites appear to be forming today where cold oceanic waters flow onto warm shallow banks, as in the Bahamas. The carbonate is precipitated on bits of shell, quartz grains or other nuclei. They are also known to form in springs and caves, as "cave pearls." See also Calcite; Limestone; Sedimentary Rocks.
(F. J. P.)

OOLOGY: see Egg.

OOTACAMUND, the headquarters of the Nilgiris (*q.v.*) district of Madras. India, approached by a metre-gauge rack railway from Mettupalaiyam station, Podanur-Coimbatore-Mettupalaiyam branch of the Southern; it is 37 mi. N.N.W. of Coimbatore. Pop. (1951) 41,370.

Ootacamund is the principal summer resort of southern India and summer residence of the governor of Madras and is noted for hunting, fishing and shooting, It is on a plateau 7,220 ft. above the sea, with a fine artificial lake, and mountains rising above 8,000 ft. The mean annual temperature is 58° F., with a minimum of 38° in January and a maximum of 76° in May; mean annual rainfall is 49 in. The houses are scattered on the hillsides amid luxuriant gardens. In the neighbourhood are plantations of coffee, tea and cinchona.

The Lawrence Memorial school for the children of soldiers was founded in 1858.

OPAH (*Lampris luna*), a pelagic fish of the order Allotriognathi. The body is compressed and deep, with minute scales. A dorsal fin: high anteriorly, runs along nearly the whole length of the back; the caudal is strong and deeply cleft, for rapid swimming. The pelvic fins contain numerous (15 to 17) rays. In its gorgeous colours the opah surpasses even the dolphin. The fins are bright scarlet, and the sides bluish-green above, violet in the middle, red beneath, variegated with oval spots of brilliant silver. The opah's home is the Atlantic, especially near Madeira and the Azores. It occurs also in the Pacific, and is rare in the Mediterranean. It grows to a length of four to five feet and a weight exceeding 100 lb.

OPAL, a mineral consisting of amorphous silica and variable amounts of water. Many kinds are recognized, and a few of these, highly valued as gem stones, are known collectively as precious opal. In ancient times precious opal was included among the noble gems and was ranked second only to emerald by the Romans. Many superstitions have centred about this stone; in the middle ages it was supposed to be lucky, but in modern times it has been regarded as unlucky.

Opal is fundamentally colourless, but such material is rarely found. Disseminated impurities are common and impart various dull body colours ranging from the yellows and reds of iron oxides to the black of manganese oxides and organic carbon. The milkiness of many white and gray opals is due to an abundance of tiny gas-filled cavities. Most varietal names are applied on the basis of general appearance; *e.g.,* milk opal, resin opal, liver opal, agate opal, plasma and prase opals (green), jasper opal (red), sunstone opal (yellow) and carnelian opal (orange-red).

Precious opals, which are translucent to transparent, are distinguished by a combination of milky to pearly opalescence and an attractive play of many colours. These colours flash and change as a stone is viewed from different directions and are caused by interference of light along minute cracks, veinlets of younger opal and other internal inhomogeneities.

In the variety known as harlequin opal the rainbow colours originate from little angular surfaces, forming a mosaic. Black opal, with a very dark gray or blue to black body colour, is both rare and highly prized. White opal, with light body colours, and fire opal, characterized by yellow, orange or red body colour, are much more common. The finest specimens of all varieties show an intense play of colours among large, even-size patches, each of uniform colour.

The composition of opal is represented by the formula $SiO_2.nH_2O$. Common opal contains 1% to 21% water and precious opal 6% to 10%. The mineral has a hardness of j.j to 6.5 and is easily scratched by quartz. It is brittle, with an irregular to conchoidal fracture, and is minutely porous. An extremely porous variety, known as hydrophane, can absorb surprising quantities of water and will adhere to the tongue. It is almost opaque when dry but nearly transparent when saturated. Another porous variety is cachelong, which has a lustre like mother-of-pearl.

Opal is deposited from circulating waters as nodules, stalactitic masses, veinlets and encrustations and is widely distributed in nearly all kinds of rocks. It is most abundant in volcanic rocks, especially in areas of hot-spring activity. It also forms pseudomorphs after wood and other fossil organic matter, and after gypsum, calcite, feldspars and many other minerals that it has replaced. Some pseudomorphic aggregates are known as pineapple opal. As the siliceous material secreted by organisms such as diatoms and radiolarians, opal constitutes important parts of many sedimentary accumulations.

The finest gem opals have been obtained from Queensland and New South Wales in Australia. and the Lightning Ridge field is famous for superb black stones. Deposits of white opal in Japan, fire opal in Mexico and Honduras and several varieties of precious opal in India, New Zealand and the western United States also have yielded much gem material. Most of the precious opal marketed in ancient times was obtained from occurrences in Czechoslovakia. Various forms of common opal are widely mined for industrial uses; *e.g.*, as abrasives. insulation media, fillers and ceramic ingredients.

Fire opals usually are facet cut, but most other precious opals are finished *en cabochon*, as their optical properties are best displayed on smoothly rounded surfaces. Undersized fragments are used for inlay work and small pieces scattered throughout a natural matrix commonly are sold as such under the name "root of opal." Drying of opal gems through heating or use in arid regions can cause cracking and significant loss of colours. Many finished stones are protected by water or films of oil until they are sold Opals absorb liquids very readily, and light-coloured stones often are dyed to resemble rarer, more deeply coloured varieties. *See* also GEM; SILICA: *The Silica Minerals.* (R. H. J.)

OPATIJA (formerly ABBAZIA), a seaside town in Croatia, Yugos., j6 mi. S.E. of Trieste by rail. Pop. (1953) 6,830. Opatija lies on the gulf of Quarnero at the foot of the Učka mountain (4.580 ft.). It is sheltered by the Učka and surrounding laurel woods. The town's name derives from the old abbey. San Giacomo al Palo, situated in the main park. Opatija, with an average of 50,000 visitors each year, has a rocky and picturesque seacoast to the north and south. Before World War I, Opatija belonged to Austria, but was ceded to Italy in 1924 and to Yugoslavia in 1947. (M Pd)

OPAVA (Ger., TROPPAU), Czech., lies on the Opava, a tributary of the Oder, in the middle of a wide fertile plain. The old town, founded in the 13th century, is girdled by parkland beyond which stretch extensive suburbs of the new town. in which are centred the industries (brewing, sugar refining, cloth and industrial machinery). Pop. (1950) 35,576.

OPEN BILL. A curious stork (*q.v.*) of the genus *Anastomus*, so called from the formation of the loaer mandible, which is hollowed out so as to meet the maxilla at the base and tip. There is an African and an Indian species.

OPEN-FIELD SYSTEM. The open-field system was the method of cultivating arable crops by a group of farmers, in common, in large unfenced fields, each man's holding being a number of narrow strips intermixed with those of his neighbours. Its origins go back into prehistory, and some form of it was practised over most of Europe and parts of Russia — in fact wherever men lived in small communities and worked together to supply their basic needs by tilling the soil with oxen and the moldboard plow. Evidence for the existence of open-field farming has been found over most of England and parts of Wales. It was practised in pre-Roman times, but came gradually to its full development after the Norman Conquest, when it fitted in well with the manorial system of land tenure. With local variations. it was the prevailing system of farming over the greater part of England and much of Europe for many centuries.

The chief characteristics of open-field farming at the time of its full development in the English midlands were fourfold: a common rotation of cropping, usually a three-course of winter grain (wheat), spring-sown crops, and fallow; holdings scattered in strips throughout the common fields; common grazing, carefully regulated as to numbers and kinds of stock; and the control of the whole system by the manor court, consisting of all the freeholders and tenants. The court made bylaws regulating the use of the arable fields, common meadows and grazing places, and an elected jury enforced its decisions.

The open-field system was admirably suited to a small community producing all its own food, but as society became more complex it gradually gave place before the necessity for farming for the market instead of for self-supply. In England as population increased, fresh land was taken in from the woodland and waste, but instead of being added to the open fields it was fenced off and farmed separately. With the growth of the wool trade in the 15th century many open fields disappeared altogether, giving place to sheep pasture. As knowledge of new crops and better methods of farming spread, progressive farmers wanted to farm as they pleased instead of conforming to the general pattern. Landlords, too, found they could get higher rents from land held in severalty. At first by voluntary agreements to exchange strips and consolidate holdings, and then by private acts of parliament from the 18th century onward, one village after another gave up its open fields and was carved up into separate farms, the process being accelerated by the high grain prices during the Napoleonic Wars. Very little open field remained through the 19th century, but in the village of Laxton. Nottinghamshire, open-field farming in many of its essential features was still being practised in the middle of the 20th century.

See also LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS; COMMONS; AGRICULTURE: *British Commonwealth.*

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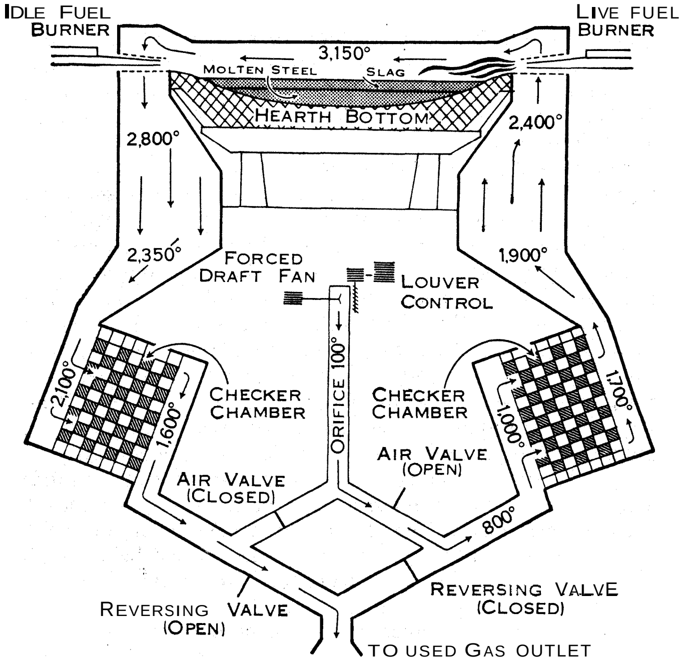
OPEN-HEARTH STEEL PROCESS. The idea that steel could be made from pig iron by oxidizing carbon with iron ore, using the regenerative principle for preheating gaseous fuels, was proved in 1868 by Karl Wilhelm Siemens, a naturalized British citizen of German birth. The Martin brothers of France substituted scrap for ore in the Siemens process, which reduced the extent of oxidation required. Open-hearth furnaces in Europe today are called Siemens-Martin or Martin furnaces. Of the additional modifications made since the Martin brothers, the Talbot (duplex) process proved the most important. This furnace is a tilting open-hearth, which refines molten metal which has had carbon removed in an acid converter. Although only a small percentage of open-hearth steel is made by this process today, it is useful during scrap shortages and for removing phosphorus from molten metal, which cannot be removed in the converter.

The modern open-hearth plant is usually made up of 9 to 12 furnaces arranged side by side. The trend is toward larger furnaces ranging from 200 to 275 tons, with a cost of more than $4,000,000 per furnace, including auxiliary equipment. An open-hearth furnace with a capacity of 550 tons per heat was built at Weirton, W. Va.

Modern open-hearth furnaces are of the reverberatory type and have a hearth in the shape of a large, oval dish, as the accompanying diagram shows. At each end of the furnace are ports where the fuel and air meet; these are connected to the refractory checkers — regenerators — by flues. Through a system of valves and flues, the checkers are connected either to the incoming air supply or the stack for waste gases. Utilization of heat from waste gases is made possible by these valves, which change the direction of the flow of air and gases automatically about every 15 min. to maintain a checker temperature of from 1,800° to 2,200° F., which is required for efficient operations.

Oil, tar, natural gas and coke-oven gas are the most common fuels used in the U.S. in open-hearth furnaces. To obtain high enough flame temperature and economic fuel consumption, the air supplied for combustion is always preheated, and when gases of low British thermal unit (B.T.U.) values, such as producer gas, or blast-furnace gas enriched with coke-oven gas, are used as fuel,



BY COURTESY OF INLAND STEEL CO.

OPEN-HEARTH FURNACE

these are also preheated. Since a large number of furnaces were designed originally for producer gas, they were built with two regenerators at each end of the furnace, a small one for gas and a large one for air. The majority of these furnaces were converted for high-B.T.U.-value fuels and use all chambers for heating air. Modern furnaces which are not designed for use of a gas requiring preheating are built with only one chamber for air at each end.

Fuel consumption, using hot metal (molten pig iron) and scrap, varies from 2,850,000 to, 4,800,000 B.T.U. per ton of steel produced. Oxygen, used by some open-hearth plants for flame enrichment, increases the flame temperature and reduces the quantity of combustion gases produced, which in turn reduces the heat loss in flue gases.

Except for the hearth, the refractory material used in building an open-hearth is about the same for acid or basic types. Both use silica-brick roofs, which will withstand temperatures up to 3,100° F. A typical basic hearth is made up of insulating brick and magnesite or chrome brick covered with magnesite and dolomite. Chrome brick is also frequently used to separate the bottom and roof because of its neutral chemical properties. In the acid hearth, silica brick and silica sand are used.

The basic open-hearth charge usually consists of limestone, steel scrap and pig iron (molten or cold). Charges vary from nearly 100% scrap with very little pig iron to 100% hot metal. The most widely used charge in the United States is one consisting of 40% to 65% hot metal and 35% to 65% scrap. When the hot-metal portion exceeds about 55%, enough iron ore is charged to oxidize part of the carbon and other impurities from the hot metal. A violent reaction (ore boil) takes place when the hot metal is added to this type of charge, which produces a flush slag containing about 30% iron, 22% silica, 3% aluminum oxide, 20% calcium oxide (lime) plus magnesium oxide, 1% phosphorus, 8% manganese and 0.1% sulphur. This slag, which accounts for about 5% metallics lost, is run off into slag ladles. The next step in the process is the lime boil, which is caused by calcination of the limestone. The lime (CaO), which comes to the surface. makes the second slag for the above operation and the first slag for heats that make use of less than 55% hot metal. During the lime boil and refining period, lumpy iron ore is added to furnish available oxygen to oxidize the carbon, silicon and phosphorus from the molten bath. Carbon is liberated as carbon dioxide, and the latter two are held in the slag in the form of calcium compounds. Oxygen, supplied through a lance injected into the molten bath, was used in some open-hearth plants to supplement iron ore. Fluorspar is added to thin the slag (break up lumps of lime) to make it more adaptable to hold silicon, phosphorus, and other impurities.

Removal of sulphur is one of the most serious problems in the open-hearth as well as the entire steel industry. It enters the bath as a constituent in most raw materials, as well as from the flame. Large slag volumes, high slag basicity, and fluid slags with good bath action tend to aid desulphurization. High temperatures aid in promoting fluidity and motion.

When all the above impurities have been removed, the desired carbon content is reached, and the temperature is correct (2,850°–3,000° F.), the melt is tapped and cast into ingots or castings. Adjustments to meet specification are made by adding ferroalloys to the furnace before tapping and to the ladle during tapping. In the acid process the elimination of sulphur and phosphorus is not possible. The basic slag, essential to the removal of these impurities, cannot be used in tbe acid-lined furnace without injury to the acid (silica) lining. Oxidation of the carbon is accomplished in the same manner as in the basic process. To produce good steel, therefore, it is necessary to use raw materials low in impurities in the acid process.

In the early 1950s approximately 90% of the steel made in the United States was produced in open-hearth furnaces. The annual ingot capacity of the United States steel industry, as reported by the American Iron and Steel institute, was 117,500,000 net tons as of Jan. 1, 1953, of which open-hearth furnaces supplied 102,700,000 tons. *(See* also IRON *AND* STEEL.)

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OPEN SHOP: *see* CLOSED SHOP.

OPERA, a dramatic work in which the words, instead of being spoken in verse or prose, are wholly or partly sung to an instrumental accompaniment almost invariably assigned to an orchestra of variable size. The music of an opera may be divided into separate, formal pieces for single or combined voices (arias, concerted numbers), and sometimes for instruments only (interludes, dances), connected either by spoken dialogue or by sung recitative; or it may be composed continuously in a more or less symphonic manner, with structural sections still discernible or entirely submerged in an organization spread over whole acts. Whatever the composer's procedure, which depends partly on his individual disposition and partly on his place in operatic history, there must be musical structure of some kind in opera.

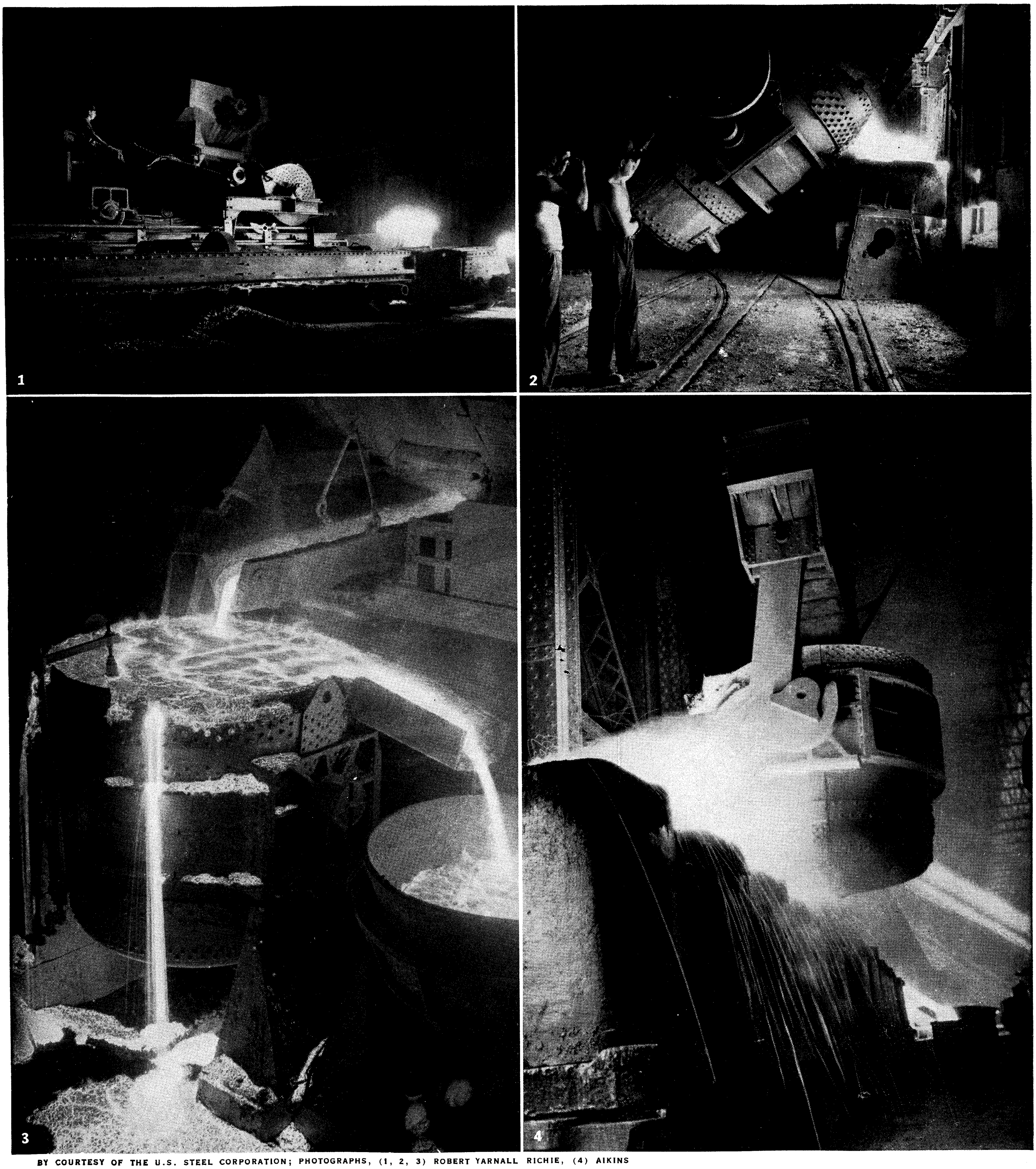
The question of the relative importance of the various elements found in opera cannot be better expounded than by quoting from Sir Donald Tovey's article on this subject in an earlier edition of the *Encyclopaedia Britannica:*

"... here we may profitably consider what are the qualities necessary for success in opera. It is notorious that the absolute value of the music comes last, if it is a factor of success at all. Unquestionably it is a factor in immortality; and the music of *Idomeneo* is immortal, though that opera is revived only in Mozart festivals. But operas cannot wait for immortality, and can manage on quite flimsy music to achieve as much immortality as musical history has given time for. It might be thought that success depends on dramatic power; and this is nearer the truth. But dramatic power comes only third in the conditions, and coherence is not necessary at all.

Two qualities take precedence of dramatic power as conditions for success in opera; one is the theatrical sense, and the other the histrionic sense. They are inseparable but not identical. The theatrical sense can thrill the listener before the curtain rises, as in the modulation to F major at the end of the overture to *Don Giovanni;* the histrionic sense can save the stage-manager the trouble of telling the actors what to do with their hands. ..."

Beginnings.—The opening date of the history of opera can be conveniently placed in the year 1600, when J. Peri's *Euridice* was produced at Florence, though he had already brought out his setting of O. Rinuccini's *Dafne* in 1597. But opera has a long prehistory, which it is not too far-fetched to trace back to Greek tragedy of the Periclean age, portions of which were undoubtedly sung. The share music may have had in the Roman theatre and in quasi-dramatic performance up to the middle ages is so uncertain as to be unprofitable to speculate upon, but we do know that the mediae-

OPEN-HEARTH STEEL PROCESS



BY COURTESY OF THE U.S. STEEL CORPORATION; PHOTOGRAPHS, (1, 2, 3) ROBERT YARNALL RICHIE, (4) AIKINS

MELTING AND CASTING OF STEEL

1. Charging an oven hearth with scrap iron
2. Charging an open-hearth furnace with molten pig iron
3. Tapping molten steel from an open-hearth furnace
4. Pouring molten steel from ladle into ingots

val church, from the 10th century onward, had an elaborate form of sacred music drama, performed on particular feast days by clergy in costume, with the chancel for a stage, and intoned in plainsong. Allowing for the conditions of the time, we may say that these performances had every feature of opera except that of instrumental accompaniment.

Italy. — Outside the church, and nearer the time of opera proper, performances of mystery and miracle plays made enough of music, now instrumental as well as vocal, to show distinctly operatic ingredients, and out of them grew in Italy a special type of acted oratorio or allegorical drama with music, the 16th century *rappresentazione*. The most famous and one of the last before opera came into its own was Emilio de' Cavalieri's La *Rappresentazione* di *anima* e di *corpo,* performed in Rome in Feb. 1600. The "soul" and the "body" of the title are impersonated by human characters, and so are various abstractions, such as virtues and vices.

The madrigal opera, of which O. Vecchi's *L'Amfiparnasso* of 1594 is the best-known example, anticipated by A. Striggio and others and imitated by A. Banchieri and others, cannot really be regarded as a direct forerunner of true opera, except in so far as it was in a kind of dramatic form; for modern scholarship no longer regards it as having been performed on the stage in dumb show, with the voice parts sung behind the scenes. Nevertheless, it must be taken into account, if only because it may have done something to discourage dramatic stage presentation with music of a highly wrought character. Composers who cultivated polyphony (the mass and motet in church, the madrigal and its forerunners in the polite world) left the stage alone, because their music could not be accommodated to dramatic action; and this gave a chance to musicians who were performers rather than creative artists to try their hands at dramatic pieces with words turned into song. Simplicity of treatment, which to the fully trained composers would have been an embarrassment, if not an impossibility, was an advantage to the dilettanti who gathered at Florence in the house of Count Bardi, an aristocratic patron of the arts. The most gifted of the musicians among them were V. Galilei, the father of Galileo, who however did not dabble in dramatic music, Peri and G. Caccini. It was not the art of composition in the first place that was felt by the Bardi camerata to be required for what they had in mind, which was nothing less than a revival of Greek drama as they imagined it; and in setting about to give shape to their imagination they did what the great composers had failed to do — they produced opera for the first time in a form recognizably like that we still know today.

Three days after the production of Peri's Euridice came Caccini's *Il* Rapimento di Cefalo, and this composer made his new setting of Euridice for 1602. These pieces were feeble enough musically; the vocal line was little more than continual recitative and the accompaniments were played on whatever was available, from the sketchiest of scores; but as essays in the treatment of the voice for the purpose of eloquent and often truly dramatic declamation they were remarkable enough to exercise a decisive influence on the first great master of opera. Claudio Monteverdi, who was soon at hand. His La Favola *d'Orfeo* (Mantua, 1607), is in the declamatory style of the Florentines, with the difference that an artist is in charge for whom musical invention is important and who seizes every chance to insert organized musical pieces. An even greater surviving work by Monteverdi is his last, *L'Incoronazione* di *Poppea* (Venice, 1642). interesting also for its treatment of a subject from history instead of mythology. We non see the two chief sources opened up from which serious opera during the 17th century was to draw its librettos exclusively.

Monteverdi's orchestra was still an ad *hoc* affair: the score remained incomplete, with the harmony indicated in the continuo part, and the general principle was that such instruments should be used as happened to be available. But we have a specification of what he suggested for Orfeo, extravagantly enough. At Venice, where Monteverdi moved from Mantua in 1613, he took his share in the establishment of opera for the first time as a public entertainment, as distinct from a court function. In his last years there were four public theatres in the city devoted to music. The chief Venetian composers succeeding him before 1660 were F. Cavalli, M. Cesti, P. Sacrati and the elder Ziani. Their works were elaborately spectacular, and there is small doubt that the stage machinery was regarded as more exciting than either the plot or the music, both of which mere apt to stiffen into conventions which only in the best composers' best moments escaped being tedious. There was also public opera in Rome, with S. Landi, L. Rossi and D. Mazzocchi as the main musical figures. Nowhere else did it as yet flourish outside the courts.

Germany. — Meanwhile there had been an abortive beginning in Germany. An adaptation of Rinuccini's *Dafne* libretto by Martin Opitz was set as an opera by Heinrich Schutz and produced at Torgau in 1627. But Schütz was diverted into other activities and never again wrote an opera. No other German composer did for half a century, and even then there was only one public opera house in all Germany, at the free Hansa city of Hamburg, uhich had no court. The courts themselves cultivated Italian opera and some of them French a little later. Had it not been for the German princes, who vied with each other in keeping up luxurious establishments, opera might easily have suffered the same neglect in Germany as in England. for it was from the courts that during the 19th century the municipalities of the larger towns gradually inherited the tradition that opera must be subsidized.

England. — The English neglect had various causes. The most potent cause was not a lack of composers to whom opera was congenial, but an ovenvhelmingly great school of spoken drama that flourished at the very time opera arose in Italy and produced verse drama in which the words often reached a splendour apt to make a perfectly satisfactory substitute for music. The commonwealth also had something to do with the stagnation of opera before Henry Purcell's maturity. All the same, the suppression was not complete. The masque, which in England had much the same influence on the musical stage as the ballet had in France, was well established, and what is called the first English opera, Sir William D'Avenant's The *Siege* of Rhodes, with music by M. Locke, H. Lawes, H. Cooke, E Coleman and G. Hudson, was staged in 1656, four years before the Restoration.

France. — In France tournaments and masquerades led to the immediate predecessor of opera, the court ballet, the most famous specimen of which, Le Ballet comique de la reine of 1581, already shows operatic elements. But the composer, Balthasar de Beaujoyeulx (Baldassare de Belgioioso) was Italian-horn. It was long before the first real French opera appeared. It is sometimes claimed that this was the *Andromède* of 1650; but this was a play by Corneille in which the words immeasurably overtowered what was little more than incidental music, by C. d'Assoucy. A better claim to priority is disputed by M. de La Guerre's *Le* Triomphe de *l'amour* (1655) and R. Cambert's Pastorale (1659). The latter is rather more important musically, but both pieces are pastorals, lyrical and spectacular, and both give as much scope to dancing as to drama. The earliest French operas had some influence in London. particularly those of Cambert. who went to live there.

In Paris the next great figure. indeed the first truly great one in French opera, was Jean-Baptiste Lully, again originally an Italian, Giovanni Battista Lulli of Florence. but belonging at least as much to French music as Handel later did to English. Nevertheless, it is significant that before him Italian opera was cultivated in Paris to some extent. Lully's musical technique is limited, and he avoided counterpoint except in the fugal allegro section of his overtures, where he created a type of instrumental piece that remained in force, by no means only in France, until well into the 18th century, even being used by Bach and Handel. On the other hand Lully had a great fund of graceful and sometimes pathetic melody, and he laid much stress, especially in his recitatives, on correct declamation of the French language, a difficult problem where so little syllabic stress occurs, and yet one to which so literary a nation as the French attached great importance.

It was in French opera that recitative first became sharply detached from set musical numbers. which had to be formally self-sufficient because they were not only rounded-off airs, but quite often dances. Rut French recitative was accompanied by the orchestral strings, whereas in Italian opera, which soon began to use it in even more strict separation from the formal numbers, it became relegated to the harpsichord that played the continuo throughout the opera, but in the recitatives was supported by bass strings alone.

The Later 17th Century. — During the last third of the 17th century, while France and Italy continued to build at opera in their several ways, with M. A. Charpentier, P. Colasse, A. Campra, H. Desmarets and A. C. Destouches as new figures in France and A. Draghi, B. Pasquini, A. Stradella and A. Steffani in Italy. there were some isolated events in Spain and Germany. J. Hidalgo in Madrid, J. Theile at Hamburg and Nicholas Adam Strungk (the younger Strungk) there and at Leipzig. H. J. F. von Biber at Salzburg brought out the first work by an Austrian (strictly speaking Bohemian) in 1687. But this still had an Italian libretto, and the court in Vienna had already patronized Italian opera on a lavish scale, with Cesti's *Il Pomo d'oro* (1666–67) as the most extravagantly spectacular work.

Two major figures now arose, the first opera composers whose work is capable of maintaining itself in the regular modern repertory. They were Alessandro Scarlatti in Italy and Henry Purcell in England. Born within less than a year of each other, they dominate this period, both by superior musical genius and Purcell, in addition, by a realistic foresight that penetrated far into the next century. He was hampered by texts which were in every case but one sadly nonoperatic, in the sense that they were merely plays containing an unusually large number of opportunities for musical settings. The exception was the small-scale *Dido and Aeneas,* the libretto of which, in spite of Nahum Tate's doggerel. enabled Purcell to anticipate by more than 70 years C. W. von Gluck's *Orfeo.* For if Gluck swept away the artificialities that had been grafted on Italian opera ever since Purcell's youth and earlier, Purcell simply ignored them and allowed his own common sense and imagination to guide him toward the shaping in *Dido and Aeneas* of what *Orfeo* is usually called — the first "reform opera." (Indeed, one might call it the first music drama, as distinct from opera in the conventional sense.) But this was his only chance, and his isolated, insular position conspired with his early death, the absence of any sufficiently strong successor and any system of patronage in damming up what might have grown into an operatic main stream in Britain. For Purcell, while as independently enterprising as Gluck, was technically a far more accomplished master.

Scarlatti, too, was a master of the first order. However, he did nothing to alter the Italian operatic conventions which by his time had become too rigid to be easily upset; he simply did first-rate work within their limitations. Among these was an exclusively Italian phenomenon, which however found its way until well into the middle of the 18th century into opera elsewhere — that of the male soprano and contralto. The barbarism of turning boys into eunuchs before their voices broke began in the church, where women singers were not allowed. Artificial treble voices were thus available which it became the fashion to admire in opera, the more so because these freak singers were capable of performing incredibly difficult florid passages, not only written for them by the composers, but also improvised by them in long cadenzas as elaborate as those inserted later into instrumental concertos. The absurdity of seeing eunuchs with soprano voices interpreting Greek gods and heroes, and sometimes taking women's parts, was accepted as one of the ordinances of opera.

Scarlatti's numerous and splendid operas are among the chief exemplars of this phase of excessive artifice, which causes them to survive all too precariously as historical curiosities. It has also robbed other composers of this period of any but the slenderest chance of survival, however fine the music of such men as A. Caldara, L. Vinci, L. Leo, J. A. Hasse, N. A. Porpora and G. B. Bononcini may have been. R. Keiser is also an offshoot of this school; he brought the Hamburg opera to its culmination with works of the Scarlatti type in a mixture of German and Italian words set to wholly Italianate music. J. Mattheson was associated with him; and so was the youthful Handel, who thus knew the Italian style of the day before his visit to Italy and his settling in England. Handel's first operas were like Keiser's and appeared at Hamburg. Those produced by him in London (35 works between 1711 and 1741) are all full of glorious music, but music almost entirely confined to arias, cruelly difficult to sing and such a dead weight on the plots that the whole of his operatic output is now an all but complete loss to the stage. Handel's operas are far less dramatic than his oratorios.

18th-Century Developments. — The greatest 18th-century librettist was Metastasio. It was chiefly he who influenced composers for a long time to come to persist in this overformalized kind of opera, which he handled with consummate skill. Between 1724 and 1771 most of the important opera composers, and many unimportant ones, in Italy and abroad, set Metastasio's texts, many of which were used over and over again. He caused much fine music to be written and opera as an art form to become stuck in a rut. But this happened only to the so-called *opera seria,* and another species — the *opera buffa*—now began to emerge in Italy and to revitalize the musical stage with characters more directly in touch with the audiences than the gods and heroes of antiquity, though even they at first appeared in the conventional guise of the harlequinade figures of the *commedia dell'arte.* The first Italian comic operas were not independent works, but interludes inserted, scene by scene, between the acts of the serious operas to enliven the evening. These *intermezzi* were very slight, and only one has survived—*La serva padrona* by G. B. Pergolesi, produced in 1733.

It was this work which in 1752 brought the *opera buffa* to Paris as a model for the coming French comic opera; it was this, too, which unleashed the quarrel known as the *guerre des bouffons.* This lasted until 1754 and was nothing more than an argument, for argument's sake, between the partisans for Italian and for French opera, a dispute between men of letters rather than musicians.

The next great figure in French serious opera after Lully was J. P. Rameau. He did not follow the Metastasian conventions, but had rigid theories of his own and was musically somewhat cold and dry. But his works are as nobly classical in their way as the tragedies of Corneille and Racine, and bigger, though of lower vitality, than the French type of comic opera which developed in the hands of small-scale but delightful composers like A. Dauvergne, F. A. Philidor, P. A. Monsigny and, a little later, A. E. M. Grétry and N. Dalayrac. Their pieces were often tearfully sentimental, but also freshly and charmingly human. Out of them developed the quite peculiar type of *opéra-comique,* which is not necessarily comic, but has to contain spoken dialogue. As late a work as G. Bizet's *Carmen,* with its original dialogue, is still an *opéra-comique,* for all its tragic ending, and so were the "rescue operas" of the Revolution period, one of which, P. Gaveaux's *Léonore,* led by way of a close translation of its libretto straight to Beethoven's *Fidelio,* which is thus also in a sense an *opéra-comique.* In Italy the *opera buffa* continued well, and one of its major composers, B. Galuppi, had the advantage of finding a playwright of genius, C. Goldoni, for his librettist.

In Germany opera in the vernacular at last began to emerge in the middle of the 18th century. It did so as modestly as English so-called opera, which had started with the most famous of the ballad operas, *The Beggar's Opera* of 1728, and was to continue for a long time with slight pieces by T. Arne, S. Arnold, C. Dibdin, W. Shield and others. Indeed, the first impulse came to Germany from England: a translation of C. Coffey's ballad opera *The Devil to Pay,* with music by J. C. Standfuss, given at Leipzig in 1752, began the vogue of the *Singspiel,* a simply sentimental and even more naïvely humorous play with music restricted mainly to songs and choruses of an easy, popular kind. The first full-scale German opera, Mozart's *Die Entführung,* was still 30 years off, and even this retained some elements of the "song-play."

With Gluck began the period which still supplies the regular repertory of today, although in recent times a few isolated works of earlier date have been added. But Gluck himself was slow to produce anything capable of surviving a first production, as indeed operas up to nearly the end of the 18th century were never intended to do. His numerous Italian operas, not all of them written before *Orfeo,* are in fact technically weaker than those by the best of his contemporaries, such as D. Terradellas, N. Jommelli and T. Traetta. There is more vitality in his French comic operas, written for the Viennese court, but they are little more than plays with songs. For German opera he did nothing; indeed, like Handel, he set next to no German words to music.

Gluck's first "reform opera," *Orjeo ed Euridice,* appeared in Vienna in 1762 and *Alceste* followed in 1767. French versions of both (1774 and 1776), together with his four original French serious operas (1774–79), spread his influence to Paris, though he was himself influenced by Rameau to some extent, and they provoked another literary dispute there among his partisans and those of N. Piccinni, an Italian who wrote as nobly as Jommelli, but remained conservative. He and Gluck respected each other and took no part in the quarrel. Gluck's reforms—which did away with vocal virtuosity shown off for its own sake, suited the character of the music to the situation and turned stock figures into human beings—were really due in the first place as much to R. Calzabigi, the librettist of *Orjeo;* but that the composer knew very well what he was doing is evident from his preface to *Alceste.* Gluck still had to concede artificially happy endings, however, and in the works specially written for Paris he was obliged to retain the traditional ballet, which remained a feature of French *grand opéra.*

The 19th Century.—When we reach what may be called the modern repertory, it is possible to survey the rest of operatic history much more briefly, both because its major works are still familiar, or at least accessible, and because discussions of the principles underlying them (*e.g.,* Wagner's) may be found in many of the articles on individual composers.

The entry of Mozart into German opera with *Die Entführung aus dem Serail* has already been mentioned, and in his last year he was to climb to the topmost peak of the *Singspiel* with *Die Zauberflöte* (1791), which still belongs to that category, exalted and for the most part solemn and uplifting though it be. But he had already written several Italian works and produced his first masterpiece in that class, *Idomeneo,* in 1781. The three greatest, which indeed place him with Wagner and Verdi in the triumvirate of opera composers who have so far remained unmatched are *Le Nozze di Figaro* (1786), *Don Giovanni* (1787) and *Cosi fan tutte* (1790). In some ways Mozart stands alone in supreme mastery. Never has opera achieved such ideal balance between the conflicting elements that go to the making of it. In him alone music in itself of the purest shape and quality, the most flaw-less workmanship, is reconciled with all the dramatic claims made by a libretto: perfect delineation of characters, faultless timing of every situation, simultaneous handling of conflicting emotions in unified concerted pieces.

Some minor Germans continued to set Italian words; others tried their own language. But the first great opera in German was Beethoven's *Fidelio* (1805, revised 1806, 1814), though, as we have seen, its model was French and the musical influences behind it were Franco-Italian (M. L. Cherubini, F. Paer, E. Méhul). As an opera it is not perfect, and the spoken dialogue lowers its temperature; but its high moral tone is divested of smugness or ingenuousness by the incomparable elevation of the composer's musical thinking and feeling. *Fidelio* had no influence on later German works: its form was unsatisfactory and its music unapproachable.

The progress of German opera was threatened at the outset by the enormous success of G. A. Rossini, whose career began as early as 1810. His new type of *opera buffa,* with its enticing, peppery music, was made as welcome in Vienna and Germany as anywhere and interfered with the operatic careers of Germanic composers, making Schubert's impossible and C. M. von Weber's dificult, and driving G. Meyerbeer first to Italy and then to Paris. Still, in 1821 Weber managed to bring out *Der Freischütz* in Berlin, and here for the first time was a musically important work thoroughly German in every respect, so much so indeed that it has never taken a firm footing anywhere else. It was also the first romantic opera of any consequence.

Romanticism, by this time established in literature, poured into opera after Weber's lurid story of the magic bullet. He also dealt with a French subject in *Ezrryanthe* (1823) and actually set an English libretto in *Oberon* (London, 1826). In Germany, though, a strongly romantic vein had already been apparent by 1816 in E. T. A. Hoffmann's *Undine,* a musically rather feeble work by a man whose major gift was literary, and to a lesser extent in Ludwig Spohr's *Faust.* In France romanticism took a rather different, semihistorical form in D. F. E. Auber's *La Muette de Portici,* a revolutionary opera (1828), and in Meyerbeer's works, especially *Robert le diable* (1831). Even in Italy, which was far less open to it, a streak of it is perceptible in works based on Sir Walter Scott: Rossini's *La Donna del lago* (1819) and G. Donizetti's *Lucia di Lammermoor* (1835). But both Rossini and Donizetti were at their best in *opera buffa,*which indeed, with the exception of the suavely lyrical works by the short-lived V. Bellini, remained the most vital operatic phenomenon in Italy until the advent of Verdi, who furnished only two examples of it, a failure in 1840 and *Falstaff* (1893), which, written when the composer was 80, is his most perfect work, flawless in every particular and even, unlike the operas of his earlier years, incomparably refined. It improves immeasureably on conventional *opera buffa* by removing its heartlessness and by adding poetry.

Verdi up to *Otello* (1887), and even there once or twice, could be crude; but from the first he never failed to be strikingly effective, and at his best he had not only an unfailing sense of the stage, but also a discriminating and resourceful musicianship far exceeding that of any of his Italian, and most of his other, contemporaries, and much more mastery in technical matters than is generally acknowledged. He was matched in skill only by Wagner, his exact contemporary, who, however, matured later. Wagner's *Rienzi* (1842) still shows the influence of G. L. P. Spontini, H. A. Marschner and Meyerbeer, whose works he knew well as a conductor. Wagner also knew what to his mind mas feeble, artificial and illogical in conventional opera and by much theorizing arrived gradually at a thoroughgoing reform. Though this reform has not proved as vital in the hands of his imitators as he doubtless hoped, much less found general acceptance among later composers, it was more than suited to his own needs. What ultimately saved his work for future generations was not his feat of turning opera into music drama so much as his surpassing eminence as a composer. His resources are endless and perfectly serve his special requirements; his use of the leitmotiv (*q.v.*) is wonderfully eloquent and flexible, not only because it does so much to allow the orchestra to express what the characters on the stage are doing and even thinking. but also because his handling of these themes developed into the very highest art of symphonic composition.

Romanticism in German opera verged on hysterical extravagance in Marschner's *Der Vampyr* (1828) and *Hans Heiling* (1833). Marschner also wrote an opera based on Scott's *Ivanhoe, Der Templer und die Jüdin* (1829). Another *Undine,* by G. A. Lortzing (1845), still enjoys some favour in Germany; but Lortzing's talent was particularly suited to comic opera, pieces deriving from the *Singspiel* and influenced by French works of the lighter kind, which flowered charmingly in Paris during the first half of the century under D. F. E. Auber, F. A. Boieldieu, A. C. Adam and L. J. F. Hérold.

In Russia, which now came on the operatic scene with M. I. Glinka, opera took a rather different turn, its subjects being as a rule either historical or fairy-tale material. Glinka's two operas represent both tendencies: *A Life for the Tsar* (1836) the historical, *Russlan and Ludmilla* (1842) the fairy tale. Subsequent historical works were M. Mussorgsky's *Boris Godunov* (1874), A. Borodin's *Prince Igor* (posthumously, 1890) and N. Rimsky-Korsakov's *Ivan the Terrible* (1873) Most of Rimsky-Korsakov's works were fairy tales. Glinka is the great originator of many devices used by later Russians, Mussorgsky the undisciplined but powerful realist. All these were nationalist composers, but Tchaikovsky was more cosmopolitan. Except for *Eugene Onegin* (1879), however, he mas never quite happy in his choice of subjects. his inspiration was unequal and his dramatic sense weak; but his technical competence and lyrical charm are considerable.

England for long had nothing of lasting value to contribute in the 19th century, but M. Balfe scored successes in Italy, France and Russia as well as at home. During the last decades C. V. Stanford wrote fine, if not very stageworthy, works and Sir

Arthur Sullivan's light pieces have remained unique of their kind, with a musical craftsmanship far surpassing that shown in the operettas of Jacques Offenbach and Johann Strauss. There were beginnings of national opera in Bohemia with F. Smetana, in Hungary with F. Erkel, in Poland with S. Moniuszko and in Spain with F. A. Barbieri.

.Perhaps the most characteristic product of the 19th century, though by no means the most valuable, was the French *grand opéra,* in which C. F. Gounod, J. E. F. Massenet, among others, followed Meyerbeer and to which Rossini's last opera, *Guillaume Tell* (Paris, 1829), also belongs. It suffered from a heavy load of absurd traditions, such as the obligatory five acts and ballet. Bizet's work, culminating in the daringly inventive, realistic and splendidly orchestrated *Carmen* (Paris, 1875), blew refreshing air into this conventional stuffiness, as did, in another way, the profoundly original operas by H. Berlioz, which unfortunately had no success. A. Bruneau at the end of the century followed Bizet in a sense and V, d'Indy followed Berlioz, with a difference, but with much the same lack of success. In Italy the school of *verismo* began at that time. A. Ponchielli, R. Leoncavallo, P. Mascagni and U. Giordano turned out crudely effective works which appealed to the masses. G. Puccini followed the same lines, with better musicianship and a rather more refined artistic conscience. His *Tosca,* and G. Charpentier's *Louise,* a French work following some of the tendencies of *verismo,* both produced in 1900, brought the century to a close with a threat and a promise.

The 20th Century.—In the next two years appeared two new composers who seemed to sweep all this away. Richard Strauss's *Feuersnot* (1901) was still Wagnerian in its music, but attempted to scandalize the public by a modern and "immoral" libretto. Claude Debussy's *Pelléas et Mélisande* (1902) first of all made a new departure by using a spoken play by Maeterlinck instead of a specially written libretto, and it shocked its hearers as much as Strauss's work had done, though in quite a different way, by disappointing every expectation of accustomed procedures. It was uneventful, unemphatic, undervitalized and almost devoid of action. But those who looked for musical quality of the finest kind and were not to be put off by understatement and drastic harmonic innovations learned to cherish this ultra-refined work, which remained unique, for Debussy never wrote another opera. Strauss did, and continued until long into old age, retaining his mastery to the last, but falling back too often on what had served him well before. Even at his best he is uncertain in style and taste, but astonishingly inventive and vibrant. *Der Rosenkavalier* (1911) is his most glamorous success, *Ariadne auf Naxos* (1912) his most enchanting work, but just beginning to show the first cracks of decay.

E. F. C. d'Albert's *Tiefland* (1903), F. Schreker's various works, which approach decadence, R. Zandonai, I. Montemezzi and E. Wolf-Ferrari (in *I Gioielli della Madonna)* continued along the line of *verismo.* Wolf-Ferrari also revived the Goldonian comedy of the 18th century, with a charm that seemed faded and a humour more Germanic than Italian. High comedy of the most sophisticated kind is represented by M. Ravel's brilliant *L'Heure espagnole* (1911). F. B. Busoni's operas ran along a remote sideline in the 20th century much as Berlioz's had done in the 19th.

One of the most interesting figures of the 20th century is the Slovak L. Janáček, as thorough a nationalist as Mussorgsky and one of the most original minds in all opera, untouched by any fashion and free from preconceived theories except those connected with the natural declamation of words which unfortunately make his work almost untranslatable. The notion that theory must come first and practice conform to it, on the other hand, makes A. Schonberg's short essays in opera inaccessible to those who wish to see what an opera looks like on the stage rather than in the score. It must be said, though, that Schonberg did not apply his 12-note system rigidly to his dramatic works. A. Berg in his remarkable *Wozzeck* (1925) and his unfinished *Lulu* (posthumously, 1937) used it only as far as it would bend to his intentions. What is more remarkable about his works is that they are cast in various traditional musical forms scene by scene mithout allowing the least constraint to appear in the dramatic events, if also, it has to be admitted, without making these forms perceptible to the listener. An *a priori* theorist of another sort is I. Stravinsky, who always makes up his mind precisely beforehand as to what he is to do and then does it in cold blood, with extraordinary precision and skill. His Hogarthian opera, *The Rake's Progress* (Venice, 1951), which has actually very little to do with Hogarth, is deliberate 18th-century pastiche, refined, witty, often charming, but dry and appealing to intellect and taste alone.

In Germany H. Pfitzner, after several neoromantic works, produced a masterpiece of a kind in *Palestrina* (1917), long and heavy-handed, old-fashioned in some ways, but impressive. P. Hindemith's *Mathis der Maler* (Ziirich, 1938) is something of the same sort, masterly, noble and inclined to dullness, but more up-to-date in its idiom. In Italy I. Pizzetti has written severely classicist works, rather like a latter-day Cherubini, and G. F. Malipiero has renewed styles and traditions of the past, not unlike Stravinsky, but exclusively Italian and with more warmth.

To modern English opera Ralph Vaughan Williams has contributed a good deal, notably his setting of J. M. Synge's *Riders to the Sea* (1938), a concentrated and profoundly truthful tragic masterpiece in one act. With Benjamin Britten's *Peter Grimes* (1945), English opera conquered the cosmopolitan scene far more quickly than Purcell did and with much greater justification than Balfe. None of his later stage works—except *The Turn of the Screw* (Venice, 1954)—made the same impression abroad, but they made opera once again seem worthy of the attention of British composers of genius. By 1954 others had written or were writing full-scale works for the stage, including A. Benjamin, Lennox Berkeley, Sir Arthur Bliss, A. Bush, M. Tippett and Sir William Walton. In the middle of the century operatic output in the United States brought forward work either actually or potentially capable of being exported with success. G. Gershwin's only opera, *Porgy and Bess* (1935) was perhaps helped to widespread European appreciation by the previous vogue of his musical comedies and jazz pieces. Among others whose operas travelled abroad were G. C. Menotti, M. Blitzstein and V. Thomson. *See* also Index references under "Opera" in vol. 24.

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OPHICLEIDE, a brass mind instrument with a cup-shaped mouthpiece and keys; in fact the bass of the now obsolete family of keyed bugles. The ophicleide is almost perfect theoretically, for it combines the natural harmonic scale of the brass wind instruments having cup-shaped mouthpieces, such as the trumpet, mith a system of keys, producing a full chromatic scale, and it is capable of absolutely accurate intonation. Unfortunately its tone is not satisfactory, but for some special effects it served well (*e.g.,* the donkey's bray in Mendelssohn's *Midsummer Night's Dream* overture). It has been orchestrally superseded by the bass tuba and by the double bassoon and, in the military band, by the bombardon.

The invention of the ophicleide is sometimes falsely attributed to Alexandre Frichot, a professor of music at Lisieux. Actually the first idea of adding keys to instruments with cupped mouthpieces, unprovided with lateral holes, goes back to Kolbel, a horn player in the St. Petersburg Imperial orchestra, about 1760. Anton Weidinger, trumpeter in the Austrian imperial band, improved upon this first attempt, and applied it in 1800 to the trumpet. In 1810 Joseph Halliday, bandmaster of the Cavan militia, patented a key bugle: a copy of it was ordered in Paris from Halary, a professor of music and instrument maker, who brought out in 1817 and patented in 1821 a set oi three key bugles, the bass instrument of which he named *ophicléide.*

OPHIOGLOSSACEAE, the adder's-tongue family, consists of 3 genera and about 60 species of usually small herbaceous ferns found in both hemispheres, with simple or compound leaves arising from a short rootstock, and with yellow spores in sporangia borne in separate fertile spikes or panicles. Two of the genera are native to North America, *Botrychium,* moonwort or grape fern (11 of a total of 23 species are native to the U.S.) and *Ophioglossum,* the adder's-tongue (7 of the 28 species are considered native to the U.S.). (J. M. Bl.)

OPHIR, an unidentified region famous in Old Testament times for its fine gold. Solomon's Tyrian sailors brought its gold for that monarch. The geographical list of Genesis x associates it with Sheba and Havilah, the latter also being a recognized gold-bearing region (Gen. ii, 11). Solomon's ships set forth from Ezion-geber, at the head of the Gulf of Aqaba. Presumably then it lay somewhat to the south of Suez, but where?

(1) East Africa.—The extensive and imposing ruins discovered at Zimbabwe, in Mashonaland, about 200 mi. inland from Sofala, have been acclaimed as marking the site of long-lost Ophir. But careful investigation has resulted in depriving the ruins of any claim to great antiquity. Zanzibar has been suggested.

(2) The Far East.—The fact that three years were occupied in the voyage to Ophir (I Kings x, 22) as well as the nature of the cargoes (gold, silver, ivory, apes and peacocks) suggests a distant voyage, although attempts have been made to minimize these arguments. The Indus delta, Johore, Supara in Goa, Farther India, Malabar, Malacca and Sumatra have all been adduced.

(3) Abyssinia.—The territory on the Abyssinian coast from ancient Adulis to Bab-el-Mandeb, whose inhabitants call themselves Aphar.

(4) Arabia.—The most common and, indeed, the most plausible view is that Ophir was somewhere in Arabia. It has been sought in west Arabia at Asyr, between the Hejãz and Yemen; but the view that it is some district on the southern coast appears the most attractive.

The lack of sufficient data for identification has given and no doubt will continue to give scope for imagination. There have not been wanting wild and fanciful surmisings. Spain, Armenia, Phrygia and even Peru have had their advocates. (E. Ro.)

OPHITES. Strictly speaking, an obscure sect of Gnostics but more important the comprehensive name for a group of Gnostic sects which resemble one another, first, because no name of any personal founder or leading teacher is associated with any of them; and further, because they attach religious importance to the serpent. The type of mythology may be illustrated from the account of Irenaeus. It begins with a triad, the highest deity, described as "primal Man"; intellect or reason, his Son, the "second Man"; and the Spirit, introduced as a female principle. Through her the Christ is begotten as "third Man." Christ ascended, with the Spirit, but in their ascent a ray of light fell on the waters. This was Sophia (prudence or wisdom), and from this contact came Ialdabaoth the "demiurge." He in turn produced six powers and (from the dregs of matter) the serpent. Ialdabaoth then announced himself as the supreme Being; and when man (created by the six powers) gave thanks not to Ialdabaoth but to the primal Man, the former created a woman (Eve) to destroy him. Then Sophia sent the serpent (as benefactor) to persuade Adam and Eve to eat of the tree of knowledge and so break the commandment of Ialdabaoth, who banished them from paradise to earth. After a long war between mankind, aided by Sophia, and Ialdabaoth (this is the inner meaning of the Old Testament story) the Spirit sent the Christ to earth to enter the pure vessel, the virgin-born Jesus. Jesus Christ worked miracles and declared himself the Son of the primal Man. Ialdabaoth instigated the Jews to kill him, but only Jesus died on the cross, for Christ had departed from him. Christ then raised the spiritual body of Jesus, which remained on earth for 18 months, initiating a small circle of elect disciples.

This form of Ophitism is Christianized to a larger extent than others of the kindred sects, in most of which the Christian element is slighter and less essential. They are also far less impregnated with Greek philosophy than the "classic systems of Gnosticism"; and the early sources warrant the inference that the mythology itself is only a covering for observances (ritpal. initiation, secret passwords, incantations) characteristic of mystery religions.

The prevalent view is that Ophitism represents a primitive phase of Gnosticism, which was gradually developed and transformed into various great speculative systems by a series of historic teachers. (S. H. M.)

See also GNOSTICISM.

OPHIUCHUS, in astronomy, a constellation of the northern hemisphere, anciently named Aesculapius, and mentioned by Eudoxus (4th century B.C.) and Aratus (3rd century B.C.). According to the Greek fables it variously represents: Carnabon (or Charnabon), king of the Getae, killing one of the dragons of Triptolemus, or Heracles killing the serpent at the river Sangarius (or Sagaris) or the physician Asclepius (Aesculapius) to denote his skill in curing snakebites. Like Sagittarius (which it adjoins) it includes a region of the sky rich in globular clusters and diffuse nebulae. A very bright nova or new star was observed in Ophiuchus in 1604.

OPHIUROIDEA: see BRITTLE STAR.

OPHRYS, a genus of plants of the orchid family (*Orchidaceae*), comprising about 30 species native to Europe, western Asia and north Africa, including the bee orchis (*O. apifera*), the spider orchis (*O. aranifera*) and the fly orchis (*O. muscifera*), the second of which is one of the few orchids that are self-fertilized. See ORCHIDS.

OPHTHALMOLOGY (see EYE, HUMAN). The science of ophthalmology deals with the processes by means of which the images of external objects are brought to our consciousness. It is therefore concerned with:

(a) the eye itself; (b) the nerve paths and tracts which convey visual impulses originating in the eye through the different parts of the brain to the brain cortex, where these impulses are converted into conscious impressions; (c) the eyelids, which cover and protect the eyes; (d) the tear glands and ducts; (e) the muscles that bring about the movements of the eyes and keep them trained in the desired direction; (f) the nerves and their complicated cerebral connections which supply these muscles; (g) the bony walls of the orbit; (h) the blood vessels and lymph paths which maintain the nutrition of all these structures. It treats of disease in these parts and derives importance from the fact that many diseases of the central nervous system and many general diseases manifest themselves by some derangement of function or structure which can be detected by the ophthalmic surgeon.

The eye is unique in the body in that its retina, which is available to minute examination by means of the ophthalmoscope, is the only portion of the brain available to inspection during life. Similarly, the arteries and veins which supply the retina can also be minutely examined during life, the diseases of them observed and followed in all their changes. The value of these observations is enhanced by the fact that the eye itself acts as a low-power microscope providing a magnification of about 15 diameters for the examination of these structures. The eyes are subject to a number of hereditary diseases and form one of the most convenient media for the study of transmission of such diseases.

Affections of the Eye.—The function of the eyeball is to provide that a clear image of external objects shall be formed upon the retina, but in certain cases it departs from the normal and the acuity of sight is lowered. It may be too long, so that the retina lies behind the point at which the images of external objects are formed; this is myopia, or shortsightedness, and may be compensated by the wearing of concave lenses in the form of spectacles. In other cases the eyeball is too short and the retina lies in front of the point at which the image of external objects is formed. This is hypermetropia, or long-sightedness; it can be compensated by the focusing muscle of the eye, making the lens more convex, or, preferably, by the wearing of appropriate convex lenses in the form of spectacles. In astigmatism the refractive power of the eye varies in different axes so that, for instance, in an extreme case the vertical axis may be myopic while the horizontal axis is hypermetropic.

Normally the visual axes of the two eyes are parallel and images of external objects are formed upon corresponding points of each retina. This arrangement is largely responsible for stereoscopic vision, which enables us to judge the position of objects in space. Should it be upset, *e.g.*, by paralysis of some of the muscles, stereoscopic vision is lost and double vision usually arises.

Eyeball and Camera Compared.—The eyeball may be likened to a photographic camera. Roughly speaking it is globular in shape and is an inch long in all dimensions. The front part, or cornea, is curved, is perfectly transparent and functions as a lens. Behind it is a chamber filled by the aqueous humor—little more than water. Farther back is the iris—the coloured part of the eye. The hole in its centre forms the pupil, and by contraction or dilation of the tissues of the iris the pupil can be varied in size through a wide range; it may be compared to the stop in the camera. In bright lights the pupil is small, and it becomes large in dull illumination. The iris rests behind upon the lens.

The lens is biconvex. its back surface having the greater curvature. It is perfectly transparent, and the focusing of the eye for near or distant objects is brought about by alteration in its curvatures by contraction of the ciliary muscle. Here is an essential difference between the eye and the photographic camera, whose focus is adjusted by shifting the position of the lens. As age proceeds opacities frequently develop in the lens; almost everyone at the age of 60 or over may be said to have the beginnings of cataract, though the sight is quite unaffected thereby. When, however, these opacities involve the centre of the lens, and render sight very imperfect, the term cataract becomes applicable; the cataract can be removed by surgery and sight restored.

Vitreous Chamber and Retina.—Behind the lens is the vitreous chamber. which is occupied by a perfectly transparent, colourless substance much like the white of egg. Clothing the back of the eye, and extending forward some distance in front of its equator. is the retina. It rests upon a highly vascular membrane which is responsible for the nutrition of the greater part of it. namely, the choroid; in man. however: the retina has its own blood vessels clearly visible with the ophthalmoscope. The retina may be likened to the sensitive plate of the camera, for upon it images are formed which initiate impulses which. when conveyed to the cortex of the brain, give rise to the sensations of sight. Its sensitive layer is placed posteriorly and is composed of delicate structures known as the rods and cones.

At the central spot or yellow spot of the retina, the point of distinct vision; cones alone are present. The rods are believed to be concerned with lights of lower intensities and in accordance with this they alone are present in night-flying birds *(see* VISION or SIGHT).

Optic Nerves and the Cerebral Cortex.—The nerve fibres from the retina converge upon the optic disc and leave the eye as the optic nerve, which traverses the orbit to enter the skull. Inside the skull the two optic nerves meet and each is divided into two parts, one part continuing to the midbrain on the same side, the other part crossing over to the opposite side. This crossing forms the chiasma; in many animals, the birds for instance, the whole of each optic nerve crosses over in this way. Beyond the chiasma the nerve fibres are again collected into a compact bundle known as the optic tract, which terminates in the midbrain. From here nervous impulses are relayed in two chief directions; some connect up with the nerves which control the movements of the eyes and others, forming the so-called optic radiations, make a long sweep backward to reach the cerebral cortex. where. as already stated, the impulses are transformed to sensations of sight.

The exact area of the cerebral cortex, in which these fibres end, is known with great accuracy and forms the visual cortex. It is placed at the extreme hind end of the brain. and the adjoining mesial surface of each hemisphere, in the region of the calcarine fissure *(see* BRAIN). Should a minute portion of this cortex be cut out as the result of injury or blocking of its blood supply. the precise area of the defect which will be found in the vision can be stated with certainty. This accurate localization was much advanced as a result of observations during World War I.

General Diseases and the Eye.—Among the general diseases of the body in which important manifestations occur in connection with the eye a few may be mentioned.

In brain tumours or abscesses swelling of the optic disc is seldom absent and forms perhaps the most important sign in the diagnosis of the condition. In addition the ocular nerves may have their functions interrupted so that the movements of the eyes are interfered with. they no longer move in unison and double vision occurs. If nothing can be done for the brain tumour the optic nerve atrophies and blindness ensues. In advanced renal disease changes in the retina develop and convey a particularly grave prognosis! for patients seldom live as long as two years after their discovery. In diabetes a similar change may also arise which may greatly spoil the sight, and although of less serious import than in renal cases it must be considered a bad omen. Venereal disease frequently attacks the eye. whether in the early or late stages, and is perhaps the most prolific source of blindness. Tuberculous disease occasionally occurs. In diseases of the blood in general eye signs are very common, and there are many other diseases where the diagnosis may be greatly assisted by the discovery of changes in some part of the ocular apparatus.

The introduction of the "slit lamp" has made possible many investigations which previously were quite outside the scope of an ophthalmologist. (R. F. M.)

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OPIE, AMELIA (1769–1853), English author, daughter of James Alderson, a physician in Norwich, where she was born on Nov. 12, 1769. Miss Alderson had inherited radical principles and was an ardent admirer of Horne Tooke. She was intimate with the Kembles and with Mrs. Siddons, with Godwin and Mary Wollstonecraft. In 1798 she married John Opie, the painter. In 1801 she produced a novel entitled *Father and Daughter,* which showed genuine fancy and pathos. She published a volume of graceful verse in 1802; *Adeline Mowbray* followed in 1804, *Simple Tales* in 1806, *Temper* in 1812. *Tales of Real Life* in 1813, *Valentine's Eve* in 1816, *Tales of the Heart* in 1818 and *Madeline* in 1822. In 1825 she joined the Society of Friends. She died at Norwich on Dec. 2, 1853.

OPIE, JOHN (1761–1807), English portrait and historical painter, was born at St. Agnes, Cornwall, in May 1761, the son of a carpenter. He received instruction from John Wolcot ("Peter Pindar") in Truro from about 1775; and in 1781 Wolcot successfully launched him in London as a "Cornish Wonder," a self-taught genius. Opie attempted fashionable portrait painting but was most at ease with unsophisticated subjects, where his gifts for depicting rough textures in strong chiaroscuro could best be displayed, as in "A School" (1784; C. L. Lloyd collection) or the rugged portrait of "Lloyd Kenyon, 1st Baron Kenyon" (1789; Lord Kenyon collection). The works of Rembrandt, M. da Caravaggio and Velázquez were strong formative elements in his art. His first exhibited historical work was the "Assassination of James I of Scotland," followed by "The Murder of Rizzio," which secured his election, in 1786, as associate of the Royal Academy. In that year, also, he was commissioned to paint seven illustrations for John Boydell's "Shakespeare Gallery," becoming a full academician the following year. Just before his death in London on April 9, 1807, Opie delivered four lectures on painting to the academy students which were remarkable for their lucid exposition. The lectures were published in 1809. with a memoir by his wife Amelia. Ten works are in the Tate gallery, London. Opie also wrote a *Life of Reynolds,* in Wolcot's edition of Pilkington, and a *Letter on the Cultization of the Fine Arts in England,* in which he advocated the formation of a British national gallery.

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OPITZ VON BOBERFELD, MARTIN (1597–1639), German poet and literary theorist nho introduced Renaissance poetic theories into Germany, nas born at Bunzlau, Silesia, on Dec. 23, 1597, and studied at Frankfurt an der Oder, Heidelberg and Leyden. where he met Daniel Heinsius He led a wandering life in the service of various territorial nobles. In 1625, as a reward for a requiem poem on the death of Archduke Charles of Austria he was cronned laureate by the emperor Ferdinand II, who later ennobled him. In 1629 he was elected to the Fruchtbringende Gesellschaft. the most important of the literary societies which aimed to reform the German language. In 1630 he went to Paris. nhere he made the acquaintance of Hugo Grotius. He settled in 1635 at Danzig, where Ladislaus IV of Poland made him his historiographer and secretary. There he died of plague on Aug. 20, 1639.

Opitz was the head of the so-called First Silesian school of poets and during his life was regarded as the greatest German poet. He was the "father of German poetry," at least in respect of its form. His Aristarchus sive de Contemptu Linguae Teutonicae (1617) defended his native tongue. His influential Buch von der *deutschen* Poeterey, written in 1624 and based on the work of Joseph Scaliger, Pierre Ronsard and Daniel Heinsius, established rules for the "purity" of language, style, verse and rhyme. It insisted upon word stress rather than syllable counting as the basis of German verse and recommended the alexandrine. The scholarly, stilted and courtly style introduced by Opitz dominated German poetry until the middle of the 18th century. Opitz' poems follow his own rigorous rules. They are mostly didactic and descriptive—formal elaborations of carefully considered themes—containing little beauty and less feeling. His Trostgedichte in Widerwartigkeiten des Krieges (1633) praised Christian stoicism. He translated from Heinsius, Grotius. Seneca and Sophocles; partly translated from the text by O. Rinuccini the libretto of Dafne, the first opera in German; introduced the political novel (John Barclay's Argenis) into Germany; and edited (1638) the German version of Sir Philip Sidney's Arcadia, and the 11th-century Annolicd.

Opitz's Opera *Poetica* appeared in 1646. His *Ausgewählte Dichtungen* were edited by J. Tittmann (1869) and by H. Oesterley, in J. Kiirschner's *Deutsche Nationalliteratur*, vol. 27 (1889). There are modern reprints of the *Buch* von der deutschen Poeterey by W. Braune. 6th ed. (1954), and, together with Aristarchus, by G. Witkowski (1888).

Opitz's Teutsche Poemata (1621) were also edited by G. Witkowski (1902).

See F. Gundolf, *M. Opitz* (1923); ***J. B.*** Birrer, ***Die Beurteilung*** von ***Martin Opitz in der*** *deutschen* ***Literaturgeschichte*** **(1940). (A.** Gs.)

OPIUM. The drug known as opium is obtained from the immature fruits of the opium poppy, *Papaver somniferum* (fig. 1), family Papaveraceae. by slightly incising the fruits and collecting and partially or completely drying the exuded juice. The juice is white and liquid at first. but it coagulates and turns brown on exposure to the air, and some types of opium are virtually black. The raw opium is made into lumps, cakes. bricks, etc., which when fairly fresh are generally soft inside. similar in consistency to fresh putty. The chief active principle of opium is the alkaloid morphine (see ALKALOIDS).

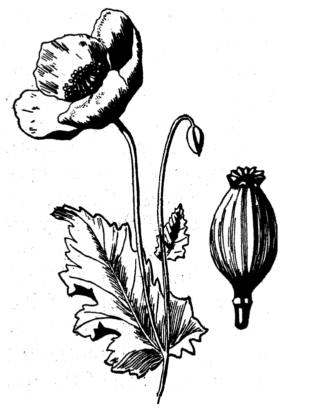

FIG. 1.—OPIUM POPPY (PAPAVER SOMNIFERUM)

Uses.—Demands for opium may be (1) for medical (and scientific) uses, partly of opium as such. but chiefly of purified alkaloids extracted from it and their derivatives: (2) for opium eating (and drinking of infusions). from "quasi-medical" to illicit: (3) for opium smoking: and (4) for the manufacture of illicit morphine and heroin for drug addicts (see DRUG ADDICTION)

Possible Sources.—In general. poppies have a milky juice. and produce various alkaloids. but only P. somniferum, the "sleep-bearing" poppy. and its close relative P. *setigerum* are known to produce morphine. The former species is almost wholly a cultivated plant, and any specimens found growing wild are likely to be merely escapes from cultivation. P. *setigerum* is an unimportant wild plant of the Mediterranean region; it was formerly considered by many botanists to be a mere variety of P. *somniferum* and the ancestral or "truly wild form." It has, however. twice the chromosome count of P. *somniferum* and probably should be considered as a distinct species, though similar to the semiwild forms of P. *somniferum*. These two poppies are the only ones thus far found with haploid chromosome numbers of 11 or a multiple. P. *setigerum* is not the source of any opium of commerce: either licit or illicit. In the 19th century, morphine was occasionally reported in a few other members of the poppy family, and in hops. but none of these reports bears examination. The oriental poppy, P. *orientale,* a perennial native to the Caucasus (see POPPY), is not an opium poppy and does not produce morphine.

The Plant.—Although extremely variable, and cultivated in different, distinct types. the opium poppy plant can generally be recognized easily, especially by its foliage. Most varieties are tall, when well grown about three to four feet in height. and the flowers are large, four to five inches across. The foliage is smooth and of a characteristic whitish dull green colour. called "glaucous." There is a main stalk, ending in the largest flower and largest capsule, and (unless the plant is quite small) side branches end in smaller blooms and capsules. The plant is an annual. It can be identified chemically, for morphine is present even in tiny seedlings. The seeds, however, do not contain morphine, and are virtually alkaloid free.

Reasons for. *Cultivating* the Plant.—The opium poppy—in Europe also called the garden poppy or oil poppy—is grown over a large part of the world, in some regions primarily for opium and in others for its edible and oil-containing seeds (see POPPY OIL). Since the 1930s some countries in the latter group, particularly Hungary, have utilized the chaff left after obtaining the seeds, consisting primarily of the dried, mature capsules, for the direct extraction of morphine from the plant material. Conversely, the seeds can be collected from capsules incised for opium. Rarely, the poppy may be grown primarily for its capsules, which have a limited use in pharmacy. The capsules. dried and gilded. are also used as decorations. P. somniferum is also often grown merely for its flowers, largest of any annual poppy. In the United States the cultivation of the opium poppy was prohibited: except under licence, by the Opium Poppy Control act of 1942 and seedsmen ceased to offer it, even for floral purposes.

Varieties of the Plant.—Floral forms may be either single or double, and the petals may be either plain or fringed. The flowers may be white, pink, red, purple, lavender or violet, generally with a white or violet spot at the base of each petal. The utilitarian varieties have large single flowers, possibly the commonest kind being white with large dark violet spots at the base of each petal. There seems to be an unfounded idea in many parts of the world (not in the actual opium-producing districts) that the variety with pure white flowers and white seeds is the "true" opium poppy. In descriptions of varieties cultivated for opium or for seeds. stress is often laid on the colour of the flowers, but this has no bearing on the quality or quantity of either the opium or the seeds. and little, if any, even on the colour of the seeds. The latter characteristic has also been stressed in descriptions of varieties and even supposed species (*Papaver album* and P. *nigrum*), but there is no evidence that it has any relation to any morphological or useful characteristics. The seeds may be white, yellow, pink, blue, gray, brown or black.

The capsules of the semiwild and floral forms are relatively small, and are dehiscent (opening pores to scatter their seeds at maturity) (see POPPY). The cultivated varieties most highly developed for utilitarian purposes have large capsules. which may be the size of a hen's egg or bigger, and are largely indehiscent; in some cases, however, dehiscent varieties are cultivated for opium.

There are agronomic and ecological varieties, and geographical races or even subspecies. There are chemical varieties, differing in the proportions of the various alkaloids produced. The principal opium-producing countries each have their own varieties, adapted to the local soil and climate over hundreds of years. The different varieties of the plant account for many differences in the opium produced; there are also differences due to methods of collection and handling of the opium. However, the differences between varieties of *Papaver* somniferum should not be exaggerated. The European "garden poppy," despite its culture for centuries without collection of opium, is capable of yielding opium with 10% or more of morphine, just like the poppies which have long been cultivated primarily for their opium.

Historical Spread of the Plant.—The original home of the wild opium poppy is believed to have been the region around the eastern Mediterranean. It was probably first domesticated for its seeds. though some knowledge by the herb women of the properties of "poppy tea" may be equally old. The culture for seeds spread westward through central Europe. probably in the Neolithic Age, and still exists there today.

The garden poppy was well known to the ancient Greeks. Homer in the *Odyssey* described the use of an infusion of a drug as a beverage of hospitality: this sort of use of opium has been known in India down to modern times. Dioscorides in the 1st century A.D. described exactly modern opium. Knowledge of the drug was also ancient in Mesopotamia; Assyrian herb lists and medical texts, as translated from cuneiform, refer to the opium poppy plant and to opium, the latter known as "lion fat," among other names.

From these lands. the culture of the poppy for opium spread slowly eastward. Apparently it was unknown in ancient times in either India or China; the widespread cultivation in those countries in modern times is a comparatively recent development. Some knowledge of the opium poppy first reached China about the 7th century A.D., while Japan probably did not begin its cultivation until the 15th century. Opium smoking, the vice of the far east. in any case did not even begin until well after the discovery of America. for previously there was no custom of smoking anything in the old world. It first became a terrible problem in China about the middle of the 17th century. Between World Wars I and II the illicit cultivation of the poppy for opium crossed the Pacific and became established in the mountains of western Mexico. Later, it was begun to some extent in Peru and Ecuador.

Cultivation for Opium.—Although the cultivators who produce opium may also use some of it, the chief reason for producing it is to exchange it for money, whether in the licit or illicit market. For an agricultural product it has high value in proportion to bulk and weight, and offers no considerable problems of storage or transport. Thus opium is a good cash crop. especially for undeveloped regions, which are often mountainous. where there are few or no roads and where farming may be mainly for subsistence. It can be profitable licitly in some fairly well-developed regions with a peasant economy.

The poppy is not a plant of the tropics (as is often supposed); but it is grown for opium in suitable districts from the subtropics to as far north as Manchuria. The climate should be dry at the time the opium is to be harvested. Much labour is required at this time; frequently the poppy is grown in small plots and such labour is supplied by the peasant's family. On a larger scale, rotation of crops is often used. and the poppy is grown in a given field only one year in three; this was the practice in Iran. The plant grows best in a rich soil, but may, nevertheless, in many cases be a profitable crop for a poor soil.

The seeds are frequently sown in the autumn, and the opium harvested the following summer. They may also be sown in the spring, the harvest being only a little later. The capsules are ready for incision generally from 9 to 1j days after the petals fall (*see* fig. 2). In Turkey and the Balkans the capsules are generally incised only once; in most other countries they are normally incised several times, as long as they will continue to yield juice. The morphine content of the opium falls with repeated lancings. The average yield of opium is about 9 kg. per hectare in Turkey; it was nearly 19 kg. per hectare in India, 1937–45.

Countries Cultivating the Poppy **for** Opium.—The cultivation for opium, both licit and illicit, is chiefly in Asia. Production is negligible in Africa, and in Europe apart from the Balkans (Yugoslavia. Bulgaria and Greece). Turkey, Iran and India were the chief producers for export after World War II, but Iran prohibited production in 1946. Pakistan has been developing some production to meet its onn needs. Afghanistan sought recognition by the United Nations as an opium-exporting country in the mid-1950s. The U.S.S.R. produces opium in the Kirgiz and Kazakh republics in the region near Lake Balkhash. Production was permitted in the Shan states of Burma and in northern Vietnam and Laos It was made illicit in China. but there was enormous production in Tunnan, the middle western provinces and Manchuria. Formerly licit in Korea under Japanese rule. it was later declared illicit there. Japan prohibited cultivation under the occupation after World War II. but revived it to meet its onn medical needs. There was some illicit production in Mexico, Peru and Ecuador in the latter 1950s; othernise there was only negligible experimental production in the Americas. (C. C. F.)

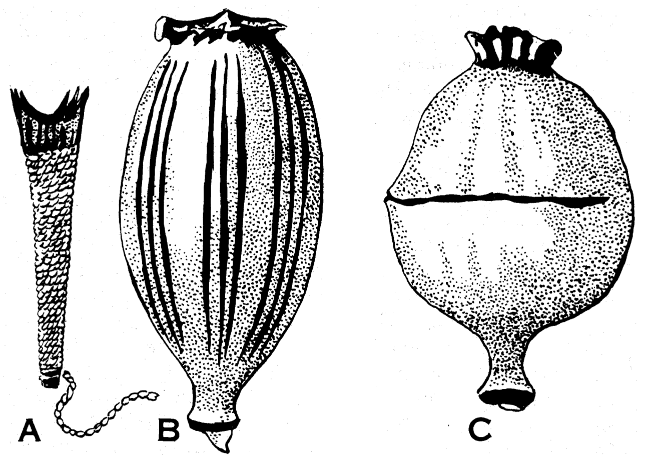

FIG. 2.— OPIUM POPPY CAPSULES. SHOWING (A) NUSHTUR. OR INSTRUMENT USED IN INDIA FOR MAKING THE INCISIONS. DRAWN FROM SPECIMENS IN THE MUSEUM OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN: (B) CAPSULE AS INCISED IN INDIA: (C) MODE OF INCISION PRACTISED IN TURKEY

Medicine.—The alkaloids of opium are of two types in chemical structure and action. Members of one group are analgesic, narcotic and potentially addicting, morphine and codeine (qq *v.*) principally, though these tno differ markedly in all three respects. Members of the other group are not analgesic, narcotic or addicting, papaverine (*q.v.*) and noscapine (formerly called narcotine) principally. Morphine has long been the standard and the physician's mainstay for the relief of severe pain. By the late 1950s the work of synthetic organic chemists had made powerful substitutes available. Codeine is effective for mild pain and relieves cough. Papaverine is used in circulatory diseases and noscapine has been shown to be as effective as codeine in the relief of cough but is free of narcotic properties and is nonaddicting.

So complex a drug as opium is necessarily incompatible with many substances. Tannic acid precipitates codeine as a tannate; salts of many of the heavy metals form precipitates of meconates and sulfates; and the various alkalis. alkaline carbonates and ammonia precipitate the alkaloids (*see* ALKALOIDS).

The effect of opium and its preparations, including the mixtures of all its alkaloids marketed under various names. Pantopon, Omnopon. etc.. is essentially that of its principal ingredient, morphine; the presence of the other constituents does little to modify the effect of morphine, either to exaggerate its desirable or to offset its undesirable properties. If one takes body weight into account the effect of morphine is not greatly different in children and adults. However, partly at least because of their sensitivity to convulsant agents, opium should never be given to infants under one year of age. since it contains thebaine, a potentially convulsant alkaloid. Opium, as well as morphine, taken by mouth is less reliable and less effective as a pain reliever, but is especially valuable as an antidiarrheic. It may upset digestion or it may relieve vomiting, differing with the individual and with the dose.

Toxicology.—Under this heading must be considered acute poisoning by opium and the chronic intoxication seen in those who eat or smoke the drug.

Chronic Intoxication.—The chronic taking of laudanum, tincture of opium—as in the famous 19th-century case of Thomas De Quincey (*q.v.*)—was later almost entirely supplanted by the use of the hypodermic syringe; but opium smoking continues to be a major problem in some parts of the world (see below).

Acute Poisoning.—Acute opium (or morphine) poisoning presents symptoms that may be confused with those produced by alcohol, cerebral hemorrhage, an overdose of sleeping pills and other morbid conditions. The differential diagnosis is important. It has been facilitated and recovery has been speeded by the discovery of the morphine antagonists. The patient who has swallowed a toxic or lethal dose of opium. of laudanum for instance, usually passes rapidly into the narcotic state without any prior excitement. Drowsiness yields to sleep and coma which ends in death from failure of respiration. The comatose patient has a cold and clammy skin, livid lips and ear tips and "pinpoint" pupils. The heart's action may be feeble, the pulse small, irregular and slow. Except for the slowness of the pulse the action on the circulation is largely secondary, however, to the all-important action of opium (morphine) on the respiratory centre in the medulla oblongata (the prolongation of the spinal cord into the brain). The centre is directly affected by the circulation through it of morphine-containing blood and the patient's breathing becomes progressively slower, shallower and more irregular until it ceases altogether.

Treatment.—If the opium was taken by mouth, it is important to rid the patient of any unabsorbed drug by emptying the stomach. Apomorphine (*q.v.*), ordinarily a powerful emetic, is inadvisable because it may fail to break through existing depression of the vomiting centre. and its depressant effect may add to that of the opium. It is better to wash out the stomach with plain warm water followed by a solution containing about ten grains of salt to the ounce of water or with a weak solution of potassium permanganate, if available, which may decompose morphine by oxidation. The essential of treatment is restoration of normal breathing and for this specific morphine antagonists, nalorphine and levallorphan, are available. Either of these given by injection. intravenously if the situation is urgent, promptly restores normal breathing though the patient may not awake immediately. Morphine is longer acting and the respiration may slow again, requiring a repetition of the antagonist. Nalorphine and levallorphan are effective against respiratory depression due to morphine and related substances only, so that if their use is not promptly beneficial the case is probably not one of poisoning by this class of substances. If the specific antagonists are not at hand one must, of course, resort to other means to stimulate the respiration. Hot strong coffee by mouth or rectum or caffeine by injection may help; mechanical stimulation by flicking with a towel, or other means of stimulating the skin, getting the patient on his feet, making him walk, and repeated application of smelling salts may be of some benefit. Artificial respiration should be used if necessary and persisted in as long as the heart continues to beat. The patient should be kept warm and if he can be kept awake the danger will pass. (See also POISON: Systemic Poisons.)

(N. B. E.)

Opium Eating.—This is mostly practised in Iran and India, and in the latter country on a larger scale than elsewhere. Studies by Sir R. N. Chopra show that in India little opium is used by the practitioners of indigenous and western medicine. It is. however, used extensively as a household remedy to relieve pain, especially in gastric and respiratory ailments. Though less common now than formerly, it is still the practice to give opium to infants to keep them quiet. Opium is usually taken in the form of a pill or as a solution in water. Because of restrictions on production and sale and an increase in price, its use greatly decreased after the early years of the 20th century. Indian addicts can be divided into three groups: (1) about 50% take it for relief from ailments; (2) 20% to 30% take it to obtain escape from difficulty or worry; (3) 15% to 20% take it simply for pleasure. The dose taken by the first two groups is always small and not rapidly progressive, but in the third group it is large and ever increasing. In a series of 1,000 cases, the average daily dose was found to be about ten grains. Habitual use of opium produces physical, mental and moral deterioration, proportional to the dose taken. Those taking small doses such as one to three grains daily show no apparent signs of the dulling of physical and mental faculties or the chronic toxemia that are marked effects of larger doses.

Opium Smoking.—This is indulged in on a large scale in China. Indonesia and India. It is the outcome of tobacco smoking and presents a serious problem. In India the habit was held in contempt, and stringent regulations were enacted against it. By 1950, therefore, opium smoking was dying out in India, except in Assam and Madhya Pradesh. where social and economic factors were responsible for its continuance. In Chopra's series of 300 cases. it was found that the habit had been contracted in 50% of the cases by association with other smokers purely for its pleasurable effects, in 33% for relief of ailments and in 17% to overcome worry and strain. Much larger quantities of opium were used for smoking than for eating, and the effect on the general health of even moderate smokers was much more marked. The dose ranged from 2 to 180 gr. a day, the average being 25 gr. The abstinence symptoms were also more severe. The racial factor was significant; although the average daily doses taken by a Chinese were two to three times larger than those of an Indian, the ill effects in the former were much less marked. In the case of the Indians, excessive indulgence seriously damaged health, caused loss of physical energy and deterioration of intellect and so reduced earning capacity and shortened life.

Opium is prepared for smoking by prolonged boiling with water and removing impurities in the form of scum, by evaporating and, lastly, by a process of toasting. The preparations used in India are: (1) chandoo, which is opium prepared as above and which is also the form smoked in China; (2) madak, which is purified opium diluted with charred leaves of Acacia arabica (babal): (3) opium dross, which is the residue left in the pipe after smoking and contains more than 7% of morphine and is smoked again. The smoker does not absorb more than one-tenth of the total amount of morphine contained in opium; there must, therefore, be other unrecognized factors responsible for the intense effects produced.

The method of smoking opium followed by the Chinese and Indian smokers is similar. The apparatus consists of a pipe, a stylet, a lamp and a headrest. The dose of prepared opium is heated over the flame at the end of the stylet until a small ball of roasted opium is formed. This is then pushed into the pipe head and the pipe is ready for smoking. The opium mass is held over a flame or live charcoal. while the smoker inhales deeply a number of times, taking the smoke well into the lungs. The actual smoking of the pipe takes about a minute; more prepared opium is taken if the smoker desires to continue. The effects produced are immediate since the lungs present a large surface for absorption.

(R. N. C.; X.)

Opium Traffic.—Organized use of the poppy and the coca leaf for the purposes of commerce and revenue seems to have developed after 1700, in spite of protests against its use for other than medical and scientific purposes. The importation of opium into China by foreign traders led to the war of 1839-42 between Great Britain and China. The Chinese, in spite of the fact that they were not the victors and despite any pressure brought to bear upon them, still refused to legalize the opium trade. China was now open to the world and a huge smuggling trade in opium sprang up which gave rise to endless difficulties, both to the Chinese and to the British government.

The second war broke out between China and Great Britain, with France as its ally, 15 years later, and, after its close, not only was the cultivation of opium in China itself permitted, but the import of opium from India was also legalized. Yet the Chinese government still continued to regard the use of opium as an important moral and economic question, and in 1906 it decided to put an end to the use of the drug within ten years. For this reason, in the following year, China entered into what is known as the "Ten Years' Agreement with India," by which China should cease the cultivation of the poppy and forbid the consumption of opium on the understanding that the export of Indian opium to China should be reduced in equal proportion and cease altogether in ten years. At first this undertaking was carried out faithfully by both parties concerned, and according to a statement made by Sir John Jordan at one of the meetings of the opium advisory committee, China in 1917 had almost freed itself from the curse of the poppy. Political troubles, however, broke out, effective government in China was suspended, and the production of opium in China became not only a great national but also an international problem.

International Action.—It was first realized in 1906 that if the Chinese government were to suppress the opium evil, it must be assisted by other nations. In 1909 Pres. Theodore Roosevelt proposed that an international investigation be made. As a result, an international opium commission met that year at Shanghai, at which 13 powers were represented.

The recommendations made at this meeting formed the basis of the first opium convention: which was drawn up at The Hague in 1912. The articles of this convention may be summarized as follows:

1. The distribution of raw opium to be controlled and the use of prepared opium to be gradually suppressed.

2. The export of raw opium to countries prohibiting its entry to be stopped and its export to countries restricting its import to be controlled.

3. The export and import of prepared opium to be prohibited except to those countries not yet ready to suppress its use.

4. The use of alkaloids of opium and its derivatives to be confined to medical and legitimate purposes; a government licence to be obtained by all persons engaged in the manufacture, sale, distribution, import and export of the drugs.

5. The last chapter of the convention consisted of clauses dealing with assistance to China and with certain obligations undertaken by China itself.

6. Before the convention came into effect, the adherence of the 34 nonsignatory powers in Europe and America was required.

International opium conferences were held at The Hague in July 1913 and June 1914, at which a number of powers ratified the convention. During World War I all action in this connection was suspended until the Paris peace conference in 1919. In the peace treaties of 1919–20, the signatory powers agreed that the ratification of these treaties should constitute a ratification of the convention of 1912 and the protocol adopted by the third opium conference of 1914 (according to which the convention should come into effect upon its ratification regardless of the nonsignatory powers).

The Advisory Committee and the *League* of Nations.—Under the covenant (art. 23c), the duty of supervising the execution of agreements with regard to the traffic in opium and other dangerous drugs devolved upon the League of Nations. In order to carry out this obligation, the first assembly of the League constituted an advisdry committee on opium and other dangerous drugs. The commiftee, which sat once a year except in special circumstances, obtained certain important and definite results, such as additional ratifications to The Hague convention and the adoption by a large number of countries of an important certificate system. Under this system no government could allow the export from its territories of any dangerous drugs covered by The Hague convention, except on the production by the exporter of a licence from the importing country, certifying that the drugs in question were required for legitimate purposes.

The council, on the recommendation of the advisory committee, invited the governments and members of the League to prepare an estimate of total annual requirements for the inhabitants of their territories for medical, scientific and other uses, with a view to proposing at some future date to the states concerned a new distribution of production which would limit the total output of raw material to the amount required for legitimate medical and scientific purposes. Subsequently two conferences met during the latter part of 1924 and the early months of 1925.

The 1924 conference did not find it possible to recommend the immediate complete suppression of the use of prepared opium, but drew up an agreement that embodied the substitution of government monopoly for other systems in force. It was held by the majority of members of the conference that no rationing could be enforced or total suppression imposed as long as a large illicit supply of opium remained uncontrolled. To this the representative of China objected, protesting against the refusal of the majority to take immediate steps to suppress opium smoking until producing countries should find it possible to control smuggling. The conference, in a protocol to the agreement. decided to take any necessary measures not already taken for the entire suppression within a period of 15 years of the consumption of prepared opium in the territories under their authority, this period to begin as soon as the effective execution of the measures required to prevent illicit exportation of raw opium from their territories had been undertaken by the poppy-growing countries. Provision under the agreement was made for a League commission to decide when these measures had been effectively executed. The agreements reached took the form of an agreement, a protocol and a final act. Instruments of ratification were deposited by all states represented at the conference, other than China and Japan. The agreement was, therefore, put into effect.

The Convention of *1925*.—The result of the deliberations and discussions of the conference of 1925 was a convention providing for the more effective restriction of the production and manufacture of narcotics, and establishing stricter control and supervision of the international trade.

Among the suggestions made in the convention was the creation of a central board. whose task it would be to follow the course of international trade and the general acceptation of the export and import certificate system. The conference also drew up a protocol by which the signatory states, recognizing their obligations to establish such control over the production, distribution and exportation of raw opium as would put a stop to illicit traffic, agreed to take within five years of the date of the coming into force of the protocol such measures as might be required to prevent the smuggling of opium seriously interfering with the effective suppression of the use of prepared opium in those territories where such use was temporarily authorized. A final act. containing further recommendations, was drawn up.

The *Convention* of 1931.—The international convention of 1931 for limiting the manufacture and regulating the distribution of narcotic drugs introduced the obligatory estimate system to carry out the principle of limiting the manufacture and trade of narcotic drugs to medical and scientific needs. Each country is required to furnish, annually, advance estimates of the narcotic drugs needed for these purposes. These estimates are binding and determine the maximum amounts to be manufactured or imported in any given year. They are examined by the supervisory body, which is composed of four experts who are not government representatives.

Limitation of *Manufacture*.—Actions to limit manufacture of narcotic drugs and control international distribution were taken through six international conventions and agreements concluded between 1912 and 1936, supplemented by two international protocols concluded under the auspices of the Cnited Nations in 1946 and 1948 respectively. Seventy-one sovereign countries being parties to one or more of these treaties. their application became universal, as is the problem which is the subject of this international legislation.

United Nations Commission on *Narcotic* Drugs.—The United Nations took over from the League of Nations, and the governments signatory to the treaties, by the protocol of 1946, vested in the appropriate agencies of the United Nations the powers formerly held by the League agencies. The council no longer existed; the UN Economic and Social council was given its powers and duties; the UN general assembly took over powers and duties from the assembly of the League. The Opium Advisory committee became the Commission on Narcotic Drugs, appointed by the Economic and Social council, and other modifications in form were made to correspond with the new situation.

At the sixth session of the UN Commission on Narcotic Drugs, held in New York city in 1950, an agreement was reached on principles for the limitation of production of opium to medical and scientific needs. The producing countries, Turkey. Iran, Yugoslavia and India, agreed with the drug manufacturing and consuming countries to limit areas of production and stocks in accordance with estimates to be supplied by each country to an international body. (R.E. C.; H.J.A.; X.)

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OPON, a municipality (with administrative centre and 23 barrios or districts), on the small island of Mactan (area about 45 sq mi), province of Cebu. Republic of the Philippines The island of Mactan, where Magellan was slain by the natives in March 1521, is separated from Cebu by a channel only about one mile wide. Pop. (1960) 48.662. Opon is a shipping and commercial suburb of the municipality of Cebu. the harbour of which is sheltered by Mactan Island. Its extensive groves of coconut trees afford supplies of copra, while maize (corn) and maguey are cultivated and fisheries are important The vernacular is Cebuano, a dialect of Bisayan. Of the inhabitants aged 6 to 19 inclusive 21.9% in 1939 attended school. while 35.1% of the population 10 years old and over was literate.

OPOPANAX. A gum resin obtained from the root of *Opopanax chironium,* formerly used as an antispasmodic medicine. The perfume known as opopanax is distilled from a *Commiphora.*

OPORTO, the second city of Portugal, capital of the Porto district and seat of a bishop, lies on the Douro river in the most densely populated area of the country, 175 mi. N.N.E of Lisbon. World famous for its port wine, Oporto is the commercial and industrial centre for the zone north of the Mondego river. Pop. (1960) 310.474; (1950) 284,842.

The approach to Oporto up the winding and fjordlike Douro is of great beauty. The city lies chiefly on the north or right bank. the streets rising steeply from the riverside; in many cases the houses, looking more oriental than European. are built in granite overlaid with plaster. so that white is the prevailing colour of the city The older districts of the tonn in the east are extremely picturesque where the steep narrow lanes are overhung by lofty balconied houses. On the south bank are the hamlets of Gaia and Afurada. and the red-tiled wine lodges of Vila Nova de Gaia where vast quantities of port are blended and stored.

The Douro is spanned by three bridges The Dom Luis I bridge (j60 ft). built in 1881–85, has one of the largest arches in Europe, its high and low carriageways serving different levels of the town on the north and Gaia on the south. The Maria Pia bridge (1876–77), which rests on a granite substructure. carries the Lisbon railway line across the high ravine at a height of 200 ft The arch of the new Arrábida bridge at the time of construction in the late 1950s was the largest in Europe.

The density of the population of Oporto is greater than in any other city of Portugal, and overcrowding is common. A number of housing projects have improved conditions, and the town's program. when completed, will house 50,000 people. In the late 1950s extensive residential quarters were being built by the approaches of the new bridge at Arrábida. The principal suburbs are Bonfim to the east, Monte Pedral and Paranhos to the north, Vilar. Lordelo and Sio Joio da Foz to the west and Ramalde, Vilarinho. Matozinhos, Leqa da Palmeira and the port of Leixões to the northwest.

The surroundings of Oporto are full of interest and charm and the town is a good tourists' centre; in addition to the seaside resort of Fozdo-Douro, within the city limits. there are the beaches of Leqa and Boa Hora to the north and those of bliramar, Granja and Espinho to the south, the last, with its casino, swimming pools and large hotels, being especially popular.

One of the busiest streets in Oporto is the Rua Nova dos Ingleses where many of the banks, warehouses and steamship offices are situated. The English club, formerly an English factory (built 1790), which gave this street its name, serves the large British community whose members are chiefly connected with the wine and shipping trades. The Rua da Alfândega skirts the right bank of the Douro and passes the customhouse, and there may be seen fishermen and peasants from northern Portugal. On the eastern side of the colourful Rua das Flores are the shops of the cloth dealers, while opposite are the jewelers' shops with their remarkable display of gold and silver filigree work and enameled gold, the ornaments worn by the women on feast days.

Most of Oporto's many interesting buildings are churches. The cathedral, which stands at the highest point of eastern Oporto, on the site of the Visigothic citadel, nas originally a Romanesque building of the 12th century; its Gothic cloisters are of the 14th century, but the greater part of the fabric was modernized in the 17th and 18th centuries. The interior of the cloisters is adorned with blue and white tiles, painted to represent scenes from the Song of Solomon. The Romanesque and early Gothic church of Sio Martinho de Cedo Feita is the most interesting ecclesiastical building in Oporto, its pillars having curiously carved capitals. Though the present structure is not older, except in details, than the 12th century, the church is said to have been "hastily built" (*cedo* feita, *cito facta*) by Theodomir, king of the Visigoths, in 559, to receive the relics of St. Martin of Tours, nhich were then on their way there from France. The Torre dos Clérigos, a granite tower 246 ft. high, built in the middle of the 18th century at the expense of the local clergy (*clérigos*), stands on a hill and forms a conspicuous landmark for sailors. São Francisco is a Gothic basilica dating from 1410; and Nossa Senhora da Serra do Pilar is a secularized Augustinian convent used as artillery barracks, and marks the spot at which Wellington forced the passage of the Douro in 1809.

Of Oporto's public buildings some. such as the museum, library and opera house, are of historic interest. The crystal palace, a large glass and iron structure, nas built for the industrial exhibition of 1865. The Palácio da Bolsa (exchange) was built in classic style in 1891: its main hall is a pastiche of the palace of the Alhambra. Other imposing public buildings have been completed in the 1950s and include the new county hall at the top of the main avenue. the university hospital. the sports arena and the football stadium; at that time. too, wide modern roads such as Marginal avenue were completed or in process of construction.

Transport and Communications.— Oporto is nell served for transport. Three main railway lines meet there, from Valença do Minho on the northern frontier. from Barca de Alva on the northwestern frontier and from Pampilhosa where the connection nith the Sud-Express and other international trains is made. Express trains connect nith the capital a journey of just over four hours. The airport, at Pedras Rubras, is growing in importance. In addition to daily Lisbon services, it is used by a number of foreign aircraft, mainly carrying tourists. It is possible to fly from London and Paris to Oporto via Lisbon. Queen Elizabeth II of England at the end of her visit to Portugal in 1957 left Portugal from this airport

Trade and Industries.— Oporto is chiefly famous for the export of the wine which bears its name. An act passed on Jan. 29, 1906, defined "port" as a wine grown in the Douro district and exported from Oporto, and nith an alcoholic strength of more than 16.5%. The grapes from nhich it is made grow in the Paiz do Vinho, a hilly region 27 mi. long and 6 mi. broad about 60 mi. up the river The trade was established in 1678, but the shipments for several years did not exceed 600 pipes (of 115 gal. each). In 1703 the British government concluded the Methuen treaty with Portugal, under nhich Portuguese wines were admitted on easier terms than wines from France and Germany, and from that date "port" was drunk in England (see PORT WINE). In 1747, 17,000 pipes were exported. In 1754 the great wine monopoly company of Oporto was set up. and shipments rose to 33,000 pipes. At the beginning of the 19th century the policy of the government more and more favoured the port nine trade, besides which the vintages from 1802 to 1815 were splendid both in Portugal and in Madeira —that of 1815 has, in fact, never been excelled. For the next few years the grape crop was not at all good, but the 1820 vintage was the most remarkable of any. It was singularly sweet and black. besides being equal in quality to that of 1815. In 1852 the *Oïdium* which spread over Europe destroyed many of the Portuguese vineyards and in 1865 *Phylloxera* did much damage; from 1867, when the second monopoly company was abolished, exports again increased. Some more recent good vintages were 1908, 1927, 1934, 1935, 1947, 1938. 1955. The port wine is brought down from the "Quintas" to the lodges at Vila Nova de Gaia by train or by the typical "barcos Rabello." flatbottom barges with huge rudders, which are able to navigate the fast rapids of the Douro.

About a third of the population is engaged in the manufacture of cottons. woolens. leather: silk, gloves, hats, shoes, pottery, corks. tobacco, slates. spirits, beer. aerated waters (carbonated beverages), preserved foods: soap and jewelry. Among industrial products are tires, tire cloths (casings) and inner tubes, electric apparatus and appliances. piston rings, motor bicycles and chemical products. The fisheries are important. catches being chiefly of hake. bream and sardines. The town of Matosinhos nearby is a fish-canning centre. Between Oporto and Matosinhos, on the Atlantic coast, is the artificial port of Leixões. with its huge sea walls, the harbour consisting of two basins which provide anchorage and unloading facilities for big ships.

History. — The history of Oporto dates from an early period. Before the Roman invasion. under the name of Portus Cale, it was a town on the south bank of the Douro with a good trade; the Alani subsequently founded a city on the north bank, calling it Castrum Novum. About A.D. 540 the Visigoths under Leovigild took possession, hut yielded in 716 to the Moors. The Christians, however, recaptured Oporto in 997, and it became the capital of the counts of Portucalia for part of the period during which the Rloors ruled in the southern provinces of Portugal *(see* PORTUGAL: *History).* The Moors once more became its masters for a short period. but in 1092 it was brought finally under Christian domination. Popular rebellions occurred in 1628 and 1661 against an unpopular tax, in 1757 against the wine monopoly and in 1308 against the French. The town is renowned in British military annals for the duke of Wellington's crossing of the Douro. by which he surprised and put to flight the French army under Marshal Soult, and captured the city on May 12, 1809. During a severe siege in 1832–33, Oporto was bravely defended against the Miguelites by Dom Pedro with 7,000 soldiers; 16.000 of its inhabitants perished. In the constitutional crises of 1830. 1826, 1836, 1832. 1846–47, 1891 and 1908–10 the action of Oporto, as the capital of northern Portugal, was always of the utmost importance. In 1919 the monarchy was proclaimed at Oporto and lasted for three weeks. In Feb. 1927 Oporto was the scene of an army rising and was bombarded during three days by government troops. After World War II a great many new roads and buildings were made and the city increased in size. (A. B. F. M.)

OPOSSUM, the name of sex-eral American marsupials, also applied in Australia to the phalangers (*q.v.*). True opossums are found almost throughout America *(see* MARSUPIALIA). They form the family Didelphidse. distinguished by the opposable first hind toe and by the dentition. They are small., nocturnal animals, with long noses. ears and tails, the latter being usually naked and prehensile. The opposable first hind toe is clawless and the tip is expanded into a flat pad. The other digits all hear claws. Mainly arboreal. they feed on birds. insects and fruit. The best known species of the type genus is *Didelphis virginianus,* which is very common in the United States. It is nearly the size of a cat. gray in colour, the fur being woolly. When caught, it feigns death (hence the expression "playing 'possum"). The ova of opossums have a thin horny shell, and many more are produced than can survive. The female produces 6 to 16 young, after a period of gestation of 14 to 17 days. At birth the immature and helpless young. only about ½ in. long. are placed by the mother in her pouch, where they cling to the nipples by their mouths. When big enough to leave the pouch. the young are often carried on the mother's back, holding onto her fur or clinging to her tail by their own prehensile tails.

The water opossum (*Chironectes minimus*) has webbed feet. (*see* WATER-OPOSSUM). Numerous other species inhabit various parts of America, being especially numerous in the tropical parts.

OPPELN (now OPOLE), a town in the former Prussian province of Silesia. Ger.. now Opole province, Pol., on the Oder, 51 mi. S.E. of Kreslau, on the railway to Kattowitz and at the junction of lines to Ratibor, Neisse and Tarnowitz. Pop. (1950) 38,500. Oppeln was a flourishing place at the beginning of the 11th century, and became a town in 1228. It was the capital of the duchy of Oppeln and the residence of the duke from 1163 to 1532, when the ruling family became extinct. Then it passed to Austria, and with the rest of Silesia was ceded to Prussia in 1742. In the partition of Cpper Silesia between Germany and Poland in 1921 *(see* SILESIA) Oppeln was retained by Germany. It is the seat of the provincial administration of Upper Silesia, and contains the oldest Christian church in the district, that of St. Adalbert, founded at the close of the 10th century. It has a 1jth-century palace on an island in the Oder. The industries of Oppeln include the manufacture of portland cement. beer. soap, cigars, chemicals, clogs and lime; trade is carried on by rail and river in cattle: grain and the vast mineral output of the district. of which Oppeln is the chief centre. The upper classes speak German. the lower Polish.

OPPENHEIM, LASSA FRANCIS LAWRENCE (1858–1919), German-born jurist, was born on March 30. 1858, at Windekken. Frankfurt am Main. He studied law at Gottingen, Berlin and Heidelberg between 1878 and 1880. For a short time he also studied philosophy. medicine and theology. In 1883 he went to Leipzig to hear Karl Binding. Thering and J. H. Bluntschli. He taught at Freiburg im Breisgau for about seven years, and for three years was professor at Basel, where he lectured on constitutional and international law. He moved to London in 189j.

In London he began an exhaustive study of public international law, and the opening of the London Srhool of Economics afforded him opportunities to teach the subject. As a result he wrote the treatise *International Law* (2 vol., 1905–06) for which he is best known. It was nritten from the point of view that international law is positive law and not a form of natural law or mere diplomatic usage. In 1908 he was elected to the Whewell professorship of international law at Cambridge and subsequently was primarily concerned with the teaching of international law and the assimilation of new material for future editions of his treatise.

His other published works included his earlier writings on German criminal law and criminal responsibility, his editions of John Westlake's papers (1914) and the series of *Contributions to International Law and Diplomacy* (1917–). *Land Warfare* in collaboration with Col. J. E. Edmonds (1912), a monograph, *The Panama Canal Conflict* (1913), *Die Zukunft des Völkerrechts* (1911), *Le Caractère essentiel de la Société des Nations* and *The League of Nations and Its Problems* (1917).

See appreciations in ***British*** Year *Book of International Law,* **pp.** 1–9 (1920–21). (E. H. Ln.)

OPPIAN, the name of the authors of two (or three) didactic poems in Greek hexameters, formerly identified. but now generally regarded as two different persons. (1) Oppian of Corycus (or Anabarzus) in Cilicia, who flourished in the reign of Marcus Aurelius (A.D. 161–180). According to an anonymous biographer, his father was banished to Malta by Verus. Oppian. who had accompanied his father into exile. returned after the death of Verus (169) and went on a visit to Rome. There he presented his poems to Aurelius and regained the imperial favour for his family. Oppian subsequently returned to his native country. hut died of the plague at the age of 30. His poem on fishing (*Halieutica*), of about 3,500 lines. dedicated to Aurelius and his son Commodus, is still extant. (2j Oppian of Apamea (or Pellaj in Syria. His extant poem on hunting (*Cynegetica*) is dedicated to the emperor Caracalla, so that it must have been written after 211. It consists of about 2,150 lines. and is divided into four books, the last of which seems incomplete. It is inferior to the *Halieutica*.

A third poem on bird catching (*Ixeutica,* from *ixos,* birdlime), also formerly attributed to an Oppian. is lost; a paraphrase in Greek prose by a certain Eutecnius is extant.

The chief editions are J. G. Schneider (1776); F. S. Lehrs (1846);

U. C. Bussemaker (Scholia, 1849); *Cynegetica,* P. Boudreaux (1908). The anonymous biography referred to above will be found in A. Westermann's *Biographi Graeci* (1845). On the subject generally *see* A. Martin, *Etudes sur la vie et les oeuvres d'Oppien de Cilicie* (1863); A. Ausfeld, *De Oppiano et scriptis sub ejus nomine traditis* (1876). There are translations of the *Halieutica,* in English by Diaper and Jones (1722), and in French by E. J. Bourquin (1877).

OPPOSITION, in logic, means the various relations which can exist between judgments or propositions having the same subject and predicate but differing in quality or quantity. See LOGIC.

OPTIC, OLIVER: see ADAMS, **WILLIAM** TAYLOR.

OPTICS. The study of optics is usually divided into three parts: physical, physiological and geometrical. Physical optics is primarily concerned with the nature and properties of light itself and is treated under LIGHT. Physiological optics deals with the mechanism of vision, and is treated under VISION.

Geometrical optics, which is the subject of this article, is the name applied to that part of optics which deals with the properties of optical instruments such as telescopes, microscopes, photographic lenses, spectroscopes and the elementary lenses, mirrors and prisms from which they are constructed. (For the history and development of these instruments and for theory as particularly applied to them, see TELESCOPE; MICROSCOPE; LENS; SPECTROSCOPY; PHOTOGRAPHY; MIRROR.) A study of the wave theory of light shows that the practical usefulness of geometrical methods applied in this branch of optics is a direct consequence of the extremely short pulse-length or wave length of light. Because the pulse-length is finite, however, there are inherent limitations to geometrical ray theory; for example, it cannot explain the ultimate resolving power of ideal optical instruments. In spite of this fact, an account of the geometrical ray theory must be given here, partly because of the simplicity with which it explains many of the essential properties of optical instruments, but also because much of the literature on this subject still employs geometrical concepts and terminology.

The basic conception of geometrical optics in this theory is the ray of light. The fact that light travels in straight paths was well known to the Greek mathematicians and the transition from optics to pure geometry was thus simple. More precisely in geometrical optics we assume that the ray of light continues in the same straight line while it travels in the same homogeneous medium. When it meets a surface separating one medium from another, such as the surface between air and water, the light flux divides, in general, and follows two paths, one of which remains in the original medium while the other passes into the second. Each of these paths continue as straight lines, insofar as the media are homogeneous, until another surface is encountered, at which there may be another division of path. At each surface. the original light path mill be called the incident ray, the light path in the second medium. the refracted ray, and the path that returns into the original medium, the reflected ray. The relative intensity of the light flux in the directions of the reflected and refracted rays depends on the optical properties of the two media and on the angle of incidence. If the second medium is a metallic substance. the reflected light flux is much greater than that refracted. and the latter is absorbed after penetrating a very short distance. On the other hand. if both media are transparent. the refracted light flux is much greater than that reflected, except at grazing incidence or beyond some critical angle. The specific amounts of reflectance and transmittance under various conditions may be computed by Fresnel's formulas. These can be derived by an application of the electromagnetic theory of light as explained in the article LIGHT.

The new paths of the light flux are determined by simple geometrical laws. The law of reflection states (1) the incident ray, the reflected ray and the normal to the surface at the point of reflection lie in one plane; (2) the incident and reflected rays lie on opposite sides of the normal; (3) the angles made by the incident and reflected rays with the normal are equal. The law of refraction states (1) the incident ray, the refracted ray and the normal to the surface at the point of refraction lie in the same plane; (2) the incident ray and the refracted ray lie on opposite sides of the normal; (3) the sine of the angle made by the incident ray with the normal bears a constant ratio to the sine of the angle made by the refracted ray with the normal. This ratio depends only on the composition of the tno media separated by the surface, and is known as the relative index of refraction.

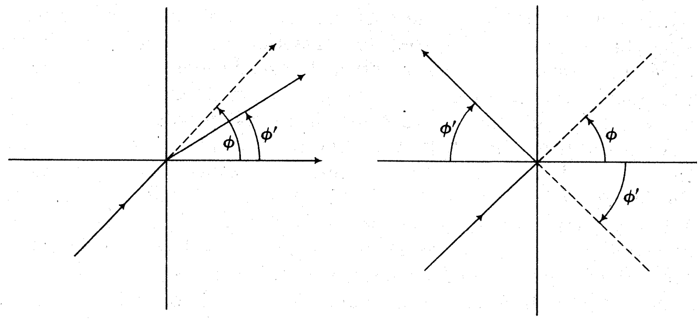

FIG. 1.— ANGULAR-SIGN CONVENTIONS, SHOWING (LEFT) REFRACTION: ANGLES OF INCIDENCE AND REFRACTION BOTH POSITIVE; AND (RIGHT) ANGLE OF INCIDENCE POSITIVE. ANGLE OF REFLECTION NEGATIVE

A comparison of these two laws suggests that one may, for convenience, consider the law of reflection as a special case of the law of refraction. Let us adopt the convention that angles are to be measured by the value of the anticlockwise rotation needed to reach the ray position from the onward drawn normal. Thus in fig. 1, left, the angles of incidence and refraction ϕ and ϕ' are positive, and if μ is the relative refractive index sin$= μ sin@. When reflection occurs the angle of reflection is equal to but opposed in sign to the angle of incidence (see fig. 1, right), and μ should therefore receive the value -1. It will be noted also that the reflected ray travels in the opposite direction to that contemplated in the law of refraction. As we shall see later all lengths entering into optical equations are either multiplied or divided by a refractive index and the double reversal of sign frees us from all difficulties regarding the signs of the quantities we employ. We are therefore enabled to dispense with any detailed consideration of reflecting instruments and can proceed to deal with refraction as an inclusive process.

For a reason which will become apparent later it is necessary for the reflecting and refracting surfaces used in optical instruments to approach very closely to ideal geometrical forms. The manufacturing processes by which the necessary degree of perfection can be reached impose severe limitations on the types of surface nhich may be employed, and in practice any surface but a portion of a sphere—with the plane as a special case—is rarely employed. We will therefore consider the refraction of light at a spherical surface.

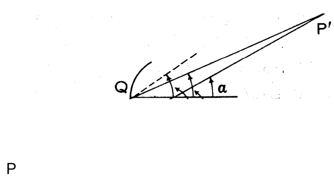

FIG. 2 —REFRACTION AT A SPHERICAL SURFACE

In fig. 2 let a ray passing through the point P be refracted at Q, a point on a spherical surface whose centre is at C. The refracted ray lies in the plane PQC containing the incident ray PQ and the normal QC, and it will therefore in general meet PC at some point P'. Let PC meet the surface in R and make an angle α with QC, and let ϕ and ϕ' be the angles of incidence and refraction. Then from the triangles PQC $P'QC$

$$\frac{\sin\alpha}{\sin\phi} = \frac{PQ}{PC} \qquad \frac{\sin\alpha}{\sin\phi'} = \frac{QP'}{CP'}$$

and therefore by the law of refraction

$$\mu\frac{PQ}{PC} = \frac{QP'}{CP'}$$

If now Q is near R, PQ and QP' differ from PR and RP' by small quantities of the second order, and the equation becomes

$$\mu\frac{PC-r}{PC} = \frac{r+CP'}{CP'}$$

$$\frac{\mu-1}{r} = \frac{\mu}{PC} + \frac{1}{CP'}$$

where r is the radius of the surface. It follows from this expression that all rays which. before refraction in the neighbourhood of R. pass through P, will afterward pass through P'. Physically this means that light energy diverging from a particle of matter placed at P will converge to P or alternatively will diverge in the new medium as though it nere liberated at P'. The reunion of the rays at P is thus of the greatest significance, and P is called the image of the object P. If P' is so situated that the rays can actually pass through it the image is called real, but if it is so placed that they may merely be regarded as having originated there the image is called virtual. It should be observed that there is no need for the rays to have actually passed through the point P, that is to say we may deal with virtual objects as well as virtual images.

The final equation above may be converted into a similar but more convenient form in terms of the distances of P and P' from the vertex point R on the axis PP' that passes through the centre of curvature C. Thus substitution of $PC=PR+r$ and $P'C=P'R-r$ gives

$$\frac{\mu-1}{r}=\frac{\mu}{PR+r}+\frac{1}{P'R-r}$$

Multiplication of both sides of this equation by the product of the denominators gives many terms that disappear by subtraction and leaves

$$(\mu-1)PR.P'R = rP'R + \mu rPR$$

This may be written in the usual form

$$\frac{\mu-1}{r}=\frac{1}{PR}+\frac{\mu}{P'R}$$

that relates the distances of P and P from the point R on the refracting surface instead of their distances from the centre of curvature C. The requirement that Q and R be close together still applies. Rays such as PQ and QP' that are close to and nearly parallel to an axis are called paraxial rays.

Consider now a succession of spherical surfaces which are all met by rays under the conditions just described. Corresponding to an object point P, real or virtual, the first surface forms an image at a definite point P_1. The point P_1 may be regarded as a source of rays falling upon the second surface. which forms an image P_2 of P_1. Each surface in turn forms a point image of that due to the preceding surfaces, and we conclude that the whole series of surfaces mill form at a definite point P in the final medium, an image, either real or virtual, of an arbitrary point P in the object space. The relation connecting P and P' may be shown to be unique and reversible, so that it is a matter of convention which of the spaces external to the system is regarded as the object space and uhich as the image space. It will be observed that we have not assumed axial symmetry in the system, so that this conclusion holds whether the centres of curvature of the various refracting surfaces are collinear or not.

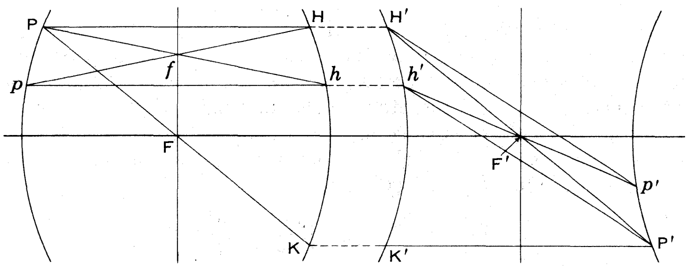

FIG. 3.— IMAGESURFACES IN AN IDEAL INSTRUMENT
Determination of surfaces in which object and image are equal to one another, and also equal but inverted

Symmetrical Optical Instruments.— The refracting surfaces in a great majority of optical instruments are surfaces of revolution with a common axis of symmetry. In consequence of this rotational symmetry the theory of these instruments is particularly simple. Rays which lie initially in a plane containing the axis remain in that plane, and the general one-one correspondence between the points of the two spaces degenerates to a one-one correspondence between points of a plane.

The theory of the symmetrical instrument has been treated very comprehensively by James Clerk Maxwell and later by Ernest Abbe on the assumption that this two dimensional point-to-point correspondence holds. From symmetry it is clear that the image of each point on the axis is itself a point on the axis. Thus the axis is a self-conjugate ray for the system. that is to say the axis, regarded as a whole is its own image. Corresponding to the point at infinity on the axis in the object space there corresponds a point F (see fig. 3), usually at a finite distance, in the image space. This is named the second principal focus of the system. Then all rays which in the object space are parallel to the axis will be refracted so as to pass through F in the image space, and conversely all rays in the image space which pass through F correspond to rays which are parallel to axis in the object space. Similarly there is a point F on the axis in the object space such that all rays passing through F emerge in the image space as rays parallel to the axis. This point is called the first principal focus of the system. Since the incident portion of any ray refracted parallel to the axis lies in the same axial plane as the emergent portion, the two will meet if produced in some point K. The point thus determined on the incident ray is at the same distance from the axis as the whole of the emergent portion of the ray, and the height of the image of an object extending from K to the axis is equal to the height of the object itself, a fact usually expressed by saying that the transverse magnification is 1. The locus of points K determined in this manner is therefore called the first unit surface. It is to be considered as situated entirely in the object space.

In a similar way by considering the intersections of the incident and emergent portions of rays which pass through F in the image space we determine the second unit surface situated in the image space. Clearly these two surfaces have rotational symmetry about the axis and are conjugate to one another, that is, the one surface is the image of the other, and any ray striking the first unit surface in the point H will follow a path in the image space passing through H' in the second unit surface where HH' is parallel to the axis. Now let $PHH'F'P'$ and $PFKK'P'$ be two rays meeting in P and P', the former being parallel to the axis 'in the object space and the latter in the image space. Let these two parallel portions be at equal distances from the axis and on opposite sides of it. The image extending from P' to the axis is of equal height to an object lying between P and the axis, and is inverted. P and P' therefore trace out conjugate surfaces corresponding to the transverse magnification -1. F and F' are the mid-points of PK and H'P' and the new surfaces are therefore precisely equal to the corresponding unit surfaces but face opposite ways. Now let $phh'F'p'$ be another ray parallel to the axis in the object space meeting the unit surfaces in h and h' and the negative unit surfaces in p and p'. From symmetry Ph and pH intersect in a point f situated in the plane through F normal to the axis of the system, and from the congruent triangles $h'F'P'$, $H'F'p'$, $h'P'$ and $H'p'$ are parallel. In other words the normal plane through F is conjugate to the surface at infinity in the image space, and similarly the normal plane through F is conjugate to the infinitely distant surface in the object space. By taking a pair of rays similar to $KK'P'$ and PHH' but with distances from the axis in any assigned ratio we can construct the conjugate surfaces for a magnification equal to this ratio by drawing rays from K through F and from H' through F'.

It is a simple matter to show that the object space surfaces are all similar and similarly situated about F. and the image space surfaces also similar and similarly situated about F. Since we have taken the ratio of the distances of corresponding points from the axis as the measure of the magnification. any corresponding secondary elements of length (that is elements normal to the plane through the axis of symmetry) in the image and object surfaces are in this ratio. Now consider two parallel incident rays inclined to the axis. not intersecting it but situated symmetrically nith respect to it on the trio sides of F. the separation between them being small. They determine on every constant magnification object surface a secondary element of unvarying length. In the image space these rays intersect in a point f' in the focal plane through F'. The lengths of the secondary elements intercepted on the constant magnification surfaces in the image space are therefore proportional to the distances of the points of intersection from f'. In other words these surfaces must be similarly situated with respect to any point f' in the focal plane

It follows that all the constant magnification surfaces are planes normal to the axis, and that the magnification in every such plane is uniform in all directions. All the properties of the system may therefore be related to the points in which these planes meet the axis of symmetry. With the aid of rays passing through F and F (fig. 4) we readily prove. if U and U' are the unit points, that is the points in which the unit planes meet the axis, and P and P' are any pair of conjugate axial points

$$\text{transverse magnification} = \frac{FU}{FP} = \frac{P'F'}{U'F'}$$

so that conjugate points are determined by $FP.P'F' = FU.U'F'$.

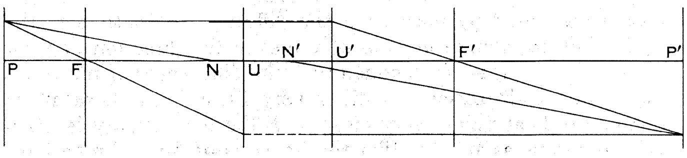

FIG I — COLLINEAR IMAGERY SHOWING THAT ANY RAY THROUGH THE NODAL POINT N EMERGES IN A PARALLEL DIRECTION THROUGH N'

If we draw through j a straight line fN, parallel to the direction of the emergent rays arising from f, to meet the axis in N, we have $FN = U'F'$. The conjugate point N' by the above relation is given by $N'F' = FU$ These points, from the circumstance that the incident and emergent rays through them are parallel to one another. are called the nodal points of the system. FU and $U'F'$ are named the first and second focal lengths of the system. When these tno focal lengths are equal the unit points coincide with the nodal points and are frequently called the principal points.

It is easy to show with a system consisting of a single surface that if an object point is moved along the axis. the image moves in the same direction. It follows that this holds also for any compound instrument. and hence FC and $U'F'$ are always measured in the same direction. There are thus only tno types of system—positive systems. illustrated in fig. 4, in which the principal foci F and F are reached by proceeding from L and C toward the real distant part of the corresponding space (the focal lengths thus being positive), and negative systems in which all these signs are reversed. The unit planes are usually situated close to or betneen the extreme refracting surfaces of the lens, and in a negative instrument all the real portions of the object space and of the image space are thus on a single side of the respective focal planes. It follows that such a negative system cannot yield a real image of a real object, and since the focal planes separate upright from inverted images, there is no inversion if either object or image is real. With a positive lens we can obtain a real inverted image of a real object, but if there is no inversion either the object or the image or both are virtual.

As we have based this discussion on the general correspondence of object and image points. the conclusions hold whenever the initial assumptions are satisfied irrespective of the way in which the system is constructed. Had we first considered the properties of a single spherical surface and extended the result to a combination of several such surfaces. our conclusions would not necessarily have applied to a system in which aspherical surfaces are employed.

Formulas are frequently used in which measurements are made from the unit points instead of from the principal foci. If we denote the transverse magnification by m, we have

from which it follows that

$$\frac{PU}{FU} = 1 - \frac{1}{m} \qquad \frac{U'P'}{U'F'} = 1 - m \qquad \frac{U'P'}{PU} = -m\frac{U'F'}{FU}$$

and

$$\frac{FU}{PU} + \frac{U'F'}{U'P'} = 1$$

When the two focal lengths have the common value f the last two equations become

$$m = -\frac{U'P'}{PU} \text{ and } \frac{1}{PU} + \frac{1}{U'P'} = \frac{1}{f}$$

Systems which yield on a uniform scale a plane image of a plane object (and incidentally a plane image of every plane object) are admirably fitted for many practical purposes. for example the photographic reproduction of maps. The scheme we have just described. nhich is known as collinear imagery, has therefore been nidely used as a standard with which the performance of real instruments may be compared. It is of value as an artificial reference frame, rather than as a scheme to which real instruments tend to conform.

Collinear imagery follows from geometrical theory when only paraxial rays are considered and one can make the approximation that the sines of all slope angles and angles of incidence and refraction can be replaced by the angles themselves. This means that in the power series expansion of the sine functions one retains only the first term Consequently. the resulting theory is called the first-order theory. It is often attributed to the mathematician Karl Gauss (1777–1855). In this restricted theory image formation is strictly collinear. Deviations from collinear imagery due to each of the neglected higher powers in the series expansion are called aberrations of the same order as the power of the neglected term. Equations for the five third-order aberrations were first derived by Ludwig von Seidel in 185j in connection with the design of lenses of high quality. While von Seidel's equations are seldom used in computations, they do provide the conventional basis for classifying the principal defects of optical systems. These aberrations are discussed in other paragraphs in this article.

The Wave **Theory** and Lenses.—We will now consider the properties of lenses according to the wave theory of light. The postulates of this theory. which have been justified by the most varied experiments, are that monochromatic light may be regarded as an undulatory disturbance of unvarying period which spreads out in all directions from the source at a uniform speed which depends only on the medium in which it is traveling. In common with other forms of wave motion the disturbance at a given instant at any point may be obtained by replacing the actual wave system by a system of secondary sources of proper intensities and phases distributed over a surface. The statistical distribution of light energy is assumed to be that of the energy distribution of the wave system on the assumption that a long train of waves is involved. On this basis the phenomena observed in the neighbourhood of an optical image—that is, the point where the energy of the wave motion has its greatest value through the contributions of the secondary sources arriving in the same phase—have been very satisfactorily accounted for. It is shown in treatises on physical optics (see LIGHT) that these assumptions involve the propagation of light in straight paths normal to the wave front (so that the rays of the geometrical theory are to be regarded as normals to the wave front). and changes in the directions of these paths in agreement with the laws of reflection and refraction provided the relative refractive index is made equal to the ratio of the times taken by light to travel equal distances in the new and old media. It would therefore appear that we should find agreement between the deductions to which we are led by the geometrical and the wave theories. This conclusion however is incorrect. An essential condition in deducing the law of rectilinear propagation is that the wave front should be of considerable lateral extent. When light approaches a real focus this condition is violated, with the result that the direction of propagation in fact is not constrained to the straight paths assumed in the geometrical theory. It is therefore not surprising to find that while the geometrical theory indicates correctly the positions in which images are formed and the conditions which should be satisfied if an instrument is to yield images *of the highest quality, it is misleading in the character of the image it leads us to expect, and the effectsto be observed in the neighbourhood of the image. The* two *theories also differin the course they nould lead us to adopt nhen any of the conditions corresponding to perfect imagery are not satisfied*

Since the relative refractive index depends only on the relative speed with which *light travels in the tno media* we *may, by assigning the value unity arbitrarily as the refractive index of a suitable substance under specified physical conditions. obtain an absolute refractive index for any other substance. As an absolute standard medium empty space is taken, but for practical purposes the refractive index of air at standard temperature and pressure is adopted.* We *shall hereafter,uhen we speak of refractive index. imply the absolute refractive index of a substance on one or other of these conventions.* We will *now show that the two focal lengths of any symmetrical optical system are in the ratio of the refractive indices of the* two *external media.*

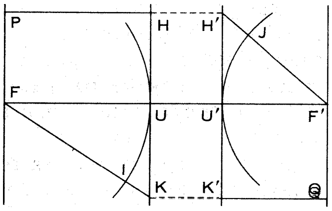

FIG 5 — RATIO OF FOCAL LENGTHS

Let a plane wave normal to the lens axis in the object space of refractive index μ travel from the position PF, fig. 5, until. after being converted by the instrument into the spherical wave L'J. in the image space of refractive index p', it reaches the principal focus at F'. Let another plane wave in the image space travel in the reverse direction from F'Q to F. As different parts of the same wave front take equal times to reach the focus, the time taken by the light to travel by the path PHH'JF' is equal to that taken along the axial path FUU'F'. and similarly the paths QK'KIF and F'G'UF take equal times. The time taken to traverse the same axial path FUU'F' is independent of the direction. and the times for all these paths are thus equal. Now *the times taken along PH and FU are equal, and the times along the equal distances G'F' and JF' in the same medium are equal. It follows that the time taken to travel from U to U' exceeds that between H and H' by the time needed to traverse the distance H'J Similarly the time for the journey UU' exceeds that* between *K and K' by the time taken to cover the distance IK.* Now *if H and K are at equal distances y from the axis the time taken to travel between H and H', from the symmetry of the instrument, is equal to that taken between K and K'. It follows that $\mu.IK=\mu'.H'J$, or*

$$\mu[\{(FU)^2+y^2\}^{\frac{1}{2}}-FU]=\mu'[\{(U'F')^2+y^2\}^{\frac{1}{2}}-U'F']$$

that is, *if the terms in y^4 and higher powers of y are negligible,*

$$\tfrac{1}{2}\mu\frac{y^2}{FU}=\tfrac{1}{2}\mu'\frac{y^2}{U'F'}$$

and since this holds for finite values of y we must have

$$FU : U'F'=\mu : \mu'$$

In particular if the two external media are composed of *the same kind of matter the* two *focal lengths are equal to one another.*

The Size of a Point Image: Resolving Power.—The extent of the divergence between the two theories may be illustrated by considering properties of importance to the user of the instrument. First we will *consider the size of the image of a point source. Of the spherical wave which spreads out from the source only a portion can enter the instrument, and corresponding to the perfect reunion of the rays in an image point* we *have an emergent* wave *of spherical form. In fig. 6. BAC represents a wave front filling* the *aperture BC: the wave is in the form of a portion of a concave sphere of which F is the centre. According to geometrical optics the image is the point F, and is formed by rays filling the cone BFC of nhich AF is the axis and a is the semi-angle. By the principles of physical optics the disturbances produced by the train of waves are the same as* would *be produced by a suitable series of disturbances situated in the wave front BAC. Now any disturbance at A gives rise to* a *spherical wave with A as centre.*

If we confine ourselves to a region around F of dimensions small compared with *AF* we *may consider the wave from A to be a plane wave PP' at F.* Similarly *from B and C* we *get plane waves QQ' and RR' making angles $\pm$ a uith PP'. Now all parts of the wave front BAC are equidistant from F. and the component disturbances at F are therefore all in the same phase—that is to say, all the displacements are in the same direction and reach their maximum values at the same instant.*

The energy of the wave motion is therefore a maximum at F, for there the co-operation is as great as possible. The wave from B will, however, have already passed beyond P, and that from C will not yet have reached P by the time the wave from A has arrived at the position PFP. To find the disturbance at P we therefore have to take the displacement at B when the wave front BAC is short of the position shown by the distance PQ, and similarly the displacement at C when this wave front has advanced beyond the position shown by the distance PR. That is to say the component displacements at P vary in phase, the total range being found by measuring the difference of path, i.e., the length $2PF\sin\alpha$, along the train of waves in the direction of their motion. Now *if P is near enough to F the differencesof phase are small, and'the displacements differ very little from those at F; in other nords at points very close to F the light energy is practically the same as at F, so that the image is of finite dimensions, and not a point. As P moves farther away from F the range of phase increases, and at a certain stage we begin to receive contributions from points near B which tend to neutralize those contributed from points near C, so that the light energy as we pass through these positions of P diminishes rapidly. Finally we reach a position of P at which the range of phase is great enough for the various contributions to neutralize one another, or at least to so nearly neutralize one another that our impression on looking at this point is that we have reached or passed the edge of the image.*

Since the changes of intensity are due wholly to differences of phase, the image edge will be reached when the differenceof path is some constant θ times the wave length λ of the light, i.e.,

$$2PF\sin\alpha=\theta\lambda$$

or

$$\text{image diameter}=2PF=\frac{\theta\lambda}{\sin\alpha}=d$$

If λ_0 is the wave length of the light in the standard medium $A_0=\lambda\mu$, and the last fraction becomes $\theta\lambda_0/\mu\sin\alpha$. As the aperture which limits the light passing through the instrument is reduced, $\sin\alpha$ *decreases, and the size of the image increases. If two near object points are to be distinguished on examining them through the instrument their images must be separate, and the resolving power of the instrument, as its capacity for rendering distinct images* of near *objects is called, is measured by the reciprocal of the image diameter, that is by $\mu\sin\alpha/\theta\lambda_0$. With light of* a *given wave length the denominator is invariable. and as $d\mu\sin\alpha$. as we shall see later, is unaltered by refraction,the resolving power of an instrument is measured by $\mu'\sin\alpha'$, where the accented quantities relate to the object space. On account of its importance in microscopy this quantity is known as the numerical aperture of the instrument. The utility of an optical instrument evidently depends upon the variation in path having a small value compared with the wave length of the light used. Since the wave length is very small, a very close approach to the theoretical form,as has already been mentioned, is necessary in the refracting surfaces.*

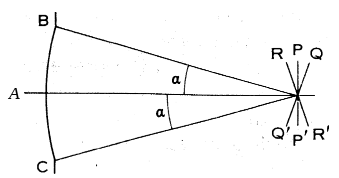

FIG. 6 — DEPENDENCE OF RESOLVING POWER ON APERTURE

Depth **of Focus.**—We will *now consider according to the two theories how far we may expect to be able to depart along the axis of the instrument from the ideal focus F and still retain a satisfactory image. According to geometrical optics light rays fill the cone BFC, fig. 7, and the image in the plane XY will be a* circle of 'diameter IJ. The image is considered satisfactory if IJ does not exceed a certain diameter. say d, so that the permissible range for G is given by the condition

$$FG=\tfrac{1}{2}d\cot\alpha$$

or very approximately

$$FG=d\cdot\frac{I}{a}$$

where I is the distance of the image from the principal point and a is the effective diameter of the lens aperture supposed situated in the unit plane. The important feature of this formula is that the depth of focus is inversely proportional to the first power of the diameter of the aperture.

Let us now consider the same problem from the point of view of the wave theory. Instead of relying on the geometrician's hypothesis we are able to rest on the well-attested fact that an image begins to appear less sharp when the extreme difference betneen the phases of the component waves at the centre of the image reaches a definite value, that is to say, when the path difference at G amounts to $\phi\lambda$ where ϕ is a definite number. This criterion differs from that considered on the geometrical theory less radically than might at first sight appear, for the existence of an appreciable phase difference at the image centre means that in this neighbourhood the light energy is less but the total light energy of the waves is the same wherever the plane may be placed, and energy removed from the central regions must therefore appear in some other place. But to say that an appreciable amount of energy is found farther from the centre is only another way of stating that the image is sensibly enlarged.

Resuming, hoaever, the determination of the range for G, the distance of this point from B differs by an unimportant amount from BH. where GH is perpendicular to BF. Since the extreme paths obviously arise from A at one limit and marginal points such as B at the other, and since all path lengths to F are equal, the extreme path difference is the difference between FG and FH, or $FG(1-\cos\alpha)$ or

$$FG=\frac{\phi\lambda}{1-\cos\alpha}$$

Now $a=2I\sin\alpha$, and therefore approximately

$$FG=8\phi\lambda\left(\frac{I}{a}\right)^2$$

This formula indicates a law of a quite different type from that derived geometrically, the range varying inversely as the square of the aperture diameter, instead of as the first power.

The Depth of Field.—By reasoning of a character essentially similar to that of the foregoing section we can find expressions for the nearest and greatest distances x and x' at which objects may be situated from the lens for their images to appear sharp on a screen focused for a distance X. According to the geometrical theory the conditions are

$$\frac{1}{x}-\frac{1}{X}=\frac{1}{X}-\frac{1}{x'}=\frac{d}{Ia}$$

and the conditions derived from a limiting difference of path are

$$\frac{1}{x}-\frac{1}{X}=\frac{1}{X}-\frac{1}{x'}=\frac{8\phi\lambda}{a^2}$$

where the symbols bear the same meanings as in the previous section. Thus assuming the objects are at a considerable distance from the lens, so that I is approximately equal to the focal length of the lens, according to geometrical optics the focal length of the lens and the aperture are equally important. the range being inversely proportional to both. On the other hand according to the wave theory the focal length has nothing whatever to do with the question, and the range is inversely proportional to the square of the aperture. Both theories. it will be observed, indicate the selection of the same plane for the theoretical focus to secure the utmost sharpness for all objects between two given extreme planes.

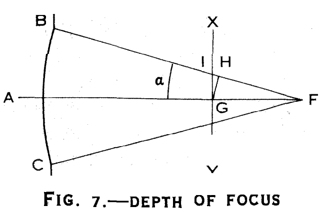

FIG. 7.—DEPTH OF FOCUS

The quantity Ia/d in the first equation is generally called the hyperfocal distance. H. and is often used in computing the depth of field. x to x'. corresponding to an object distance. X. in exact focus. For example, X may be the setting on the focusing scale of a camera. For this application one usually assumes an acceptable diameter for the image spot, IG. in fig. 7 of $d=0.004$ in. The effective diameter of the lens aperture a is obtained from the focal length f and the f-number N of the stop by the relation $a=f/N$. When the objects are many focal lengths distant from the lens. one may write $I\cong f$. The hyperfocal distance is then given by the equation

$$H=\frac{Ia}{d}=\frac{f^2}{dN}\cong 250\frac{f^2}{N}$$

where f and H are in inches. For example, when $f=2$ in. (35 mm. camera) and $N=4$ (stop setting $f/4$), the value of H is 250 in. or about 21 ft. If images of objects at a distance of $X=H=21$ ft. are precisely in focus, one obtains acceptably good focus for object distances from $x=X/2\cong 10.5$ ft. to $x'=\infty$. This illustrates the principle of the "fixed focus" camera. Thus if one desires a depth of field from 5 it. to ∞ one must use a hyperfocal distance of $H=10$ ft. and therefore make $f^2/N=0.5$. Unless the focal length is rather small, however, this requires so large a value of N (*i.e.*, so small a stop) that diffraction effects will cease to be negligible as assumed in geometrical theory. Under this condition the first equation loses its applicability and one should use the second equation that is based on wave theory.

It is instructive to compare the equations for the hyperfocal distance according to the two theories and consider why they differ and how they might be reconciled. For objects at several focal lengths distance one finds that. according to wave theory,

$$H=\frac{a^2}{8\phi\lambda}=\frac{f^2}{8\phi\lambda N^2}$$

Comparing this with the previous formula for H. one observes that the wave theory implies an acceptable diameter of the image circle equal to $8\phi\lambda N$, where $\phi\lambda$ is the acceptable path difference to the centre of the image. Thus for a fixed value of 4. which might be 0.6, the acceptable diameter of the image circle in wave theory is proportional to the f-number of the stop. For small values of N this diameter is much smaller than the standard 0.004 in.. which is based primarily on the resolving power of the usual photographic emulsion

Diffraction theory indicates that in the ideal image nearly all of the light flux is concentrated in a spot, called the Airy disk, having a diameter of

$$D=2.44\frac{I\lambda}{a}\cong 2.44\,\lambda N$$

For reasonable values of N, this is quite small because of the smallness of the wave length of light. A comparison of the size of the Airy disk and that of the acceptable diameter of image spot in the nave theory shows that one is effectively assuming that the latter is a constant multiple $8\phi/2.44$ times the former, since both are proportional to N. In the geometrical ray theory, on the other hand. one assumes a fixed diameter for the acceptable image spot that is independent of N. This theory becomes inapplicable if the diameter of the Airy disk is not negligible compared with the assumed tolerance of 0.004 in. It also ceases to apply if the aberrations of the lens are so large that the image disk cannot be as small as the standard 0.004 in. tolerance. If a larger tolerance is adopted, the computed depth of field is naturally larger whether the lens is good or poor. A poor lens would, however. give a poorer image over the entire depth of field.

Aberrations of Optical Systems.—Returning to geometrical ray theory, the reader will recall that the approximations used in developing the equations for the location and magnification of the image are such that the results are accurate only nhen the rays are close to and make small angles with the axis of symmetry of the lens or optical system. Even if these conditions are satisfied, however, perfect sharpness of the image cannot be obtained. A certain degree of diffuseness is always present due to diffraction of light waves. *(See* LIGHT.) Fortunately this effect is small because of the smallness of the wave length of light, and may be neglected in an introductory discussion of the principal faults of optical systems.

When one considers object points removed from the axis and computes rays that make appreciable angles with the axis, one finds deviations from the ideal behaviour of an optical system as predicted by the first-order theory. These deviations are classified as aberrations of several varieties. Since in practice a lens is usually expected to give sharp and undistorted images of objects having an appreciable extent (field) and utilizing cones of rays having an appreciable angular divergence (aperture), the reduction of aberrations is an important part of lens design. The design of high quality optical systems is an extremely technical operation that calls for great skill. experience and familiarity with optical theory. The details will not be discussed here but the nature of the principal aberrations and the general procedure followed in their reduction will be explained in an elementary fashion. A knowledge of aberrations helps the user of lenses to make an intelligent selection and application of available lenses.

When light rays from an object point on the axis of a lens pass through the lens, it is found that the rays through the various circular zones of the lens around the axis are focused at different points along the axis. This defect is called longitudinal spherical aberration. The refracted rays create a locus of intersections in space along a caustic curve the tip of which is the focus of paraxial rays. The same kind of focus is created by rays reflected from concave or convex spherical mirrors. Spherical aberration may be eliminated by using an aspherical surface whose shape depends on the location of the object point and its image. Because such aspherical surfaces cannot be constructed by mass-production methods with sufficient accuracy, they are seldom used. there being some notable exceptions. The longitudinal spherical aberration of lenses with spherical surfaces varies as the square of their aperture and inversely as their focal length. The amount of spherical aberration of a given simple lens depends greatly on the ratio of the radii of curvature of the lens surfaces, being least, but not zero. when the light rays pass through the lens symmetrically so that they make equal angles nith the normals to the surfaces of the lens. For a thin lens made of glass having a refractive index of 1.5 and for a distant object, this is achieved when the second surface has a radius of curvature six times that of the first surface and of opposite sign. With a given shape of lens. one obtains the least spherical aberration when the flatter side is toward the object or image, whichever is the closer, for this gives the more symmetrical ray passage through the lens. Spherical aberration is eliminated by using a combination of positive and negative spherical lenses with radii computed so that their spherical aberrations are equal and of opposite sign but yield lens powers such that the combination has the desired focal length.

Images formed by reflection also suffer from spherical aberration unless suitable, often aspherical. mirrors are employed. The best-known example is the parabolic reflector which is free from spherical aberration when one of the conjugate points is located at infinity in the axial direction, the other conjugate point being at the geometrical focus of the paraboloid. When both conjugate foci are at finite distances from the mirror, an ellipsoidal mirror uill be free from spherical aberration for conjugate points at the geometrical foci of the ellipsoid. When one of the conjugate foci is virtual, a hyperboloidal mirror gives focusing without spherical aberration.

It should be noted that all of the above surfaces produce images free from spherical aberration only for a single object point that is located at some specific place on the axis of the mirror. Since one is generally interested in securing high quality images of objects having some lateral and longitudinal extent, it is imperative to consider aberrations of correspondingly displaced object points. The nature and seriousness of the problem may be illustrated by considering the ellipsoidal mirror. All rays leaving an object point at one focus mill, after reflection, pass through the other focus regardless of the aperture of the mirror, which may even surround the two foci in the extreme case. If we consider an object of some lateral extent at one of the foci, it is well known that the image at the other focus will have a magnification that is given by the ratio of the distances of the image and object measured from the reflecting surface. If this magnification is m, for example four, when the light is reflected from the nearest portion of the ellipsoid, it will be $1/m$, for example one-fourth, when the light is reflected from the farthest portion. Other zones will give magnifications between these two extremes. It is evident that a superposition of images having such diverse magnifications for the different zones of the mirror will result in an intolerably imperfect image. The defect may often be reduced to an acceptable amount by using only a small enough portion of the mirror, but it can never be completely eliminated in this way. This particular variety of aberration, arising from a variation in magnification with aperture angle or zone of a mirror or lens, is called coma.

Abbe has proved that an optical system will be free of coma if, in addition to being free of spherical aberration, it satisfies the equation, knonn as Abbe's sine law: $\mu'\sin\alpha' = m\mu\sin\alpha$ where m is the transverse linear magnification, μ' and μ are the indices of refraction of the media in the object space and in the image space, respectively. and a' and a are the slope angles of conjugate rays through the axial object point and image point. Since the absence of coma requires that m be constant for the various zones of the lens or mirror, the condition that must be satisfied is

$$\frac{\sin\alpha'}{\sin\alpha} = \text{constant}$$

which is known as the sine condition. All optical systems of high quality satisfy this condition. If the object is at a very great distance, one may consider $\sin\alpha'$ to be proportional to the axial height h of the entering ray so that the sine condition becomes

$$\frac{h}{\sin\alpha} = \text{constant}$$

A system that is free of spherical aberration and satisfies the sine condition is said to be aplanatic.

Schmidt System.—Neither an ellipsoidal nor a paraboloidal mirror is truly aplanatic. A parabolic mirror therefore can be used with only a very restricted field for a given aperture, and vice versa, if serious marring of the image is to be avoided. It is in this respect that a Schmidt system is greatly superior to the parabolic reflector. Because of its considerably greater useful field with a large light-gathering power, many astronomers consider the big Schmidt telescope at Palomar observatory, for example, to be superior to the zoo-in. reflector, particularly for mapping the skies and determining the location and distribution of distant galaxies. This 48-in. Schmidt telescope has a relative aperture of $f/2.5$ and covers a field of 44 square degrees while the zoo-in. paraboloid covers only $\frac{1}{20}$ of a square degree with a considerably smaller relative aperture.

The Schmidt system employs a concave spherical mirror with a transparent corrector plate designed to correct for spherical aberration and coma. This plate is a disk of glass or plastic of variable thickness and is located at the centre of curvature of the spherical mirror. The aspherical curves on the plate need not be very steep to correct for spherical aberration. The location of the plate at the centre of curvature is essential for the correction of coma. Chromatic aberration is negligible because of the shallow curves on the corrector plate and the fact that the spherical mirror is, of course, achromatic.

To gain an elementary understanding of the Schmidt system, first consider the spherical aberration of a spherical mirror. It is expedient to do this by computing the optical path for a ray entering parallel to a line or axis through the centre of curvature, the ray being at a distance h from that axis. The ray path is computed from a starting point on a reference plane that is normal to the axis and proceeds along the ray to the mirror and back to the focal point on the axis. It is known that all such paths are equal for rays reflected from a paraboloid that has the same vertex as the sphere. Hence twice the distance between the sphere and paraboloid at the height h gives the amount of spherical aberration expressed as an error in optical path. For a sphere of radius R, the distance from a plane that is tangent to the sphere and paraboloid at their common vertex is

$$x=R-R\left(1-\frac{h^2}{R^2}\right)^{\frac{1}{2}}$$

which may be expanded into a power series in terms of h/R giving

$$x=\frac{h^2}{2R}+\frac{h^4}{8R^3}+\cdots$$

For the paraboloid the value of x is just the first term in this expansion. Hence the sphere reflects the ray too soon by the amount $h^4/8R^3\cdots$ and the error in optical path that causes the spherical aberration of the spherical reflector is just twice this amount. In a Schmidt system of the simpler "first" type the advance in path at the mirror is compensated by a retardation of the same amount in the corrector plate. If t represents the thickness of the corrector plate and μ its refractive index, the necessary correction is obtained when

$$(\mu-1)t=\frac{h^4}{4R^3}$$

This shows how the thickness of the plate must depend on the distance h from the axis. The thickness of the plate may be increased by any constant amount so long as the variations in thickness are such as to equalize the optical paths.

Correction for spherical aberration does not fix the location of the plate and indeed suggests that it should be close to the mirror because of the divergence of the rays resulting from refraction in the plate. As stated before. correction for coma requires that the plate be located at the centre of curvature of the spherical mirror for only then is the sine condition satisfied. Using F_0 to represent the distance of the focus of paraxial rays from the mirror vertex, the sine condition is

$$\frac{h}{\sin\alpha}=F_0$$

Now, in general, the location of the second unit surface of any optical system is the locus of points at which the projection of entering rays intersects the projection of the conjugate emerging rays. Thus the sine condition is seen to require that this locus be a spherical surface of radius F_0 which is half the radius of curvature in the case of a spherical mirror. This surface is indicated in fig. 8 by the dotted circle. Let the corrector plate be located at some distance S from the vertex of the mirror. We need to show that S must equal R in order that the projected entering ray intersects the reflected ray at some point U on the unit circle of radius $R/2$. To show this, one first notes that the entering ray is deviated outward through the angle

$$\delta=(\mu-1)\frac{dt}{dh}=\frac{d}{dh}\left(\frac{h^4}{4R^3}\right)=\frac{h^3}{R^3}$$

at the corrector plate. The resulting linear deviation at the mirror is

$$\Delta y=\frac{h^3S}{R^3}$$

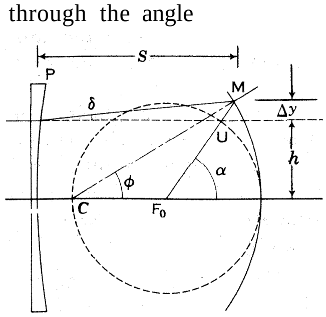

FIG. 8 —THE FIRST SCHMIDT SYSTEM. THE ASPHERICAL SURFACE ON PLATE P CORRECTS THE SPHERICAL ABERRATION AND COMA OF THE MIRROR M

This must equal the y component of the distance between the points U and M at which the reflected ray, whose slope angle is a, intersects the unit sphere and the mirror, respectively. Referring to the figure, we must equate $UM\sin\alpha$ to h^3S/R^3 and find the value of S for which this equality holds. It is not very difficult to show that the required value of S is the radius of curvature R of the spherical mirror.

The second Schmidt system is an improvement over that described above, since it requires less steep curves on the corrector plate and the small residual chromatic aberration introduced by the plate is still smaller than that of the first Schmidt system. The corrector plate in the second system not only compensates for spherical aberration and coma, as explained above, but also shifts the focus from the paraxial ray location to the point at which the width of the reflected beam from the spherical mirror is smallest. At this point the radius of the beam is one-fourth the radius of the aberration circle at the paraxial focus. The smaller correction required for spherical aberration, particularly for ray s at large distance from the centre line, requires less steep curves on the plate. The plate in this case is not uniformly concave, as in the first system, but has a weak convex central portion which displaces the paraxial focus to the desired point. The required thickness t is given by the equation

$$(\mu-1)t=-\frac{3}{8}\frac{H^2}{R^3}h^2+\frac{h^4}{4R^3}$$

in which H is the maximum height of the ray that strikes the mirror. The height h_0 of the ray that is undeviated at the corrector plate is obtained by setting $dt/dh=0$ from which one finds that $h_0=0.866\ H$.

The image formed by a Schmidt system is not flat but has a concave curvature toward the entering light, or convex toward the mirror. The image must accordingly be projected on a curved surface, for example, the film must be curved in photographing with a Schmidt camera. Since, however, lens systems characteristically tend to produce the opposite sense of curvature, one can compensate for the curvature of the Schmidt image when necessary.

Aplanatic Points of a Sphere.— It can be shown that a spherical refracting surface is aplanatic for conjugate points at distances μR and Rip from its centre where μ is the relative refractive index of the sphere. In fig. g, P and P' are two such points with $PC=\mu AC$ and $P'C=AC/\mu$. Consider any point S on the forward side of the sphere and construct the rays PS and P'S. The triangles PCS and P'CS are similar because they have one angle, at C, in common and the sides adjacent to this angle are in the same ratio, p, by construction. Hence the corresponding angles are equal and one may apply the sine law of trigonometry $\sin PSC:\sin CPS=\mu:1$ to show that $\sin PSC/\sin P'SC=\mu$, proving that the rays PS and $P'S$ satisfy the law of refraction. Hence any ray from a source P' inside a sphere of radius R at a distance **Rip** from its centre will emerge in a line that passes through a fixed conjugate point P regardless of the point S at which refraction occurs on the sphere. There is consequently no spherical aberration. To show that Abbe's sine law is also satisfied one compares the sines of the slope angles $CP'S\equiv\alpha'$ and $CPS\equiv\alpha$ and finds that $\sin\alpha'=\mu\sin\alpha$ which is the sine condition for absence of coma.

The first lens of an immersion type of microscope objective utilizes these aplanatic points in the first stage of magnification. A second pair of aplanatic points coincide at the centre of any sphere, but for these there is no magnification. This seemingly trivial situation may, however, be applied at one surface of an aplanatic lens with the second surface satisfying the principle previously discussed. Such a lens is often used as the second element in a compound microscope objective. This construction is generally not applied more than twice because of the necessity of correcting for other aberrations than spherical aberration and coma.

Herschel Condition.— It has been seen that the condition for accurate focusing of rays that are laterally displaced from an axial point at which there is no spherical aberration is Abbe's sine condition. The analogous condition for points that are displaced longitudinally along the axis is

$$\mu\sin^2\frac{\alpha}{2}=\mu\sin^2\frac{\alpha'}{2}$$

which is known as the Herschel condition. Comparison of the two equations shows that they are in general incompatible except for rather special cases such as $\alpha=\alpha'$. Hence, a lens system can be corrected for spherical aberration and coma only for a definite location of the object. This implies that a lens designed for creating high quality images of distant objects. for example, a telescope objective or a conventional camera lens, cannot give equally good images of objects that are close to the lens. Conversely, the best lenses for copying or enlarging, for example, must be designed for this specific purpose and cannot be as satisfactory in photographing distant objects as a lens designed for that purpose. There is no such thing as a universal-purpose lens if one requires the best possible results.

Astigmatism.—When the field of an optical system is extended laterally in such a way that coma is eliminated, one observes that in general, object points off the axis are imaged as two sharp lines at right angles to each other and at different locations. This defect. called astigmatism. is illustrated in fig. 10. One may account for this defect as due to the conversion of a spherical wave front from an object point into a toroidal wave front with two principal curvatures similar to those of a portion of the surface of a doughnut or tire. Light rays associated with such waves focus on two lines passing through the two mutually perpendicular loci of the centres of principal curvature.

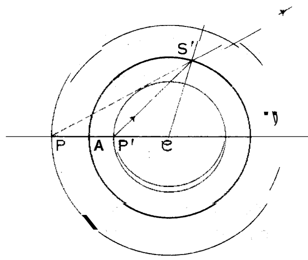

FIG. 9.—LOCATION OF APLANTIC POINTS P' AND P OF A SPHERICAL REFRACTING SURFACE

The line foci corresponding to object points distributed in a plane normal to the axis of symmetry are located on two curved surfaces. The so-called primary or tangential focal surface is the surface on which concentric circles of object points are sharply focused since the short line focus conjugate to each object point on the circle is directed along the circumference of a circle in image space. The secondary or sagittal focal surface, on the other hand, is a surface on which object points that lie on radial lines in object space are sharply focused as radial lines in image space. Astigmatism is particularly serious in photographic objectives since these are normally required to give point images of object points that are located in a field extending 25° or more from the axis of the lens.

The many designs of excellent objectives (see PHOTOGRAPHY) show the nature of the lens combinations that are required to overcome astigmatism. coma and spherical aberration as well as several other aberrations to be discussed.

Curvature of Image and Distortion.—One may eliminate astigmatism by "bending" the elements of a lens system and by changing the location of the aperture stop. This alters the shape of the two astigmatic surfaces and brings them into coincidence on a common surface called the Petzval surface. This surface, which is conjugate to a plane in object space, is in general a curved surface. If the image is to be projected on a plane (*e.g.*, a photographic plate, film or paper) it will be impossible to simultaneously obtain a sharp image of the entire object plane. Hence, for these and many other applications, such a curvature of the image must be considered as another aberration that must be corrected by making the Petzval surface approximate a plane within the useful field of the optical system. For a simple system of two thin lenses whose focal lengths are f_1 and f_2 with refractive indices μ_1 and μ_2 respectively, J. Petzval has shown that a flat field requires that

$$\frac{1}{f_1\mu_1}+\frac{1}{f_2\mu_2}=0 \qquad \text{w}$$

This equation is known as the Petzval condition.

Another defect of particular importance in producing images that are to be measured accurately is distortion. This aberration consists of a variation in magnification radially outward from the central point in the image. If the magnification increases outward from the centre, a square object is imaged in the shape of a pincushion, hence the name "pincushion distortion." If the magnification decredses radially outward. the image of a square has laterally bulging sides and the distortion is said to be "barrel-shaped." Distortion is greatly influenced by the location of the aperture stop. The lens elements must be corrected for spherical aberration for rays passing through the centre of the aperture stop at various slope angles and the ratio of the tangents of conjugate slope angles must be constant.

Chromatic Aberrations.—Since the refractive index of any medium depends on the wave length or colour of the light, all of the pruperties of a refracting optical system mill vary with wave length. The chromatic variations in the aberrations discussed above are of a second order of smallness and are therefore usually negligible The change in focal length of the lens system and the location of its unit planes, however. leads to important defects called chromatic aberrations Of these there are tno principal forms. The first, longitudinal chromatisin. is a variation in location of the image nith change in wave length. The second. lateral chromatism, is a variation in image size or magnification with wave length. In thin lenses. the absence of one is accompanied by the absence of the other, but in general they are t o independent chromatic defects.

Consider. for example. the image of a distant object formed by an anastigmatic camera lens. This necessarily must be a lens of several elements, a thick lens. The locations of the unit planes and the focal planes will depend on the colour of the light Absence of longitudinal chromatism requires. for a distant object, that the location of the second focal plane be independent of the wave length of the light Actually this correction can be accomplished accurately for only two or three specific wave lengths, and this usually proves sufficient. Since in a thick lens. the locations of the principal planes are also dependent on wave length, and are determined by entirely independent equations, the coincidence of the focal planes does not necessarily imply that the unit planes are also coincident for different wave lengths. Thus the focal length of the lens, and therefore the magnification of the image. in general varies with colour even when the image location does riot. The lens in our example is said to be corrected for longitudinal chromatic aberration but not necessarily for lateral chromatism. The converse may also be true. In fact, oculars of telescopes and microscopes are often primarily corrected for lateral chromatism, which is the more serious defect in this case, and they often possess large amounts of longitudinal chromatism. Such lenses are said to be partially corrected for chromatic aberration.

To gain some insight into the method of correcting for chromatism. consider two thin lenses whose focal lengths are f_1 and f_2 made of glass whose refractive indices are μ_1 and μ_2, respectively, for some particular wave length. Let d represent the axial separation of the lenses. The power $1/f$ of the combindtion is given by the equation

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1f_2}$$

The power of each individual lens $1/f_1$, or $1/f_2$, may be written in the form

$$\frac{1}{f_1}=(\mu-1)K_1$$

where K_1 represents a geometrical factor that depends on the shape of the lens and is therefore independent of colour. The change in power of the first thin lens due to a change in wave length is

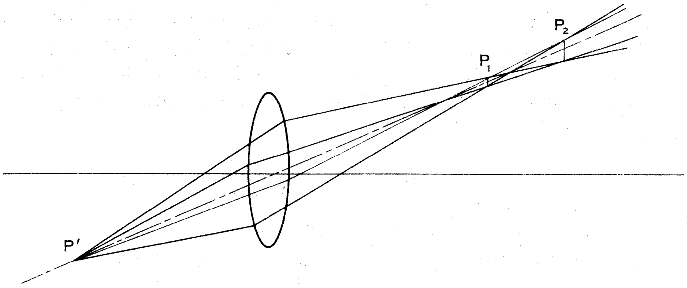

FIG. 10.—ASTIGMATIC FOCUSING. RAYS FROM AN OBJECT POINT P' FOCUS ALONG TWO MUTUALLY PERPENDICULAR LINES AT Pi AND P2

related to the change in refractive index $\Delta\mu_1$ by the equation

$$\Delta\left(\frac{1}{f_1}\right)=\Delta\mu_1 K_1=\left(\frac{\Delta\mu_1}{\mu_1-1}\right)\frac{1}{f_1}=\frac{\omega_1}{f_1}$$

where ω_1 is called the dispersive power of the glass of which the lens is made. A similar equation holds for the second lens.

The change in power of the lens combination is then

$$\Delta\left(\frac{1}{f}\right)=\frac{\omega_1}{f_1}+\frac{\omega_2}{f_2}-\frac{d(\omega_1+\omega_2)}{f_1 f_2}$$

If this quantity is zero, the combination has the same power or focal length for the two wave lengths used in determining w. The combination is then partially achromatized. Two special cases are of particular importance. If the two lenses are made of the same kind of glass $\omega_1=\omega_2=w$, partial achromatization is realized when $d=\frac{1}{2}(f_1+f_2)$. This principle is used in the construction of the simpler forms of eyepieces for telescopes and microscopes where lateral chromatism is the principal defect that must be corrected. Since, however. longitudinal chromatism is quite large in such a two-lens combination, this construction cannot be used in a lens intended for a telescope or camera objective, where both varieties of chromatism are serious faults.

The simplest suitable achromat for the latter purposes consists of a cemented doublet of thin lenses for which one may assume that d is approximately zero. Consequently the above equation for zero change with colour of the power of the combination becomes simply

$$\frac{\omega_1}{f_1}+\frac{\omega_2}{f_2}=0$$

Since the dispersive powers ω_1 and ω_2 are always positive, it is evident that one of the lenses must be of negative focal length and the other positive. Moreover

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$$

gives the desired power of the combination and must be considered simultaneously with the other equation. Since the desired power is some value other than zero, it follows that ω_1 must not be equal to ω_2. In other words. the tno components of the doublet must be made of different kinds of glass, usually some variety of crown glass for one and a flint glass for the other. Flint glass is one that contains lead oxide and is characterized by a relatively high dispersive power, sometimes as high as twice that of crown glass. In a converging achromatic doublet the converging component is made of crown glass, and the weaker diverging component is made of flint glass. As before. the conditional equation for correction of chromatic aberration really applies directly to the correction of only lateral chromatism. but if the two lenses of the doublet are thin, the combination of the two in contact will also be a thin lens, and the locations of the unit planes of a thin lens are only negligibly affected by colour. Hence. longitudinal as well as lateral chromatism are corrected in such a combination. For a combination of two or more thick lenses, however, the conditions for achromatism cannot be stated so simply for one must consider the variation in location with colour of the unit planes as well as the focal planes. The analysis becomes quite complicated and may be found in the technical literature on lens design.

Theory of Stops.—Diaphragms or stops in optical systems serve (1) to restrict the field of view to that portion that is imaged acceptably well, (2) to control the light flux per unit area of the image, (3) to control the depth of focus and depth of field, (4) to reduce some of the residual aberrations and obtain a sharper image and (5) to serve as light baffles to eliminate disturbing internal reflections from the walls of the optical system.

Of prime importance is the aperture stop, nhich is that lens rim or diaphragm that determines the size of the cone of rays that enters and leaves the system. The plane angle betwten diametrically opposite entering rays from a given object point is the angular aperture. The corresponding angle between conjugate rays through the image point is called the angle of projection. In a complicated lens system it is often difficult to see immediately which lens rim or diaphragm determines these angles, The standard procedure for solving this problem is to first translate, by the use of the equations for locating conjugate points and determining the associated magnification, every lens rim and diaphragm rim into object space. In this space rays may be drawn as straight unbroken lines from any given object point to any other point in the same space, for example, to any translated lens rim or diaphragm. That translated rim of lens or diaphragm that subtends the smallest angle at the object is called the entrance pupil and the angle subtended by diametrically opposite points is the angular aperture. The f-number rating of the optical system is the ratio of the focal length of the system to the diameter of the entrance pupil. Every camera user has a practical acquaintance with this f-number rating of lenses and stops. The illuminance of the image, light flux per unit area, is inversely proportional to the square of the f-number. The smallest resolvable angular separation of two distant points is inversely proportional to the first power of the f-number if the lens is perfect.

The aperture stop is that actual physical lens rim or diaphragm that corresponds to the entrance pupil. The conjugate of the entrance pupil with respect to the entire optical system is the exit pupil. It is also conjugate to the aperture stop with respect to the optical components that follow it in the optical system. The angle subtended by the exit pupil from the location of the image is the angle of projection. The illuminance of the image is directly proportional to the square of the sine of half the angle of projection.

Rays that pass through the centres of the entrance pupil, aperture stop and exit pupil are called chief rays. They define the axes of the entering and emerging cones of rays. Their maximum angular separation determines the field of view. To determine this angle. consider again the object space translation of lens rims and diaphragms. That translated rim that subtends the smallest angle from a point at the centre of the entrance pupil is called the entrance port or entrance window. That actual lens rim or diaphragm to which the entrance window corresponds is the field stop. The angle subtended by diametrically opposite points on the entrance window from the centre of the entrance pupil is the angular field of view in object space. The conjugate of the entrance window with respect to the entire system is the exit window. This is also the conjugate of the field stop with respect to the optical elements that follow it in the system. The field of view in image space is the angle subtended by the exit window from the centre of the exit pupil. Unless the exit window coincides with the image, the boundaries of the image are not sharp. This effect is called vignetting.

As an example of stops and their functions, consider a telescope or prism binocular. The aperture stop is usually found to be the rim of the objective unless the image of some internal light baffle is smaller. Since the objective is in object space, its diameter is generally the diameter of the entrance pupil. The exit pupil is the image of the entrance pupil created by the entire system and may be seen as a bright circle just beyond the eyepiece when the telescope is pointed toward the sky or some other bright area. The magnification of a telescope may be conveniently determined as the ratio of the diameters of the entrance and exit pupils. When a binocular is designated as 7x 50, for example, the first number is the magnification, and the second is the diameter of the entrance pupil in millimetres. Hence the diameter of the exit pupil is $50/7=7+$ mm. If the diameter of the pupil of the observer's eye is less than or equal to the diameter of the exit pupil there is no reduction in visual brightness of the object areas seen through the instrument. For purpose of calculation. visual brightness is defined as the light flux per unit area of the retina. Fo: an eye pupil diameter e that is larger than the exit pupil diameter p, there is a reduction in visual brightness in the ratio of the square of p to the square of e. Hence it is desirable to have the exit pupil larger than the eye pupil or of equal size at least. Since the diameter of the eye pupil varies with illuminance from about 2 mm. in very bright light to about 7 mm. at night, a telescope should have an exit pupil of at least 2 mm. diameter for use in the daytime and at least 7 mm. for use at night. The latter type of telescope is frequently called a night glass.

Astronomical telescopes often have such a high magnification that, in spite of their large objective, the exit pupil is much smaller than the pupil of the observer's eye. Hence visual brightness of areas, such as the sky background, is greatly below their brightness with the unaided eye. On the other hand, the stars are effectively point objects, their image size being determined by diffraction rather than magnification. Consequently their images appear brighter than with the unaided eye in about the ratio of the area of the objective to the area of the pupil of the observer's eye. This large increase in brightness of star images combined with the reduction in brightness of the background makes it possible to see at least the brighter stars in full daylight through a large astronomical telescope.

The field stop in a telescope is usually the boundary of the reticle on which the eyepiece is focused. In telescopes intended for angular measurements, the reticle carries cross hairs or some kind of scale etched on glass. The image of the boundary of the reticle created by the eyepiece is the exit window and the image of the reticle created by the objective is the entrance window. Since these respectively coincide with the image and object in a properly focused telescope, the field is sharply bounded. If there is no reticle, the field is generally determined by the first lens in the eyepiece, which is then the field stop. It is easy to see that in such a case the boundary of the field is not sharp.

In a Galilean type of telescope or opera glass, which has a diverging lens as its eyepiece, the identity of the field stop and of the aperture stop depends on the magnification. At high powers the field is limited by the pupil of the observer's eye, while at low powers it is limited by the diameter of the objective. The switch from the latter to the former situation occurs when the exit pupil of the telescope considered by itself becomes smaller than the pupil of the observer's eye. In either case the boundary of the field is not sharp.

In a camera, the iris diaphragm, which is generally between the elements of the objective, is the aperture stop. Its image created by the front element is the entrance pupil and the diameter of this image divided into the focal length of the objective is the f-number designation of the stop. The exit window is the frame which limits the exposed area of the film. Being at the location of the image. the field is sharply bounded.

Line Images.—An optical system may not produce a single point image for a given point object. This is true, for example. of an axially symmetrical system for points off the axis when the system is astigmatic. It has been shown that there are then two line images at right angles to each other for each object point.

A mirror or lens with cylindrical or toroidal surfaces will produce two astigmatic line images for any location of the object point. One or both of these line images may be virtual depending on the location of the object point which itself may be real or virtual. The locations of these images may be found by considering two plane section5 in which the aspherical surface has its maximum and minimum curvature. The length of each line image is proportional to the aperture of the system and may be determined by geometrical considerations.

Another example of a line image is provided by the axicon. This name has been applied by J. H. McLeod to any optical system whose surfaces are figures of revolution and that creates a line image along its axis for a point source on its axis. The simplest example of an axicon is a reflecting or refracting conical surface. Such a system may be said to possess a universal focus. It may be used as an objective in a telescope that enables one to see two or more axial point sources in equally good focus even though the sources are at different distances. The axial line image of the axicon is finding application in the accurate alignment of the parts of an optical or mechanical system.

The **Eikonal.**—Strictly speaking there is no such thing as a geometrically exact point image nor a line image, but rather a distribution of intensity in space which ideally approximates a point or a line. The exact distribution of intensity in the image can only be computed exactly by the methods of physical optics in which one considers the superposition of an infinite number of infinitesimal wavelets arriving at any selected point in image space by all routes through the optical system. The relative phases of the uavelets are determined by the optical paths from a given object point to the selected image point via the various elements of area in the exit or in the entrance pupil. It will be recalled that optical paths are the sums or line integrals along the chosen paths of the product of each increment in path distance multiplied by the refractive index of the medium in which the increment is located. Since refractive index is the speed of light in free space divided by the speed in the medium, optical path is equal to the time taken for light to travel the selected path multiplied by a constant c, the speed of light in free space.

To define the frequently used terms, stationary path and nonstationary path, consider an infinitesimal change in any one of the co-ordinates that define an arbitrarily chosen path of light. If the resulting change in the optical path changes by an amount that depends on the first order, or power, of the infinitesimal, the path is said to be nonstationary. If, however. the resulting change in optical path depends only on second or higher powers of infinitesimal changes in all co-ordinates that define the path, the path is said to be stationary. A principle due to Pierre de Fermat states that actual ray paths are always stationary paths. One may derive the laws of rectilinear propagation, reflection and refraction by the use of Fermat's principle. Conversely, the introduction of the laws of reflection and refraction into optical path equations, for the purpose of simplification by reduction of the number of variables, restricts these equations to stationary paths or actual rays of light.

If the optical paths along different routes through an optical system are nearly the same, the wavelets arrive in nearly the same phase and there is a high intensity at the point of arrival. The maximum intensity is found at that point in image space to which there is the least variation in optical path from the object point. This is the location of the optical image point in the sense of physical optics. The sharpness or quality of the image depends on how rapidly the variation in optical path increases with displacement from the image point at ahich there is the least variation. It is evident that one must work with optical path functions to obtain exact information on image quality and the consequent resolving power. Further applications, leading to actual intensity distributions in image space require complicated integrations and will not be considered here.

Optical path functions may also be used to determine the location, magnification and the aberrations of images without calculating actual intensity distributions. Such functions nere first applied to these problems by W. R. Hamilton. His work was ignored for 60 years until redeveloped independently by H. Bruns in 1895. Hamilton defined four optical path functions expressed in terms of four different sets of variables. The best known of Hamilton's functions, called the eikonal by Bruns, is applied in the following paragraphs to the development of a mathematical theory of optical systems. This theory provides not only a mathematically elegant and powerful means of solving many optical problems but is considered to be more adaptable to modern machine computation than the older trigonometric ray-tracing methods.

All calculations will therefore be related to geometrical paths, but variation in the lengths of these paths rather than their distances from a mean point in the neighbourhood of an image is to be regarded as the significant factor on which the quality of the image depends. The two sets of magnitudes are not independent, and we proceed to find the connection betueen them.

Take origins of rectangular co-ordinates in both object and image spaces. Suppose in the first space that a point source of light is situated at (x, y, z) in the object space. Light is radiated from this point in all directions, and some traverses the optical system and finds its way into the image space. Generally the wave front in the image space will be a curved surface, and the normals or rays at different points of this surface differ in direction. A particular emergent ray may therefore be specified by its direction cosines. Let these be (L', M', N'), and suppose also that (ξ', η', ζ') is a point on this ray. The disturbance has taken a definite time to reach (ξ', η', ζ') from (x, y, z). let the corresponding optical path length, that is, the distance light travels in a standard medium in this time. be denoted by $\mathcal{V}$. Let $\mathcal{V}+\delta\mathcal{V}$ be the path length for a neighbouring ray starting from (x, y, z) and finishing at $(\xi'+\delta\xi', \eta'+\delta\eta', \zeta'+\delta\zeta')$, the final direction being $(L'+\delta L', M'+\delta M', N'+\delta N')$. If μ' is the refractive index of the final medium. the second path exceeds the first by

$$\mu'\{(L'+\delta L')\delta\xi'+(M'+\delta M')\delta\eta'+(N'+\delta N')\delta\zeta'\}$$

since the wave front. which marks the locus of points optically equidistant from (x, y, z), is normal to the ray. Now suppose that the tangent planes to the wave fronts at (ξ', η', ζ') and $(\xi'+\delta\xi', \eta'+\delta\eta', \zeta'+\delta\zeta')$ pass through the image space origin. Then

$$L'\xi'+M'\eta'+N'\zeta'=0$$

$$(L'+\delta L')(\xi'+\delta\xi')+(M'+\delta M')(\eta'+\delta\eta')+(N'+\delta N')(\zeta'+\delta\zeta')=0$$

and these conditions enable the expression we have found for the path difference to be written

$$-\mu'\{\xi'\delta L'+\eta'\delta M'+\zeta'\delta N'\}=\delta\mathcal{V} \tag{1}$$

Now L', M', N' are connected by the relation

$$L'^2+M'^2+N'^2=1$$

and therefore only two of them. say M' and N', may be regarded as independent variables. On eliminating L' (1) becomes

$$-\mu'\left(\eta'-\frac{M'}{L'}\xi'\right)\delta M'-\mu'\left(\zeta'-\frac{N'}{L'}\xi'\right)\delta N'=\delta\mathcal{V}$$

Since $\mathcal{V}$ is now regarded as a function of M' and N', for any small variations of M' and N' we shall have

$$\delta\mathcal{V}=\frac{\partial\mathcal{V}}{\partial M'}\delta M'+\frac{\partial\mathcal{V}}{\partial N'}\delta N'$$

and, since M' and N' may be varied independently, we find, by comparing these equations,

$$\mu'\left(\eta'-\frac{M'}{L'}\xi'\right)=-\frac{\partial\mathcal{V}}{\partial M'} \qquad \mu'\left(\zeta'-\frac{N'}{L'}\xi'\right)=-\frac{\partial\mathcal{V}}{\partial N'}$$

Now

$$\eta'-\frac{M'}{L'}\xi' \text{ and } \zeta'-\frac{N'}{L'}\xi'$$

are invariants for any given ray, and represent the y' and z' co-ordinates of the intersection of the ray with the plane $x'=0$. If we understand that y' and z' are the co-ordinates of a point in this plane we may write these equations

$$\mu'y'=-\frac{\partial\mathcal{V}}{\partial M'} \qquad \mu'z'=-\frac{\partial\mathcal{V}}{\partial N'} \tag{2}$$

If then we know $\mathcal{V}$ as a function of M' and N', that is to say if we know how the length of the optical path from the source to a plane through the image space origin varies as the direction of this plane alters, we can find where the common normal to this plane and the wave meets an arbitrary fixed plane through the origin.

If, instead of starting with a source of light at a known point of the object space. we had assumed it to be situated in the image space. some of the light diverging from this point would reach the lens and after refraction would emerge into the object space. We could take $\mathcal{V}'$ as a measure of the time taken by the light to reach a plane in the direction (L, M, N) passing through the object space origin. and obtain the equations

$$\mu y=\frac{\partial\mathcal{V}'}{\partial M} \qquad \mu z=\frac{\partial\mathcal{V}'}{\partial N} \tag{3}$$

for the point (y, z) in which the common normal to the wave front and the plane $L\xi+M\eta+N\zeta=0$ meets the plane $x=0$. The change of sign which will be observed on comparing equations (2) and (3) is due to the assumption that the positive directions of the axes are unaltered. so that a positive displacement of (ξ, η, ζ) corresponds to a decrease in the time $\mathcal{V}'$.

The function $\mathcal{V}$ suffers from the grave disadvantage that it is unsymmetrical, the variables in the object space being point co-ordinates. and in the image space direction cosines. A function which is symmetrical is at once obtained by considering the particular case in which the source of light is at infinity. It is convenient to include in the function the infinite term representing the length of the path between the source and a reference position near the lens, so the path is measured from the wave front which passes through the object space origin. Since all points on the same wave front are at the same optical distance from the source, $\mathcal{E}$, the new finite path length, which is a function of (M, N, M', N'), differs from $\mathcal{V}$ only by a constant, and, as in the case of $\mathcal{V}$, the equations

$$\mu'y'=-\frac{\partial\mathcal{E}}{\partial M'} \qquad \mu'z'=-\frac{\partial\mathcal{E}}{\partial N'} \tag{4}$$

are satisfied. In a similar way from $\mathcal{V}'$, by placing the source at infinity in the image space in the direction L', M', N', and rejecting the constant infinite part of the path. we obtain a finite function $\mathcal{E}'$ having (M, N, M', N') as its variables and satisfying the equations

$$\mu y=\frac{\partial\mathcal{E}'}{\partial M} \qquad \mu z=\frac{\partial\mathcal{E}'}{\partial N} \tag{5}$$

Now $\mathcal{E}$ and $\mathcal{E}'$ measure the time taken by the light to travel between the same two planes in opposite directions along the stationary path. This stationary path between two planes is unique and independent of the curvature of the wave front at either plane. Moreover the speed of light is independent of direction. It follows that $\mathcal{E}$ and $\mathcal{E}'$ are equal, and, since they are expressed in terms of the same variables. they must be identical.

In the application of this function the planes $x=0$ and $x'=0$ will be chosen to coincide with the object and image planes, or at least to be parallel to them. Equations (4) and (5) then show how this function. which itself expresses the length of a path carried through the refracting surfaces, and is thus particularly suitable for investigations according to the wave theory. enables the points in which rays traveling in specified directions meet the object and image surfaces to be found

Focal Lengths and Principal Foci.—The rays. being the normals to the wave front, are the loci of points for which the path is stationary for slightly displaced routes, and conjugate foci are points of a particular path between which the path length is stationary for larger deviations In an axially symmetrical system we can see immediately that a pair of such points for a skew ray (that is to say, a ray which does not lie entirely in an axial plane) are the intersections of any axial plane with the incident and emergent rays. By considering a ray in an axial plane as the limiting position of a skew ray, we can extend the definition to all rays. We shall call such conjugate points secondary foci. We proceed to find the positions of the principal secondary foci and the magnitudes of the corresponding focal lengths.

Take the axes of x and x' in coincidence with the axis of symmetry, so that $\mathcal{E}$ may be regarded as a function of three variables only, viz., $\frac{1}{2}\mu^2(M^2+N^2)$, $\mu\mu'(MM'+NN')$ and $\frac{1}{2}\mu'^2(M'^2+N'^2)$. Denoting these by a, b, c respectively, and differentiation by the addition of a suffix. equations (4) give

$$y'+\mu M\mathcal{E}_b+\mu'M'\mathcal{E}_c=z'+\mu N\mathcal{E}_b+\mu'N'\mathcal{E}_c=0 \tag{5a}$$

that is to say, the ray goes through the point $(\rho'L', Y', Z')$ distant p along the ray from the reference plane $x'=0$, where $\rho'=\mu'\mathcal{E}_c$ provided

$$Y'=-\mu M\mathcal{E}_b \qquad Z'=-\mu N\mathcal{E}_b \tag{6}$$

These equations show that at this point the ray goes through a point in the axial plane containing the infinitely distant origin of light (L, M, N). In other words the secondary principal focus lies on the ray at the distance $\mu'\mathcal{E}_c$ beyond its intersection with the reference plane $x'=0$. Similarly the secondary principal focus in the object space lies on the ray at a distance $-\mu\mathcal{E}_a$ from its intersection with the reference plane $x=0$ the measurement being made in the positive direction. By partial analogy with the properties associated with the nodal points of collinear imagery, if f is the object space secondary focal length, the y' and z' co-ordinates of the secondary image of the infinitely distant object (L, M, N) are Mf and Nf respectively. Equations (6) thus give $f=-\mu\mathcal{E}_b$, and similarly the image space secondary focal length is given by $f'=-\mu'\mathcal{E}_b$.

The secondary conjugate points corresponding to the magnification S must satisfy

$$\frac{Y'}{Y}=\frac{Z'}{Z}=s$$

and if these points are distant p and p from the corresponding principal foci, by equations (5) we have

$$\frac{\rho' M'-\mu M\mathcal{E}_b}{\rho M+\mu' M'\mathcal{E}_b}=\frac{\rho' N'-\mu N\mathcal{E}_b}{\rho N+\mu' N'\mathcal{E}_b}=s$$

or
$$\rho=-\frac{\mu\mathcal{E}_b}{s}\qquad \rho'=\mu'\mathcal{E}_b\,.\,s$$

since for a skew ray M/M' and N/N' are not equal. The connection between the principal foci, the focal lengths, a pair of conjugate foci and the magnification for any ray thus correspond exactly to those found for the instrument as a whole in collinear imagery. The fact that this law is followed for lengths measured along the ray itself, and not their projections on the axis, clearly involves the failure of collinear imagery. The constant magnification surfaces in fact tend to be spherical rather than plane.

We will next determine the primary principal foci, which are the points of intersection of successive parallel incident rays lying in the same plane through the axis of the system. Without loss of generality we may suppose $z=z'=N=N'=0$, and the y' co-ordinate of the point in which the ray meets the plane $x'=X'$ is

$$\frac{M'}{L'}X'-\mu' M'\mathcal{E}_c-\mu M\mathcal{E}_b$$

If this point is conjugate to the infinitely distant point (L, M), this value of y' will be unaltered by substituting

$$\left(L'-\frac{M'}{L'}\delta M',\ M'+\delta M'\right)$$

for (L', M'). Since $\delta M'$ is finite, we see that we must travel along the ray from its intersection with the reference plane the distance

$$\frac{X'}{L'}=\mu' L'^2\{\mathcal{E}_c+2a\mathcal{E}_{bb}+2b\mathcal{E}_{bc}+2c\mathcal{E}_{cc}\}$$

to reach the primary principal focus. The corresponding distance for the object space is

$$-\mu L^2\{\mathcal{E}_a+2a\mathcal{E}_{aa}+2b\mathcal{E}_{ab}+2c\mathcal{E}_{bb}\}$$

To determine the focal lengths we note from (5a) that the ray $(M+\delta M,\ M')$ meets the reference plane in the point $y'+\delta y'$ where

$$\delta y'=-\mu\delta M\{\mathcal{E}_b+2a\mathcal{E}_{ab}+b(\mathcal{E}_{bb}+\mathcal{E}_{ac})+2c\mathcal{E}_{bc}\}$$

Now the separation between these parallel emergent rays is $L'\delta y'$, and the angle between the two incident rays is $\delta M/L$. We define the focal length as the distance at which this separation is subtended by this angle, or

$$F=-\mu LL'\{\mathcal{E}_b+2a\mathcal{E}_{ab}+b(\mathcal{E}_{bb}+\mathcal{E}_{ac})+2c\mathcal{E}_{bc}\}$$

and similarly

$$F'=-\mu' LL'\{\mathcal{E}_b+2a\mathcal{E}_{ab}+b(\mathcal{E}_{bb}+\mathcal{E}_{ac})+2c\mathcal{E}_{bc}\}$$

where F and F' are the first and second primary focal lengths respectively. Substituting these values in generalized variations of (5) we find for points distant p and p from the principal primary foci

$$L\delta Y-M\delta X=\rho\frac{\delta M}{L}-F'\frac{\delta M'}{L'}$$

$$L'\delta Y'-M'\delta X'=\rho'\frac{\delta M'}{L'}+F\frac{\delta M}{L}$$

showing that conjugate points for the transverse magnification p are given by $\rho=F/p$, $\rho'=-F'p$, in harmony with the laws found in other cases. Just as we extended the conception of secondary foci from skew rays to rays in an axial plane, we may extend the primary concept to rays in general by basing generalized definitions upon the expressions we have derived.

Construction of **the Eikonal.**—Before the expressions which have been derived can be applied the eikonal must be constructed. We proceed to show how this may be done.

Suppose that the surface whose homogeneous equation is $f(a, x, y, z)=0$ separates media whose refractive indices are μ and μ' respectively. Let the reference planes for the two media both pass through the origin of co-ordinates and have direction cosines (L, M, N) and (L', M', N') respectively. Since for the stationary path the light travels perpendicularly to these planes, the distances of (x, y, z) from these planes for the light are $Lx+My+Nz$ and $L'x+M'y+N'z$ respectively. It readily follows that in the time taken by the light to travel from the plane (L, M, N) to the plane (L', M', N') via the point (x, y, z) the distance traveled in the standard medium is

$$\mathcal{E}=\mu(Lx+My+Nz)-\mu'(L'x+M'y+N'z)$$

If (x, y, z) determines the neighbourhood of the surface for which the time is stationary between the planes, we must have

$$(\mu L-\mu' L')\delta x+(\mu M-\mu' M')\delta y+(\mu N-\mu' N')\delta z=0$$

for all infinitesimal values of δx, δy, δz which satisfy

$$f_x\delta x+f_y\delta y+f_z\delta z=0$$

That is to say, we shall have

$$\frac{\mu L-\mu' L'}{f_x}=\frac{\mu M-\mu' M'}{f_y}=\frac{\mu N-\mu' N'}{f_z}$$

and each of these will be equal to

$$\frac{\mu(Lx+My+Nz)-\mu'(L'x+M'y+N'z)}{xf_x+yf_y+zf_z}$$

Now, since f is homogeneous in a, x, y, z,

$$af_a+xf_x+yf_y+zf_z=0$$

and therefore

$$\frac{\mathcal{E}}{af_a}=\frac{\mu' L'-\mu L}{f_x}=\frac{\mu' M'-\mu M}{f_y}=\frac{\mu' N'-\mu N}{f_z}$$

Now f_a, f_x, f_y, f_z are four homogeneous functions of a, x, y, z, between which the three ratios of these variables may be eliminated. giving $\phi(f_a, f_x, f_y, f_z)=0$ where ϕ is a homogeneous function. It at once follows that $\mathcal{E}$ satisfies the equation

$$\phi(\mathcal{E}/a,\ \mathfrak{L}, \mathfrak{M}, \mathfrak{N})=0$$

where $\mathfrak{L}$, $\mathfrak{M}$, $\mathfrak{N}$ denote $\mu' L'-\mu L$, $\mu' M'-\mu M$, $\mu' N'-\mu N$ respectively. This equation expresses $\mathcal{E}$, the stationary path length between the planes (L, M, N) and (L', M', N'), in terms of their direction cosines, so that $\mathcal{E}$ is the eikonal.

As an example, consider refraction at the paraboloid of revolution $y^2+z^2-4ax=0$. Here

$$\frac{f_a}{-4x}=\frac{f_x}{-4a}=\frac{f_y}{2y}=\frac{f_z}{2z}$$

so that $f_y{}^2+f_z{}^2-f_af_x=0$ and

$$\mathcal{E}=a\frac{\mathfrak{M}^2+\mathfrak{N}^2}{\mathfrak{L}}$$

Or, again at the spherical surface $x^2+y^2+z^2-r^2=0$ we have

$$\frac{f_x}{x}=\frac{f_y}{y}=\frac{f_z}{z}=\frac{f_r}{-r}$$

and therefore $f_x{}^2+f_y{}^2+f_z{}^2=f_r{}^2$ or $\mathcal{E}=\pm r(\mathfrak{L}^2+\mathfrak{M}^2+\mathfrak{N}^2)^{\frac{1}{2}}$. One root corresponds to the part of the surface which is convex, the other to the part which is concave, to the incident light.

By a similar process the equation of the refracting surface may be found when $\mathcal{E}$ is given as a homogeneous function of the first order in $\mathfrak{L}, \mathfrak{M}, \mathfrak{N}$. The equation of the eikonal for the sphere may be written

$$\mathcal{E}=r[\mu'^2+\mu^2-2b-2(\mu^2-2a)^{\frac{1}{2}}(\mu'^2-2C)^{\frac{1}{2}}]^{\frac{1}{2}}=r(\mu'\cos\phi'-\mu\cos\phi)$$

where ϕ and ϕ' are the angles of incidence and refraction. If then we write

$$\kappa=\frac{\mu'\cos\phi'-\mu\cos\phi}{r}$$

we have $\mathcal{E}=r^2\kappa$, $\mathcal{E}\mathcal{E}_b=-r^2$ or the secondary focal lengths are μ/κ and μ'/κ respectively, where κ is called the secondary power. The equations.

$$\kappa\mathcal{E}_a=\frac{\mu'L'}{\mu L}\qquad \kappa\mathcal{E}_c=\frac{\mu L}{\mu'L'}$$

merely mean that the refracting surface is the unit surface. Again

$$\mathcal{E}_b+2a\mathcal{E}_{ab}+b\mathcal{E}_{bb}+b\mathcal{E}_{ac}+2c\mathcal{E}_{bc}=-\frac{\cos\phi\cos\phi'}{LL'\kappa}$$

so that the primary power is κ sec ϕ sec ϕ'; also

$$\mathcal{E}_c-L'^2\{\mathcal{E}_c+2a\mathcal{E}_{bb}+2b\mathcal{E}_{bc}+2c\mathcal{E}_{cc}\}=\frac{\sin^2\phi}{\kappa}$$

the quantity on the left when multiplied by μ' being the distance between the primary and secondary principal foci in the image space. that is to say the astigmatism. It is worth noting that at the two principal foci the astigmatism is inversely as the refractive index.

When the incidence is normal both powers become equal to $\frac{\mu'-\mu}{r}$, an expression of importance because in a symmetrical instrument incidence is normal for paraxial rays, that is rays which lie close to the axis of symmetry. As the unit in which powers are expressed, the diopter. the inverse of a metre, is universally employed. Thus a lens of power 5 diopters (written 5D.) has a focal length of 20 cm. in air.

The Combination of Systems.—Having found the eikonal for the separate surfaces of the instrument it is now necessary to find those for the combination. The process involved may be illustrated by combining two systems. Let O_0, O_1 and O_2 in media of refractive indices μ_0, μ_1 and μ_2 be the reference points on the axis. $\mathcal{E}_1$ the eikonal for the first portion between planes through O_0 and O_1, $\mathcal{E}_2$ that for the second part between planes through O_1 and O_2, and $\mathcal{E}_{12}$ that for the whole. From the definitions of the eikonal it follows that $\mathcal{E}_{12}=\mathcal{E}_1+\mathcal{E}_2$. Moreover

$$-\frac{\partial\mathcal{E}_1}{\partial M_1}=\mu_1y_1=\frac{\partial\mathcal{E}_2}{\partial M_1}\text{ or }\frac{\partial}{\partial M_1}(\mathcal{E}_1+\mathcal{E}_2)=0$$

with a similar equation involving N_1. These two conditions enable M_1 and N_1 to be eliminated from $\mathcal{E}_1+\mathcal{E}_2$, leaving $\mathcal{E}_{12}$ expressed in terms of the external variables only.

Paraxial Laws.—From the formulas reached in a previous section we see that the refraction of paraxial rays is determined by the part of $\mathcal{E}$ which is linear in a, b and c. Let us put

$$\mathcal{E}=\text{const.}+\alpha a+\beta b+\gamma c+\cdots$$

then the conditions from which M_1 and N_1 are to be found are

$$\mu_0M_0\beta_1+\mu_1M_1\gamma_1+\mu_1M_1\alpha_2+\mu_2M_2\beta_2=0$$
$$\mu_0N_0\beta_1+\mu_1N_1\gamma_1+\mu_1N_1\alpha_2+\mu_2N_2\beta_2=0$$

Squaring and adding we find for the combination

$$\mathcal{E}=\text{constant}+\alpha_1a-\frac{\beta_1^2a+\beta_1\beta_2b+\beta_2^2c}{\gamma_1+\alpha_2}+\gamma_2c+\cdots$$

This expression shows that if we put

$$\alpha=\frac{A}{B}\qquad\beta=-\frac{1}{B}\qquad\gamma=\frac{C}{B}\qquad AC-BD=1$$

the paraxial constants of the compound instrument are given by the matrix law

$$\begin{pmatrix}A_{12} & D_{12}\\ B_{12} & C_{12}\end{pmatrix}=\begin{pmatrix}A_1 & D_1\\ B_1 & C_1\end{pmatrix}\begin{pmatrix}A_2 & D_2\\ B_2 & C_2\end{pmatrix}$$

the extension of which to any number of systems is simple.

For further applications of the eikonal to optical problems the reader is referred to the article "Optical Calculations" in R. T. Glazebrook's *Dictionary of Applied Physics,* vol. iv, p. 309 (New York, 1923), and to later articles on the subject in the *Transactions of the Optical Society* (London, 1899–1932) and in the *Journal of the Optical Society of America* (Philadelphia, 1917 *et seq.).*

Main Types of Optical **Instruments.**—Optical instruments tend to assume one of a few forms. Telescopes are systems of very great or even infinite focal length; they may invariably be regarded as a combination of two systems of finite focal length placed with their inner principal focal surfaces nearly or exactly in coincidence. The one part, often of large absolute aperture and long focal length, usually conforms to the thin lens type and is corrected for coma and central aberration. In the other part, the eyepiece, attention is chiefly given to the curvature and astigmatism. Telescopes are essentially instruments for increasing the angle an object appears to subtend at an observer's eye, and in most of them the field of view is small. At the opposite extreme are microscopes, also divisible into objective and eyepiece, but the former is of short focal length and small absolute, but large numerical, aperture. In the higher powers (that is, shorter focal lengths) the objectives tend to be very complex. As with telescopes the most important objective corrections are those for colour, central aberration and coma. The eyepiece is of simple construction. Only a small part of an object can be viewed at once. Camera lenses form a class in some respects intermediate between telescopes and microscopes. The field is large and the numerical aperture moderate. In general they are not separable into parts having distinct functions, and all aberrations must be considered. The use of lenses at appreciable axial separations is necessary for the attainment of satisfactory corrections.

Ray Tracing.—The professional optical designer in evolving complex instruments finds it expedient to use formulas for the aberrational coefficients merely as a general qualitative or roughly quantitative guide to indicate the modifications he should make in a partially developed system to reduce as far as possible the remaining aberrations. The outstanding difficulty in the way of using algebraic expansions for the whole of his work is the uncertain value of the terms of the expansion he must neglect. As he aims at taking into consideration lengths as small as a quarter of a wave length or less, that is to say about one ten-thousandth of a millimetre, it will be appreciated that our knowledge of the higher order aberrations must be thorough before reliance can in general be placed on expansions. The method adopted by the designer is to trace step by step through the system a selected set of rays, and to infer from their positions in the image space the aberrations remaining in the system. For tracing these rays many methods have been devised, of which particulars may be obtained from practical treatises. They are usually entirely trigonometrical, and logarithmic tables are generally employed. The calculations for skew rays are necessarily much more troublesome than those for rays in an axial plane, and in practice skew rays are rarely computed. A method of computing rays in an axial plane, suitable for use with a calculating machine, is as follows.

The incident ray is defined by $\mathfrak{b}$, the length of the perpendicular to the ray from the vertex of the surface, and sin*, where ψ is the angle between the ray and the axis. The refractive index is denoted by μ, the angle of incidence by ϕ, the curvature of the surface by R, and the separation between the vertices of this and the next surface by t. The same letters, with accents where necessary, are used for the refracted ray, and with the suffix 1 for the following surface.

In the customary methods of calculation ψ_1 is found by the angular relation $\psi_1=\psi'=\psi-\phi+\phi'$ which necessitates references to tables. In the present method the use of these tables is avoided by first finding an approximate value sin0 for $\sin\psi'$ given by $\sin\theta=\sin\psi-\sin\phi+\sin\phi'$. In the absence of aberration this value is correct, and also $\mathfrak{b}'=\mathfrak{b}$. In general aberration is present and corrections of aberrational magnitude are required. The working equations are

$$\sin\phi = \sin\psi + R\mathfrak{b}$$
$$\sin\phi' = \sin\phi \times \mu/\mu$$
$$\sin\theta = \sin\psi - \sin\phi + \sin\phi'$$
$$N = \mathfrak{b}\ (\sin\phi - \sin\phi')\ (\sin\psi + \sin\phi')$$
$$D = \tfrac{1}{4}\{\sin^2\theta + (\cos\psi + \cos\phi + \cos\psi')^2 - 1\}$$
$$\mathfrak{b}' - \mathfrak{b} = N/D$$
$$\sin\psi' = \sin\theta - R(\mathfrak{b}' - \mathfrak{b})$$
$$\mathfrak{b}_1 = \mathfrak{b}' + t\sin\psi_1$$

It is to be noted that $\frac{1}{2}N$ and $\frac{1}{2}N\mu\sin\phi$ are the linear first order coma and spherical aberration respectively for the single refraction, D is the ratio of twice the first order aberration to the total aberration, and

$$\frac{(\mathfrak{b}' - \mathfrak{b})\,\mu\sin\phi}{\{(1+\cos\psi)\ (1+\cos\phi)\ (1+\cos\phi')\ (1+\cos\psi')\}^{\frac{1}{2}}}$$

which is represented at most refractions with ample accuracy by $\frac{1}{4}(\mathfrak{b}' - \mathfrak{b})\mu\sin\phi$, is the difference in path between the route along the ray and that along the axis from their first to their second crossing point. Brief tables are used for finding D.

Graphical methods of representing the state of correction of the system are widely used. For example, the central aberrations may be shown by taking as ordinate the distance from the axis at which a ray crosses the unit surface and as abscissa the distance of its intersection with the axis from a suitable fixed point. The type of curve thus secured is widely used. The paraxial portion of the curve touches the ordinate axis. A more useful curve is obtained by taking the square of the height at which the unit surface is crossed as ordinate. The inclination of this curve to the ordinate axis for rays near the axis depends on the lowest order central aberration, and the curvature gives higher order aberrations. Moreover, if we draw through any point X on the abscissa axis a straight line parallel to the ordinate axis, the areas intercepted between this line and the curve measure the differences of path for light passing through the corresponding zones of the unit surface when the image point is at X. By choosing this ordinate so as to cut off alternately equal areas on opposite sides of the curve we can determine the point for which the differences of phase will be least. Corresponding to each geometrical figure a second curve may be drawn with the same ordinates, and the phase at a given image point as abscissa. When only first order aberration is present the geometrical figure is an inclined straight line. the phase curve is a parabola, and the best focus will be at the mid-point of the projection of the straight line on the abscissa axis. This result is at variance with the geometrical prediction that the best position of focus is three times as far from the position where the paraxial rays come to a focus as from the intersection of a marginal ray with the axis.

Asymmetrical **Systems.**—We have discussed at some length the properties of symmetrical lens systems because they form by far the most important section of geometrical optics. The expressions that have been given enable all the ordinary problems to be dealt with—for example, the paraxial expressions are sufficiently accurate to determine how large any simple lens must be to pass the rays the instrument should transmit. It is also a simple matter to derive a number of well-known conclusions from the general laws that have been given—for example, that the use of an optical instrument will not enable a brighter image of an object subtending an appreciable angle to be formed on the retina of an observer's eye. The reader is not likely to encounter any difficulty arising from the use of prisms inserted for the reflection of light at plane surfaces into the system, for they are equivalent to the insertion of a thick plate of glass with plane parallel faces. Methods of designing prisms to produce desired results cannot be considered in detail here. As a rule a trigonometrical procedure is adopted, but algebraic methods employing matrices appear to offer decided advantages.

Experimental Methods.—The marked changes in the way optical instruments have come to be regarded in recent years is reflected in experimental applications of the theory. A good example is afforded by the use of modified types of Michelson interferometers for the testing of optical instruments. This application of interference is due to F. Twyman. An early instrument of this type, equipped for varied work. was constructed by Adam Hilger, Ltd., for the National Physical laboratory, at Teddington, Eng. In the Twyman interferometer, monochromatic light passes through a pinhole and is collimated by a good objective so that plane waves strike the 45° beam-splitting plate. The lens to be tested is placed in one arm of the interferometer betueen the beam-splitter and a movable convex mirror. The centre of curvature of the mirror is made to coincide with a principal focus of the lens being tested. If the aberrations of this lens are negligible, the incident plane wave is converted into a spherical wave that is reflected back through the lens and returns as a plane wave. Interference betneen this wave and the plane wave from the other arm of the interferometer produces a few straight equally spaced fringes that can be reduced in number to zero by tilting the side mirror. The fringe system is viewed with the aid of a lens with the observer's eye at its principal focus. The presence of aberrations in the test lens causes the returning wave to deviate from a plane. One then sees distorted. elliptical or circular interference fringes that indicate, in steps of half waves, the deviations of the wave from flatness. In simple cases, the form of the fringes reveals the nature of the aberration, showing whether it is principally spherical aberration, coma, astigmatism, curvature of image or distortion. Space does not permit a further discussion of many interesting points that arise in the use of this and other methods for investigating the properties of optical instruments experimentally. *(See* LENS.)

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(T. SM.; J. VK.)

OPTIMISM, in philosophy, is the theory that the world is the best possible. or that life is worth living (to allude to the popular form of the problem).

For a discussion *see* PESSIMISM; PLATO; LEIBNITZ. GOTTFRIED WILHELM; HEGEL, GEORG WILHELM FRIEDRICH; also J. Sully, *Pessimism* (1877).

OPTION, the action of choosing, choice or the opportunity of choosing. In ecclesiastical law option was the right claimed by an archbishop to select one benefice from the diocese of a newly appointed bishop, the next presentation to which would fall to his, the archbishop's, patronage. This right was abolished in the early 19th century.

For the stock exchange options *see* OPTIONS (STOCK). Local option or local veto in politics is the power given to the electorate of a particular district to choose whether licences for the sale of intoxicating liquor shall be granted or not. *(See* LIQUOR LAWS AND LIQUOR CONTROL.)

OPTIONS (STOCK). Essentially. a stock option in security markets is a contract, paid for in advance, in which the holder has the right to buy (in the case of a "call" contract) or sell (in the case of a "put" contract) a specified number of shares of stock (generally 100) at a fixed price (normally the market price at the time the contract is made) at any time within the period covered by the contract (usually 30,60 or 90 days, or 6 months).

Consider the speculative possibility first. Let us assume the investor feels that XYZ stock is low priced at $70 a share and that it could advance to $8j a share in three months. To buy 100 shares under 75% margin rules would require a cash investment of $5,250. Unwilling to tie up this amount of cash and take the market risk that such a commitment involves, the investor buys a "call" option for $400, giving him the right to buy 100 shares at 70 within go days.

In that period, suppose XYZ climbs to 82. The investor could exercise his right to buy 100 shares at 70 from the endorser of the contract (a member firm of the New York Stock exchange) and immediately sell it in the open market at 82 for a profit of $1,200 less $400, the price of the contract, and usual brokerage commissions and taxes. If his judgment is wrong and XYZ drops to 50, his loss is limited to $400 as the price of the call option whereas an outright owner of the stock would have a paper loss of $2,000 and the possibility of further decline. At no time is the possible loss greater than the cost of the option contract.

To show the use of a put contract for speculation, let us consider the following. The investor feels that XYZ selling at 70 has a good chance of declining to possibly 50 in the next 90 days. He buys a "put" option contract at 70 good for go days for $350. If at any time in the 90-day period XYZ should decline to 50, he buys 100 shares in the market at jo and delivers it to the maker of the put contract at 70, showing a profit of $2,000 less $350, the cost of the option contract less brokerage commissions and taxes.

The protective feature of options may be explained as follows. A person owns 100 shares of XYZ selling at 70; believing that some political or other event might change the course of the stock temporarily, he buys a put option at 70 for 90 days for $350. Now through his put contract, he is guaranteed that regardless of how low the stock should decline in the next go days, he can deliver his stock at 70 to the maker of the contract. On the other hand, if the expected decline does not take place and instead the market rises and the stock goes to 85, his profit from the advance in the value of the security has more than offset his cost of $350 for the protection.

The call option serves the same purpose in insuring against unlimited loss in connection with a short sale. For example: a man short 100 shares of stock at 70 with no protection of a call contract has an unlimited liability. But the man who. when he sells short at 70, protects his commitment with a call contract at 70 for go days at a cost of $400 knows that even if the stock should sell at 100 in go days he can cover his short position by calling for his stock at 70. Thus his loss is limited to $400 plus commissions instead of an actual market loss of $3,000.

A call contract can be useful to an owner of stock who, because of need for cash, desires to sell his security and still would like to have an interest in the stock. As an example, a man owns 100 shares of XYZ which he bought at 70 and is now selling at 8j. He sells his stock in the market at 85 and buys a call option contract at 85 good for go days for $400. If after selling his stock XTZ continues to rise, he can in the go days recapture the stock at 85 through his call option.

If on the other hand, however, the stock should decline again to 70, he is in a position to buy back at 70 the stock which he sold at 85. While the cost of such "recapture protection" was $400, the gain afforded by the ability to buy back the stock 1j points loner than where it was sold made the purchase of the call worth while.

Makers of Options. — The put on XYZ mentioned above was probably sold by an individual or company who would be willing to issue a contract guaranteeing to the holder of the contract that for such $350 premium they mould accept 100 shares of XYZ at 70 any time during the life of the contract.

If the stock should decline and the issuer of such a contract has the stock delivered to him at 70, his cost would be 70 less the S350 already received for the contract or a price of $66\frac{1}{2}$. If the stock is not put to him, he has benefited by the $350 premium which he considered an adequate return in go days on the $7,000 investment.

The seller of a call on the other hand is probably one who owns XYZ and who for the sum of $400 would "give" someone a call on his stock at the current price of 70 good for go days. If the stock is called, the holder of the security loses his 100 shares at 70 plus the $400 already received. In other words, he has sold his stock at a price equivalent to 74. On the other hand, if the call is not exercised, the seller of the call has benefited by the $400 received in premium.

Practically, all of the put and call option business in the United States is handled by about 25 option dealers located in New York who operate through an association. Quotes on put and call option contracts may be obtained through local brokers or directly from a dealer in options. Orders to buy options may be placed in the same way.

All of the contracts in which they deal are guaranteed or endorsed by member firms of the New York Stock exchange and this Association of Put and Call Brokers and Dealers. Inc.. operates under the supervision of the Securities and Exchange commission. (HT. F.)

OPTOMETRY is a nonmedical profession concerned with determining the refraction of the eye by methods that can be applied without the use of drugs, and with the supplying of glasses. The optometrist also may administer eye exercises and fit contact lenses. Optometry is not concerned with diseases of the eye or with the practice of medicine and surgery. The word optometry was first used in 1877 by Landolt, an eye physician. to describe the use of the optometer to measure or refract the eye.

Spectacles were invented in 1300, and spectacle makers eventually became known as opticians. Following the development of refraction as a science by the physician F. C. Donders (1818–89) in the middle of the 19th century, the prescribing of eyeglasses by physicians became common. In the latter part of the century some opticians confined themselves to selling glasses on the physician's prescription. while others emphasized sight testing and became known as refracting opticians.

The term optometry was adopted by these refracting opticians when they were seeking legal recognition; thus the American Association of Opticians adopted the name American Optometric association in 1904. The term optometrist subsequently came into use in Canada and Australia and to a lesser extent in England, nhere the older terms sight-testing optician and ophthalmic optician are still in use. On the continent no distinction is made between refracting and dispensing opticians. The optometrist should not be confused with the ophthalmologist (also called oculist), who is a physician with training in everything pertaining to the eye.

There is considerable variation in the training of optometrists in the United States, ranging from apprenticeship to five years of college. An applicant for state licensing board examination must be a graduate of an optometry school accredited by the individual state board; before beginning practice he must pass an examination in the state in which he wishes to practise. The practice of optometry is recognized and regulated by state laws in every state in the United States. It is also regulated in each Canadian province. in Cnited States possessions and territories and in some other countries. In Great Britain qualifying examinations. requiring three years at an optical college, are held by the four professional associations according to the standards of the National Service act.

In 1958 there were ten schools of optometry in the U.S., five in England and two in Canada. as well as a number in other countries. Five of the ten schools in the United States were affiliated nith universities and offered a course leading to a bachelor of science degree after four or five years of combined preoptometry and optometry training, one also granting the degree of master of optometry after the fifth year. Schools not affiliated with universities conferred the degree doctor of optometry. both for their earlier courses of one or two years after high school and currently for their four or five years of combined preoptometry and optometry.

See also OPHTHALMOLOGY. (T. F. S.)

OPUS (OPOUS), in ancient Greece, the chief city of the Opuntian Locrians; the walls of the city were built on a hill about 6 mi. S.E. of the modern Atalante and about 1 mi. from the channel which separates the mainland from Euboea.

It was mentioned in the Homeric catalogue among the towns of the Locrians, who were led by Ajax Oileus; there were games called Aiantea and an altar at Opus in honour of Ajax. Opus was also the birthplace of Patroclus.

Pindar's Ninth Olympian ode is mainly devoted to the glory and traditions of Opus.

Its founder was Opus, the son of Zeus and Protogeneia, the daughter of an Elian Opus, or, according to another version, of Deucalion and Pyrrha, and the wife of Locros.

The Locrians deserted the Greek side in the Persian wars; they were among the allies of Sparta in the Peloponnesian War. In the struggle between Philip V of Macedon and the Romans, the town went over to the latter in 197 B.C.; however, the Acropolis continued to hold out for Philip until his defeat at Cynoscephalae (Livy xxxii, 32).

The town suffered from earthquakes, such as that which destroyed the neighbouring Atalante in 1894.

OPZOOMER, CORNELIUS WILLIAM (1821–1892), Dutch philosopher, was born in Rotterdam on Sept. 20, 1821. He studied at the University of Leyden, receiving the degree of doctor of law in 1845.

In 1846 Opzoomer was appointed professor of philosophy at the University of Utrecht, which position he held the remainder of his life. His specialty was jurisprudence and many of his numerous writings were in that field, notably *Scheiding van Kerk en Staat* (1875), in which he sustained the primacy of the civil power, and a commentary on the civil code of the Netherlands (11 vol., 1864–87).

His greatest influence, however, was in the field of philosophy. He was an empiricist of the positivistic type. His thought can best be traced in such of his writings as *Der Weg de Wetenschap* (1851), *Wetenschap en Wijsbegeerte* (1857), *Het Wezen der Kennis* (1863), *De Wanrheid en hare Kenbronnen* (1863), *De Godsdienst* (1864). *Goethe's Godsdienst* (1868) and *Ein Nieuwe Kritick der Wijsbegeerte* (1871). He advocated expulsion of the unscientific from religion, believing that the latter would be left unimpaired, and that it would lead to the reconciliation of religion and science and bring about a new Reformation. Though vigorously opposed at first, his views rapidly gained adherents and he became the leader of the liberals and the founder of modern theology in his country.

Opzoomer was also a widely read man of letters, translated the *Antigone* of Sophocles and the *Julius Caesar* of William Shakespeare into Dutch, and published (1872) a volume of critical studies on the great English dramatist. He died in Osterbeck on Aug. 23, 1892.

ORACH or MOUNTAIN SPINACH (also called sea purslane). known botanically as *Atriplex hortensis* (family, Chenopodiaceae), is a tall-growing hardy annual, whose leaves, though coarsely flavoured, are very often used as a substitute for spinach when young

The white and the green are the most desirable varieties. The plant should be grown quickly in rich soil. It may be sown in rows two feet apart, and about the same distance in the row, about April, and for succession again in June. If needful. water must be given freely, so as to maintain a rapid growth. A variety. with reddish foliage, is a hardy annual three to four feet high sometimes grown for ornament.

ORACLE, a shrine of a god or a hero at which inquiries may be made of him; the word also stands for the answer given at such a shrine. (The Latin word is *oraculum* from *orare,* "to speak"; the corresponding Greek expression is *chrēstērion, manteion,* and for the answer itself. *chrēsmos*) Such shrines were numerous in antiquity. among the most celebrated being those of Dodona (*q.v*), of the hero Amphiaraus in Boeotia, of Trophonius at Lebadea and above all, of Apollo at Delphi although Apollo had several other famous oracles In Italy, perhaps the best-known oracle was that of Fortuna at Praeneste (Palestrina). No one method of consultation and answer was used in all cases. The commonest methods were incubation, when the inquirer slept in the holy precinct and received an answer in a dream; divination by lot, as at Praeneste and at least sometimes at Delphi; and direct inquiry of an inspired person who answered orally. This last was the most characteristic Apolline method. Individuals not confined to oracular shrines mere on occasion thought to be inspired to give prophecies, and many collections of their utterances were extant, among the most celebrated being those of a certain Bakis, of the Sibyl or Sibyls *(see* SIBYLLA), and, for Rome, of Marcius or the Marcii. Apollo's propagandists often claimed that these prophets were inspired by him, and sometimes that they were his offspring.

Incubation in temples and other holy places was but a special application of the widespread belief that dreams were significant, a notion by no means confined to Greece and Rome or to antiquity. Dream communications from deities could take place anywhere. This can be seen, for example, from their occurrence, according to epic narratives, when the recipient was in his or her own bed; but, naturally, the dream was all the more likely to be genuine if received at a sacred spot. Thus. Pindar *(Olympians* 13, 75) shows Bellerophon sleeping at the altar of Athena. She appears to him in a vision so real that the bridle which she gives to him is actually in his hand when he awakes. This type of procedure took place most characteristically, though by no means only, at the temples of Asclepius at Epidaurus, and elsewhere. Of the surviving tablets which record cures. a great number tell of dreams in which the god or some of his attendants performed operations, not seldom of an impossible and fantastic kind. There is no need to doubt that believers had such dreams. Christians do to this day at the various churches where similar practices continue *(see* M. Hamilton. *Incubation,* p. 199 [1906], for the miracle of the Panaghiá at Tenos). Nor need it be doubted that a certain number of genuine cures resulted, whatever be the scientific explanation of them. In some cases the consultant wore or lay upon the hide of a victim recently sacrificed to the deity, thus reinforcing the sacredness of the place.

As regards Italy, the only kind of oracles seemingly native to the country were the lot-oracles *(sortes).* Something of the procedure at Praeneste is known from Cicero, who says that the *sortes* were slips of wood inscribed in antique lettering, that they were stirred and that one of them was then pulled out by a boy. An idea of the content of the inscriptions can be got from Livy: He records a portent: the *sortes* shrank and one, bearing the ominous words "Mars shakes his weapon." fell out. It appears, then. that the *sortes* were kept in a bundle when not in use, and that there was available only a limited number of possible replies! no doubt couched in general terms, like the one quoted by Livy. This, however, as Cicero shows, was at a time when the oracle had fallen into disrepute among the upper classes; in earlier and more believing times the procedure may well have been less mechanical. One could throw down uninscribed *sortes* and draw conclusions from their relative position to one another. or the like. That this was an ancient method of eliciting responses at Delphi is indicated by the recurrent use of the locution *aneile* for "gave answer." as in Herodotus. The literal meaning of the word is "took up." and this expression would obviously be appropriate in describing the action of picking up (and examining) objects such as the Praenestine *sortes.* There is indeed no sufficient reason to suppose that this method of oracle taking did not continue in use in fully historical times.

The history of Delphi, the most celebrated of ancient oracles: is long and complicated. and the early period of the shrine is very imperfectly known. Although in historical times Apollo gave answers there, tradition is unanimous that the shrine was not originally his. According to the "Homeric" hymn (or hymns) in his honour, Apollo guided a shipload of Cretans from Knossos to Pytho, as Delphi was then called, and appointed them his first clergy. In other words, it was believed that the origins of the oracle went back to Minoan times. The hymn recounts how Apollo, far from being the first occupant of the holy place, kills a female dragon or serpent who is already in possession. Her name, according to later informants, was Delphyna. The more usual account, however, makes the serpent a male named Python. There is an obvious connection betn een these names and the names of the place itself; underworld powers, moreover. very commonly manifest themselves in the form of a serpent. This belief fits the story in Aeschylus (Eumenides i, ff.), which seems to be the legend of the shrine. According to him, the original giver of oracles was Earth. Earth was succeeded by her daughter Themis and Themis by Phoebe, who gave the shrine to Apollo as a birthday present. There is nothing unlikely in the supposition that originally the oracles were given by an underworld power, whether by the earth-goddess or some other, and this possibility would bear out Delphi's reputed antiquity, for the worship of goddesses is known to have been prominent in pre-Hellenic cults. The most sacred object at Delphi was the omphalos or navel. This was allegedly the centre of the earth, which was conceived of as flat. (Its true form was not discovered until several centuries after any possible date for Apollo's arrival.) Artistic representations show the omphalos to have been a conical object, presumably of stone. For a time it was believed that French excavations on the spot had discovered it, but closer investigation of the object found revealed that it was simply an ornamental stone from one of the many buildings in the precinct. The letters on it, once read as GAS (*i.e.*, "belonging to the earth-goddess"), are part of a modern name scratched on it in recent times. (See A B. Cook, Zeus, ii, p. 169 ff., with plate ix; also Bousquet in Bull. corr. hell., 1951, pp. 210–223.) But that the centre of the earth should be marked is appropriate in the shrine of an under orld power, and in shape the omphalos resembles other sacred objects that are not statues, as, for instance, the idol of Aphrodite at Paphos.

Hardly less sacred than the omphalos was the tripod, on which the Delphic priestess sat while awaiting the inspiration that should stimulate her oracular utterance. Concerning the cause of this inspiration many theories have been put forward. One of the most celebrated is the ancient one, found in several Hellenistic and later authors, that a vapour issued from a cleft in the floor of the ndytum (holy of holies), where the tripod was, and intoxicated the priestess. Geologically and architecturally this is quite impossible; there was no such cleft, and the local strata have never been capable of producing any kind of gas. But that the Pythia, as she is regularly called, did pass into some kind of trance is highly likely. She was not an expert on divination, but a simple woman chosen from the local inhabitants. According to Diodorus Siculus she was a young virgin, but "in later times," he says, a certain Echecrates violated the then Pythia, and consequently the Delphians resolved in future to appoint women of not less than 50 years old to the office. When these "later times" were is not known, nor if there is any truth in the story, which even the credulous Diodorus introduces with "they say." Certainly the Pythia was old by the time of Aeschylus. After Apollo's willingness to inspire her had been ascertained by preliminary ceremonies, she took her seat on the tripod and there was supposedly filled with his divine power. P. Amandry sufficiently has shown that there is no reason to suppose that she underwent the violent convulsions described in Vergil's Aeneid as seizing the Cumaean Sibyl. It is furthermore clear both that the divine will was not alnays ascertained through the Pythia and that she need not be seated upon her tripod in order to prophesy. As already stated, there is reason to suppose that divination by lot was practised on occasion; and inscriptional evidence, together with an isolated mention in literature, shows that sometimes at least the lots were simply beans, doubtless of different colours or distinguished in some other way (see H. W. Parke and D. E. W. Wormell, The Delphic Oracle, vol. i, p. 18 and note 3 there, 1956). Presumably the lot procedure took place on days when inspiration of the Pythia was not be expected. She was inspired during nine months of the year, on the seventh day of each, as Apollo was born on that day. according to tradition, and it was sacred to him. The other three months belonged not to Apollo but to Dionysus. When, on the prescribed days. she mounted the tripod, the Pythia would be already in a very receptive condition. She would have been brought up in the atmosphere of Apolline cult; she certainly would be a wholehearted believer in the god's power and in his willingness to dictate messages to her; and the preliminary ceremonies would have confirmed her in her belief. Under such conditions, self-hypnotism or some allied phenomenon would be not unlikely to occur. While in her abnormal state, the Pythia would speak, intelligibly or otherwise. But her words were not directly recorded by the inquirer; he was handed a written document supposed to contain what she had said and, in the great days of the oracle, regularly couched in hexameters. This was the official response. Manifestly there was room here for extensive editing or even for wholesale forgery, which would account, among other things, for the good advice frequently given by the oracle (especially on such matters as the right place to found a colony) and also for the fairly numerous cases in which the response was couched in language so obscure, vague or ambiguous as to leave room for different interpretations. Thus there would be a sufficient explanation if events did not agree with the meaning which the inquirer had attached to the reply given him. But it is only fair to acquit the Pythia herself of any share in such pious frauds. If sundry legends of the shrine may be believed. there were occasions when she gave an answer without waiting for the usual preliminaries. A famous story concerns Alexander the Great. He arrived at Delphi on a day when inspiration of the Pythia did not take place and was told that she would not prophesy; he then laid hands on her and started to drag her to the tripod. She cried out, "My lad, you are invincible." and he took this as a sufficient reply. In other words, it was held that she might be inspired at any moment, and some such belief may have been current as early as the 5th century B.C. In Aeschylus' Eumenides she clearly sees the Erinyes in all their hideousness, whereas they are invisible to the chorus in the Choephoroe and are seen only by Orestes, as in the later play they are visible to the supernatural characters. The Pythia, however, has not yet mounted the tripod, but merely uttered her prayer for success in her prophecies.

As to the method of consultation, in early times at least it mould seem from Aeschylus that if there were a number of inquirers, they cast lots to see who should be answered first, and this may have remained the normal procedure. But the Delphians not only claimed the right of first inquiry, but granted it to whom they would. Plutarch gives a vivid picture of the way in which business increased and decreased at various periods. According to tradition, there was a time when the Pythia was inspired but once a year, on the seventh day of the local month Bysios (in early spring). Later, the press of consultants was so great that there were two Pythias on duty and a third in reserve; but in Plutarch's own time, one was enough. Whether consultation was allowable on other days than the seventh of those months during which Apollo was supposedly present (Dionysus gave no oracles at Delphi) is a debated question (see Plutarch. Quaestiones Graecae, trans. and ed. by W. R. Halliday, p. 61, 1928). There is evidence that sometimes at least it could take place, perhaps by special arrangement. Presumably the god was a free agent and might depart from normal procedure if and when he would.

Delphi, with its numerous and obviously far from unintelligent clergy, was the nearest approach to a head-centre of Greek religion. The prestige of the oracle. from early times to the Hellenistic period, together with the fame of the great Pythian games, held every fourth year, ensured a steady stream of visitors from all parts of the Greek world. People came from abroad also; the consultations said to have been made by Croesus of Lydia and by the Romans in the time of the Etruscan dynasty have at least some historical foundation. Thus the priests had good opportunities of learning far more about foreign countries and out-of-the-way corners of the Hellenic world than most Greek city-states' rulers were ever likely to discover. Therefore, if advice were asked about a good site for a new colony. it could be given, by what prompting of the Pythia before she went into her trance or by what "editing" of her reply is unknown. But certainly Apollo deserved his common title of *archegetes*, or leader (especially of colonists). Given any reasonable system of recording the information which judicious questioning would obtain from visitors to the holy place, the amount of Delphian knowledge concerning advantages and disadvantages of sites, accessibility of water supply and trade routes and other relevant matters would soon be very great. Hence. for instance. the two different accounts of the founding of Byzantium (Istanbul) need not be disbelieved nor regarded as hopelessly contradictory. According to the earlier record, in Herodotus, a Persian satrap, having the not uncommon name of Megabazos (Bagabusha) and said to have been contemporary with Darius I, was remembered in the Hellespontine district for having said that the founders of Chalcedon (modern Kadikoy), across the Bosporus from the site where Istanbul now stands, must have been blind to choose the inferior position when the better one was available. In the other account. doubtless current in Delphi, the Megarians, 17 years after the foundation of Chalcedon, sought advice about the position of a new colony and were told to build the city "over the way from the blind." The immediate advantage was that the tunny fishing was much better at the Golden Horn. The only adjustment necessary to the stories is to put Megabazos earlier than Darius. for Byzantium was traditionally founded in 667 B.C., about a century and a half before Darius came to the throne. A local jest, such as that credited to Megabazos, is precisely the kind of information which a visitor from that region would be likely to have, and some further questioning would soon produce the explanation. Certainly the stories of the foundation of colonies by Delphic advice are far too numerous to be thought of as mere pious legends or as propaganda by Apollo's servants.

Politically the importance of Delphi was considerable from early times down to the age of Alexander the Great. The oracle was not consulted on questions of ritual alone. such as recognition of a new cult, the proper measures to be taken to stop a plague or a famine. the method of dealing with a portent and so forth. Constitutions also were felt to need its sanction, and more than one system of laws, notably that of Sparta, was claimed as an actual dictation from Apollo or as a production of authors designated by him. There can be little doubt that, at most, approval of a draft constitution was signified in such cases. In what may perhaps be called international politics, it would seem that the oracle was in favour of the union of Greece under a strong ruler, native or foreign. This is not surprising in view of the constant bickering of the city-states; it was in effect the policy which Isocrates urged in the 4th century B.C., and from the standpoint of self-interest it was natural enough. An emperor of Greece, should one arise, would be likely to encourage the cult of an already popular god who supported him; and thus the Delphians, whose little community was insignificant apart from its religious prestige, might hope for a brilliant future under him. A hope of this kind makes it understandable that on the two noteworthy occasions when Greece was in danger of foreign conquest, Delphi more or less openly supported the invader (Xerxes I in the early 5th century B.C. and Philip II of Macedon in the 4th). In the Peloponnesian War, too, its sympathies were decidedly on the side of Sparta. This state, besides being solidly conservative. had for a long time held together a confederacy of the mainland powers of Greece, while Athens, though strong at sea and in the islands, had failed to do this.

But in an age when the reliability of oracles, like every other traditional idea, was under criticism, such partiality no doubt contributed to the decline in real importance of Apollo and his clergy. One symptom of this is the sorry figure which the god cuts in more than one play of Euripides, notably in the *Ion* and the *Orestes*. After Alexander the Great, the prestige of Delphi declined. There appears to be no certain instance (apart from fairly obvious fictions) of any of the new powers consulting it on really important political matters, though religious questions continued to be referred to it.

The holy place itself was occupied and its treasures plundered by the Phocians in 356 B.C. It was not freed until ten years later, Philip of Macedon taking the credit for its liberation and winning the support of the oracle. During most of the next century. Delphi was more or less under the power of the Aetolian league. A Gaulish raiding force endangered it in 279 B.C.—the tale of the defeat of this force has survived bedecked with miracles and an appropriate pronouncement of Apollo. The oracle was treated with respect and occasionally consulted by the Romans, but on the whole gradually declined in importance. After the fall of Macedon, danger from the Illyrians and Thracians threatened Greece. and in 85–84 B.C. Delphi, along with several other places, was taken and sacked by them. Most of the treasures, however, had already been appropriated (theoretically on loan) by the Roman Sulla. The emperor Hadrian brought about a temporary revival of the place, but after him its decline continued. The giving of oracles had ceased by the time Julian the Apostate made his attempt at a pagan revival. His inquiries elicited the famous "last oracle," to the effect that the shrine was in ruins and that no prophetic inspiration was forthcoming.

The growing feeling that religion ought to be associated with enlightened ethics led, not perhaps to any noteworthy change in the nature of the oracles given at Delphi or to modifications of Delphi's priestly policy, but certainly to a development in the opinions commonly held about the god and about his advice. Apollo had been concerned with at least some aspects of morality and with a certain legalism from early times. Herodotus preserves a tale, allegedly dating from about the middle of the 6th century B.C., about a Spartan named Glaucus. who tried to get the Pythia to sanction his intended perjury, was warned of the consequences of false swearing and, on expressing repentance, was further told that to tempt the god was as bad as committing the actual offense. Much later there was current a story about three pilgrims on their way to Delphi. They were attacked by brigands. and in the scuffle one pilgrim ran away while another accidentally killed the third in driving the robbers off. On asking how he might be purified, the pilgrim was told that he was not polluted at all by the blood of the man whom he had slain in trying to defend him. Another story concerns a rich and ostentatious man who made an elaborate sacrifice, only to be told that a certain poor but pious countryman was the god's most acceptable worshiper.

A pretty little poem, alleged to be an oracular response, says that holy places are always open to the good, who need no purification before entering, whereas no lustrations will cleanse the soul of the wicked. This shows a development similar to that observable in the Hebrew writers, with their increasing insistence on the comparative unimportance of ritual beside inward holiness and virtue; it results from a like advance in ethical thought in the two nations.

While Delphi was the best-known Apolline oracle, it was by no means the only one. A very celebrated oracular centre was Claros in Asia Minor, which flourished especially in late imperial times. There was a mystery cult as well at Claros—this was unusual, for Apollo has as a rule nothing to do with mysteries (see MYSTERY). Not only have various records of offerings to and consultations of the god been found at the site, but inscriptions from distant parts of the empire, such as Britain, Africa and other provinces, testify to acts of piety resulting from an "oracle" (*chrēsmos*) or "interpretation" (interpretatio) of the Clarian god. Various late authors also mention oracles of theological content. a noteworthy example being preserved by Macrobius. This shows strong Jewish influence, for it proclaims that Iao (*i.e.,* Yahweh) is the chief of all gods, but it is far from being orthodox Judaism, for it proceeds to identify him with Hades. Zeus. Helios and a fourth deity whose name is corrupted past certain restoration, each at a different season of the year. Behind these pronouncements there evidently lies a philosophical religion akin to Gnosticism (*q.v.*). The Clarian oracle moved with the times, but Delphi was slow to imitate it, although a few late oracles attributed to the Pythian Apollo show decided Neoplatonic influence. Philosophical oracles were much in vogue in imperial times, and collections of them were made with commentaries. There were, for example, the so-called Chaldean oracles put forth by the seer Julian, a contemporary of Marcus Aurelius, which were extensively commented upon by the later Neoplatonists. It does not appear, however, that Julian claimed that his oracles belonged to any particular shrine; they were rather alleged personal revelations to himself (see M P. Nilsson, Geschichte der *griechischen Religion,* vol ii, p. 455 ff., 1940). Oracles were also a common form of propaganda The extant collection of so-called Sibylline oracles (*q.v.*), a dozen books of very indifferent hexameters with additional fragments, are of Jewish origin and were worked over by Christians. They are of various dates from the time of Domitian (A.D. 81–96) and contain furious outbursts not only against paganism in general but specifically against Rome. In an age curiously devoid of anything like historical criticism of documents, these blatant forgeries were accepted in good faith as genuine pronouncements of the ancient Sibyls.

It remains to mention a few instances of abnormal oracles. A curious one was that of Hermes at Pharae in Achaea, described by Pausanias. This town had a large market place (agora), and in the middle of it stood a statue of Hermes with a stone hearth in front, to which were attached bronze lamps. The consultant came in the evening, burned incense on the hearth, filled and lit the lamps, put a coin locally current in the right hand of the statue and whispered his question into its ear. He then stopped his own ears and left the market place, unstopped his ears and listened to the first sound that was audible; this contained the answer to his question. The rite was a local development of a belief in a recognized omen, the ***klēdōn,*** or utterance which meant more than the speaker realized. A classical instance is to be found in the *Odyssey* (xx, 100 ff.), where Odysseus asks for a sign from the palace and overhears a tired servant girl cursing the suitors who make more work for her, and hoping that the meal which she is helping to prepare for them may be their last. The first sounds heard by the inquirer at Pharae would most likely be the talk of passers-by, and their words could easily be interpreted appropriately. Although there is nothing to indicate that Hermes' statue was very old, there are features of the cult of Pharae that seem archaic. and among these may be reckoned the treatment of the statue as if it were a living person. The oracle, or at least this oracular method, may have gone back to very ancient times.

A very remarkable oracle was that of Trophonius at Lebadea. Pausanias describes the method of consultation; in his time (about A.D. 150) it may well have been elaborated to suit contemporary tastes for the mysterious and impressive. The inquirer had first to spend several days in a building dedicated to the Good Daemon and to Tyche, where he was subject to certain restrictions, which included abstinence from bathing except in the local river, Hercyna. Animal sacrifices were made to several deities. and a diviner inspected the entrails to see if Trophonius was favourably disposed. Finally a nocturnal sacrifice was made, the blood of a black ram being run into a ritual trench *(bothros)* and Agamedes, the legendary associate of Trophonius, being invoked. The entrails of the last victim contained the final indication whether the oracle might be consulted or not. If the answer was favourable, the inquirer was bathed and anointed by two boys called Hermai. (Their title is the plural form of Hermes' name—the god perhaps watched over this rite in his capacity of Guide of Souls.) The consultant was then made to drink of two springs called, respectively. Lethe and Mnemosyne (Forgetfulness and Memory). so that he should forget everything but what was revealed to him. After a few more preliminaries, he descended into the shrine and thrust his feet into a hole in the wall. Having been mysteriously sucked down, he had his revelation, sometimes by sight, sometimes by hearing, and returned by the same opening. He was then seated on the so-called Throne of Memory and questioned by the priests while still in a bemused state. He had also to make a written record of his experiences and dedicate it. Pausanias had himself consulted the oracle and is therefore a trustworthy witness (Paus. ix, 39). Clearly the inquirer was strongly influenced by the strange ritual and took some little time to recover his normal state of mind and in particular to be able to laugh.

See also APOLLO; AUGURS; DELPHI; DIVINATION; MAGIC.

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ORADEA MARE, a town of Rumania, in the region of Oradea. Pop. (1956) 98,950. It is situated in a plain on both banks of the Crisul Repede river, and is the seat of a Roman Catholic and of a Greek Uniate bishopric (founded 1776). Among its principal buildings are the St. Ladislaus parish church, built in 1723, which contains the remains of the king St. Ladislaus (d. 1095), the Roman Catholic cathedral, built in 1752–79, the Greek cathedral, the large rococo palace of the Roman Catholic bishop, built in 1778, and the archaeological and historical museum. There is a law academy, a seminary for priests, a modem school, a Roman Catholic and a Calvinistic *Gymnasium,* a commercial academy, a training school for teachers and a secondary school for girls. Oradea Mare is an important railway junction; it possesses extensive manufactures of pottery and large distilleries, and carries on a brisk trade in agricultural produce, cattle, horses, fruit and wine.

Oradea Mare is a very old town; its bishopric was founded by St. Ladislaus in 1080. The town was destroyed by the Tatars in 1241. Peace was concluded there on Feb. 24, 1538, between Ferdinand I of Austria and his rival John Zápolya, voivode of Transylvania. In 1556 it passed to Transylvania, but afterward reverted to Austria.

In 1598 the Turks besieged the fortress unsuccessfully, but took it in 1660 and held it till 1692. After World War I it was ceded to Rumania and in Aug. 1940 back to Hungary, where it remained until 1945.

ORAKZAI, a Pathan tribe on the Kohat border of the North-West Frontier region, West Pakistan. The Orakzais inhabit the mountains to the northwest of Kohat district, bounded on the north and east by the Afridis, on the south by the Miranzai valley and on the west by the Zaimukht country and the Safed Koh mountains.

Their name means "lost tribes," and their origin is buried in obscurity; although they resemble the Afghans in language, features and many of their customs, they are rejected by them as brethren. One branch, the Ali Khel, has been traced to Swat, from which they were expelled by the other inhabitants, and it is not improbable that the whole tribe consists of refugee clans of the surrounding races. They are very wiry-looking mountaineers.

See TIRAH.

ORAL SURGERY is a specialty of dentistry that includes the diagnosis and surgical and adjunctive treatment of diseases, injuries and defects of the human jaws and associated structures. In general, this includes the treatment of wounds; the reduction of fractures of the upper and lower jaw and cheekbones; treatment of acute and chronic infections of the mouth and jaws, including fascia1 abscesses and osteomyelitis; repair of acquired and congenital deformities, including the use of bone grafts; the surgical correction of prognathism and severe occlusal abnormalities; the conservative and surgical treatment of such conditions of the mandibular joint as inflammation, infection and ankylosis; the excision of hard and soft tissue lesions of the mouth and jaws, such as cysts, as well as benign and malignant tumours; the extraction of teeth, including impacted and unerupted teeth; the preparation and improvement of the jaws for dental prostheses; the treatment of maxillary sinus infection of dental origin; the surgical treatment of diseases of the salivary glands; and operations on peripheral branches of the trigeminal nerve in cases of neuralgia.

History.—Diseases of the jaws are discussed in very early records. The Edwin Smith surgical papyrus of *c.* 1600 B.C. contains the oldest information regarding the treatment of jaw fractures, as practised in Egypt. The hieroglyphics deal with examination, diagnosis and treatment. Other old documents dealing with the treatment of diseases of the jaws include the works of Hippocrates (400 B.C.) and the *De medicina* of the Roman Aulus Cornelius Celsus (A.D. 30), in which the treatment of jaw fractures with gold thread is described. In the middle ages Avicenna included in his *Cantica* a chapter on mandibular fractures. Guglielmo da Piacenza was the first to recommend. in his *Liber in Scientia Medicinale (c.* 1275), intermaxillary fixation.

In ancient times medical and dental care nere combined, but separation gradually developed and they progressed independently. At the time of Pierre Fauchard, diseases of the teeth and jaws were treated by dental surgeons. In his *Chirurgien* dentiste (1728) Fauchard discussed many procedures in oral surgery, as did R. Bunon in Essai *sur* les maladies des dents, published in Paris in 1743. In Great Britain, Treatise on the Disorders and Deformation of the Teeth and Gums by Thomas Berdmore (1768); Dental Surgery by John Tomes (1859), who invented dental forceps; System of Surgery by T. Holmes (1870) ; and Science and Practice of Surgery by F. T. Grant (1878) consider some procedures in oral surgery. At that time, dental prostheses were already used to treat fractures of the jaws. Regarding other operations, the replantation of teeth accidentally lost is featured.

Today oral surgery is part of the dental profession, which considers oral surgery a dental specialty. Educational standards and oral-surgery literature were all matured under the auspices of the dental profession. A study of the professional life of pioneers in oral surgery shows that these men laid the foundation of the'oral surgery specialty at a time when the practice of medicine was all-embracing. Apathy and disinterest toward oral conditions existed in the medical profession. Physicians and surgeons did not desire to treat diseases of the teeth and jaws because resultant deformities of the face might leave the operator open to criticism. Furthermore, oral diseases presented no emergency because patients, although suffering, rarely died of such ailments. This situation was recognized by Simon P. Hullihen (1810–57), who emerged as the first to devote his special skill to the treatment of oral surgical diseases and so is recognized as the first oral surgeon in the United States. With little formal training available, he developed his skill with an innate ability and extraordinary dexterity but very limited background in medicine. During his short professional career, he operated on at least 200 antrum patients, more than 90 cleft lips and between 50 and 60 cleft palate patients. He performed more than 100 operations on cancer of the face and mouth, as well as an astonishing number of other surgical procedures, for some of which he invented ingenious instruments.

James E. Garretson (1828–95), who is called the father of oral surgery in the United States. named the specialty and further secured its future when, in 1864, he introduced it as a major subject in the dental curriculum of the Philadelphia Dental college, now the school of dentistry of Temple university. He was the first professor of oral surgery to be appointed to a dental faculty, and he emphasized the need for a broader education of dentists. In his textbook entitled *A* System of Oral Surgery (1869), he described both dental operations and oral surgery procedures. The book contains chapters on fractures, wounds, malformations and diseases of the jaws, maxillary sinuses and tongue. It contains information regarding cysts, benign and malignant tumours, operations for cleft lip and cleft palate and a chapter on resection of the maxillary bones.

Procedures. — Special Surgical Techniques. — While the principles of surgery are the same no matter what part of the body is operated on, the oral cavity presents a number of individual conditions that make modifications necessary. Even with careful technique, complete asepsis cannot be achieved, and it is fortunate that the oral tissues have a natural protective mechanism. This, however, is not effective if the surface is broken by a surgical wound. Even when operations are performed from an extraoral approach, contamination occurs if by accident or purposely the mouth is entered.

The jaws also differ from other bones in that they contain teeth, which frequently are infected, and normal as well as pathologic dental remnants. The jaws are supplied with abundant vessels and nerves leading to the teeth and lip; damage to these may cause severe hemorrhage or anesthesia and paresthesia in the face. The soft tissue contains an extensive capillary system that sometimes causes excessive bleeding, and this must be controlled.

In operations performed inside the mouth, special methods are required to make the field of operation more accessible, among these being excellent lighting, good retraction and hemostasis. The intraoral approach is often used to avoid disfiguring facial scars and because it facilitates the extraction of involved teeth and the preservation of functional occlusion.

The psychologic aspect of operations on the jaws and teeth is of great importance. Good cosmetic results are of major significance, since the patient values them more highly than he does functional restoration.

Exodontia.—This, one of the commonest oral operations, includes the extraction of teeth. Usually the alveolar bone and surface mucous membranes require surgical modification to improve the shape and contour of the ridges after multiple tooth extractions so that the patient may wear prosthetic replacements more comfortably and efficiently. This technique is termed alveoplasty. When unerupted or impacted teeth (usually third molars) are excised from the jaw bones, the term odontectomy is used.

Implant Dentures. — When there is extensive atrophy of the alveolar ridges so that denture retention is impossible, a number of surgical procedures may be employed to produce a ridge. The sulcus may be extended by stainless steel, tantalum or other inert metal implants attached to what remains of the jawbone. From oral projections of these implants, modified dentures may be firmly supported. Implant denture technique holds prospects of rehabilitating orally patients who otherwise would remain without teeth.

Injuries. — These include fractures and other injuries of the maxilla, zygoma and mandible, and damage to associated soft tissue. Uncomplicated jaw fractures are usually reduced and immobilized with wires, splints or arch bars attached to the teeth. In more complicated fractures, open techniques for reduction are employed, with wiring or plating of the fractured segments; in some instances bone grafts are used.

Odontogenic Infections.—These are the commonest cause of oral inflammatory swellings. Prompt removal of the infected tooth, root, cyst or other dental pathology is indicated. Antibiotics and general supportive therapy are commonly used; and when the infection has spread beyond the jawbone, extraoral drainage may be necessary.

Cysts and Turnours. — Cysts occur both in the soft tissues of the mouth, because of retention of secretions, and in the jaws, where they cause wide destruction. Nearly all the tumours that are found in other parts of the body, both benign and malignant, occur in the mouth.

The Temporomandibular Joint. — This joint and associated structures may be involved in inflammations that interfere with proper function of the jaws. Conservative treatment, such as is used in the treatment of arthritic joints elsewhere in the body, is usually palliative. Mandibular joint surgery is indicated in severe joint disturbances that do not respond to nonsurgical therapy and that either are very painful or seriously impair function.

Neuralgia. — This distressing affliction requires expert diagnosis. In some instances the pain is due to infection associated with teeth, but many times a neuritis or trifacial neuralgia is the basic cause. The nerve branches involved are injected or removed.

Professional Organizations. — In the United States, the American Society of Oral Surgeons was founded in 1918, and by the late 1950s the membership was over 700. Members are elected after passing an examination; they must have confined their practice exclusively to oral surgery for at least five years. A certifying board conducts examinations for certification of specialists in oral surgery, after they have had a minimum of three years of postgraduate oral surgical training in one of the 22 university-sponsored training centres in the United States.

In Great Britain oral surgery has usually been performed either by surgeons or by dental practitioners who had a medical qualification, and major operations, such as removal of malignant tumours, are still usually performed by surgeons. In 1947 the Royal College of Surgeons of England instituted a fellowship in dental surgery, which is awarded after passage of a primary and final examinations. The fellowship in dental surgery of the Royal College of Surgeons is now practically a requirement for a dentist who wishes to specialize in oral surgery, and postgraduate students come from the British Commonwealth and other countries to study for this qualification. In 1949 the Royal College of Surgeons of Edinburgh also instituted a fellowship in dental surgery. In Great Britain the Oral Surgery club was formed in 1937, limited to 40 active members, who are elected by ballot.

In western Europe, though there are varying requirements in different countries, oral surgery is generally performed by medical practitioners who in some cases also have a dental qualification or training.

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ORAN, a town and port of Algeria and the capital of the *département* of the same name, stands at the head of the Gulf of Oran, on the Mediterranean, about halfway between Tangier and Algiers, at the point where Algeria is closest to Spain. It covers an area of 6.1 sq.mi. Pop. (1960) 430,000, of which 212,000 were French.

The town, which is built on a series of terraces, was successively under Arab, Spanish, Turkish and French occupation, and shows a great variety of architectural styles. It was originally divided into halves by the ravine of Raz el-Aïn, now for the most part covered by boulevards and buildings. There are now three sections: La Blanca, the fortress and old town on the hill; La Marine, near the sea; and the Ville Nouvelle, which is built on the terraces on the right bank of the ravine.

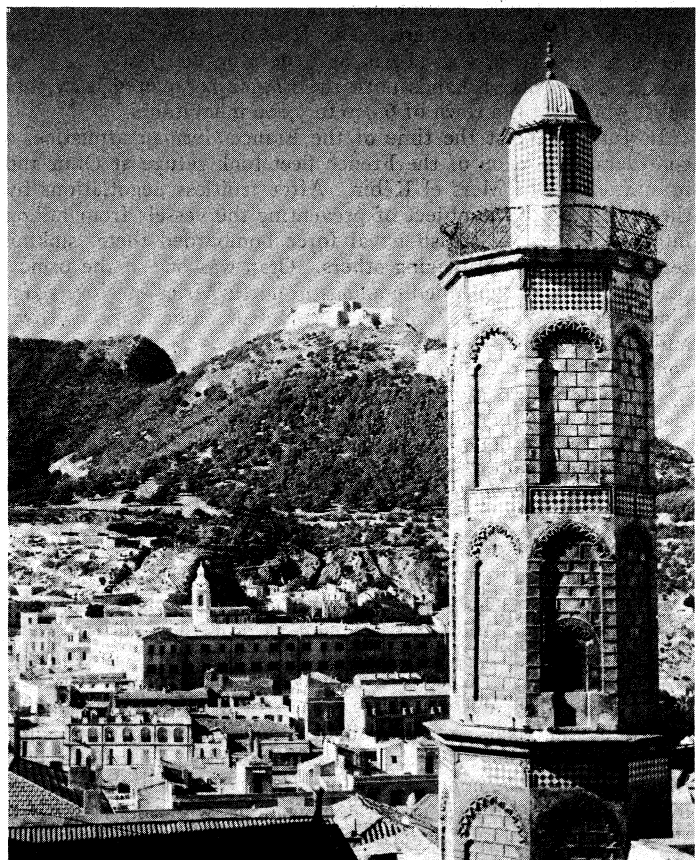
West of the ravine lies the old port, and above this is La Blanca, crowned by the ancient citadel of Santa Cruz. Originally built by the Turks, the castle of Santa Cruz was altered by the Spaniards in the 16th century and eventually restored by French military engineers between 1854 and 1860. The Spanish quarter of La Blanca also contains the former cathedral of St. Louis, originally the church of Our Lady of the Victory, built by Cardinal Jiménes, and the first church in Oran. It was founded on the site of a mosque. Severely damaged by the earthquake of 1790, it was rebuilt by the French in 1838 and rededicated as a cathedral in 1866. It became a church again in 1913. Other traces of the town's Spanish past include the Porte de Canastel (reconstructed by the Spanish in 1734), which was the chief gateway to Oran, and the fountain in the Place Emerat (1789).

In the Turkish part of the town (in the Rue Philippe) is the mosque built by the Turks in 1796 with money obtained from the ransoming of Spanish prisoners. To the east lies the Château Neuf, once the seat of the beys of Oran and later a French army headquarters. With its massive 14th-century keep, its drawbridge and its vast reception hall with Hispano-Moorish arches, this impressive building commands the sea approaches and in the past protected the city against the incursions of pirates. In the highest part of the old city is the Kasbah, surrounding the old castle, close to which is the elegant mausoleum of Sidi el-Haouari, a scholar and monk of the 15th century. Behind the Kasbah are the former barracks of the janissaries and the harem of the beys.

The construction of the French town was begun in 1831, and the buildings which composed it gradually spread across the ravine Raz el-Aïn. Around the Place Kléber, in the centre, are grouped the government buildings, including the prefecture (1852), the municipal buildings and the chamber of commerce. Since World War I the new town has extended far outside the second city wall, built in 1866 (now largely demolished), and has formed many suburbs, the chief of which are St. Eugène, Gambetta, Eckmühl, Choupot and Boulanger. Oran's notable buildings include the Hôtel de Ville (1882–85), with its imposing Renaissance façade and its vast staircase flanked by two bronze lions; the municipal opera house (1906) in the classical Italian style with two gilded domes; and the railway station (1913), built in the Hispano-Moorish style. The fine arts museum, which was built in 1930 and enlarged in 1955, contains, besides a museum, the municipal library and a school of fine arts. Between the Jewish cemetery and the public park is the Negro village (Sidi Okbar) built in 1845.

Communications and Industries.—Oran is a port of call for ships sailing from Europe, the U.S. and South America. It was greatly enlarged by the French after 1848 and is now the centre of a flourishing trade. Its jetty is nearly 4,000 ft. long and it has four large basins covering an area of about 330 ac. Near the Place Karguentah there is a station for motor coaches, which are controlled by the Algerian railway authorities and provide a network for the whole *département* of Oran. The railway connects Oran with Algiers to the east, Morocco to the west and Colomb-Béchar to the southwest. The airport lies beyond the village of La Sénia, nearly 4 mi. to the south-southeast.

The industrial part of Oran lies near the port and contains various food-processing factories including dairies and flour mills. Olives and other fruits, vegetables and fish are preserved and tinned. There has also been a growth in heavy industry with foundries, factories for making agricultural machines and shipbuilding. After World War II new industries developed, including glassworks, distilling and the manufacture of soft drinks and shoes. There are also spinning and weaving mills and carpets, baskets and cigarettes are made. Oran's principal exports include wines, cereals, vegetables, fruit and preserved olives, and among its chief imports are foodstuffs, building materials, timber, paper, textiles, fertilizers, agricultural machinery and motorcars.



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VIEW OF ORAN WITH THE CITADEL OF SANTA CRUZ ON THE HILL. IN THE FOREGROUND IS A MINARET FROM WHICH THE MUEZZIN, OR CRIER, CALLS THE MOSLEMS TO PRAYER

History.—Andalusian sailors settled at Oran at the beginning of the 10th century, using it as a base for their commercial operations with the African interior. From the 10th to the 16th century it grew in importance as a seaport, because of its maritime connections with Marseilles, Barcelona, Venice and Genoa. It became the seaport of the kingdom of Tlemçen, having been taken by the sultan in 1437. Its imports included textiles, tinware, wines, spices and perfumes, and its exports were wool, copper, skins, grain, dates, wax and sometimes slaves. Oran was also an emporium for trade with the Sudan and there the products of European industries were exchanged for ivory, gold dust, ostrich feathers and slaves. This brought great prosperity to the town up till the 15th century when the Portuguese gained control of the sea route of the Gulf of Guinea. In 1492 and 1502 Spanish Moslems, forced to become Christians, took refuge in Oran and founded a colony. During the early 16th century Oran sank into general decadence and became, with the nearby seaport of Mers el Kébir, a centre for pirates, but was rescued by the Spanish Cardinal Jiménes in 1509.

Until the 18th century the people of Oran were imprisoned in their fortifications, blockaded by Arabs or Turks. ravaged by plague and only irregularly provisioned by the Spaniards. In 1708. after a siege lasting five months. the town. which contained only 2.000 inhabitants, fell to the Turks. The population rapidly increased after the entry of indigenous peoples from the African interior and of French merchants. Wool, tinware, skins, corn, etc., were exported in exchange for textiles, sulfur, pig iron and other products.

The constant raids of pirates from Mers el Kébir led the Spaniards to retake Oran in 1732. In 1774 Oran had 10,000 inhabitants of which 4,300 were soldiers. In 1790 an earthquake destroyed a third of the city, particularly the Kasbah and old town, and half the population was killed. In 1792 the town was evacuated and the Spanish king Charles IV ceded it to the Turks, who settled a Jewish community among the adventurers who had established themselves there. The Jews built the Jewish village between the ravine Raz el-Aïn and the Rue des Jardins. Oran remained in Turkish hands until the French conquered it in Jan. 1831, when it was a town of 6,000 to 7,000 inhabitants.

In June 1940, at the time of the Franco-German armistice, a considerable portion of the French fleet took refuge at Oran and its naval base of Mers el Kébir. After fruitless negotiations by the British, with the object of preventing the vessels from falling into axis hands, a British naval force bombarded them, sinking some and severely damaging others. Oran was one of the principal objectives in the Allied landings in north Africa in Nov. 1942. Since World War II Oran has become an administrative town and trading centre. At the end of the 1950s plans were under consideration for joining the ports of Oran and Mers el Kébir by a jetty to form a deepwater harbour for the largest ships. It was also planned to build a military atomic base.

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ORANGE, HOUSE OF. The small principality of Orange, a district now included in the French *de'partement* of Vaucluse, traces back its history as an independent sovereignty to the time of Charlemagne. William, surnamed *le Cornet*, who lived toward the end of the 8th century, is said to have been the first prince of Orange, but the succession is only certainly known after the time of Gerald Adhemar (fl. 1086). In 1174 the principality passed by marriage to Bertrand de Baux, and there were nine princes of this line. By the marriage of John of Châlons with Marie de Baux, the house of Chblons succeeded to the sovereignty in 1393. The princes of Orange-Châlons were: (1) John I, 1393–1418; (2) Louis I, 1418–63; (3) William VIII, 1463–75; (4) John II, 1475–1502; (5) Philibert, 1502–30. Philibert was a great warrior and statesman, who was held in great esteem by the emperor Charles V. For his services in his campaigns the emperor gave him considerable possessions in the Netherlands in 1522, and Francis I of France, who had occupied Orange, was compelled, when a prisoner in Madrid, to restore it to him. Philibert had no children, and he was succeeded by his nephew Réné of Nassau-Châlons, son of Philibert's sister Claudia and Henry, count of Nassau, the confidential friend and counselor of Charles V. He too died without an heir in 1544 at the siege of St. Dizier, having devised all his titles and possessions to his first cousin William, the eldest son of William, count of Nassau-Dillenburg, who was the younger brother of Réné's father, and had inherited the German possessions of the family.

William of Orange-Nassau was but 11 years old when he succeeded to the principality. He was brought up at the court of Charles V and became famous in history as William the Silent (*q.v.*), the founder of the Dutch republic. On his assassination in 1584 he was succeeded by his eldest son, Philip William, who had been kidnapped by Philip II of Spain in his boyhood and brought up at Madrid. This prince never married, and on his death in 1618 his next brother, Maurice of Nassau (*q.v.*), stadholder in the United Netherlands and one of the greatest generals of his time, became prince of Orange. Maurice died in 162j, also unmarried.

Frederick Henry, the son of Louise de Coligny, William's fourth wife, born just before his father's murder, now succeeded to the princedom of Orange and to all his brother's dignities, posts and property in the Netherlands. Frederick Henry was both a great general and statesman. His only son. William II (*q.v.*), was married in 1641 to Mary, princess royal of England, he being 1 j and the princess 9 years old at that date, and he succeeded to the title of prince of Orange on his father's death in 1647. At the very outset of a promising career he suddenly succumbed to an attack of smallpox on Nov. 6, 1650, his son William III (*q.v.*) being born a week after his father's death.

A revolution now took place in the system of government in the United Provinces, and the offices of stadholder and captain- and admiral-general, held by four successive princes of Orange, were abolished. However, the counterrevolution of 1672 called William III to the head of affairs. At this time Louis XIV conquered the principality of Orange and the territory was incorporated in France, the title alone being recognized by the treaty of Ryswick. For William III's accession to the throne of England, *see* ENGLISH HISTORY. He left no children, and a dispute arose among various claimants to the title of prince of Orange. The king of Prussia claimed it as the descendant of the eldest daughter of Frederick Henry; John William Friso of Nassau-Dietz claimed it as the descendant of John, the brother of William the Silent, and also of the second daughter of Frederick Henry. The result was that at the peace of Utrecht in 1713, the king of Prussia abandoned the principality to the king of France in exchange for compensation elsewhere, and John William Friso gained the barren title and became William IV, prince of Orange. His sons, William V and William VI, succeeded him. William VI in 181j became William I, king of the Netherlands (*q.v.*).

See Bastet, *Histoire de la ville et de la principauté d'Orange* (Orange, 1856). (G. E.)

ORANGE, a town of France in the *de'partement* of Vaucluse, 18 mi. N. of Avignon on the P.L.M. railway. Pop. (1954) 10,515. Orange (Arausio), capital of the Cavari, was in 105 B.C. the scene of the defeat of a Roman army by the Cimbri and Teutones. After Caesar it became an important Roman colony. Its ramparts and fine buildings were partly destroyed by the Alamanni and Visigoths, and partly ruined by the erections of the middle ages. Orange was included in the kingdom of Austrasia, fell into the hands of the Saracens and was recovered by Charlemagne. It became the seat of an independent countship in the 11th century. The town had a university from the 14th century until the Revolution. Orange stands at some distance from the left bank of the Rhône, in the midst of meadows, orchards and mulberry plantations, watered by the Meyne, and overlooked by Mont Ventoux, 22 mi. to the east.

Orange has famous Roman remains. The triumphal arch ranks third in size and importance among those still extant in Europe; 72 ft. in height, 69 ft. in width and 26 ft. in depth, it is composed of three arches supported by Corinthian columns. On three sides its sculptured decorations are well preserved. The arch seems to have been set up in honour of Tiberius, perhaps to commemorate his victory over the Gallic chieftain Sacrovir in A.D. 21. It was used as a donjon in the middle ages. The theatre, dating from the time of the emporer Hadrian and built against a hill on the summit of which a colossal figure of the Virgin stands. has a façade 121 ft. high, 340 ft. long and 13 ft. thick, which is pierced by three square gates surmounted by a range of blind arches and a double row of projecting corbels, with holes in which the poles of the awning were placed. Of the seats for the spectators, only the lower tiers remain. It was used as an outwork to the fortress built on the hill by Maurice of Nassau in 1622, and destroyed 50 years later by order of Louis XIV, who in 1660 captured the town. At the beginning of the 19th century it mas filled with hovels and stables; the building has been cleared and restored, and serves as a national theatre. Near the theatre traces have been found of a hippodrome; and there are statues, bas-reliefs and ruins of an amphitheatre. Notre Dame, the old cathedral, originally built by the prefect of Gaul, was ruined by the barbarians, rebuilt in the 11th and 12th centuries. and damaged by the Protestants.

There are manufactories of footwear, brooms, jewelry and beet sugar. The town deals largely in fruit, and millet stalks for brooms, as well as in wool, silk, honey and truffles.

ORANGE, a city of Orange county, Calif., U.S., located 34 mi. S.E. of Los Angeles and just north of Santa Ana, has an average year-round temperature of 62° F. Situated in an orange-growing area, it was named after that crop. On July 1, 1810, the Spanish government granted Antonio Yorba and Juan Pablo Peralta the Rancho Santiago de Santa Ana, which included what is now Orange. A. B. Chapman and Andrew Glassell, law partners, received tracts of this land in payment of fees due them and founded the town as Richland in 1868. In 1871, the original townsite was laid out. The name was changed from Richland to Orange in 1875, and the town was incorporated in 1888.

The city is a centre of citrus- and walnut-packing, has aircraft, electronics and other manufacturing industries, and is the home of Chapman college, a fully accredited four-year liberal arts college.

For comparative population figures see table in CALIFORNIA: *Population.* (*B. J.* OR.)

ORANGE, a city of Essex county, N.J., U.S., 12 mi. W. of New York city and 4 mi. W. of Newark, N.J., was named Mountain Plantation from the time of its original settlement in 1678, until its present name was adopted to honour William, prince of Orange, who became King William III of England. The city has been a centre for the making of hats since 1785, the most famous being the Stetson which was produced there until the firm moved to Philadelphia.

The completion of the Morris and Essex railroad, now a division of the Delaware, Lackawanna, and Western, in the 1830s not only created an expanded market for the hatters of Orange but also brought the first commuters. George Huntington Hartford, onetime mayor of the town, founded the Great Atlantic and Pacific Tea company in New York city in 1859. From the industrial revolution until after the Civil War the shoe industry flourished in Orange.

Long a part of Newark, Orange became a separate community in 1806. It was incorporated as a town in 1860, was chartered as a city in 1872 and adopted the commission form of government in 1914. It originally included within its boundaries the present municipalities of East Orange, West Orange, South Orange and Maplewood. The five form a socioeconomic community that is unique in the U S. They contain some industry and plants in Orange manufacture calculating machines, aircraft parts, pharmaceuticals and wearing apparel, but they are primarily residential suburbs of New York city and Newark, N.J. They collaborate in many activities, especially those that are sccial service in nature.

The Beard school. a private institution in Orange, prepares young women for college.

For comparative population figures see table in NEW JERSEY: *Population.* (E. R. D.)

ORANGE, a city on the eastern boundary of Texas, U.S., and county seat of Orange county, lies at the head of the Sabine river; its deepnater harbour (32 ft.), which handles more than 1,000,000 tons a year, is connected with the Gulf of Mexico by the Sabine-Neches waterway.

The name of the settlement of Orange, originally called Green's Bluff, was changed to Madison in 1840 in honour of Pres. James Madison. In 1858 the city's name was changed to Orange to avoid confusion with another Texas town, Madisonville. By 1860 the Texas and New Orleans railroad was completed as far west as Orange. While the Civil War years marked a sharp decline in the activities of the town, recovery began in 1881.

Shipping and lumber were the pioneer industries, steam sawmills being used as early as 1840. In the years of World Wars I and II shipbuilding was a major industry; during the boom of World War II the population reached 60.000. After World War II the United States navy maintained a naval station and a "moth-ball fleet" at Orange.

Located in an area of major gas and oil fields, key industries include a large chemical plant manufacturing nylon salts, methanol and plastics; other industries consist of shipbuilding, steel fabricating, pulp and paper, sea food canning, lumber and milling, rice processing and cement manufacturing.

The council manager form of government was adopted in 1954.

For comparative population figures see table in TEXAS: *Population.* (E. W. F.)

ORANGE, the longest river of South Africa, almost traversing the continent from ocean to ocean. It rises in Basutoland, less than 200 mi. from the Indian ocean, and flows west, with wide sweeps south and north, to the Atlantic. It drains, with its tributaries, an area estimated at more than 170,000 sq.mi., passing through more than twelve degrees of longitude or 750 mi. in a straight line from source to mouth. The valley of the river exceeds 1,000 mi., and the stream has a length of not less than 1,300 mi.

Its headstreams are in the highest part of the Drakensberg range, the principal source, the Sinqu, rising, at an elevation of 10.822 ft., on the Mont aux Sources in 28° 48' E., 28° 50′ S.

Rising on the inner slopes of the hills these rivulets all join the Sinqu, which receives from the north several streams which rise in the Maluti mountains. Of these the largest are the Semene and Sinqunyane (little Sinqu) and the best known the Maletsunyane, by reason of its magnificent waterfall—an unbroken leap of 630 ft. Increased by the perennial waters of these numerous torrents the Sinqu makes its way southwest across the upland valleys between the Maluti and Drakensberg ranges. After a course of some 200 mi., the Sinqu, already known as the Orange, receives the Makhaleng, or Kornet Spruit (go mi.), which rises in Machacha mountain. The Orange here enters the great inner plateau of South Africa, which at Aliwal North, the first town of any size on the banks of the river, 80 mi. below the Kornet Spruit confluence, has an elevation of 4,300 ft. Forty miles lower down the Orange is joined by the first of its large tributaries the Caledon (230 mi.), which, rising on the western side of the Mont aux Sources, flows, first west and then south, through a broad and fertile valley. At the confluence the united stream has a width of 350 yd. Thirty miles lower down the Orange reaches, in 25° 40' E., its southernmost point—go° 40' S., approaching within 20 mi. of the Zuurberg range.

In this part of its course the river receives from the south the streams, often intermittent, which rise on the northern slopes of the Stormberg, Zuurberg and Sneeuwberg ranges. Of these the chief are the Kraai, which joins the Orange near Aliwal North, the Stormberg and the Zeekoe (Sea Cow), the last named having a length of 1zo mi.

From its most southern point the Orange turns sharply N.W. for zoo mi., when, having reached 29° 3' S., 23" 36' E., it is joined by its second great affluent, the Vaal (*q.v.*). There it bends south again, and with many a zigzag continues its general westerly direction, crossing the arid plains of Bechuana, Bushman and Namaqualand.

Flowing between steep banks, considerably below the general level of the country, there about 3,000 ft., it receives, between the Vaal confluence and the Atlantic, a distance of more than 400 mi. in a direct line, no perennial tributary but on the contrary loses a great deal of its water by evaporation.

In this region, nevertheless, skeleton river systems cover the country north and south. These usually dry, sandy beds, which on many maps appear as rivers of imposing length, are deep and turbulent streams for a few hours or days following rare but violent thunderstorms.

In 28° 35′ S., 20° 20' E., are the great waterfalls of the Orange, where in cataracts and cascades the river drops 480 ft. The Aughrabies or Hundred falls, as they are called, are divided by ledges, reefs and islets, the last named often assuming fantastic shapes. Below the falls the river rushes through a rocky gorge, and openings in the cliffs to the water are rare. These openings are usually the sandy beds of dried-up or intermittent affluents, such as the Bak, Ham, Houm. Aub (or Great Fish) rivers of Great Namaqualand.

Crossing the narrow coastal plain the river, with a southwesterly sweep, enters the ocean by a single mouth, studded with small islands, in 28° 37' S., 16° 30' E. A large sand bar obstructs the entrance to the river, which is not quite 1 mi. wide. The river when in flood, at which time it has a depth of 40 ft., scours a channel through the bar, but the Orange is at all times inaccessible to seagoing vessels. Above the bar it is navigable by small vessels for 30 or 40 mi.

Capt. Henry Hop first crossed the Orange in Sept. 1761, but returned shortly afterward. In 1777 Capt. (afterward Col.) R. J. Gordon, a Dutch officer of Scottish extraction, who commanded the garrison at Cape Town, reached the river in its middle course and named it the Orange in honour of the prince of Orange. Next year Lieut. W. Paterson, an English traveler, reached the river in its lower course, and in 1779 Paterson and Gordon journeyed along the west coast of the colony and explored the mouth of the river. F. Le Vaillant also visited the Orange near its mouth in 1784. Mission stations north of the Orange were established a few days later, and in 1813 the Rev. John Campbell, after visiting Griqualand West for the London Missionary society, traced the Harts river, and from its junction with the Vaal followed the latter stream to its confluence with the Orange, journeying thence by the banks of the Orange as far as Pella, in Little Namaqualand, discovering the great falls. These falls were in 1885 visited and described by G. A. Farini, from whom they received the name of the Hundred falls. The source of the Orange was first reached by the French Protestant missionaries T. Arbousset and F Daumas in 1836.

ORANGE, any of several species of small tropical and subtropical trees or shrubs of the genus Citrus (family Rutaceae) and their nearly round, orange-coloured fruits, ahich, like the fruits of other members of the genus—lemon, grapefruit, kumquat, citron, lime, shaddock (*qq.v.*)—have leathery and oily outer rinds and edible, juicy inner flesh. The species of orange most important commercially are the China orange (C. sinensis), which is the sweet or common orange; the mandarin orange (C. reticulata), some varieties of which are called tangerines; and the sour orange (C. aurantium), which is grown to a smaller extent than the common and mandarin oranges.

The species of orange are believed to be native to the tropical regions of Asia and especially the Malay archipelago. Oranges have spread from these regions to practically all sections of the world that have suitable climates. Along with other citrus species oranges have been cultivated from remote ages, and records of the early distribution from the original habitat to nearby countries are incomplete and fragmentary. It appears that orange culture spread from its native habitat to India, the east coast of Africa and from there to the eastern Mediterranean region. Samuel Tolkowsky in his book on the history of citrus fruits (see BIBLIOGRAPHY below) concluded that by the middle of the 1st century A.D. orange trees were being cultivated in Italy. Probably the four human activities that contributed most to the early spread and appreciation of oranges were: (1) the Roman conquests; (2) the Arab trade routes; (3) the following of and expansion of Islam entirely around the Mediterranean sea except the French and Italian coasts; and (4) the crusades. By the time Columbus sailed on his voyage of discovery, orange trees were common in the Canary Islands.

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BLOSSOMS AND FRUIT OF THE SWEET OR COMMON ORANGE TREE (CITRUS SINENSIS)

Oranges were introduced into the western hemisphere by Columbus when he established a settlement on the island of Hispaniola, Nov. 22, 1493, on his second expedition. The orange seeds for this first planting were obtained from the island of Gomera in the Canaries.

One of the first mentions of citrus trees being planted on continental America is to be found in an old manuscript in the official archives of Guatemala. In this manuscript, written in 1568 by Bernal Diaz del Castillo, is a direct reference to planting orange seeds in 1518. The coast of Darién (Panamá) was reconnoitered by Rodrigo de Bastidas as early as 1501, and a permanent settlement was made in 1509. It seems certain that orange seeds and plants were taken by this expedition and planted at Caribana, Nombre de Dios and Graba. Oranges are among other citrus trees reported growing at Caribana as early as 1516. It seems probable, therefore. that additional references may be found to planting of oranges earlier than the time shown by the Diaz record.

Orange culture spread to South America by the middle of the 16th century. The exact date of the introduction of oranges into Florida is not known. A statement was made by Pedro Menendez at St. Augustine on April 2, 1579, that "There are beginning to be many of the fruits of Spain. such as figs pomegranates. oranges, grapes. in great quantity . . ." From this we are probably justified in assuming that oranges were introduced into Florida when St Augustine was first settled in 1565. Two centuries later, wild citrus trees were to be found in various parts of the state.

Orange culture was introduced into Arizona on the establishment of the early missions between 1707 and 1710, and into California at the date of the establishment of the first mission in San Diego in 1769.

In the 18th century the orange tree became a favourite object of conservatory growth in England; in the open air, in protected locations, it has often stood the cold of many seasons in the southern English counties and has occasionally borne abundant fruit. The orange has usually been cultivated in England, however. for the beauty of the plant and the fragrance of the blossoms, rather than for the supply of edible fruit. In garden culture in southern Europe, the orange is sometimes trained as an espalier, and with careful attention yields fruit in great profusion when thus grown.

Oranges continue to be extensively cultivated in certain regions of the tropical and subtropical Americas and in the northern and eastern Mediterranean.

Plant Characteristics.—Growth Form.—The tree of the sweet orange (Citrus *sinensis*), often grows to a height of 20 feet and sometimes attains 35 ft. The broad. glossy evergreen leaves are medium sized and ovate-; petioles (leaf stalks) have narrow wings. The white flowers are very fragrant. Although the usual shape of the sweet orange fruit is round, certain varieties are greatly elongated and others much flattened; several (e g., the Washington Navel) have a conical protuberance, the navel, at the apex. The pulp of the sweet orange is agreeably acidulous and sweet, the peel is comparatively smooth, and the oil glands are convex.

The mandarin orange (Citrus reticulata) was formerly classified as a variety of C. *nobilis*. Mandarin orange trees are smaller than those of sweet or sour oranges, the twigs are slender and the leaves lance-shaped. The fruit is somewhat flattened at either end, with very thin loose peel, easily separated from the segments—giving them the name kid-glove oranges—and is bright orange colour when ripe. Some varieties, especially tangerines, are decidedly reddish tinted; the segments are readily separated from each other and the flavour is mild and pleasing. Some varieties. such as Satsuma, are seedless.

The tree of the sour orange (Citrus *aurantium*), also called Seville, bigarade or bitter orange, rarely exceeds 25 ft. in height. The green shoots bear sharp axillary thorns. Leaf colour is a glossy dark green; petioles are more broadly winged than those or' the sweet orange. Mature fruit is slightly depressed at both ends and sometimes nippled at the apex; the fruit surface is rough, dotted closely with concave oil glands. The fruit at maturity is brilliant orange with a slight reddish tint The pulp of the sour orange is only moderately juicy. relatively low in sugar and decidedly acid flavoured (3 5% to 4.5% acid); seeds are numerous.

These three species of orange reproduce themselves true to type. in most cases, by seed; and, where hybridizing is prevented, the seedlings of the smeet, mandarin and sour oranges retain the more distinctive features of their respective parent plants.

The Fruit **and** Its Composition. — The fruit of the orange is. botanically speaking, a special type of berry called a hesperidium (see FRUIT: *Classification* and Structure). The peel, composed of two distinct portions, the flavedo and the albedo, is easily separated from the pulp, the edible portion of the fruit. The flavedo (epicarp). the outer portion of the peel, is composed chiefly of carotenoid pigments, vitamins, and essential oils. The albedo (mesocarp) the spongy inner portion of the peel, is composed chiefly of celluloses. soluble carbohydrates, pectic substances (protopectin and pectin), flavonoids, amino acids and vitamins.

The pulp (endocarp) of citrus fruits, unlike that of most edible fruits. is divided into segments (carpels), the walls of which are not readily permeable; each segment is composed of hundreds of vesicles (juice sacs), the walls of which are still more impermeable, especially laterally. The vesicles are composed of celluloses, hemicelluloses. protopectin. pectin, sugars. flavonoids, amino acids. vitamin C, mineral salts and other nutrients. The juice, which is located in the vesicles, contains soluble constituents composed of soluble carbohydrates (glucose. fructose, and sucrose), organic acids (chiefly citric acids), vitamin C, vitamin B complex, mineral salts, a small concentration of pectic materials and many other nutrients.

Varieties. — In 1943 H. J. Webber described 97 varieties of sweet and mandarin oranges that had been gronn in the various subtropical parts of the world. Of the sweet oranges, the Washington Navel is the principal winter variety grown in California and Arizona. and the Valencia is the principal summer variety grown in these areas The principal sweet varieties gronn in Florida are Hamlin, Pineapple. Parson Brown, Homosassa and Valencia In Texas, the cultivation of the Valencia and Hamlin varieties increased greatly in the decade 1940–50. Blood oranges form another group of sweet oranges. They are characterized by the deep red tint of the pulp and comprise some of the best varieties; they are gronn extensively in the Mediterranean region but have not become popular in the U.S.

The mandarin oranges, nhich include the tangerines, are grown more extensively in Florida than elsenhere in the United States; the variety most widely grown is the Dancy tangerine The Temple a loose-, thin-skinned fruit which was especially desirable at one time in Florida, appears to be a hybrid between the mandarin and the sneet orange.

Another loose-skinned type of orange of the mandarin group is the Satsuma, nhich was introduced into the United States in 1876 from Japan, nhere it is nidely grown. Satsumas ripen earlier in the fall and are more resistant to frost than other commercially grown citrus fruit. They have been rather extensively groan in certain areas bordering the Gulf of Mexico, nhere it is too cold for the production of smeet oranges, but freezes during the two decades 1922–42 greatly reduced the acreage.

Mandarin oranges are highly prized as dessert fruits because of their attractive appearance and because their loose skin and easily separable segments make them easy to handle. The mandarins are lower in vitamin C content than are sweet oranges, lemons or grapefruit.

The Calamondin orange appears to be a variant mutation from some mandarin type with small fruit containing 7 to 10 segments. The tree is quite cold resistant, being apparently as hardy as the Satsuma, and it is grown in various parts of the United States as an ornamental tree.

The sour orange is grown to some extent in all citrus-producing sections, but its production on a commercial scale has been mainly limited to southern Spain, where it was first planted by the Moorish conquerors. The most important commercial use of the fruit is in the manufacture of marmalade. The sour orange in general is too acid and bitter for use as a fresh fruit; the juice, however, has a distinctive flavour which makes it a pleasing addition to certain beverages.

The fruit is also used in making confections, liqueurs (curaçao) and other drinks. The fruit and leaves are used in making a number of medicinal preparations. and the flowers, leaves and fruits yield volatile oils (bigarade oils) of characteristic odour, much prized for perfumes.

The oranges of the bergamot group (subspecies Citrus *bergamia*) are largely grown in southern Italy and Sicily for the essential oil that is expressed from the peel for making perfume. The bergamot group is thought to be of hybrid origin, with the sour orange as one of the parent species.

Cultivation. — Oranges are not strictly tropical plants, and they thrive best where the trees are chilled somewhat by occasional slight night frosts in ninter. The trees are semidormant at that season, and temperatures as low as 30° to 28° F. will not harm trees or fruits unless frost occurs early, before the trees have finished their annual growth. On the coldest sites, some means of heating the orchards is resorted to in California, and, to a lesser degree, in Florida. In such cases the critical temperature is 26° F. In California. the usual practice is to burn petroleurn oil in small five- to eight-gallon-capacity heaters (40 to 50 per acre) ; and to use large power-driven fans mounted on permanent towers for raising orchard temperatures as much as 8° F. under ideal conditions of temperature inversion; in Florida, pine or oak wood is the most widely used fuel.

The orange thrives in a wide range of soil conditions. from extremely sandy soils to rather heavy clay loams; it grows especially well in the intermediate types of soil. Orange orchards are generally planted in relatively deep soil where drainage is good. The orange trees are usually budded on stocks grown from the seed of selected trees of mandarin. sour or sweet orange, or the so-called Rough lemon. The seeds are sown in nell-prepared soil in a lath house; after about 12 months' growth there, the seedlings are removed to a nursery.

After 12 to 16 months in the nursery, the trees, then about $\frac{3}{8}$ in. in diameter at a distance 6 in. above the ground, are usually large enough to bud. When the budded tops are one to two years old, the trees are large enough to plant in the orchard. The number of trees planted per acre in the United States ranges from 48 to 110, depending upon vigour and variety and upon the method of culture.

The culture of intercrops. such as beans. tomatoes or melons, helps to provide favourable conditions for the young orange trees for the first five or six years. until they reach the age of profitable production. The gronth of cover crops during the ninter months in California. and during the summer months in Florida, prevents erosion damage and makes use of the seasonal rainfall for the production of organic matter to be incorporated into the soil. In California, approximately 50% of the orchards have no cover crops and are non-cultivated nhich results in the reduction of soil compaction with an increase of water penetration to the root zone. In addition to organic material supplied by cover crops. it is essential to use relatively large amounts of fertilizers, such as various nitrogenous materials; in Florida, applications of phosphate and potash are essential. Some of the minor nutritional elements, especially zinc, copper, manganese and magnesium, are frequently lacking in citrus soils. and small applications are then necessary. In many areas where oranges are grown, it is necessary to supplement the rainfall with irrigation; this is generally the practice in California! Texas, Palestine. Spain, Morocco and parts of South Africa. Orange trees will continue to bear abundantly from 50 to 80 years or even more, and some old orange trees whose age must be reckoned by centuries still produce crops. These very ancient trees are generally of the sour orange and have probably been frozen back and then rejuvenated by sprouts from near the ground. Sweet orange trees growing under orchard conditions occasionally acquire a considerable size; a 67-year-old sweet orange tree near Pasadena. Calif.. had a spread of $36\frac{1}{2}$ ft.; its height was 33 ft., and its circumference 1 ft. above ground was 5 ft. 7 in.

Harvesting.— Oranges are picked when fully ripe, for, unlike some deciduous fruits. they do not ripen or improve in quality after being picked. In the United States it is unlawful to sell oranges until they have reached a certain state of maturity, determined by the ratio of total soluble solids to acids in the fruit juice. In California the fruit must attain a maturity ratio of soluble solids to acids of 8:1 before it may be lawfully sold. As 80% to 85% of the soluble materials are sugars, and citric acid is the principle that gives oranges the typical mildly acid flavour, this ratio is often erroneously spoken of as the sugar-to-acid ratio.

In some sections oranges can be left on the trees for five to six months after they become mature enough to eat; during this period the sugars increase and the acids decrease, so that the ratio of soluble solids to acids at the end of the picking season is sometimes as high as 17:1. The vitamin content of oranges declines as the fruit becomes overmature.

Oranges are carefully handled during the picking and packing operations to prevent them from being punctured, scratched, bruised or scarred by abrasions. This care is necessary to prevent losses from decay caused by various molds, such as blue mold and other fungus organisms, which are widely distributed. The normal unbroken surface of the peel of the orange is very resistant to such diseases, but they readily gain entrance to the very susceptible inner portion of the peel and to the pulp of the fruit if the surface of the peel is injured even in the most minute way. To prevent such injury, and to prevent scarring of the fruit by the fingernails, oranges are picked by well-trained workmen wearing cloth gloves. The orange is removed from the twig by clipping the stem as close to the fruit as practicable. By this care in handling, millions of dollars north of fruit is saved that otherwise would be lost by decay.

Packing.— As the oranges pass through the packing house, they are handled largely by machinery, from the time the field boxes are dumped until the fruit is finally ready for packing in the shipping boxes. The usual processes through which the fruit goes in the packing house are: (1) doused in hot soapy water (115° F.); (2) cleaned as it passes under revolving brushes; (3) rinsed in clear water and brushed simultaneously; (4) rinsed in water and borax solution; (5) rinsed in clear water; (6) dried by passing on a belt conveyor through a tunnel through which air is forced at a high velocity; (7) culled by hand as it passes over a belt conveyor; (8) graded for size; and (9) packed in wooden boxes or cartons. In many packing houses supplementary aids, such as biphenyl, are used in the cartons to prevent decay of the oranges. A very thin layer of wax is applied to most oranges to prevent undue drying in transit or in the market. California boxes hold approximately 77 lb. of fruit, and Florida boxes hold approximately 90 lb. Each carton holds one-half box. Each box is packed with the same-sized fruit throughout. A medium-sized orange is $2\frac{3}{4}$ in in diameter and packs 176 to a California box.

Pests.—The insect pests most commonly troublesome to oranges in California are five species of scale: California red scale (*Aonidiella* aztrantii), black scale (Saissetia oleae), yellow scale (*Aoni*diella citrina), purple scale (Lepdiosaphes beckii) and citricola scale (Coccus *pseudomagnoliarum*). Several species of mealy bugs cause damage during some seasons, but, because of parasites and predators, they are not so generally harmful as the scale insects. In some districts in California, the citrus thrips (*Scirto*thrips citri) are a serious pest.

The citrus red mite (Panonychus citri), an arachnid, as well as aphids and other insects which cause damage in the coastal and intermediate areas may be controlled by pesticides. Other especially important pests are the Mexican fruit fly (Anastrepha *ludens*) in Texas and the citrus rust mite (Phyllocoptes *oleivorus*), citrus white fly (Dialeurodes citri), Florida red scale (*Chrysomphalus aonidum*) and also purple scale in Florida. The control of insect pests in all citrus-producing areas is one of the most difficult and expensive factors in the commercial production of oranges.

One of the serious pests of oranges in subtropical areas of the world is the Mediterranean fruit fly (Ceratitis capitata). The fly lays its eggs in the peel of the fruit and the larvae develoo in the pulp. Alarming infestations occurred in Florida in the spring of 1929 and again in 1956 but eradication programs were successfully implemented each time.

Most of the insect pests. as well as the various mites, are usually controlled satisfactorily by sprays or dusts. Applications are usually made with fully mechanized sprayers or dusters mounted on trucks or drawn by tractors. Mist spraying or dusting for the control of mites, thrips or certain other pests is sometimes done by properly equipped aircraft. One of the spray materials most commonly used for scale control is petroleum oil. Highly refined, light-medium or medium-grade oils applied at concentrations of $1\frac{1}{2}$% to 2% in aqueous emulsions are in use. Organic phosphorus compounds, such as malathion or parathion, have been used extensively in recent years, either alone or in combination with the petroleum oils. Other materials used principally for mite control include dinitro-o-cyclohexylphenol, Ovotran, demeton, Chlorobenzilate, zineb and Kelthane. Demeton has also been used effectively for aphid control.

ORANGE DISEASES

Fungus Diseases.—Several diseases of fungus or virus origin are generally distributed over most of the subtropical areas where oranges are grown. One of the most troublesome of these diseases, brown-rot gummosis or foot rot, is caused by several species of fungi (Phytophthora species). This disease affects the lower trunk and the crown roots of the tree and also produces a brown rot on the fruit, while it is still on the trees. in those years when weather is especially damp during the picking season. Phytophtlzora decays also cause loss of picked fruit. Spray mixtures in which copper is the lethal element are commonly used to spray the lower part of the tree, as the splashing of rain spreads the fungus spores most readily to the low-hanging fruits. When the disease is present on the crown roots and trunk, the tree has a devitalized appearance characterized by poor growth, pale small leaves and more than the normal number of dead twigs. The affected crown has dark-coloured areas from which gum exudes: beneath these areas the cambium is dead and discoloured. If not cut out and disinfected, the diseased areas continue to enlarge and finally girdle the tree. Preventive measures consist in avoiding both too deep planting and excessive water next to the trunk.

Loss of fruit in storage and transit is caused by rots produced by Phytophthora species, green mold (*Penicillium* digitaturn), blue mold (P. *italicum*), black rot (*Alternaria* citri) and others. Loss from these diseases is greatly reduced by the care exercised in handling the fruit during picking and packing.

Virus Diseases.—The most devastating virus disease is *tristeza*, occurring in Florida, California, Africa. South America and Java. It is spread by propagating from diseased trees and also by two species of aphids. Trees are killed suddenly by this disease. Another virus disease is psorosis, formerly called scaly bark in California. Seriously affected trees become valueless. The disease is spread largely by propagating from diseased trees, and may be avoided by care in selecting healthy trees from which to take buds.

ORANGE PRODUCTION AND USE

The sweet orange and the mandarin orange are the principal species produced commercially in the following countries, listed in order of importance in the early 1960s: the United States, Brazil, Spain, Italy, Japan, Mexico, Argentina, Algeria, Egypt and Israel. The world production of oranges, of these and other countries, ranges from the equivalent of 332,000,000 to 352,000,000 boxes (70 lb. each) annually. This enormous production of oranges, in comparison with that of other citrus fruits. is evidence of their world-wide popularity. Florida, California. Texas and Arizona, in that order. are the principal producing states of the United States.

Prior to 1920 the orange was considered principally as a dessert fruit. The drinking of orange juice, in contrast with the eating of the fresh fruit, was a major factor in the increase in per capita consumption. Another important factor was the increase in knowledge, gained by the mid-1950s throughout the whole world, of the dietary value of all citrus fruit. One of the primary reasons for the important dietary value of oranges is their high vitamin C content. Research showed the added value of citrus bioflavonoids from the pulp of oranges. This greatly increases the beneficial effectiveness of vitamin C in the juice and pulp.

The most important product made from oranges in the United States is frozen concentrated juice, nearly 40% of the crop being used for this purpose. Essential oils, pectin, candied peel and orange marmalade are among the important by-products. Stock feed is made from the waste material left from the processing of some of the afore-mentioned articles. This dried residue, known as orange meal, compares favourably with beet pulp and other semiconcentrates used as stock feeds and conditioners in preparing cattle for market.

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(L. D. B.; W. B. SR.)

ORANGE FREE STATE, an inland province of the Republic of South Africa. It is divided from Natal by the Drakensberg. from Basutoland by the Caledon river, from the Transvaal by the Vaal river and from the Cape Province by the Orange river and, in the west, by a line drawn across the veld from the Orange to the Vaal. It lies between latitudes 26° 30' and 30° 40' S. and between longitudes 24° 10' and 29° 40' E. Area. 49,866 sq.mi.

The country forms part of the inner plateau of South Africa, and most of it lies between 4.000 and 5,000 ft. above sea level. From the mountainous eastern districts it slopes gradually westward, no natural boundary marking its western frontier. The aspect of the country is that of vast, undulating, treeless plains, with a certain number of willows and thorn trees along the streams. The latter were formerly more widely spread but have nearly all been cut down for fuel. The Australian black wattle, gums and the pepper tree have been successfully introduced and are grown along the streets of the towns and in plantations on farms. especially in the eastern districts, to provide shelter, poles and firewood.

The general level of the surface is broken by low ridges and isolated table mountains, the latter attaining considerable elevation above the plain. They are particularly numerous and well developed in the east and are caused by the outcrop of beds of sandstones and dolerites. The rivers, except the Orange, Vaal and Caledon. are drq or nearly dry for three or four months during the dry wmter season; but after rain even the small spruits may become raging torrents. (For geology, climate, flora and fauna, see SOUTH AFRICA, UNION OF.) (R. U. S.)

HISTORY

At the beginning of the 19th century the great plateau between the Vaal, the Orange and the Drakensberg mountains was a no man's land, and the passes over the Drakensberg the haunt of cannibals and assassins. The indigenous tribal structure, mainly Bechuana, had been broken by refugee Zulu impis that attacked and despoiled one another in the wilderness that they created. Matiwane betneen 1818 and 1829 ravaged the whole of the territory, annihilated Mpanazita at Mekwatleng (20 mi. N. of Ladybrand) and scattered the remnants of his tribe from the Yaal to Queenstonn. Pursued by Shaka's impis, he fled across the Orange. His forces harried Pondoland but, mistaken for Shaka's, nere dispersed by an expedition from the Cape. Equally formidable was the young Sikonyela and his mother Mantatisi, the amazon and witch who guided the last stand of the Batlokua.

There seem to have been only two stable focal points in the area. Immediately north of the Orange river, on both sides of the Vaal (in the Campbell lands; in the modern Griqualand \Vest; and round Philippolis between the Orange and the Riet) there were contiguous Griqua settlements, protected by the formidable John Philip and encouraged by the government at the Cape as a buffer against incursions from the north. The Griqua frontiers fluctuated with their power, which, as they were the only people north of the Orange armed with rifles and as they were used to commando tactics, was greater than their numbers (see GRIQUALAND EAST AND GRIQUALAND WEST). The second nebular state mas to the east, where, on the rocky slopes of the Drakensberg, Moshesh (Msheshwe) had rallied shattered groups of Bechuana and was forging the Basuto nation. Within his fortress kraal at Thaba Bosigo he had an impregnable refuge from which he defied Sikonyela and even the great Zulu Mzilikazi (Mosilikatze). Patron of missionaries, chiefly French, gifted not only with military skill but also with Machiavellian astuteness, Moshesh held out between Mzilikazi and a horde of lesser chiefs on the west and Dingaan across the mountains to the east. When times were favourable, his family with their folloners diffused over the fertile Caledon plains and peacefully surrounded the territories of minor rivals. Moshesh used tribal structure as the basis of a new diplomacy at a time when the whole political geography of the Transorangia was fluid and chaotic.

In the 1830s systematic penetration of the lands across the Orange river began from the south. Missionaries, mainly Wesleyan in the west and Paris evangelicals in the east. embarked on a double and often rival program of conversion and settlement for displaced tribal groups. But even earlier than the Griqua settlement (1803) and the missionary penetration. a new kind of infiltration had begun, also from the south. Hunters and explorers had reported that there were great uninhabited plains north of the Orange river and fertile soil in the Caledon area. The Trek-Boers, ever questing after new pastures and new land to farm, began seasonal grazing across the Orange and then, by what they defined as grant and purchase (though often there was no written deed). procured lands from the Griquas or squatted in the Caledon area. Thus, nhile the Cape government strove to make a stable frontier at the Fish river, the frontier became increasingly an administrative myth. Then, in 1835, Lord Glenelg advised Sir Benjamin d'Urban to abandon the newly annexed province of Queen Adelaide and the retraction of the frontier was the signal for the Great Trek (see CAPE OF GOOD HOPE). North of the Orange river the cautious probing of the Trek-Boers was engulfed in the exodus of about 2,000 frontier folk, mainly Boers, lured by the prospect of more land and impelled by resentment against British colonial policy in the Cape. It was the beginning of an invasion and revolution that altered the structure and to a great extent determined the future development of Transorangia.

The trekkers were assisted by the Barolong chief Moroka at Thaba Nchu. and it is said that, until his death A H Potgieter was the friend of the Barolong. After initial reverses the trekkers mdpped out and planned a republic, but dissensions led to a forking of their enterprise. While a core remained in the Winburg region. one branch pushed north across the Vaal and another, under Potgieter and Piet Retief, crossed the Drakensberg into Zululand and Natal (*qq.v.*). After the massacre of Retief's party, the Natal trekkers made a treaty with Panda. who overthrew his brother Dingaan and rewarded them with the cession of most of Natal, then denuded of inhabitants by the flight of the victims of the Zulu wars. There the trekkers organized a republic with its capital at Pietermaritzburg. Exiled tribes flocking back perturbed the trekkers, whose proposal to resettle them south of Natal in territory flanking Pondoland threatened a shunting movement that would have reacted on the frontier structure of the Eastern provmce. Though a philanthropic native policy nas one of their objectives, it was probably this threat and, above all, commercial interests that induced the British to annex Natal in 1843. This, coupled with the announcement that there would be no colour bar in Natal and with the British attempt to resettle displaced Zulus there determined many trekkers to abandon Natal as they had abandoned the Cape. The Boers recrossed the Drakensberg and concentrated, some across the Vaal and some at Winburg. Thus Winburg in 1843 as in 1837 was the axis of Boer republicanism. In the same way, for different reasons, Transorangia became the axial point of British colonial policy.

Legally the attitude of the British government was based on the Cape of Good Hope Punishment act, passed in 1836 to extend criminal jurisdiction to all British subjects as far north as latitude 25° S. In political terms, this meant that the emigrants were not considered to have shed their allegiance by shaking the dust of the colony off their feet. Such, however, was the sole object of a resolute body of the trekkers; and men like Andries Pretorius, who abandoned ten farms in Natal to struggle back across the Drakensberg, made desperate sacrifices for their ideals. But British policy also had ideals, namely the controlled sale of crown lands so that some were held in trusteeship, the protection and civilization of native peoples and the extension of democratic institutions in areas of consolidated white settlement. The principles of British policy, especially in the "hungry forties," were crippled by lack of financial resources and by the interplay of crosscurrents of opinion on a disintegrated party structure in Great Britain. Ill-informed but sincere and powerful missionary interests in England demanded ever more protection for natives, while the equal eloquence of the Manchester school of economists demanded retrenchment and reform. In the swirl a policy coherent in principle was often impotent, sometimes mischievous in practice. Logically the annexation of Natal should have been preceded by the annexation of Transorangia. Instead the period 1837-48 was a disastrous interregnum which helped to jeopardize the experimental annexation between 1848 and 1854.

Between 1837 and 1848 the British fumbled to find means of enforcing the Punishment act and stabilizing native territories without incurring the responsibilities of sovereignty. In 1843 the Napier treaties with Adam Kok III (allied since 1838 to Waterboer) and with Moshesh tried to fix frontiers and tenures which in fact ignored Boer claims as well as the claims of minor chieftains in the centre. The signatories were to enforce the Punishment act. This led to armed protest from the Boers and almost consolidated a Boer front against Great Britain, until armed clash was followed in June 1845 by the Maitland treaties at Touwfontein. These planned to divide native lands into two: an inalienable tribal block; and lands which could be leased, the quitrents from which were to be divided between the chief and the expenses of a British resident to be established in the territory. This was a step forward; but many Boers had already purchased land outright! the frontiers claimed by Adam Kok were dubious, and Moshesh, who claimed inalienable sovereignty over lands wherever his people had fought or planted, was systematically surrounding the lesser chiefs between the Basutos and the Griquas with Basuto settlers. Inevitably the treaties failed to give stability or security. Though H. D. Warden was installed as resident at Bloemfontein, he had no white garrison in the whole of the area. More and more Boers relied on private enterprise, indifferently co-ordinated by Winburg.

When in Dec. 1847 Sir Henry Smith was made governor of the Cape and high commissioner for South Africa, it seemed as if the problem of South Africa was to be treated as a whole and no longer in segments. He had vigour and popularity and, up to the limits allowed by the colonial office, the courage of his convictions. He rounded off the seventh Kaffir war by annexing the Stormberg area and Kaffraria to the Cape; he speeded up the land commission in Natal with consideration for Boer demands there; and, after a tour that included an interview with Andries Pretorius at the Tugela Drifts, he annexed Transorangia to the crown and in Feb. 1848 proclaimed the Orange River sovereignty.

The Orange River Sovereignty, 1848–54.—Between 1848 and 1854 Great Britain sought to evolve an effective policy that would satisfy all groups at home and give firm ground to all in the quicksands of the new sovereignty. On frontier policy, all settlers on the fringes tended to think alike, whether Boer, Scots or English. so that a local patriotism independent of racial or political theory tended to crystallize at Bloemfontein as it had done in the Eastern province. When the annexation was proclaimed, because it seemed to promise security it was on the whole welcome to the majority of the white settlers. The Boer settlers seem to have fallen into two groups (apart from an indeterminate and scattered number of pioneers, who were not politicians) the pre-Great Trek settlers and loyalists.; and the minority of irreconcilable~, concentrated mainly in the Winburg area, who were moved by almost religious conviction that the theory of British policy was wrong and that their spiritual freedom lay in their political extrication from its clutches. It was this Winburg section that summoned Pretorius from Magaliesburg to lead revolt. To make that revolt successful, negotiations were conducted not only with Moshesh but with Panda, their former ally.

Such a tactic, if successful, would have exposed the whole of the sovereignty to the ravages of Zulu impis. The means could neither have justified nor served the end. More, extremists like Willelm Jacobs and Gert Kruger resolved at Winburg (Feb. 1848) to punish with fine, confiscation and death Boers who refused to cooperate. Many who joined the revolt did so because of compulsion; others claimed that they had thought an armed remonstrance was all that was intended; Potgieter sent no assistance from Ohrigstad across the Vaal. Pretorius and his party, having evicted British officials from Winburg, drove the embryo administration out of Bloemfontein and across the Orange, while loyalist Boers went into laager. When troops were available, Smith made a leisurely crossing of the Orange and advanced until attacked by Pretorius at Boomplaats (Aug. 1848). A vigorous skirmish of three hours culminated with the withdrawal of Pretorius across the Vaal with a price on his head. Two rebels taken in arms were shot and fines were levied, but there was no wholesale policy of total eviction. In the Cape, the children of Pretorius kept their extensive farms. Boomplaats, which was later to assume a distorted significance, cleared the air at the time; and when in Jan. 1852 the Sand River con ention with Pretorius secured the Klip river and Harrismith to the sovereignty, it was possible for the latter to develop as a distinct geographical and political entity.

The Orange River sovereignty was divided into four administrative districts, Bloemfontein, Smithfield (Caledon River), Winburg and Harrismith. Each was equipped with a minimum official staff, but only Bloemfontein maintained a garrison. The colonists were responsible under their field cornets for their own defense. Quitrents and traders' licences were the main source of the sovereignty's revenue. There was a central legislative council, nominated but two-thirds burgher. There was, however, no burgher representation on the executive until July 1853. Thus the official government tended to get out of touch with burgher sentiment when it sought to tackle the land question. In the 20th century the plan of administration would be described as one of reciprocal *apartheid:* the native chiefs were to remain undisturbed within surveyed frontiers, while their "foreign relations" one with another were subject to British control; they were otherwise to be "self-governing" through tribal structure, which, however, it was hoped would be modified by missionary guidance. But this ambitious policy could not be enforced by an understaffed administration. Moroka and Sikonyela and other minor chiefs, supported in some cases by their several missionaries, contested the frontiers claimed by Moshesh and his missionaries. No less than six frontiers were proposed to edge the Basuto lands off, and the Warden line (1849) satisfied no one—least of all the white settlers, because it cut through the fertile Caledon farming area. Bickering led to a series of local wars in the course of which Moshesh smashed his rivals (including Sikonyela). The administration was helpless, as the burghers were reluctant in disturbed times to abandon their farms for commando duty to enforce a policy of delimitation that, though it gave them full legal title to their farms! ran contrary to their traditions.

Given time, resources and sympathy, a solution was, though difficult, not inconceivable in the sovereignty. Warden laid the foundation stone of the Dutch Reformed church in Bloemfontein in 1849 and that of St. Andrew's cathedral in 1850. Settlers both Boer and British were trickling in, together with a sprinkling of foreign immigrants. The *Friend* of *the Sovereignty* was being printed in both Dutch and English. Special Commissioners W. S. Hogge and Mostyn Owen, who had sponsored Transvaal independence, could urge that the case of the sovereignty was different and that its evacuation would be a betrayal of responsibility. But like Earl Grey, his counterpart at the colonial, office, Sir George Cathcart, who became high commissioner on Sir Henry Smith's recall in March 1852, was bent on withdrawal after an abortive attack on and defeat by Moshesh at the Berea (Dec. 1852). In Sept. 1853 Sir George Clerk arrived with special powers to "settle and adjust the affairs of the Sovereignty." This was a euphemism for abandonment, a decision which the spectacle of Moshesh's private wars served to harden. A convention, elected on universal manhood suffrage, refused to vote itself into a republic. A public subscription raised enough to send the Rev. Andrew Murray and A. J. Fraser to England to protest against abandonment. Before they arrived in England, the die was cast. Clerk began importing supporters from the Transvaal to cabal for the negation of British policy in the sovereignty. A contrived assembly accepted the convention of Bloemfontein, which thrust independence on what was now the Free State, in Feb. 1854. Ten months later, Sir George Grey arrived in South Africa as high commissioner, a year too late to save the sovereignty. Great Britain abandoned not only the sovereignty but also all existing treaties with native states north of the Orange river, save only those with Adam Kok. Clerk undertook to "establish affairs in Griqualand," but neither then nor in 1861 (when Kok sold the remnants of his land to the Free State) were the Griqua lands defined.

The Orange Free State to 1900.—The constitution devised by the burghers in April 1854 was a blend of traditional Boer institutions with U.S. and Dutch constitutional theory. The unicameral *volksraad* had parliamentary sovereignty with control over taxation and over legislation and the right to ratify treaties and to declare war. No constitutional change could be made without a three-quarter majority in favour in each of two succeeding annual sessions (in 188; the high court was given power to decide whether a law was against the constitution). Franchise depended on the possession of burgher rights, which were limited to adult male Europeans, qualified either by birth or by property or by residence. Executive power was vested in a president and an executive council. The president was elected by direct vote of qualified burghers for five years and was eligible for re-election. Roman Dutch law was declared the law of the land, Dutch the officiallanguage. Equality before the law, freedom of association and freedom of the press were among the rights secured to burghers. The Dutch Reformed Church was to be promoted by the *volksraad*. Local government and defense turned on the traditional election of field cornets and all burghers were liable for commando duty. The judicial structure, central and local, and the provision of municipal boards followed the Cape pattern. The constitution was liberal and worked well. The small quorum of 12, however, tended at times to let power slip into the hands of an inner circle; but as new districts were created and controversial issues were raised, burghers in the outlying areas, who had at first regarded the constitution as a superfluous addition to the Ten Commandments, took a more active part in politics (since, moreover, the representative structure of single-member constituencies was related not to population but to districts, a small town like Hoopstad uith 30 voters came by the end of the century to have as much weight as a large city like Bloemfontein).

Until 1871, and to a certain extent throughout its existence, the Free State had the same problems that the sovereignty had had. The southern area looked to the Cape for its commerce and was influenced by Cape traditions, while the eastern and northern parts were dependent on the Harrismith route to Natal and had even closer links with the Transvaal—a cleavage corresponding to that betueen the Winburg and the sovereignty men. But wise leadership and the facing of common dangers welded the Free State for a time into what James Bryce defined with confidence as a model state.

The first president was J. H. Hoffman (1854–55), chosen for his reputed ability to cope with Moshesh; but his diplomatic present of a keg of gunpowder to the chief raised the outcry that forced him to resign. He was followed by the *voortrekker* J. N. Boshoff, formerly secretary to the Natal *raad*. M. W. Pretorius, of Potchefstroom, heir to the Winburg policy of his father Andries, tried by a coup at Rhenoster river (1857) to force the alignment of the Free State with Potchefstroom (Transvaal), but force was met by force and in June peace was made between the two republics, through whose histories, however, the idea of fusion was to run like a theme. Peace was timely, for Moshesh had seized the opportunity to pounce again. A bold Free State move against Thaba Bosigo failed so completely that Boshoff appealed both to Pretorius and to Grey, and the *volksraad* passed a resolution in favour of confederation with the Cape. Grey. convinced that the conventions had been a blunder because it was bad strategy to handle the native question piecemeal, responded by arbitrating the first treaty of Aliwal North (Sept. 1858) on the basis of adjusting the Warden line to give the Basuto more land in the Caledon area. This made explicit what the convention of Bloemiontein had evaded, namely that the western frontier of Basutoland marched with the eastern frontier of the Free State, and neither state had jurisdiction over the lands of the other.

Thereafter constant encroachments on both sides led to outrages, murder and undeclared war. The issues were complicated by Basuto family and tribal politics. Moshesh's sons Molapo and Masupha favoured a forward policy that Moshesh professed, perhaps insincerely (*cf.* his proven intrigues with native chiefs in the northern Cape and Pondoland), to eschew. Not the least subtle part of Moshesh's propaganda was the insinuation that the Boers in the Free State were the common enemy of the Basuto and the British. With the Cape government in difficulties in the Transkei and the Transvaal disunited and menaced on two fronts, Moshesh awaited the attack that he had provoked.

The third president of the Free State, M. W. Pretorius (1859–63), who for a short time combined the presidencies of the Free State and of the Transvaal, achieved a brilliant coup when, in 1861, he purchased the lands of Adam Kok III, the Griqua, for £4,000, albeit on ambiguous terms (*see* below). But Pretorius found that he could not keep his grip on the Free State without forfeiting his position in the Transvaal and resigned the presidency of the Free State in 1863, to be succeeded by J. H. Brand.

President Brand (1864–88) declared war on Moshesh in 1865. When the Free State forces were victorious (a belated Transvaal commando did little more than rescue for itself the lion's share of the booty), Moshesh played his last card and bestowed Basutoland as a Greek gift on Queen Victoria; but meanwhile he had accepted the treaty of Thaba Bosigo, which gave the Free State half his land. The Free State, however, was too weak to enforce the treaty, and guerrilla war was resumed. In March 1868 Sir Philip Wodehouse annexed Basutoland. Brand protested vigorously, but farmers who tried to move in on their allotted farms were often unable to hold them against Basuto raiders; and in safer zones those who had no share of the spoils protested that speculators in the new lands depressed land values in the old. Moreover, in the southwest of the Free State, the frontier resulting from Pretorius' Griqua purchase still needed definition. In 1869, then, Brand signed the second treaty of Aliwal North, which reiterated the convention of 1854 and drew a final frontier between the Free State and Basutoland, by which a substantial portion of the conquered territories remained to the Free State. The *volksraad* ratified the treaty with one dissentient, even though it cut off a possibie outlet to the sea via Pondoland.

On the whole, by 1868, though coin was short and credit low, the Free State had made remarkable progress. The Grey college, nucleus of the future university, had been founded, churches were established and municipal boards created. The resources of the state were greater than its assets, for it had steadily extended its land. The new Basutoland frontier left the bulk of the wheatlands to the Free State. Most of the native enclaves were in the process of disintegration, partly because of the early wars of Moshesh. partly because of European purchase and diplomacy. In marked contrast to practice in the Cape and Natal, native ownership was forbidden, while only two substantial reserves, at Thaba

Nchu and at Witzieshoek, were destined to survive under Free State protection.

Even before he had resolved the Basutoland crisis Brand found himself involved in the ambiguities of Pretorius' Griqualand purchase. Adam Kok denied from the first that the purchase included the Campbell lands which Cornelis Kok had bequeathed to him. More vociferously, Waterboer, in Griqualand West, claimed that, whatever his intentions, Adam Kok had had no power to sell them or Cornelis any right to bequeath them, since he, Cornelis, held the lands merely as vassal of Waterboer. The Campbell lands sprawled across both sides of the Vaal river, the eastern portion having in practice been administered' by Warden from Bloemfontein and by the Free State from Jacobsdal. Quite apart from the claims of Waterboer, the British high commissioner was anxious to secure either for Great Britain or for the Cape the missionary-merchant road to the north; the Transvaal coveted most of the land west of the Vaal between the Langeberg mountains and the Molopo river; and the Free State could advance a common-sense claim to land in the angle of the Vaal and Orange rivers to reinforce its interpretation of the purchase of *1861*.

The discovery of diamonds, first on both sides of the Vaal river and then in the dry diggings (1870), sharpened the conflict and made a leisurely solution impossible. There was the immediate problem of jurisdiction over the congested cosmopolitan diggings; there was the problem of controlling native and coloured vagrants and labourers, who flocked from every quarter; there was the question of trade and transport development; and there was the question of the ownership of the diggings, which was now tossed like an apple of discord by Waterboer to Great Britain. The British government made two separate but not unrelated decisions: to enforce the Keate award *(1871)* against the Transvaal (*q.v.*); and to annex Griqualand West. To the Free State this could only seem peremptory and, as evidence which was not brought forward until after the annexation suggested, unjust.

In *1876* Brand visited London on the invitation of the secretary of state for the colonies, the earl of Carnarvon. Understandably, the Free State was at that point averse to schemes of federation, and Brand took no part in the discussions of them. He did, however, secure £90,000 in compensation; and the Free State was promised a further £15,000 if a railway linked either with the growing Cape system or with the Natal line were completed in five years. The compensation had the present advantage of liquidating the public debts of the Free State. The blow was further softened by the discovery of diamonds at Koffiefontein *(1875)* and at Jagersfontein (1878), well within the state boundaries. The Free State was no longer terra incognita, but a busy highway to the diamond fields and a transport riders' paradise. Frontier security as well as the leaven of relative prosperity stimulated farming. It was during this diamond decade that, as a result of the work of J. Brebner, the first inspector general of education, the sound foundations of a general system of primary education were laid.

Brand saw more clearly than most of his contemporaries the importance of railways; he also perceived the sound strategic position of his state in the economic development of the hinterland, especially when the Rand gold rush succeeded the Lydenburg (*see* TRANSVAAL throughout). But he also understood the temper of the Free State and how to make haste slowly. His first Railway bill was introduced in *1876*. Thereafter, for 12 years it was a hardy annual. Brand's patience, imperturbability and concern for his people, which won and held their confidence, stood him in good stead during the sustained crisis of the first British annexation of the Transvaal (1877–81) and the climax at Majuba, where he mediated between the belligerents. He was troubled during the last decade of his presidency by the renaissance of old cleavages in a new guise. The pressure of the Afrikander Bond emphasized the divergences of the two white races. The political strategy of Paulus Kruger in the Transvaal was a more formidable version of the policy of Pretorius and aimed at building an exclusive republican axis against both the Cape and Natal. A growing minority in the Free State favoured the Delagoa bay railway policy of Kruger, whereas Brand had to consider not merely the unity of his state as a political entity but also the geographical, economic and cultural links with the Cape. Brand worked unceasingly for the closer co-operation of the four white communities but was not prepared to make the Free State the footstool of any one of them. For him the immediate problem was that of railway construction, to which the whole question of transit rates and of customs duties at the ports was allied. An understanding in clause viii of the convention of Bloemfontein that the Cape would allow a customs rebate on goods in transit to the Free State had, for reasons of Cape finance and parochial politics, not been fulfilled. Brand therefore prepared the ground for a customs agreement with the Cape, from which in the next decade the Free State was to reap substantial rebates. One week before his death, he secured the belated approval of the *volksraad* for the extension of the Cape railway system to Bloemfontein. Even then it was only secured because the chairman, Sir John Fraser, used his casting vote. Opinion in the Free State, never well-informed on economic issues but instinctively averse to the cosmopolitan commercialism of the new era, was falling back on the trekker tradition of occlusiveness. Old antagonisms revived, nourished on inbred misunderstandings now made manifest in the conflict between the South Africa of Kruger's dreams and the South Africa of Cecil Rhodes' calculations.

During the presidencies of F. W. Reitz (1889–95) and of M. T. Steyn (1896–1900) a metamorphosis took place in Free State politics and opinion. From one point of view this was but a local example of tendencies current in contemporary Europe, namely the basing of political loyalties on racial ties. From the Free State point of view, it was the revival of old traditions to meet new challenges. Frontier security, increased profits and greater literacy tended to give farmers in the outlying districts leisure for politics and to revel in the propaganda of the Bond with its program of an Afrikander renaissance. Conflict between Transvaal and Cape economic interests, even earlier than conflict between the Transvaal and Great Britain, tended to split Free State opinion. The determinant, though, was the policy of Kruger in the Transvaal. His object was to secure an alliance or, if necessary, a federal as distinct from an incorporating union with the Free State. The alliance was concluded by Reitz in March *1889* and ratified by the *volksraad.* At first the implications which Fraser and Barlow had foreseen were not apparent. The customs union with the Cape was fulfilled. In *1892* the Natal-Harrismith line was completed. In *1893* the first train from Cape Town to Pretoria crossed the Free State, while the line from Kimberley to Mafeking and the north skirted the Free State on the west. For the first time the economic integration of southern Africa was possible. But the drifts crisis and then the Jameson raid (Dec. *1895)* inflamed public opinion, and the year *1896* opened with Free State commandos manning the frontiers, prepared and even anxious to assist President Kruger in the Transvaal.

For the Free State, the raid was a psychological shock and a political blunder. M. T. Steyn was elected president in Feb. *1896* on the crest of a wave of pro-Transvaal sentiment, though the opposition candidate, Fraser, knew that even before the raid his chances had been slender. Thenceforward, as the crisis in the Transvaal mounted, while still counselling moderation almost to the end, Steyn, with a clear majority behind him, kept both lines open in theory but so strengthened the links with the Transvaal that the legal obligations of the Free State government reflected the instinct and opinion of the majority. Steyn's move to introduce a referendum with its connotation of popular sovereignty failed; but the qualifications for obtaining burgher rights were stiffened, the arming of commandos was brought into line with Transvaal practice and equipment and a commission was appointed to study federal union with a view to bringing the legal structure of both states to move on parallel lines. Several Free Staters, among them Gregorowski and former President Reitz, entered the service of the Transvaal. Steyn urged Kruger to accept any compromise that would avert war without actually injuring the Transvaal and strove for peace at the Bloemfontein conference of May-June *1899* and for conciliation even after the ultimatum of October; but the Free State's refusal to accept the

British offer of neutrality turned not on diplomacy but on the conviction that, once the issue was joined, moral obligation determined conduct. (For the events of the war see SOUTH AFRICAN WAR and SOUTH AFRICA, UNION OF.)

The Orange River Colony (May 1900–May 1910).—Lord Roberts occupied Bloemfontein in March 1900; and on May 28 the Free State was annexed by Great Britain as the Orange River colony. For two more years Generals Christiaan Rudolf de Wet (*q.v.*) and J. B. M. Hertzog (*q.v.*) blazed the commando trail in the Cape until definitive peace was concluded at Vereeniging on May 31, 1902, when British sovereignty was acknowledged. In June a nominated legislative council was set up and on this prominent burghers served as unofficial members. "It would take the pen of a Joshua and a Jeremiah," wrote Jan Christiaan Smuts, "to picture the condition of the Free State": it was a picture the more shocking in that, in spite of native wars: South Africa had never before experienced total war between equal contestants. Farms were denuded of crop and stock, fences were down, houses in ruin. It is true that by grant and loan much was done to accelerate recovery and to lay new foundations. For Bloemfontein an extension to the power station and new waterworks at Mazelspoort made civic development possible; but even as late as 1904 the yield of wheat and of wool and the number of cattle were strikingly less than they had been before the war. A reconstruction loan in 1903 led to the establishing of 556 new settlers, but even Viscount Milner's administrative genius could not with the stroke of a pen restore the ravaged veld.

By 1904 two groups, the nationalist Orangia Unie and the so-called Constitutional group led by Fraser and Barlow, were agitating for constitutional government. The latter group had the ear of the British Liberal party, which was returned to office at the end of 1905. The change in government in Great Britain meant a fresh approach to South African affairs.

Lord Selborne, who had already replaced Milner as high commissioner and governor of the Transvaal and of the Orange River colony, was retained, and the intercolonial conferences! begun with those on native affairs and education, were continued; but the granting of the promised self-government was expedited. In July 1907 royal letters patent conferred full responsible government on the Orange River colony, and the first postwar election was held in Nov. 1907.

Sir H. J. Goold-Adams, hitherto lieutenant governor of the colony, now became governor; his relationship to the new parliament was defined by well-established conventions such as had been observed, in the Cape for instance, since 1872. Of 38 seats in the new parliament, the Orangia Unie won 29. A. Fischer was prime minister, General Hertzog attorney general and minister of education, Cornelius Wessels commissioner of public works and General de Wet minister of agriculture. It was an able if somewhat uneasy team, whose task had been greatly simplified by five years' postwar economic rehabilitation. But the British administration was to reap where it had sown. In 1902 men like Brebner and Ryk de Villiers had been purged from the state service; in 1908 the new anglophile bureaucracy was in its turn winnowed.

Under Milner's administration education had been made free, compulsory and nonsectarian and the whole structure of the schools had been altered; but administration had been ruthlessly centralized: and English had become the medium of instruction, while the reliance in the main on English-speaking teachers meant that little use could be made of the five hours allocated to the teaching of the Dutch language, since the teachers did not understand it. It was to meet this situation that voluntary Christian National schools were founded.

When the colony was granted self-government, the pendulum swung back. While denouncing the Dutch Reformed Church, which he accused of "setting up a papacy in every village," Hertzog allowed dogmatic instruction in the schools; and while theoretically allowing for parallel dual medium instruction where numbers warranted, in practice he made Dutch increasingly, the medium of instruction, so that by 1910 English children were being withdrawn into private schools. For Hertzog was a passionate devotee of Afrikander culture and claimed, understandably if inaccurately, that it had made the Free State.

The chief constructive work of the cabinet was continued participation in intercolonial consultation, notably the customs and railway conference of 1908 and full and constructive participation in the national convention (see SOUTH AFRICA, UNION OF) which began in Oct. 1908. The outstanding personality from the Orange River colony was former President Steyn, who was conspicuously successful as a mediator and who secured that the future appeal court of the Union should sit at Bloemfontein, which was to become the judicial capital of the proposed Union. The bill for union was passed simultaneously by the parliaments of each of the four colonies and was enacted, in the form then submitted, by the imperial parliament in 1910, and the colony entered the Union under the style of Orange Free State province.

The Province of the Orange Free State.—The new Free State, like the other provinces, preserved historical continuity by retaining its entity as a province. Like Natal, it was to send 25 members to the house of assembly in Cape Town; and from the time when Fischer and Hertzog entered the first Union cabinet, Free State members, conspicuously Hertzog and N. J. van der Merwe (1880–1940), played an important role as leaders of a compact phalanx. It was from the Free State that the revolt of De Wet in 1914 (a protest against the British war policy of invading German South-West Africa) drew its main strength; and the province fathered two successive leaders of Afrikander nationalism, namely Hertzog and D. F. Malan. In the election of 1953, all 25 seats were won by the Nationalist party. In some ways the Redistribution act of 1952 accentuated certain anomalies, since 81,329 votes were sufficient to return 25 Nationalists, whereas the 31,645 votes cast for the United party (25% of the total poll) were swamped. (W. A. ML.)

POPULATION, ADMINISTRATION AND ECONOMY

Population.—The population of the Orange Free State amounted to 1,373,790 according to the census of 1960. The total comprised 1,073,613 natives, 274,596 Europeans, 25,565 coloureds and 16 Asiatics and constituted 8.7% of the total population of the Republic of South Africa. The average density was 27.5 per square mile. The major concentrations are in the eastern and better-watered districts. The towns are mostly small administrative and provisioning centres for their surrounding districts. Bloemfontein (the capital of the province and the axis of the Union's road, rail and air communications), Kroonstad, Ladybrand, Harrismith and Ficksburg are described in separate articles. Bethlehem is a prosperous centre in the northeast. Parys (population 12,673, including 4,917 Europeans, in 1960), on the Vaal river, is a pleasure resort.

The largest element of the African population is constituted by the southern Sotho (Basuto), who are scattered widely over the province. A considerable number of Tswana (Bechuana) live in the district of Thaba Nchu; the Zulu are well represented, chiefly in the northeastern area adjoining Zululand; and the Xosa are numerous in the southern and western districts. As a result mainly of the historical development of the Free State and of the trekkers' policy of defeat and dispersal of the African populations, only about 26,000 of the total number of Africans in the province live in the reserves of Witzieshoek and of Thaba Nchu (the latter was impressively rehabilitated by the Union native affairs department); the rest are either in urban locations or squatters on European farms. Little has been done to purchase more land in terms of the Native Land Trust act; and surveys such as the Fagan report (1948) make it clear that to provide land in the Free State for Africans more than 25 times as numerous as those already in reserves is impossible. Nor is land available in adjacent Basutoland, where the movement of migration is outward, not inward, and where the direction of labour, because of working conditions and wages, is from agriculture to industry.

Administration.—The provincial council of 25 elected members meets under the presidency of the administrator who is nominated by the governor general. Members hold office for five years. A provincial ordinance has effect so long as it is not repugnant to an act of parliament, and it must have the assent of the governor general in council (since the governor general acts constitutionally on the advice of his ministry this may lead to oblique control of the provinces by the ministry of the day). Provincial powers are mainly defined by sections 85–91 of the South Africa act together with the Financial Relations Consolidation act of 1945. Provincial ordinances deal mainly with local affairs, such as hospitals, roads, etc.

Education, other than higher, has been the main field of provincial initiative. The South Africa act secured equal rights for both Dutch and English languages. An act of the Union parliament in 1912 stipulated that in the lower standards the medium of instruction should be in the home language of the pupils; but provinces differ in their administrative definition of home language, and the Free State still bears the impress of Hertzog's educational policy. In 1920 the Free State was the first province to sponsor the substitution of Afrikaans for Dutch.

In 1953 the Eiseln report proposed that, since provincial finance was inadequate, native education, like native policy generally and most tertiary and specialized education, should be extricated from provincial control and put completely under Union supervision. Despite strong opposition from Africans and the Christian churches the Bantu Education act of Jan. 1, 1954, effected this recommendation. Six months before the act was promulgated the province had 332 primary, secondary. special and teacher training schools for Europeans. with 52.418 pupils and 2,341 teachers (including white teachers in nonwhite schools). while for non-Europeans the corresponding figures were 640, 88,114 and 1,964.

Agriculture and Stock Raising. — The most fertile part of the country lies in the valley of the Caledon river. There a considerable quantity of wheat is grown, especially in the districts of Ladybrand, Ficksburg, Bethlehem and Rouxville. The same districts and Harrismith also produce oathay. There, too, are extensive apple and plum orchards, the apples being among the best grown in South Africa. Potatoes, tobacco, pumpkins, etc., are also grown. The province's most important crop. however, is maize. the districts of Heilbron and Frankfort, in the north. forming part of the South African maize belt (toward the west the area sown with maize varies greatly from year to year, according to the incidence of the rains). The Free State produces more than one-third of the Union's maize crop and might even treble its yield through a better use of fertilizers.

The country is also healthful for livestock. It is little affected by horse sickness and the number of horses in 1950 was 217,578. Cattle (1,981,518 in 1950) are most numerous in the eastern districts, especially about Ficksburg. Woolled sheep, totalling 6,594,060 in 1951, are most abundant in the Rouxville. Wepener and Smithfield districts. while goats (34,035) are kept by natives or concentrated in the dry southwestern area about Philippolis.

Mining and Industry. — The discovery of gold fields in the Odendaalsrust area, where the Welkom and St. Helena mines began production in 1952. seemed likely to transform the industrial structure of the province. In all of the seven developing mines, moreover, the production of uranium oxide from residue ore after gold extraction was authorized. The proximity of the field to the power station at Viljoensdrift suggested that the Free State might indeed be on the edge of an industrial revolution.

The province's annual output of diamonds averaged 145,000 metric carats during the 1950s. Diamonds are found around Jagersfontein (the chief mine) and Koffiefontein in the southwest. around Boshof in the west. around Theunissen toward the centre of the province and around Kroonstad; and alluvial diamonds of great purity occur in the gravels of the Vaal and some of its tributaries. During the 1950s coal production rose steadily. reaching a total of 5,704,585 short tons in 1955. the chief collieries being the Cornelia on the Vaal opposite Vereeniging and the Clydesdale 1j mi. S.; but the coal is not of the best quality. Salt is obtained from the waters of certain "pans" in the western districts, evaporated in most cases by solar heat.

The construction of grain elevators and the opening of mills and of creameries fostered subsidiary industrial enterprises. The census of industrial undertakings for 1946 (published in 1949), while confirming that the Free State was the least industrialized of the four provinces, showed an increasing variety of such undertakings on an expanding-scale. (R. U. S.; W. A. ML.)

ORANGEMEN. In 1795, after a violent conflict between Protestants and Roman Catholics in County Armagh, Ireland, known as the battle of the Diamond, a Protestant Orange society, called after William of Orange, was formed "to maintain the laws and peace of the country and the Protestant constitution." The Orange society spread its branches, called lodges, and by 1797 it had about 200.000 members. It was joined by many of the gentry and it counteracted the influence of the United Irishmen, particularly in Ulster. During the early and middle years of the 19th century the movement fell into some obscurity and disrepute; but when Gladstone declared in favour of Irish home rule in 1885, the Orange order, as it came to be called, provided a core of resistance. The order had a great influx of new members, especially in Ulster. Through the controversies which followed, it provided both a means of expression and a restraining discipline for many Unionists. The membership in Ulster at mid-20th century contained a large proportion of farmers and skilled workers and a good many professional men, and there were lodges for women. The ethical obligations of membership are high. The movement is also active in Glasgow, Liverpool, Toronto, Ont., and many other places, but the social background and ethos of the movement are somewhat different outside Ulster. July 12, the anniversary of the battle of the Boyne, is celebrated by Orangemen each year. (HU. S.)

ORANGUTAN ("man of the woods"), the giant red manlike ape of Borneo and Sumatra (Pongo *pygmaeus*). The reddish colour of the long, coarse hair distinguishes the mias, as the Dyaks call it, from African apes; the arms are such that the animal in the upright posture can rest on its bent knuckles. In some races, in the old males, which may stand $5\frac{1}{2}$ ft. high, there is a large expansion of the cheeks, caused by growth of fibrous tissue and producing a broad and flattened type of face. Another peculiarity of the males is the presence of a huge throat sac on the front of the throat and chest, which may extend even to the armpits; although present in females, it does not reach nearly the same dimensions in that sex. More than half a dozen separate races of orangutan are recognized in Borneo where the red ape inhabits the swampy forest tract at the foot of the mountains. These apes are comparatively slow and deliberate in their movements; they construct platforms of boughs in the trees, which are used as sleeping places, apparently occupied for several nights in succession. Durian, the tough spiny hide of which is torn open with their strong fingers, forms their chief food. They also eat the mangustin and other fruits. (See PRIMATES.)

BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

ORANGUTAN (PONGO PYGMAEUS)
A giant red ape of Borneo and Sumatra

ORANIENBAUM, renamed LOMONOSOV after World War II, a city in the Leningrad *oblast,* R.S.F.S.R., U.S.S.R., in 59° 54′ N., 29° 48′ E., lying 100 ft. above the sea on the south coast of the Gulf of Finland, opposite Kronstadt. Pop. (1939) 10,000. It was formerly a summer residence of the imperial family. The site was given to Menshikov in 1714 by Peter the Great, and the palace he erected still stands. Confiscated in 1727, it became an imperial residence. In 1743 the empress Elizabeth presented Oranienbaum to the future Tsar Peter III, who built there a castle, now destroyed, for his Holstein soldiers. The palace became a hospital during World War I, and was later made a rest home for workers. A school of forestry was established in one of the wings. A railway was built to link the town with the fort of Krasnaya Gorka, standing guard at the entrance to Kronstadt bay. There were established flour mills and brickworks, the sawmilling industry also being important.

ORAON, an aboriginal tribe of the Chota Nagpur plateau, India, also known as Dhangars. They call themselves *Kurukh,* but being divided into various groups are apt to be designated by group names (*e.g.*, Modi, "navvy," Kisan, "cultivator") when they emigrate. A short, sturdy race of Dravidian type, they are in demand as labourers. As Oraon mothers shape their babies' heads their dolichocephaly may be to some extent artificial. The village organization is advanced. Their speech is akin to Kanarese. Their religion is a mixture of nature worship and magic, thinly overlaid with Hinduism, Dharmes being the supreme god.

A religious movement, influenced by Christianity as well as by Brahmanism, known as the Tana Bhagat movement and manifesting itself in ghost hunting and the addition of German Baba to the pantheon, caused some excitement in 1915. It had begun with a crusade against belief in ghosts and was largely a revolt against social degradation and economic depression.

See Sarat Chandra Roy, The *Oraons of Chota Nagpur Ranchi* (1915), for a full history and valuable information; *Man in India*, I (1921).

ORATOR, one who speaks in public, especially an eloquent public speaker. *See* RHETORIC and separate articles on eminent orators, such as DEMOSTHENES; ISOCRATES; etc.

A statesman of modern times, Sir Winston Churchill, won international acclaim for his effective oratory. His skill and power as an orator were recognized by the Swedish academy, which announced on Oct. 15, 1953, that Churchill had received the Nobel prize for literature not only for his historical and biographical works but also for "the scintillating oratory in which he has stood forth as a defender of eternal human value." It was the first time that oratory had been cited as the partial basis for the Nobel award in literature.

The term also refers to an officer of the universities of Cambridge and Oxford, the orator speaking in the name of, as well as on behalf of, the university on various public and special occasions.

ORATORIO, the name given to a form of religious music with chorus, solo voices and orchestra, independent of, or at least separable from the liturgy, and on a larger scale than the cantata (*q.v.*). Its history is involved in that of opera (*see* ARIA and OPERA), but its antecedents are more definite. The term is almost certainly (but *see* Schiitz's "stilo Oratorio" on p. 844) derived from the fact that St. Filippo Neri's Oratory was the place for which Animuccia's settings of the *Laudi Spirituali* were written; and the custom of interspersing these hymns among liturgical or other forms of the recitation of a Biblical story is one of several origins of modern oratorio. A more ancient source is the use of incidental music in miracle plays and in such dramatic processions as the 12th century *Prose de l'Âne,* which on Jan. 1, celebrated at Beauvais the Flight into Egypt. But the most ancient origin of all is the Roman Catholic rite of reciting, during Holy Week, the story of the Passion according to the Four Gospels, assigning the words of the Evangelist to a tenor, distributing all *ipsissima verba* among appropriate voices, and giving the *responsa turbae,* or utterances of the whole body of disciples (*e.g.,* "Lord, is it I?") and of crowds, to a chorus. The only portion of this scheme that concerned composers was the *responsa turbae,* to which it was permitted to add polyphonic settings of the Seven Last Words or the eucharistic utterances of the Saviour. The narrative and the parts of single speakers were sung in the Gregorian tones appointed in the liturgy. Thus the settings of the Passion by Victoria and Soriano represent a perfect solution of the art-problem of oratorio. "Very tame Jews" is Mendelssohn's comment on the 16th century settings of "Crucify Him"; and it has been argued that Soriano's and Victoria's aim was not to imitate the infuriated Jews, but to express the contrition of devout Christians telling the story. On the other hand, ancient tradition ordained a noisy scraping of feet on the stone floor to indicate the departure from the place of the judgment seat! And so we owe the central forms of Bach's Lutheran Passion-oratorios to the Roman Catholic ritual for Holy Week.

With the monodic revolution at the outset of the 17th century the history of oratorio as an art-form wholly controlled by composers begins. There is nothing but its religious subject to distinguish the first oratorio, Emilio del Cavalieri's *Rappresentazione di anima* e *di corpo* from the first opera, Peri's *Euridice,* both produced in 1600. Differentiation was brought about primarily by the fact that oratorios without stage-presentation gave opportunity for a revival of choral music. And oratorios on the stage discouraged, by reason of their sacred subjects, whatever vestiges of dramatic realism could survive the ascendancy of the aria (*q.v.*). For lesser composers than Bach and Handel this ubiquitous form represented almost the only possibility of keeping music alive, or at least embalmed, until the advent of the dramatic and sonata styles. The efforts of Carissimi (d. 1674) in oratorio clearly show how limited a divergence from the method of opera was possible when music was first emancipated from the stage. Yet his art shows the corruption of Church music by a secular style rather than the rise of Biblical music-drama to the dignity of Church music. Normal Italian oratorio remains indistinguishable from serious Italian opera as late as *La Betulia liberata,* which Mozart wrote at the age of 15. Handel's La *Resurrezzione* and *Il Trionfo del Tempo* contain many pieces simultaneously used in his operas, and they contain no chorus beyond a perfunctory operatic final tune. *Il Trionfo del Tempo* was a typical morality play, and it became a masque, like *Acis and Galatea* and *Semele,* when Handel at the close of his life adapted it to an English translation with several choral and solo interpolations from other works. Yet between these two versions of the same work lies half the history of classical oratorio. The rest lies in the German Passion-oratorios that culminate in Bach; after which the greatest music avoids every form of oratorio until the two main streams, sadly silted up, and never afterwards quite pure, unite in Mendelssohn.

Luther was so musical that while the German Reformation was far from conservative of ancient liturgy, it retained almost everything which makes for musical coherence in a Church service; unlike the English Church, which with all its insistence on historic continuity, so rearranged the liturgy that no possible music for an English Church service can ever form a coherent whole. The four *Passions* and the *Historia der Auferstehung Christi* of *H.* Schütz (who was born in 1585, exactly a century before Bach) are as truly the descendants of Victoria's Passions as they are the ancestors of Bach's. They are Protestant in their use of the vulgar tongue, and narrative and dialogue are set to free composition instead of Gregorian chant, although written in Gregorian notation. The *Marcus Passion* is in a weaker and more modern style and stereotyped in its recitative. It may be spurious. But in the other Passions, and most of all in the *Auferstehung,* the recitative is a unique and wonderful language. It may have been accompanied by the organ, though the Passions contain no hint of accompaniment at all. In the *Auferstehung* the Evangelist is accompanied by four viole da gamba in preference to the organ. The players are requested to "execute appropriate runs or passages" during the sustained chords. A final non-scriptural short chorus on a chorale-tune is Schütz's only foreshadowing of the contemplative and hymnal element of later Passion oratorios.

The *Auferstehung,* the richest and most advanced of all Schiitz's works, has one strange convention, in that single persons, other than the Evangelist, are frequently represented by more than one voice. If this were confined to the part of the Saviour, it would have shown a reverent avoidance of impersonation, as in Roman Catholic polyphonic settings of the Seven Words. But Schütz writes thus only in *Die Auferstehung* and there on no particular plan. While the three holy women and the two angels in the scene at the tomb are represented naturally by three and two imitative voices, Mary Magdalene is elsewhere always represented by two sopranos.

Shortly before Bach, Passion oratorios were represented by several remarkable works of art, most notably by R. Keiser (1673–1739). Chorale-tunes, mostly in plain harmony, were freely interspersed in order that the congregation might take part in what was, after all, a church service for Holy Week. The meditations of Christendom on each incident of the story were expressed in accompanied recitatives *(arioso)* leading to arias or choruses, and the scriptural narrative was sung to dramatic recitative and ejaculatory chorus on the ancient Roman plan. On slightly different lines was Graun's beautifui *Tod Jesu,* which was famous when the contemporary works of Bach were ignored.

The difference between Bach's Passions and all others is simply the measure of his greatness. Where his chorus represents the whole body of Christendom it has as peculiar an epic power as it is dramatic where it represents tersely the *responsa turbae* of the narrative.

In the Matthew Passion the part of Christ has a special accompaniment of sustained strings, generally at a high pitch, though deepening at the most solemn moments. And at the words "Eli, Eli, lama sabacthani" this musical halo has vanished. In power of declamation Bach was anticipated by Keiser; but no one approached him in sustained inspiration and architectonic greatness. The forms of Passion music may be found in many of Bach's Church cantatas; a favourite type being the *Dialogue*; as, for instance, a dispute between a fearing and a trusting soul with, perhaps, the voice of the Saviour heard from a distance; or a dialogue between Christ and the Church, on the lines of the Song of Solomon. The Christmas Oratorio, a set of six Church cantatas for performance on separate days, treats the Bible story in the same way as the Passions, with a larger proportion of non-dramatic numbers. Many of the single Church cantatas are called oratorios, a term which by Bach's time seems definitely to have implied dialogue, possibly on the strength of a false etymology. Thus Schutz inscribes a monodic sacred piece "in stilo Oratorio," meaning "in the style of recitative." The further history of oratorio radiates from the heterogeneous works of Handel.

There are various types and several mixtures of style in Handelian oratorio. The German forms of Passion music evidently interested Handel, and it was after he came to England, and before his first English oratorio, that he set to music the famous poetic version of the Passion by Brockes, which had been adopted by all the German composers of the time, and which, with very necessary improvements of taste, was largely drawn upon by Bach for the text of his Johannes-Passion. Handel's Brockes Passion does not appear ever to have been performed, though Bach found access to it and made a careful copy; so Handel must have composed it for his own edification. He soon discovered that many kinds of oratorio were possible. The emancipation from the stage admitted of subjects ranging from semi-dramatic histories, like those of *Saul, Esther* and *Belshazzar,* to cosmic schemes expressed entirely in the words of the Bible, such as *Israel in Egypt* and *The Messiah.* Between these types there is every gradation of form and subject; besides an abrupt contrast of literary merit between the mutilated Milton of *Samson* and the amazing absurdities of *Susannah.*

The very name of Handel's first English oratorio, *Esther*, and the facts of its primary purpose as a masque and the origin of its libretto in Racine, show the transition from the stage to the Church; and, on the other hand, Haman's lamentation on his downfall is scandalously adapted from the most sacred part of the Brockes Passion.

We may roughly distinguish three main types of Handelian oratorio, not always maintained singly in whole works, but always available as methods. First, there is the operatic method, in which the arias and recitatives are the utterances of characters in the story, while the chorus is a crowd of Israelites, Babylonians or Romans *(e g., Athalia, Belshazzar, Saul,* etc.). The second method retains the dramatic rôles both in solos and in choruses, but (as, for instance, in "Envy, eldest born of Hell," in *Saul*) also uses the chorus as the voice of universal Christendom. Handel's audience demanded plenty of arias, most of which are accounted for by futile, when not apocryphal, love affairs. The haughty Merab and the gentle Michal are characterized with fatal ease. and make parts of *Saul* almost as impossible as most of *Susannah.* The third Handelian method is a series of choruses and numbers on a subject altogether beyond the scope of drama, as, for instance, the greater part of *Solomon* and, in the case of *The Messiah* and *Israel in Egypt*, treated entirely in the words of Scripture, and those not in narrative but in prophecy and psalm.

After Bach and Handel, oratorio fell upon evil days. The rise of the sonata style, which brought life to opera, was bad for oratorio; since not only did it accentuate the fashionable dislike of that polyphony which is essential even to mere euphony in choral writing, but its dramatic power became more and more disturbing to the epic treatment that oratorio naturally demands.

Philip Emanuel Bach's oratorios, though cloying in their softness and sweetness, achieved a true balance of style in the earlier days of the conflict; indeed, a judicious selection from *Die Israeliten in der Wüste* (1769) would perhaps bear revival almost as well as Haydn's *Tobias* (1774).

The Creation (Die Schopfung) and *The Seasons (Die Jahreszeiten)* will always convey to unspoilt music-lovers the profound message of the veteran Haydn, who could not help "worshipping God with a cheerful heart." This spirit was well known to Bach, the composer of *"Mein glaubiges Herze,"* and it is compatible with the romantic sound-pictures and Handelian sublimity of the opening Representation of Chaos and the great chord of C major at the words "and there was light." The childlike gaiety of much of the rest ought not to blind us to its fundamental greatness, which brings the naïvely realistic birds and beasts of *The Creation* into line with even the wine-chorus in the mainly secular *Seasons,* and removes Haydn from the influence of the vile taste which henceforth pervaded oratorios, until Mendelssohn effected a partial improvement. Haydn strenuously resisted the persuasion to undertake *The Seasons* which had a close connection with Thomson's poem, as *The Creation* had a distant connection with *Paradise Lost.* He thought the whole scheme "Philistine" (his own word) and, both before he yielded to persuasion and after he had finished the work, said all the hard things about it that have ever been said since.

Roman Catholic oratorio was under the disadvantage that it was not permitted to take Biblical texts except in the Latin language. Jomelli's *Passione* for once had the benefit of a meditative text with some distinction of style; and in closing the first part with a dominant seventh on the word *"pensaci"* he achieved *a* stroke of genius which at the present day would still startle the listener and leave his mind in the desired frame of meditative astonishment.

But words fail to characterize the libretto of Beethoven's unfortunate *Christus am Oelberge (c.* 1800). The texts of Lutheran church-music had often been grotesque and even disgusting; but their barbarity was pathetic in comparison with the sleek vulgarity of a libretto in which not only is the agony of the garden of Gethsemane represented by an aria (as in Handel's lamentation of Haman), but Christ sings a brilliant duet with the ministering angel. In after years Beethoven had not a good word for this work, which, nevertheless, contains some beautiful music exquisitely scored. And justice demands praise for the idea of making a Hallelujah chorus conclude the work as soon as the betrayal of Christ has been accomplished, thus compensating for the irreverent opening by avoiding all temptation to treat the rest of the passion-story with the same crassness. A well-meant effort was made to provide the *Mount* of *Olives* with an inoffensive subject in English, but the stupidity of ***Engedi:*** or *David in the Wilderness* passes belief.

Schubert's interesting fragment ***Lazarus*** is strangely prophetic of Wagnerian continuity and has a morbid beauty that transcends its sickly text There are signs that the despair of the Sadducee was going to be treated with some power. The result might have been a masterpiece; but fate ruled that the next advance should again be Protestant.

Bach's Passions were rediscovered by the boy Mendelssohn after a century of ignorance of their very existence; and in *St. Paul (Paulus)* and *Elijah* (***Elias***) rose upon the early middle 19th century like the sunrise of a new Handel.

To-day *St. Paul* has almost sunk below the horizon: and *Elijah,* which still shares with *The Messiah* the Christmas repertoire of every British urban choral society, is in many points an easy target for criticism. Yet the ascendancy of Mendelssohn is the one redeeming feature in the history of oratorio during the first three quarters of the 19th century. Let us admit the defects of *Elijah;* the all too lifelike tiresomeness of the widow (achieved after strenuous revision), the parochial softness of the double quartet, the Jewishness of the Jews (but is this a defect?), and the snorts of the trombones whose third summons causes the Almighty to capitulate: when all these unconscious profanities are discounted, there remains a vivid and coherent oratorio that, musically and dramatically, towers above later works by many accomplished composers who despise it. (*See* MENDELSSOHN-BARTHOLDY, JAKOB LUDWIG FELIX.) Spohr is the only contemporary of Mendelssohn whose sacred music is still known. So tremendous a subject as that of *The Last Judgment* ought, indeed, to be treated with reserve; but the softness and slowness which pervades nine-tenths of Spohr's work is not reserve but self-indulgence. Spohr has moments of vision; but an almost random glance at the pages of St. *Paul* shows that even in eclipse Mendelssohn has characterization, movement and the capacity for dramatic moments.

In England, the influence of Mendelssohn completed the devastation begun by our inveterate habit of praising the inspired literary skill of the sacred narrative, as a preface to our restatement of it in 40 times as many words of our own. Deans and chapters listened in graceful official pride and imperfectly secret glee to the strains in which the cathedral organist celebrated with equal realism the destruction of Sennacherib's hosts and his own octuply-contrapuntal doctorate of music. Before 1880 our composers had, as Dr. Walker says, "set with almost complete indiscrimination well-nigh every word of the Bible." Had they confined themselves to the second chapter of Ezra they would have escaped dangers of unconscious humour that lurk in the opportunities for "naturalness" in declaiming the dialogues and illustrating the wonders of scriptural narrative.

Neither Sterndale Bennet nor Macfarren improved matters; but Parry and Stanford, towards the end of the century, completely changed the situation. Stanford's *Eden* has a libretto by Robert Bridges. The disgruntled professional librettists, who were also musical critics, had the effrontery to say that this magnificent poem would be the better for extensive cuts. The real truth is that Stanford's music, especially in its orchestral introductions, is diffuse. But it has many beautiful features, and achieves a coherent scheme on exactly such lines of Wagnerian continuity as can be applied to oratorio. Parry preferred to be his own librettist, and by this means he achieved more significant results. The lapses of the amateur poet are less distressing than the *clichés* of the ordinary professional librettist; and the works of Parry and Stanford permanently raised English oratorio from squalor and made it once more an art-form which educated people could enjoy. Some of Parry's architectonic and dramatic ideas will never lose the power to thrill, if only the works as wholes can live in spite of a certain dryness of melody and heaviness of texture. For example, the exploit of Judith is shown with a total avoidance of the cheap and salacious opportunity for a scene between her and Holofernes. Instead, we listen to the watchmen anxiously making their circuit of the city walls in darkness. The music of their march is at a low pitch. It is reaching a normal close when, high above the tonic chord, the cry of Judith bids the watchmen open the gates to her. If this moment cannot thrill, there is no meaning in art. In *King Saul* Parry made *a* significant discovery as to the emancipation of dramatic oratorio from the stage conditions of time and space, The Witch of Endor prophesies the battle of Gilboa. Her tale becomes real in the telling and is immediately followed by the final dirge.

As with opera, so, but more easily, with oratorio, the method of Wagnerian continuity at last enabled composers to take extant poems and set them to music in their entirety. Thus the fragrant mysticism of Roman Catholic oratorio, dimly adumbrated in Schubert's *Lazarus,* at last came to fruition in Elgar's wonderful setting of Newman's *Dream of Gerontius,* while the old miracle play *Everyman* was very successfully composed by Walford Davies. In his later works, *The Apostles* and *The Kingdom,* Elgar pursues a comprehensive religious design on texts arranged by himself. Oratorio on the basis of Wagnerian continuity and *Leit-motif* is unquestionably a living art-form. Its greatest difficulty is its fatal facility. The oratorio-composer is lost who omits to transcend the limits of the stage; yet when these are transcended only the stedfastness of genius can prevent the composer from sinking to the fashion-storming eclecticism of Honegger's *Le Roi David* which, with the aid of a reciter to read the Bible, takes up the arts of all periods from Handel on and drops each of them before anything like an art-problem arises.

Why not follow more often the method of *The Messiah* and of *Israel in Egypt;* and deal with religious subjects in terms of prophecy and psalm? Brahms's *Deutsches Requiem* is really an oratorio; and since its production (all but one later movement) in 1866 it continues year by year to tower over all other choral music since Beethoven's Mass in D. Form, disciplined farm, is not the only thing needed to save future oratorios from the limbo of vanity; but it is their first need. (D. F. T.)

ORATORY, the art of speaking eloquently or in accordance with the rules of rhetoric (*q.v.*).

ORATORY OF ST. PHILIP NERI, CONGREGATION OF THE, or ORATORIANS, a religious order consisting of a number of independent houses, first organized in 1575 by the Florentine priest, Philip Neri (*see* NERI, SAINT PHILIP).

ORBIGNY, ALCIDE DESSALINES D' (1802–1857), French paleontologist, was born at Couerzon, Loire Inférieure, on Sept. 6, 1802, and was educated at La Rochelle. His first appointment was as traveling naturalist for the Museum of Natural History at Paris. The opportunities of this position strongly contributed to the value and magnitude of his contributions in later years. In 1826 he went to South America and gathered information in ethnology, natural history and geology. His studies along the barrancas of Paraná revealed the presence of fossils, both shells and bones, in the exposed strata of that region. He worked out a complex stratigraphic section of the late Cenozoic uhich, while later shonn to be in error, marked him, along with Charles Darwin, as an initiator of the study of fossil mammals in South America. The results of this study and his investigations of ethnology were embodied in his great uork *Voyage dans l'Amérique Méridionale* (1839–42). Then in 1840 he began to publish his *Pale'ontologie française, ou description des fossiles de la France,* a monumental work, accompanied by figures of the species. Eight volumes were published by him dealing with Jurassic and Cretaceous invertebrata, and after his death many later volumes were issued. In 1853 he was appointed professor of paleontology at the Museum of Natural History in Paris. He died on June 30, 18j7, at Pierresitte, near St. Denis.

D'Orbigny's works include *Cours élémentare de paléontologie et de géologie stratigraphiques,* 3 vol. (1849–52), and *Prodrome de paléontologie stratigraphique,* 3 vol. (1850–52). (E. C. O.)

ORBIT, in astronomy, is the path of a heavenly body revolving around an attracting centre (from Lat. *orbita,* "track," *orbis,* "wheel"); in particular, it denotes the path of a planet or comet around the sun, or of a satellite around its controlling planet.

Kepler's Laws.—In 1609 Johann Kepler announced two laws of planetary motion, and by 1619 he added a third:

First Law.—Kepler's first law states that a planet moves around the sun in an elliptic orbit, the sun being situated in one focus of the ellipse. If the straight line joining any two points S and T is produced equal distances beyond S and T to A and B, and

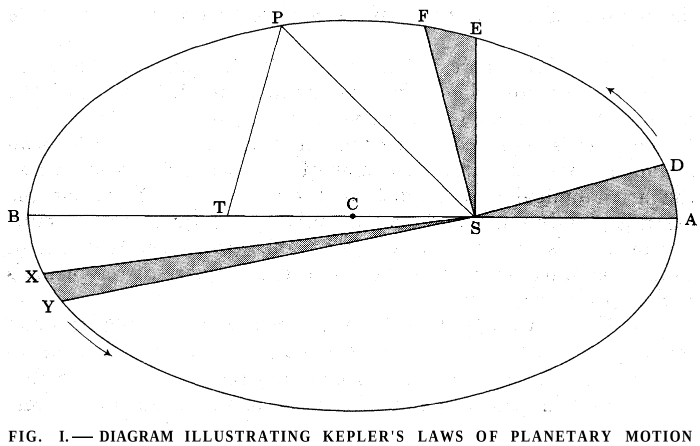

FIG. I.—DIAGRAM ILLUSTRATING KEPLER'S LAWS OF PLANETARY MOTION

if P is any point such that the sum of the distances P S and P T is equal to the distance A B, then the aggregate of all such points as P is the curve known as the ellipse. The points S and T are the foci. The curve passes through A and B and A B is called the major axis of the ellipse. If C is the mid-point of A B, the ratio of the length of C S to the length of C A is called the eccentricity. The ellipse then is specified by means of (1) the semimajor axis and (2) the eccentricity. If the eccentricity happens to be zero, the two foci must coincide at the centre C and the resulting curve is simply a circle; if the eccentricity is precisely unity, then the curve is known as a parabola. Kepler's first law simply states that if the sun is supposed situated at the focus S, the planet's path around the sun—in other words, its orbit—is an ellipse such as is represented in the diagram above. The time required for a complete revolution in the ellipse is the planet's revolution period; for example, the earth's period of revolution is a little over 365 days; Mercury describes its orbit in 88 days, and Neptune requires 165 years. At A—the point of the ellipse nearest S—the planet is said to be in perihelion, and when it reaches B, the most remote point of the ellipse from S, it is said to be in aphelion.

Second Law.—Kepler's second law states that the straight line joining the sun to the planet (the radius vector) sweeps out equal areas in equal times. In the preceding figure let D be the position of the planet in its elliptic orbit a month after it reached perihelion (A); similarly let E F be two positions of the planet separated by an interval of a month; the pair of points X, Y are defined in the same way. The shaded area S D A, for example, is the area swept out by the radius vector in one month and by the second law the three shaded areas are equal. Now it is clear from the figure that the arc A D is greater than the arc X Y, for the areas S D A and S X Y are equal and S A and S D are less than S X and S Y; consequently, the velocity of the planet in its orbit must be greater between A and D than between X and Y. More definitely, the velocity of the planet is greatest at perihelion, decreasing gradually until aphelion is reached and thereafter increasing to a maximum again at perihelion.

The figure also shows that the angles described in equal intervals of time by the radius vector vary throughout the orbit; for example the angle D S A is clearly greater than the angle X S Y. The angular velocity is greatest at perihelion and least at aphelion. In one complete revolution around the sun, the radius vector sweeps out 360° and as the period of revolution is accurately known, the average angular velocity is easily deduced. This is known as the "mean motion" and is expressed as so many degrees (or seconds of arc) per day.

Third Law.—Kepler's third law is a relation connecting the semimajor axes of the several planets with their periods of revolution. In Kepler's time, the mean distance of any one planet from the sun was not known in miles but it was known fairly accurately in terms of the earth's mean distance from the sun regarded as the unit of the distance; in other words, the planetary system had been fairly correctly mapped out but the scale of the map was lacking. Also, the periods of the several planets were known with considerable accuracy.

The third law expressed in words is: the cube of the semimajor axis of any planetary orbit divided by the square of the period of revolution is the same whatever planet is considered. If the year is regarded as the unit of time and the earth's mean distance from the sun as the unit of distance (this is known as the astronomical unit of distance) the quotient above for the earth is plainly unity and consequently by the third law the cube of the semimajor axis of any other planet (expressed in terms of the astronomical unit) must be equal to the square of the planet's period (expressed in years).

The Orbit in Space.—We have seen that the elliptic orbit of a planet is specified by the eccentricity and the semimajor axis. To apply Kepler's first and second laws to predict the position of the planet in its orbit at any time it is necessary to know in addition the time when it occupied any definite position in the orbit or the time when it passed through perihelion. The eccentricity, the length of the semimajor axis and the time of perihelion passage constitute three elements of the planet's orbit.

The planetary motions do not all take place in the same plane and consequently the plane of the orbit of a particular planet must be specified with reference to some fundamental plane: the plane chosen is that of the earth's orbit and is called the plane of the ecliptic. Imagine a sphere drawn with the sun at the centre. The plane of the earth's orbit will cut the sphere in a circle (the ecliptic) and the orbital plane of any other planet will cut the sphere in another circle inclined at some definite angle to the plane of the ecliptic. The two circles intersect at two points N and M—called the Nodes. Let V denote a definite reference point on the ecliptic—the direction S V may be thought of as the direction of a particular star as seen from the sun.

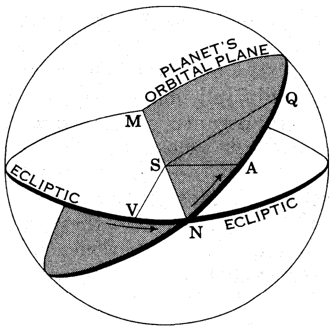

FIG. 2.— PLANET'S ORBITAL PLANE IN RELATION TO THE ECLIPTIC

The point V is known as the "vernal equinox" or "First point of Aries"; it is not necessary here to specify it more particularly. The plane of the planet's orbit is completely specified—with reference to the ecliptic and the point V—by (1) the inclination of the planet's plane to the plane of the ecliptic and (2) the position of the node N with respect to the point V. The latter is evidently given by the angle subtended at the sun by the radii S V and S N, and this angle is known as the longitude of the node. One thing more requires to be done and that is to specify the orientation of the orbital ellipse in its plane; this is accomplished by specifying the direction of perihelion—in the figure this is indicated by the direction S A. The sum of the angles subtended at S by the arcs V N and N A is called the longitude of perihelion. It should be noticed that there is an ambiguity as to the meaning of the expression "longitude of the node" for there are two nodes N and M. If the upper hemisphere in the figure contains the north pole of the heavens, the radius vector of the earth's orbit moves in the direction S V toward S N as indicated by the arrow; and if the radius vector of the planet moves in the direction S N toward S A, as indicated by the arrow, then N is called the ascending node and M the descending node and (2) above more precisely should be "the longitude of the ascending node." The ambiguity consequently disappears.

To summarize: a planet's orbit in space is completely specified by the six elements: (1) the semimajor axis, (2) the eccentricity, (3) the time of perihelion passage, (4) the longitude of the ascending node, (5) the longitude of perihelion, (6) the inclination of the orbital plane to the plane of the ecliptic.

When the six elements of a planet's orbit are known the position of the planet (the effects of the attractions of the other planets not being taken into account) with reference to the sun and the fundamental plane (the ecliptic) can be calculated for any future date by principles essentially contained in Kepler's laws. The earth's orbit also being known, the position of the planet in the heavens, as seen from the earth, can then be deduced. (W. M. S.)

The Orbit From Observations.— The problem here is to determine the six elements which describe an orbit from observations made of the planet. The measures of position may be made visually or photographically by comparing the location of the object with the positions of the background (fixed) stars. In the case of artificial earth satellites containing' radio transmitters the position may be determined by iqterferometric and Doppler measures. Each observation consists of determinations of the object's right ascension and declination, or some other pair of independent quantities. Since there are six unknowns, at least three observations are necessary for their complete determination. The observations should be spread evenly in time and extend over a considerable arc of the orbit for the best determination of the elements. In the case of a rapidly moving earth satellite this would mean observations spaced only a few minutes apart, whereas for a minor planet traveling about the sun they might be several months apart. The elements so determined describe an osculating ellipse at the mean epoch of the observations. Further refinements are necessary to account for the effects of any disturbing forces such as planetary attractions, or in the case of close earth satellites, the oblate figure of the earth and atmospheric drag (see CELESTIAL MECHANICS).

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ORCAGNA, ANDREA (ANDREA DI CIONE) (*c.* 1308–*c.* 1368), the most prominent Florentine painter, sculptor and architect of the mid-14th century, was born in or after 1308. The son of a goldsmith, Orcagna was the leading member of a family of painters which included three younger brothers: Nardo (d. 1366), Matteo and Jacopo (d. after 1398) di Cione. He matriculated in the arte dei medici e *speziali* in 1343–44, and was admitted to the guild of stonemasons in 1352. In 1354, he contracted to paint an altarpiece for the Strozzi chapel in the left transept of Sta. Maria Novella, in Florence. This polyptych (signed and dated 1357) shows Christ in a *mandorla* (an almond-shaped frame) presenting the keys to St. Peter and a book to St. Thomas Aquinas, who are represented on their knees supported by St. John the Baptist and the Virgin. In the two outer panels are SS. Michael and Catherine and SS. Paul and Lawrence, In the predella, in oblong octagonal panels, are the mass of St. Thomas, the Navicella and the death of the emperor Henry. The forceful handling of the figures is strongly individual, as is the attempt to treat the panels of the polyptych as a unitary scheme. The surviving section of a fresco of the "Triumph of Death" in Sta Croce has also been ascribed to Orcagna. In Sept. 1367 he received the commission from the Arto del Cambio for an altarpiece of the patron of the guild, St. Matthew, with four scenes from his life. In Aug. 1368 the execution of this picture (now in the Uffizi gallery, Florence) was taken over by Jacopo di Cione on account of the illness of his brother. Orcagna is assumed to have died in this year.

As a sculptor, Orcagna is known through a single work, the tabernacle in the guild oratory of Or San Michele. of which he became superintending architect in 1355. This is a decorative structure of great complexity, supported on four octagonal piers and heavily encrusted with coloured inlay. Its principal sculptural features are, on the front and sides, a number of hexagonal of the life of the Virgin, and, at the back, a large relief of the Dormition and Assumption of the Virgin, signed and dated 1359. The large relief is among the most notable surviving examples of the expressive art which sprang up in Tuscany after the Black Death. There are marked differences of quality in the figurated parts of the tabernacle, and some of these may be due to Orcagna's brother Matteo.


ALINARI

"THE ANNUNCIATION OF DEATH TO THE VIRGIN" BY ORCAGNA 1359 A DETAIL FROM THE MARBLE TABERNACLE OF THE CHAPEL OF OR SAN MICHELE, FLORENCE

It is known that Orcagna was employed as architect in the Duomo in Florence in 1357 and 1364–66. In 1358, he became architect of the cathedral at Orvieto, where he was engaged in 1359–60 with his brother Matteo in supervising the mosaic decoration of the façade.

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ORCHARDSON, SIR WILLIAM QUILLER (1832–1910), British painter of historical and domestic genre and portraitist. xas born in Edinburgh on March 27, 1832. After studying at the Trustees' academy from 1850 to 1857, he began to do black-and-white illustrations, chiefly for Good Words, after the Pre-Raphaelite manner.

His early history pieces resemble R. Scott Lauder's, but he evolved a personal style characterized by thinly hatched strokes in fluid pigment, predominantly golden in tone with relieving touches of brighter colour. After exhibiting at the Royal Scottish Academy, he came to London in 1862, exhibiting at the Royal Academy from 1863. He was elected academician in 1877 and knighted in 1907. Two of his more famous paintings, "Napoleon on Board the Bellerophon" (1880) and "Her Mother's Voice" (1888), are in the Tate gallery, London.

Orchardson died in London on April 13, 1910.

See J Stanley Little in *Art Annual (1897)*; J. L. Caw, *Scottish Painting Past and Present 1620–1908* (1908). (D. L FR.)

ORCHESTRA. In ancient Greece the orchestra was the space between the auditorium and the proscenium or stage, in which were stationed the chorus and the instrumentalists. In its modern acceptation the word means either that portion of a theatre or concert-hall provided for the accommodation of the instrumentalists or the body of instrumentalists itself; by extension in the C.S. it means the main floor of the theatre.

The modern orchestra is composed of the following:

1. A basis of strings — first and second violins, violas, violoncellos and double basses.
2. Flutes, sometimes including a piccolo.
3. The reed contingent, consisting of two complete families: (a) the oboes with their tenors and basses (the cor anglais. the fagotto or bassoon and the contrafagotto or double bassoon); (b) the clarinets with their tenor and basses (the basset horn and the bass and pedal clarinets), with the addition sometimes of saxophones.
4. The brass wind, consisting of the horns, a group sometimes completed by the tenor and tenor-bass Wagner tubas, the trumpet or cornet, the trombones (tenor, bass and contrabass), the tubas (tenor. bass and contrabass).
5. A harp or harps.
6. The percussion instruments, including the kettledrums, bells, Glockenspiel, cymbals, triangle, etc., to which are sometimes added a celesta and a pianoforte, to say nothing of such "extras" as the rattle employed by Richard Strauss in Till Eulenspiegel, the wind machine required by the same composer in Don Quixote, the iron chains introduced by Schonberg in his *Gurrelieder,* and so on.

(See also under names of musical instruments.)

Although most of the instruments from the older civilizations of Egypt, Chaldea, Persia, Phoenicia and of the Semitic races were known to the ancient Greeks, they did not share in any way their neighbours' love of orchestral effects, obtained by combining harps, lyres, guitars, tanburs, flutes, trumpets, bagpipes, cymbals, drums, etc., playing in unison or in octaves. The Greeks only cultivated to any extent the various kinds of citharas, lyres and auloi, and these were seldom used in concert. To the predilection of the Romans for wind instruments of all kinds we owe nearly all the wind instruments of the modern orchestra, each of which had its prototype among the instruments of the Roman empire: the flute, oboe and clarinet, in the tibia; the trombone and trumpet in the buccina; the tubas in the tuba; and the French horn in the cornu and buccina.

The 4th century A.D. witnessed the downfall of the Roman drama and the debasement of instrumental music, which was placed under a ban by the Church. During the convulsions which the migrations of Goths, Vandals and Huns caused in Europe after the fall of Rome instrumental music was preserved from absolute extinction by wandering actors and musicians.

The earliest instrumental compositions extant are certain 15th century dances and pieces in contrapuntal style preserved in the libraries of Berlin and Munich. The late development of notation, which long remained exclusively in the hands of monks and troubadours, personally more concerned with vocal than with instrumental music, ensured the preservation of the former, while the latter was left unrecorded.' But indications are not wanting of an independent energy and vitality which must surely have existed in unrecorded mediaeval instrumental music, since there is such evidence of this in the instruments themselves. It is, for example. significant of the attitude of the 10th century instrumentalists towards musical progress that they at once assimilated Hucbald's innovation of the *organum,* a parallel succession of fourths and fifths, accompanied sometimes by the octave, for two or three voices respectively, and that they produced in the same century the *organistrum,* named after Hucbald's *organum.*

At the time of the revival of the drama with music, afterwards modified and known as opera, at the end of the 16th century, there was as yet no orchestra in our sense of the word. but merely an abundance of instruments used in concert for special effects, uithout balance or grouping; small positive organs, regals, harpsichords. lutes, theorbos, archlutes, chittarone (bass and contrabass lutes), guitars, viols, lyras *de braccio* and *de gamba,* psalteries, citterns, harps, flutes, recorders, cornets, trumpets and trombones, drums and cymbals.

Monteverde was the first to see that a preponderance of strings is necessary to ensure a proper balance of tone. With the perfected models of the Cremona violins at his disposal. a quartet of strings nas established and all other stringed instruments not played nith the bow were ejected from the orchestra, with the exception of the harp. Under the influence of Monteverde and his successors, Cavalli and Cesti, the orchestra won for itself a separate existence with music and laws of its own As instruments were improved, new ones introduced and old ones abandoned, instrumentation became a new and favourite study in Italy and in Germany, and musicians began to find out the capabilities of the various families of instruments and their individual value.

At first the orchestra was an aristocratic luxury, performing privately at the courts of the princes and nobles of Italy; but in the 17th century performances were given in theatres, and Germany eagerly followed. Dresden, Munich and Hamburg successively built opera houses. while in England opera began with the masque, and in France J. B Lully, nith the collaboration of Molière, also greatly raised the status of the entertainments known as *ballets,* interspersed with instrumental and vocal music.

The revival of the drama seems to have exhausted the enthusiasm of Italy for instrumental music, and the field of action was shifted to Germany, where the perfecting of the orchestra was continued. Most German princes had at the beginning of the 18th century good private orchestras of *Kapelle,* and they always endeavoured to secure the services of the best available instrumentalists. Kaiser. Telemann. Graun. Mattheson and Handel contributed greatly to the development of German opera and of the orchestra in Hamburg during the first quarter of the century. Gluck, the reformer of opera; Mozart; Haydn, the father of the modern orchestra and the first to treat it independently as a power opposed to the solo and chorus, by scoring for the instruments in well-defined groups; Beethoven, who individualized the instruments, nriting solo passages for them; Weber, who brought the horn and clarinet into prominence; Schubert, who inaugurated the conversations between members of the woodnind—all left their mark on the orchestra, leading the way up to Wagner, Strauss and their successors.

ORCHESTRATION: *see* INSTRUMENTATION.

ORCHHA, a town and district in Madhya Pradesh. India. Orchha town, on the river Betwa 7 mi. S. of Jhansi. was once the capital of the princely state of the same name but was displaced in that position by Tikamgarh. which is also the headquarters of the modern district. Orchha town has an imposing fort, mainly of the early 17th century, with two magnificent palaces—the Rajmandir, a massive square building of which the exterior is almost completely plain, and the Jahangirmahal, a singularly beautiful example of domestic architecture. Elsewhere about the town are fine temples and tombs, among which may be noticed the Chaturbhuj temple on its vast stone platform.

ORCHHA DISTRICT (officially Tikamgarh district; area 1,943 sq.mi.; pop. [1951] 366,165) corresponds exactly with Orchha state (also called Tikamgarh or Tehri), which was the senior Bundela principality and the only one not subject to the Maratha empire. The state was controlled under British paramountcy through the Bundelkhand subagency of the Central India agency. It was merged with Vindhya Pradesh on April 4, 1948. The district produces grain, ghee (clarified butter) and cotton cloth. The headquarters town, Tikamgarh (or Tehri), 52 mi. S.S.E. of Jhansi, had a population in 1951 of 13,429.

ORCHID, the name given to members of the orchid family (Orchidaceae), one of the most numerous and interesting groups of flowering plants, usually uith beautiful and often with highly fragrant flowers. Orchids are found in most climates throughout the world. except in the polar regions, but they occur in by far their greatest diversity and abundance in humid tropical forests. The orchids are all perennial herbs or vines, as in the genus *Vanilla,* and are comprised in two groups: (1) terrestrial orchids, which grow in the ground, and (2) epiphytic orchids (epiphytes; *q.v.*), which grow perched upon trees, found in the tropics, where they form an important feature of the vegetation. Most orchids of the temperate zone are terrestrial.

Floral Structure.—The flowers of orchids, though extremely diverse within certain limits. are all formed upon one common plan, which is only a modification of that observable in such flowers as those of the narcissus. Such flowers consist essentially in the presence of a six-parted perianth, the three outer segments of which correspond to a calyx, the three inner ones to a corolla. These segments spring from the top of the ovary, which is inferior instead of superior as in the lily. Within the perianth, and springing from its sides, or from the top of the ovary, are six much-modified or suppressed stamens. These stamens encircle a style which is the upward continuation of the ovary and which shows at its free end traces of the three originally separate but now blended carpels of which the ovary consists.

An orchid flower has an inferior ovary, but with the ovules on the walls of the cavity (not in its axis or centre), a six-parted perianth, a stamen or stamens and stigmas. The main distinguishing features consist in the fact that one of the inner pieces of the perianth becomes in course of its growth much larger than the rest, and usually different in colour, texture and form. So different is it that it has a distinct name, that of "lip" or "labellum." In place of six stamens only one is commonly found (two in *Cypripedium; q.v.*), and that one is raised together with the stigmatic surfaces on an elongation of the floral axis known as the "column." Moreover, the pollen, instead of consisting of separate cells or grains, consists of cells aggregated into usually sticky pollen masses, the number varying in different genera, but very generally two, four or eight. In *Cypripedium* all three stigmas are functional, but in most orchids only the lateral pair form receptive surfaces, the third being sterile and forming the rostellum, ahich plays an important part in the process of pollination, often forming a peculiar pouchlike process in which the viscid disk of the pollen masses is concealed.

It would appear, then, that the orchid flower differs from the more general monocotyledonous type in the irregularity of the perianth. in the suppression of five out of six stamens and in the union of the one stamen and the stigmas. In addition to these modifications. which are common to nearly all orchids. there are others generally but not so universally met with; among them is the displacement of the floner arising from the twisting of the inferior ovary, in consequence of which the flower is so completely turned round that the "lip," which originates in that part of the flower conventionally called posterior, or that nearest to the supporting stem, becomes in course of growth turned to the anterior part of the flower nearest to the bract. Other common modifications arise from the union of certain parts of the perianth to each other. and from the varied and often very remarkable outgroa ths from the lip. These modifications are associated with the structure and habits of insects and their visits to the flowers.

Cross-Pollination **by** Insects.—In some common orchids, British *Orchis maculata,* O. *mascula* (Shakespeare's long purples), etc., the general structure of the flower is as described above. In addition there is in this particular genus, as indeed in many others, a long tubular spur or horn projecting downward from the back of the lip, whose function it is to secrete and store nectar; the forepart of the lip forms an expanded plate, usually larger and more brightly coloured than the other parts of the flower, and

Laeliocattleya (*Laeliocattleya valencia*, variety DORIS)

White cattleya (Cattleya *trianae*, variety A. C. BURRAGE)

Lady's-slipper (*Cypripedium* maudiae)

Lady's-slipper (Paphiopedilum [Cyp.], variety MILDRED HUNTER)

Sophronitis (*Sophronitis grandiflora*)

Showy lady's-slipper (*Cypripedium reginae*)

CULTIVATED AND WILD ORCHIDS

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE, BOTTOM LEFT) RUTHERFORD PLATT, (CENTRE LEFT) SHERMAN, PHOTO RESEARCHERS FROM PUBLIX, (BOTTOM RIGHT) OAKES, PHOTO RESEARCHERS FROM PUBLIX

Epidendrum (*Epidendrum falcatum*)

Angraecum (*Angraecum eburneum*)

Dendrobium LOUIS BLERIOT

Cymbidium ERICA SANDER (*C. grandiflorum* x *C. pauwelsi*)

Oncidium NONA, II (*O.* COMTESSE DE BRETON x *O. varicosum rogersi*)

Vanda (*Vanda caerulea*)

Odontonia OLGA

CULTIVATED ORCHIDS

PHOTOGRAPHS, RUTHERFORD PLATT

with hairs or ridges and spots of various kinds according to the species. The remaining parts of the perianth are much smaller, and commonly are so arranged as to form a hood overarching the "column." This column stands up from the base of the flower, almost at right angles to the lip, and it bears at the top an anther, in the two hollow lobes of which are concealed the two pollen masses, each with its stalk (caudicle) terminating below in a roundish gland, concealed at first in the pouchlike rostellum at the front of the column. Below the anther the surface of the column in front is hollowed out into a greenish depression covered with viscid fluid—this is the structure formed from the two united stigmas.

In the process of pollination a bee alights on the lip. There, guided by the hairs or ridges, it is led to the orifice of the spur with its store of nectar. The position of this orifice is at the base of the lip and of the column, so that the insect. if of sufficient size, while bending its head to insert its proboscis into the spur. almost of necessity displaces the pollen-masses. Liberated from the anthers. these adhere to the head or back of the insect by means of the sticky gland at the bottom of the caudicle. Having sipped the nectar the insect withdraws, taking the pollen-masses with it. and visits another flower. The two anther-cases in an orchis are erect and nearly parallel to each other; the pollen-masses nithin them are of course in the like position. Immediately, however. the pollen-masses are removed, movements take place at the base of the caudicle so as to effect the bending of this stalk, bringing the pollen-mass in a more or less horizontal position. or, as in the case of O. *pyramidalis,* the two pollen-masses originally placed parallel diverge from the base like the letter V. The movements of the pollen-masses may readily be seen with the naked eye by thrusting the point of a needle into the base of the anther. when the disks adhere to the needle as they would to the antenna of an insect, and may be withdrawn. Sometimes the lip is mobile and even sensitive to touch, as are also certain processes of the column. In such cases the contact of an insect or other body with those processes is sufficient to liberate the pollen often with elastic force, even when the anther itself is not touched.

In other orchids movements take place in different ways and in other directions. The object of these movements will be appreciated when it is remembered that if the pollen-masses retained the original direction they had in the anther in which they were formed, they nould, nhen transported by the insect to another flower, merely come in contact with the anther of that flower, where of course they would be of no use; but owing to the divergences and flexions above alluded to, the pollen-masses come to be so placed that, when transplanted to another flower of the same species, they come in contact with the stigma and so effect the pollination of that flower. The adaptions of orchid flowers to fertilization by insects are very numerous and often remarkably complicated. Darwin devoted two volumes to the subject.

Propagation and Growth.— The fruit of orchids is a capsule which usually splits by three lengthwise slits, forming valves that remain united above and below. The seeds. minute and innumerable. are well-adapted to wind dissemination. In many species the seeds lose their viability after a few months and often are slow and difficult to germinate after planting. some requiring from three months to two years. The roots of terrestrial orchids are often bulbous and still more frequently more or less tuberous. the tubers being partly radical (basal leaved) and partly budlike, so that propagation of new individuals by division from the parent takes place. Often there is a marked alternation in the production of vegetative and flonering shoots; sometimes the flowering shoots are not produced for several years in succession. This accounts for the profusion with which various orchids are found in floner in some seasons and for their scarcity in others.

Tropical orchids are mostly epiphytic—that is. they grow upon trees without deriving nourishment from them. They are frequently provided with pseudobulbs, large solid swellings of the stem in the tissues of which nater and nutritive materials are stored. They derive this moisture from the air by means of aerial roots developed from the stem and bearing an outer spongy structure, or *velamen,* consisting of empty cells kept open by spiral thickenings in the wall; this sponge-like tissue absorbs dew and rain and passes it on to the internal tissues.

Classification.— In number of species the orchid family probably exceeds that of any other family of flowering plants. It contains at least 10,000 species in 450 genera; some authorities place the number of species as high as 15,000 or more and genera at 600. The family is divided into two main groups based on the number of the stamens and stigmas.

The first group, Pleonandrae, has two or rarely three fertile stamens and three functional stigmas. It contains two small genera of tropical Asia and Africa with almost regular flowers and the large genus *Cypripedium* (*q.v*), containing about 350 species in the north temperate zone and tropical Asia and America. In *Cypripedium* t o stamens are present, one on each side of the column, instead of one only at the top. as in the group Monandrae, to which belong the remaining genera in which also only two stigmas are fertile.

The group Monandrae has been subdivided into 20 tribes. the characters of which are based on the structure of the anther and pollen masses, the nature of the inflorescence, whether terminal or lateral, the vernation of the leaf. the presence or absence of a joint betneen blade and sheath and the nature of the stem. The most important tribes are the following:

1. *Ophrydeae,* terrestrial orchids, mainly north temperate, including the genera *Orchis,* Aceras, *Ophrys* (*q.v.*), *Herminium,* Gyntnadenia and *Habenaria* (*q.v.*).

2. *Neottieae,* also terrestrial, contains 13 more or less widely distributed tropical or subtropical subtribes; one. *Cephalanthereae,* which includes the genera *Cephalanthera* and *Epipactis,* is chiefly north temperate The genera Spiranthes, *Listera* (see TWAYBLADE) and *Neottia* are also included in this tribe, as is also Vanilla (q v) the elongated stem of which climbs by means of tendrillike aerial roots.

3. Coelogyneae, mostly epiphytes. and inhabitants of tropical Asia. A single internode of each shoot is swollen to form a pseudo-bulb. The widely cultivated genus Coelogyne belongs in this tribe.

4. Liparideae, terrestrial; two—*Malaxis* and Corallorhiza—are Eurasian and North American. *Liparis* is a large genus widely distributed in the tropics.

5. Pleurothallidieae, natives of tropical America; one, *Pleuro*-thallis, contains about 500 species. *Masdevallia,* common in cultivation, often has brilliant scarlet, crimson or orange flowers.

6. Laelieae, natives of the warmer parts of America, including three of those best known in cultivation, *Epidendrum,* Cattleya (*q.v.*) and Laelia.

7. Phajeae, chiefly tropical Asiatic, some—Phajus and Calantlze—spreading northward into China and Japan.

8. Cyrtopodieae, tropical, but extending into north temperate Asia and South Africa; *Eulophia* and *Lissochilus* are important African genera.

9. Cataseteae, with tropical American genera; two. *Cataseltum* and *Cycnoches,* have dimorphic or trimorphic flowers.

10. *Dendrobieae,* in warmer parts of the old world; the chief genus is *Dendrobium,* with 900 species. often nith showy flowers.

11. *Cymbidieae,* in the tropics of the old world. The leaves are generally long and narrow. *Cymbidium* is well known in cultivation

12. Oncidieae, in the warmer parts of America. Odontoglossum (*q.v.*) and *Oncidium* include some of the best-known cultivated orchids.

13. *Sarcantheae,* in the tropics. *Vanda* (Asia) and *Angraecum* (Xfrica and Madagascar) are knonn in cultivation. The flower of *Angraecum sesquipedale* has a spur about 1 ft. long.

North American Orchids.— In Sorth America north of Mexico about 150 species of orchids are found, representing 42 or 43 genera. Many are widely distributed across the continent, some extending to Alaska and even to Greenland, but they occur most numerously in the eastern and especially the southeastern states. The generic groups having the largest number of species are the rein-orchises (*Habenaria*), 38 species; lady's-tresses (Spiranthes), 15 species; lady's-slippers (*Cypripedium*), 14 species; and bogorchises (Malaxis), 8 species. Tropical epiphytes are represented by Epidendrunz, 12 species and *Oncidium,* 7 species, found in Florida. Among the many attractive orchids native to the eastern states and provinces are the showy lady's slipper (*Cypripedium* reginae), yellow lady's-slipper (C. calceolus), moccasin flower (C. acaule), showing orchis (*Orchis* spectabilis), shin plasters (*O.* rotundifolia), white-fringed orchis (Habenaria blephariglottis), yellow-fringed orchis (H. ciliaris), small purple-fringed orchis (H. psycodes), rose pogonia or snakemouth (Pogonia ophioglossoides), dragon's mouth (Arethusa bulbosa) and the grass pink (*Calopogon* pulchellus). *Listera* species and Liparis liliifolia of the damp woods are called twayblade (*q.v.*) in the U.S.

In the Rocky mountain region and adjacent plains about 40 species of orchids occur. Fully half of these are found also in the eastern states and a dozen or more extend northward to Alaska. Among them are the mountain lady's-slipper (Cypripedium *montanum*) and the oval-leaved orchis (Habenaria *menziesi*). About 35 species occur in the Pacific states. Among these are the California lady's-slipper (Cypripedium californicum), Sierra rein-orchis (*Habenaria* leucostachys), giant helleborine (Epipactis *gigantea*) and the rare phantom orchis (Cephalanthera austinae).

British Orchids. — The family is well represented in Great Britain by nearly 45 species representative of 18 genera. Among these are several species of *Orchis* ("Orchis" generally refers to species of the genus *Orchis,* but some species of other genera have the term orchis in their common compound names). Gymnadenia (fragrant orchis), Habenaria (butterfly and frog orchis), Aceras (man orchis), *Herminium* (musk orchis), Ophrys (bee, spider and fly orchis), *Epipactis* (helleborine), Cephalanthera, *Neottia* (bird's-nest orchis), one of the few saprophytic genera. which have no green leaves but derive their nourishment from decaying organic matter in the soil, *Listera* (twayblade), *Spiranthes* (lady's-tresses; *q.v.*), *Malaxis* (bog-orchis), Liparis (fen-orchis), *Corallorhiza* (coral root), also a saprophyte, and Cypripedium (lady's-slipper; *q.v.*), represented by a single species, now very rare, in limestone districts in the north of England.

Cultivation. — The only orchid of substantial economic importance, furnishing a staple article of extensive use, is vanilla (*q.v.;* see also SALEP). But an immense number of tropical orchids are grown in greenhouses in Europe and North America for the flower markets and as objects of horticultural and scientific interest. More than 3,000 species, many of them epiphytes, are in cultivation, as well as thousands of hybrid forms. Among the genera thus represented in orchid culture are Cattleya, *Cypripedium, Dendrobium,* Epidendrum, Laelia, Odontoglossum and *Phalaenopsis.* Many bi-generic hybrids have been developed by orchid fanciers. Propagation of these cultivated forms is by division, cuttings and growth from seed. Many terrestrial orchids defy efforts at cultivation, due to lack of knowledge regarding soil conditions, to saprophytic habits and to their growth in association with special fungi, see MYCORHIZA. See also Index references "Orchid" in vol. 24.

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ORCHOMENUS (on coins and inscriptions, Erchomenos), the name of two cities of ancient Greece.

1. A Boeotian city, between the Cephissus river and its tributary, the Melas, on a long, narrow hill projecting south from Mt. Acontium, near the modern Skripou. The acropolis is situated at the north end of the ridge.

In prehistoric times Orchomenus is revealed alike by archaeological finds and by legends as one of the most prosperous tonns of Greece. It mas a seat of the Minyae and controlled a great part of Boeotia, especially the fertile lowlands of Lake Copais, on the drainage of which its early kings bestowed great care. After the Mycenaean period it was a member of the Calaurian league (see AEGINA: History). But political supremacy in Boeotia rapidly passed to Thebes. Nevertheless, Orchomenus long exercised some overlordship over northern Boeotia and an independent policy within the Boeotian league. In 447 it was the headquarters of the oligarchic exiles who freed Boeotia from Athenian control. In the 4th century Orchomenus was actuated throughout by an anti-Theban policy. In the Corinthian War it supported Lysander and Agesilaus in their attacks on Thebes, and it again sided with Sparta in 379. After the battle of Leuctra the Thebans first, on Epaminondas' advice, readmitted it to the Boeotian league, but in 364 destroyed the town. By 353 it had been rebuilt, for it was taken by the Phocians and used as a bulwark against Thebes. After the subjection of the Phocians in 346 it was reduced by the Thebans, but was restored by Philip of Macedon as a check upon Thebes (338). Its later history is obscure and its decadence is attested by the encroachments of Lake Copais.

The so-called "treasury of Minyas" at the foot of the ancient city is almost exactly the same size as the "treasury of Atreus" at Mycenae (see MYCENAE). The admiration of Pausanias is justified by the beautiful ornamentation of the roof of the inner chamber brought to light by H. Schliemann. Excavation by A. Furtwangler and H. Bulle revealed three superposed prehistoric settlements. The first represents the neolithic painted-ware culture of Thessaly and neighbouring parts of Greece; in the second, oval huts replace the earlier round ones, and dull smeared pottery ("Urfirniss") the painted ware; the third has rectangular houses and characteristic gray "Minyan" pottery, finely modeled but without ornament. All these cultures precede the Mycenaean occupation, to which the great "Treasury" tomb belongs.

The worship of the Charites (see GRACES) was the great cult of Orchomenus, and the site of the temple is now occupied by a chapel of the Virgin (Κοίμησις τῆς Παναγίας). The Charites were worshiped under the form of rude stones, which had fallen from heaven during the reign of Eteocles; and it was not until the time of Pausanias that statues of the goddesses were placed in the temple. Near this was another temple, dedicated to Dionysus, in whose festival, the Agrionia (*q.v.*), are apparent the traces of early human sacrifice.

2. An Arcadian city north of Mantineia and west of Stymphalus. Its district was mountainous, but had two high-lying valleys—the northern containing a lake drained by a katavothron (underground channel); the southern below the city, separated from Mantineia by the ridge Anchisia. The old city, in a strong situation, nas a ruin in Pausanias' time. Until late in the 7th century the kings of Orchomenus held some sort of sovereignty over all Arcadia. In the 5th century it was overshadowed by Mantineia, and in 418 B.C. fell for a time into its power. About 370 it lost some possessions on the east to the new Arcadian capital, Megalopolis. In the 3rd century it mainly followed the fortunes of the Spartans, but belonged for a short time to the Aetolian league and, after about 235. to the Achaean league. Its historv under Roman rule is obscure.

ORDEAL, a term of varying meaning but bearing the special sense of the medieval Lat. Dei *iudicium,* a miraculous decision as to the truth of an accusation or claim. The ordeal in principle, and often in the very forms used, belongs to ancient culture. Some ordeals, which possibly represent early stages of the practice, are simply magical, being processes of divination turned to legal purpose. Thus in Burma suits are sometimes still determined by plaintiff and defendant being each furnished uith a candle, equal in size and both lighted at once—he whose candle outlasts the other being adjudged to have won his cause. In Borneo, the two parties are represented by two shellfish on a plate, which are irritated by pouring on some lime juice, and the one first moving settles the guilt or innocence (as has been before arranged) of its owner. The administration of ordeals has been much in the hands of priests, the intervention of a deity being invoked and assumed to take place even when the process is in its nature one of symbolic magic. The ordeal is related to divination (*q.v.*). *Coscinomancy* (the use of a sieve for divination) served anciently to discover a thief when, with prayer to the gods for direction, the names of the suspected persons were called over it (Potter, Greek Antiquities, i. 352). When a suspended hatchet was used in the same way to turn to the guilty, the process was called *axinomancy*. In the modern Christian form of the key and bible, a psalter or bible is suspended by a key tied in at Psalm l. 18: "When thou sawest a thief, then thou consentedst with him"; the bow of the key being balanced on the fingers, and the names of those suspected being called over, he or she at whose name the book turns or falls is the culprit. One form of divination passing into ordeals is the appeal to the corpse itself for discovery of its murderer. Thus the natives of Australia will ask the dead man carried on his bier of boughs, who bewitched him; if he has died by witchcraft he will make the bier move round, and if the sorcerer who killed him is present a bough will touch him. The well-known ordeal of the bier in Europe in the middle ages seems founded on a different principle, the imagination that a sympathetic action of the blood causes it to flow at the touch or neighbourhood of the murderer. On Teutonic ground, this ordeal appears in the Nibelungenlied, where the murdered Siegfried is laid on his bier, and Hagen is called on to prove his innocence by going to the corpse, but at his approach the dead chief's wounds bleed afresh. In Shakespeare (*Rich.* III., act I, sc. 2):

> O gentlemen, see, see! dead Henry's wounds
> Open their congeal'd mouths, and bleed afresh!

Certain ordeals are closely related to oaths, so that the two shade into one another. Let the curse which is to fall on the oath-breaker take effect at once, it then becomes a sign condemning the swearer—in fact, an ordeal. Thus the drinking of water on which a curse or magical penalty has been laid is a mere oath so long as the time of fulfilment is unfixed (see OATH AND AFFIDAVIT). But it becomes an ordeal when. as in Brahmanic India, the accused drinks three handfuls of water in which a sacred image has been dipped; if he is innocent nothing happens. but if he is guilty sickness or misfortune will fall on him within one to three weeks. Numbers v. describes the mode of administering to a woman charged with unfaithfulness the bitter water mixed with the dust of the tabernacle floor, with the curse laid on it to cause her belly to swell and her thigh to fall if guilty. The term "bitter" is applied to the water before it has been cursed, which suggests that it already contained some drug, as in the poison-water ordeal still in constant use over a great part of Africa. The result of the ordeal depends partly on the patient's constitution, but more on the sorcerer who can prepare the proper dose to prove either guilt or innocence, and thereby acquires boundless influence. The poison-ordeal is also known to Brahmanic law, decoction of aconite root being one of the poisons given, and the accused if not sickening being declared free (Stenzler, *l.c.*). Theoretically connected with the ordeal by cursed drink is that by cursed food. The ordeal by bread and cheese, practised in Alexandria about the 2nd century, was practically the same as that known to English law five to ten centuries later as the *corsnaed* or "trial slice" of consecrated bread and cheese which was administered from the altar, with the curse that if the accused were guilty God would send the angel Gabriel to stop his throat, that he might not be able to swallow that bread and cheese. In fact, if guilty and not a hardened offender he was apt to fail, dry-mouthed and choking through terror, to get it down.

The passing through the fire is described in the Hindu codes of Ydjnavalkya and others, and in the *Râmâyana* the virtuous Sitâ thus proves her innocence to her jealous husband Râma. In European law and chronicle, Richardis, wife of Charles the Fat, proves her innocence by going into a fire clothed in a waxed shift, and is unhurt by the fire. Yet more minutely prescribed in the Hindu ordeal-books is the rite of carrying the glowing hot iron seven steps, into the seven or nine circles traced on the ground, the examination of the hands to see if they show traces of burning, and the binding them up in leaves. In a Scandinavian law it is prescribed that the red-hot iron shall be carried nine steps. In Anglo-Saxon laws the iron to be carried was at first only one pound weight, but Athelstan's law increased it to three pounds. Another form well known in old Germany and England was the walking barefoot over glowing ploughshares, generally nine. The law-codes of the early middle ages show this as an ordinary criminal procedure. Queen Emma, mother of Edward the Confessor, accused of familiarity with Alwyn bishop of Winchester, triumphantly purged herself and him by the help of St. Swithin—each of the two thus acquitted giving nine manors to the church of Winchester, in memory of the nine ploughshares, and the king being corrected with stripes. To dip the hand in boiling water or oil or melted lead and take out a stone or ring is another ordeal of this class. Some of these fiery trials are still in use, in regions of Africa or further Asia—the negro plunging his arm into the caldron of boiling oil, the Burman doing feats with melted lead, while the Bedouin will settle a conflict of evidence by the opposing witnesses licking a glowing hot iron spoon. This latter feat may be done with safety, provided the iron be clean and thoroughly white hot, while if only red-hot it would touch and burn the tongue. Probably the administerers of the ordeal know this, and the possibility of dipping the hand in melted metal; and there are stories of arts of protecting the skin, though it is not known what can be really done beyond making it horny like a smith's, which would serve as a defence in stepping on hot coals, but not in serious trials like that of carrying a heavy red-hot iron. The fire-ordeals are still performed by mountebanks. Fire walking is still practised by Hindus. The Hindu code of Manu avers that "He whom the flame does not burn, whom the water does not cast up, or whom no harm soon befalls, is to be taken as truthful in his oath." This water-ordeal is well known in Europe, where the accused is thrown bound into the water, which receives him if innocent. but rejects him if guilty. The directions given by Archbishop Hincmar in the 9th century provide that he who is let down into the water for trial is to be fastened by a rope, that he may not be in danger if the water receives him as innocent, but may be pulled out. In the later middle ages this ordeal by "swimming" or "fleeting" became the most approved means of trying a suspected witch: she was stripped naked and cross bound, the right thumb to the left toe, and the left thumb to the right toe. In this state she was cast into a pond or river. in which it mas thought impossible for her to sink. Cases of "ducking" witches which used to occur in England were remains of the ancient ordeal.

When in the warfare of Greeks and Trojans, of Jews and Philistines. of Vandals and Alamans, heroes come out from the two sides and their combat decides the victory, then we have the ordeal by battle. A passage from old German law shows the single combat accepted as a regular legal procedure: "If there be dispute concerning fields, vineyards, or money, that they avoid perjury let two be chosen to fight, and decide the cause by duel." In England, after the Conquest, trial by combat superseded other legal ordeals, which were abolished in the time of Henry III. A lord often sent his man in his stead to such combats, and priests and women were ordinarily represented by champions. (See DUEL.) (E. B. T.; X.)

ORDER, a row or series, hence grade. class or rank. sequence or orderly arrangement (Lat *ordo*, rank, arrangement). For its various meanings see MINISTRY, THE CHRISTIAN; MONASTICISM; KNIGHTHOOD AND CHIVALRY; ORDER IN COUNCIL; BILL OF EXCHANGE.

For technical mathematical uses of "order" see NUMBER; CURVE; SURFACE; DIFFERENTIAL EQUATIONS, ORDINARY.

ORDER, in architecture, is a column (*q.v.*) with its base and capital (*qq.v.*), and the entablature (*q.v.*) above, considered as a single architectural feature. The entablature consists of three parts, the architrave (the beam resting directly on the columns, known also as the epistyle), frieze (q v.), and cornice (*q.v.*, the chief member being the corona, a projecting block vertical on the face but hollowed or sloped up toward the back on the under surface to shed rain). The Five Orders are systematic classifications of five different types, Tuscan, Doric, Ionic, Corinthian and Composite.

See also ORNAMENT, ARCHITECTURAL.

This article is divided into the following sections and subsections:

I. Types
  1. Classic Orders

2. Systematization
   - Tuscan
   - Doric
   - Ionic
   - Corinthian
   - Composite

II. Practices
1. Engaged Columns and Pilasters
2. Corner Treatments
3. Column Spacings and Variant Proportions
4. Roman Arch Orders
5. Superposed and Giant Orders
6. Codification

III. History
1. Origins
2. Greek Doric
3. Roman Doric
4. Greek Ionic
5. Roman Ionic
6. Greek Corinthian
7. Roman Corinthian
8. Roman Composite
9. Renaissance and Baroque
10. Modern

I. TYPES

1. Classic Orders.——Greek architecture developed two distinct orders, Doric and Ionic, together with a third form of capital, Corinthian, all adopted by the Romans, with modifications, by the 1st century B.C. It was natural, therefore, that Vitruvius (*q.v.*), in the last quarter of 1st century B.C. should have attempted to give rules for the construction of three orders. Moreover, as the Etruscans had developed a simple order of their own, he added a section dealing with that. With the rediscovery of Vitruvius early in the 15th century, he was at once hailed as the authority, and architectural writers of the later Italian Renaissance imitated him by giving ideal rules for the orders, attempting to reconcile his standards with the varying examples of Roman work they knew. They added as a fifth order the Composite type of capital. The three most famous Renaissance compilations, those of Sebastiano Serlio (1537), Giacomo da Vignola (1562) and Andrea Palladio (1570), exerted a tremendous influence over 17th- and 18th-century architecture throughout Europe, and gave rise to the idea that these compilations were rules to be absolutely followed, an idea contradicted by the works of the three authors themselves (as of Vitruvius before them). Since knowledge of Greek remains was lacking, the Doric and Ionic orders were described only in their Roman versions; in ignorance of Etruscan temples, the Tuscan order was described as a merely simplified Roman Doric. Their passion for regularization showed also in the fact that they specified a definite pedestal (*q.v.*) and even a definite baluster (*q.v.*) to accompany each order. Various 18th-century and modern architectural writers have attempted to simplify the order descriptions of Vignola and Palladio, and have thus perpetuated the Renaissance myth of the immutability of the orders. In general, Vignola's work was followed in France and Palladio's in England.

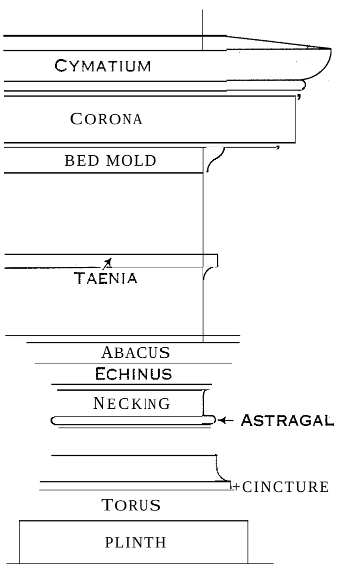

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FIG. I.— TUSCAN ORDER

2. Systematization.— The orders as systematized by the theorists are as follows (for definitions of many of the terms pertaining to decorative details see MOLDING):

Tuscan.—The column is 7 lower diameters high, including 6 diameters for an unfluted shaft (tapering toward the top) and ½ diameter each for base and capital. The base is a plain square plinth with a large circular torus (a half-round profile) and a fillet above. The capital has an astragal (miniature torus) at the top of the shaft, a necking which is merely a short continuation of the shaft, and an echinus (*q.v.*; a simple ovolo or quarter-round with a fillet below it), carrying a simple square abacus (*q.v.*). The entablature, as in all the orders, is one-quarter of the column height; the Tuscan consists of a plain architrave crowned by a simple taenia or projecting band square in cross section, a plain frieze, and a cornice with a *cyma reversa* as a bed molding, an undecorated corona, and the cymatium or gutter of ovolo profile.

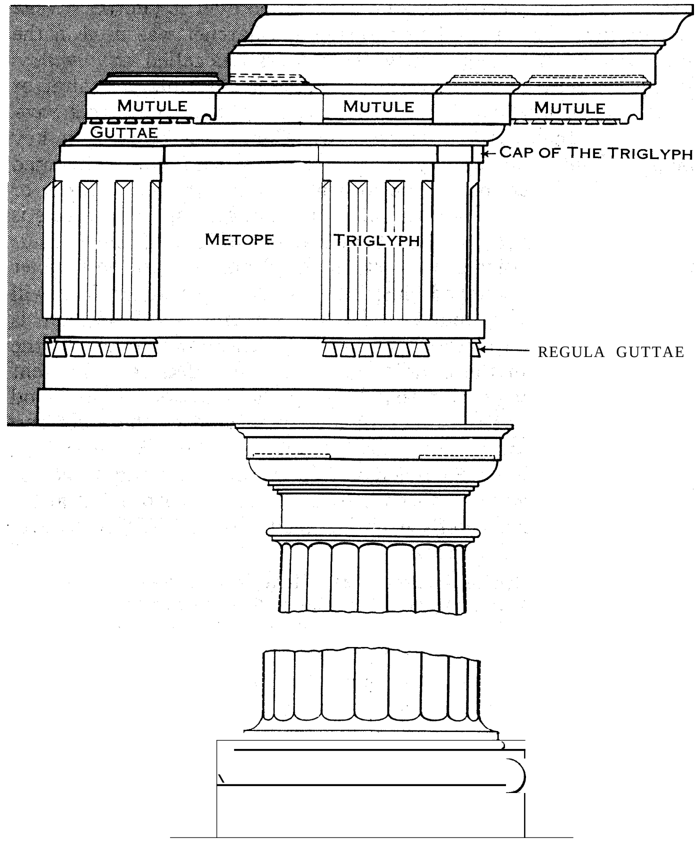

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FIG. 2.—DORIC ORDER. MUTULAR

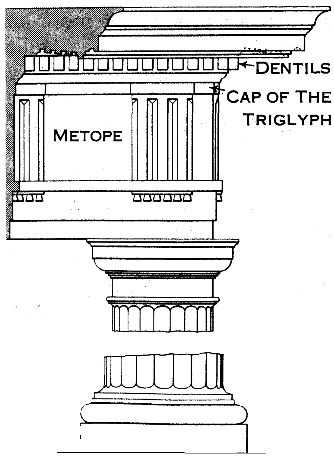

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FIG. 3.—DORIC ORDER, DENTICULAR

Doric.—The column is 8 diameters high (one more than the Tuscan), including ½ diameter each for base and capital. The shaft has 20 shallow flutes separated by sharp edges or arrises, terminating elliptically above the base and below the capital. The base differs from the Tuscan in the reduction of the height of the torus to permit the insertion of an astragal. The capital is given additional fillets or an astragal and fillet below the echinus, as well as a projecting molding at the top of the abacus. The echinus may be carved with the egg-and-dart, the necking decorated with rosettes. The architrave is sometimes divided into two fasciae (flat bands), the upper wider and projecting beyond the lower; the taenia may be decorated with a molding and, beneath each

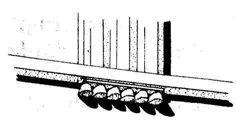

FIG. 4.—GUTTAE ON DORIC ARCHITRAVE

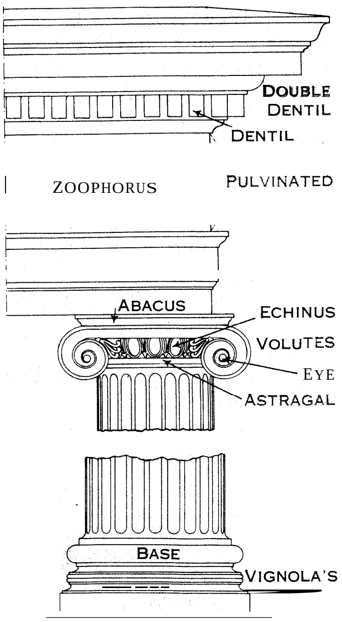

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FIG. 5.—IONIC ORDER

triglyph of the frieze, has a flat rulelike band (regula) from which hang six guttae or small conical drops. The frieze is composed of projecting triglyphs, vertical rectangles characterized by three (two whole and two half) vertical triangular grooves, alternating with receding metopes, square panels either plain or carved with sculptured reliefs. A triglyph is placed over the centre of each column, also one or more between the columns according to the variant column spacings (see below). Two forms of cornice are described: the mutular, in which the underside of the corona is decorated with projecting slablike blocks (mutules), one over each triglyph; and the denticular, in which the bed moldings are enlarged in order to include a row of little projecting blocks (dentils). In both cases guttae are used on the soffit or underside of the corona: in the mutular, the square under surfaces of the mutules have six rows each of six guttae, while in the denticular (where part of the projection is taken up by the dentils) they appear in shallower panels over each triglyph, each with three rows of six guttae. The bed molding, below mutules or dentils, is an ovolo or cyma *reversa,* while the crowning cymatium is either a cavetto or a *cyma* recta.

Ionic.—The column is 9 diameters high, including ½ diameter each for base and capital (the latter only ⅓ diameter excluding the drooping volutes). The shaft differs from the Doric in having 24 deeper (semicircular) flutes, with flat fillets between them. The base is of the Attic type (see Greek Ionic, below), with a plinth

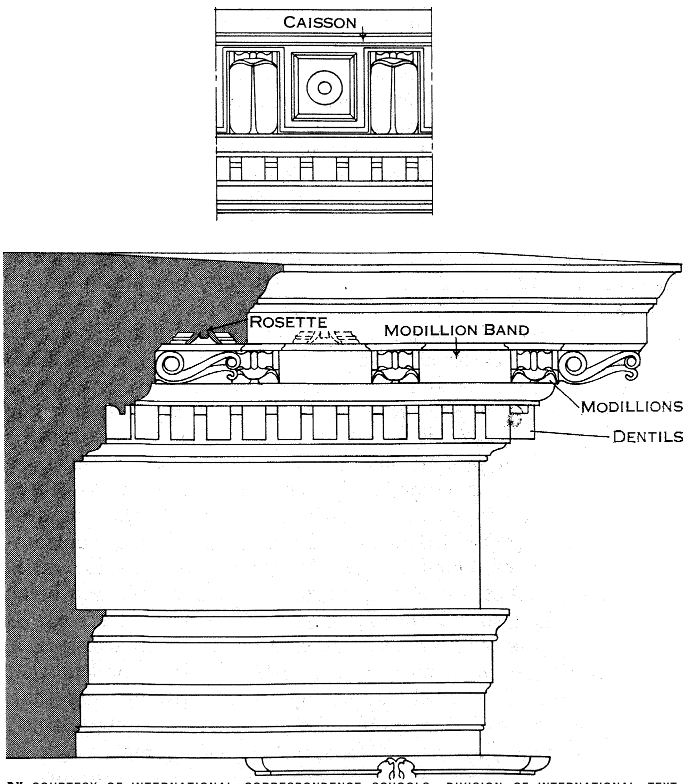

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FIG. 6(A).—CORINTHIAN ORDER

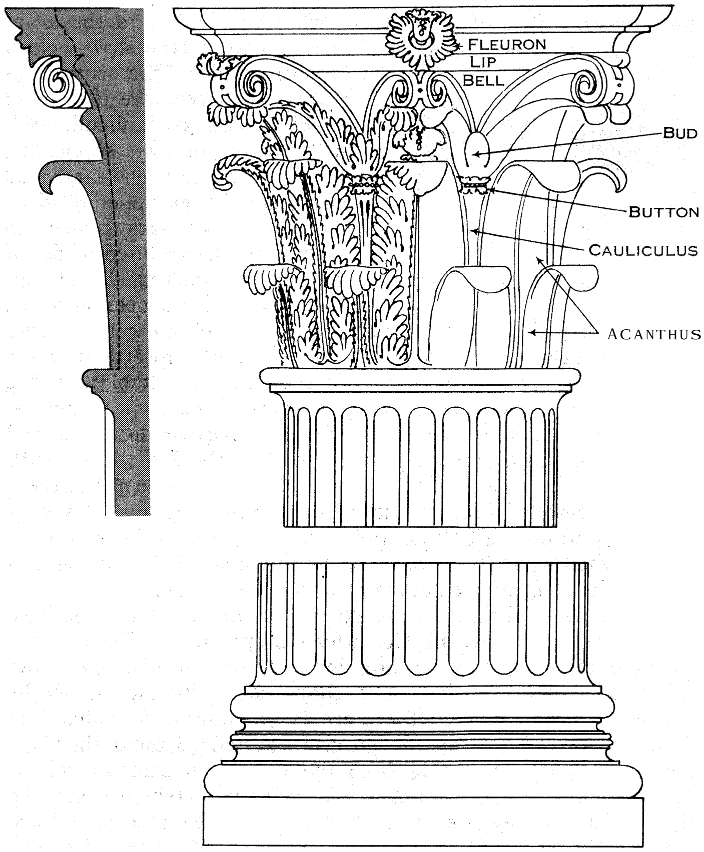

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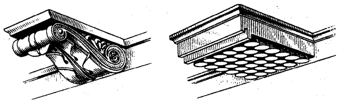
FIG. 6(B).—CORINTHIAN ORDER

carrying two tori separated by a scotia or hollow molding. The capital is characterized by volutes or spiral scrolls on its front and rear faces, where the horizontal cushion (concave in section and so called *canalis,* bordered by raised fillets) resting on the echinus minds up at either side in a volute or helix, drooping below the echinus and making the total height here ½ diameter. On the lateral faces the volutes of the front and rear are connected by a generally concave cylindrical form known as the pulvinus, bolster or baluster, which may be carved with leaves, and sometimes even takes the form of two vases, end to end. Thus the general plan of the Ionic capital is oblong rather than square, and the difference in the lateral faces causes difficulties in turning the corner of a building (see Corner Treatments, below). The echinus. of ovolo profile, is carved with the egg-and-dart, eggs above the flutes, darts above the fillets of the shaft; and where, as it follows the circle of the shaft, it disappears behind the volutes, a little radiating petal form hides the intersection. The abacus, square in plan, is very low, merely a cyma *reversa* and fillet. The entablature has an architrave divided into two or three fasciae, the upper wider and projecting more than the lower, sometimes separated by moldings, with a crowning cyma *reversa* and fillet instead of a taenia. The frieze is plain, although sometimes carved with sculpture, and the cornice has bed moldings of three parts: a dentil band separating a cyma *reversa* below from an ovolo above. The cymatium is a cyma recta with a smaller cyma *reversa* below it.

Corinthian.—The column is 10 diameters high, including the base of ½ diameter and the capital is increased to 1⅙ diameter in height. The base resembles the Ionic, but is enriched by doubling the scotia with an intervening pair of astragals with fillets (see BASE). The high capital consists of a bell-shaped core, supporting a molded abacus with concave sides so that the corners project, though chamfered at 45°. At the bottom of the bell of the capital is an astragal, and the surface of the bell is divided vertically into thirds, each of the two lower thirds having a row of eight acanthus (*q.v.*) leaves each of the width of three flutes of the shaft. The centres of the upper leaves coincide with the central flute on each face of the column, while the centres of the lower leaves alternate and so coincide with fillets of the shaft below. On either side of the central upper leaf on each face rise fluted stalks known as cauliculi, each with two leaves supporting scrolls or volutes, one large and one small, in the upper third of the bell. The arrangement is such that the voluted ends of two larger scrolls meet and support each projecting corner of the abacus, while those of two smaller scrolls, coming together under the centre of each concave abacus face, support a rosette or flower (fleuron) carved on the abacus itself. In the entablature, the architrave and frieze resemble those of the richer Ionic examples, the frieze sometimes pulvinated with a convex or double-curved profile. The cornice also resembles that of the Ionic order with the addition of a band of modillions supporting the corona; these are small scrolled brackets, usually decorated on the sides with S-scrolls and on the bottom and front face with acanthus leaves, and crowned by a little cyma *reversa* molding. Between the modillions the soffit of the corona has panels with rosettes.



MODILLION MUTULE

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FIG. 7.— MODILLIONAND MUTULE

Composite.—The column is again 10 diameters high. the base and capital repeating the Corinthian proportions. The capital, its main distinguishing feature, shows the Corinthian two rows of acanthus leaves below; but above them. instead of scrolls growing out of cauliculi, there are large volutes somewhat like those of the Ionic order, though disconnected (without the horizontal cushion) and rising from the top of an echinus, carved with the egg-and-dart, which is placed immediately beneath the abacus. Thus they rise nearly to the top of the abacus, and are brought out (canted) at an angle to meet and support its four corners, while resting on the top of the upper row of acanthus leaves. The capital is identical on all four faces. In the bed moldings of the cornice, large brackets without scrolls take the place of the modillions.

II. PRACTICES

1. Engaged Columns and Pilasters.—When columns are not free-standing but attached to walls, they are said to be engaged. Such engaged columns should not be strictly semicolumns (with centres in the wall plane), since any projecting horizontal moldings of the wall itself would then cut into the circumference; consequently the columns are slightly stilted, the centres moved out to receive such moldings without unpleasant effect.

Pilasters are flat rectangular wall strips, normally projecting for a quarter of their width, forming responds to columns or used on wall faces instead of engaged columns, analogous to the Greek antae. They have bases and capitals like those of the corresponding orders, only, since pilasters often do not taper upward, the capitals are not reduced by the diminution and may be wider than those of columns.

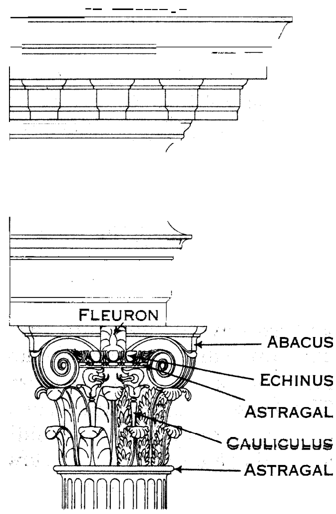

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FIG. 8.— COMPOSITE ORDER

2. Corner Treatments.— In four of the orders, Tuscan, Doric, Corinthian and Composite. the capitals are alike on all four faces and thus create no difficulties in turning the corners of buildings. But the Ionic capital, different on its front and lateral faces, has to be specially designed at corners, with two "front" faces meeting at right angles, the corner volutes which would otherwise intersect being brought out back to back at 45°, as in the Composite capital. To avoid this anomaly, a variant Ionic order was codified by Vincenzo Scamozzi (161j), and hence sometimes known as Scamozzi Ionic (though it had ancient prototypes, see below). Its chief difference from ordinary Ionic is that the capital is alike on all four faces, the volutes occurring on all four and brought out (canted) at an angle at the corners, the abacus above being concave-sided. Moreover, the volutes are not connected horizontally on each face, but curve up from the top of the echinus, so that the result is like the upper part of a Composite capital.

On the other hand, the Doric order encounters a special difficulty at corners of buildings with relation to the frieze: the triglyph being centred over the column and yet narrower than the width of the architrave soffit, but the face of the frieze coinciding with that of the architrave, there remains at each corner of a building an awkward quarter of a metope. This treatment, while seriously advocated by Vitruvius, was never followed either by the Romans or by the Greeks (for whose adjustments see below). Of the Renaissance architects who followed it, only Jacopo Sansovino adequately solved the problem in the library of St. Mark's in Venice (1536), and that at the cost of employing complicated pilasters instead of columns at the corners, permitting a half metope on each face and so a full metope folded around the corner.

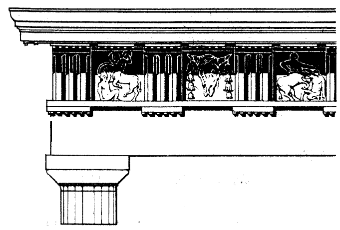


FIG 9.—CORNER OF GREEK DORIC ENTABLATURE

3. Column Spacings and Variant Proportions.-Spatings of columns, like their proportions, were subject to formulary rules. Thus Vitruvius specified five types, the unit as usual being the lower column diameter, the intervals between columns giving the names for the spacings as pycnostyle (interval $1\frac{1}{2}$ diameter), systyle (2), "metriostyle" ($2\frac{1}{2}$, the Vitruvian norm, the name coined to fill the gap left in his list of definitions), diastyle (3), and araeostyle (34 or more diameters). He also cited the eustyle ($2\frac{1}{4}$, "well-columned") as the preference of the Greek codifier Hermogenes. The spacings on centres, therefore, were $2\frac{1}{2}$, 3, 3f, 4 and 4f or more diameters in the graduated series, $3\frac{1}{4}$ in the eustyle. In the Doric order, restricted by the location of the column centres exactly beneath those of triglyphs (the latter spaced $1\frac{1}{4}$ diameters on centres), only multiples of this unit were possible, limiting the column spacings on centres to $2\frac{1}{2}$ (here called systyle), $3\frac{3}{4}$ (diastyle), and 5 diameters (araeostyle). The triglyph spacing being fixed, the systyle had one triglyph between the columns (monotriglyphic), the diastyle two (ditriglyphic), the araeostyle three or more (polytriglyphic). The closest spacing possible, with only $\frac{1}{2}$ diameter between the columns in order to allow for the projections of the capitals (and thus $1\frac{1}{2}$ diameter on centres), was not discussed by Vitruvius, but was used by later architects in the form of coupled columns. This practice led to a rhythmical spacing, alternately coupled and araeostyle, used in some of the Renaissance palaces in Rome (*e.g.*, the Cancelleria with pilasters and the palace of Raphael with engaged columns) and in the east front of the Louvre (with freestanding columns. $1\frac{1}{2} + 43 = 6$ diameters for the spacing of the bays).

With regard to proportions, Vitruvius, from whom much of this codification was immediately obtained, nevertheless stated that after working out the dimensions by formula the architect should obtain a proper balance by adjustment, adding or subtracting for the sake of the effect. He therefore gave rules for variations. For instance, the normal height of the Ionic column being 9 diameters, he also gave heights of 8 diameters (araeostyle), $8\frac{1}{2}$ (diastyle), 9 (the norm which we may designate as "metriostyle"), 93 (systyle) and 10 diameters (pycnostyle). It is evident that the height varied inversely according to the spacing, and that, added together, their sum should always be $12\frac{1}{2}$ diameters, thus: $23 + 10$ (pycnostyle), $3 + 9\frac{1}{2}$ (systyle), $3\frac{1}{2} + 9$ ("metriostyle"), $4 + 8\frac{1}{2}$ (diastyle) and $43 + 8$ (araeostyle), so that the eustyle should probably be $3\frac{1}{4} + 9\frac{1}{4}$ (though Vitruvius gave the height $9\frac{1}{2}$ as for the systyle). Reading between the lines, it is evident that these variations depend upon another element. scale or actual size; thus the plumpest and most widely spaced columns (araeostyle) were also the smallest, while the most slender and most closely spaced columns (pycnostyle) were also the largest, the reduction of spacing with increase of size being determined by the practical question of quarrying stone lintels (architraves) of adequate size. Similar consideration of scale occurs in other precepts of Vitruvius; *e.g.*, the upper diameter of a column shaft, normally $\frac{5}{6}$ of the lower, should be increased to $\frac{6}{7}$ if the height is greater than 20 ft., to $\frac{7}{8}$ if greater than **40** ft., with similar changes in the height of the architrave to allow for greater distance and foreshortening as seen from below.

4. Roman Arch Orders. — The spacing of engaged columns might be increased to 5 diameters on centres (Tabularium at Rome). $5\frac{1}{4}$ (theatre of Marcellus), $5\frac{1}{2}$ (Basilica Julia), or even $7\frac{1}{2}$ (Colosseum), by inserting arches which helped to support the architraves, these then constructed with short blocks or even as flat arches. This class of order, not discussed by Vitruvius but included by the Renaissance theorists, appeared often in superposed storys. They might involve Doric, Ionic and Corinthian, but generally Corinthian or Composite when used in triumphal arches, the latter with even greater spacings at the centre and sometimes with closer (rhythmical) spacing on either side, with considerable flexibility.

5. Superposed and Giant Orders.--When columns adorned several stories of a building, they were normally of different orders, superposed in a sequence from heaviest to most slender, Doric, Ionic and Corinthian, sometimes even Composite at the top. Since the upper diameter of the lower column properly became the lower diameter of that in the story above, giving in terms of the lowest diameter the sequence of 1; $\frac{5}{6}$, $\frac{25}{36}$, the successive heights became $8 \times 1 = 8$, $9 \times \frac{5}{6} = 7\frac{1}{2}$ and $10 \times \frac{25}{36} = 7$ of the lowest diameters, the actual heights of the stories diminishing successively from bottom to top (a rule violated in the Colosseum). These might be further varied by the interposition of pedestals. Rarely were these freestanding colonnades, as in the Septizonium at Rome; usually they were engaged columns combined with arches (Roman arch order), as around the temple of Hercules at Tivoli and in the Tabularium, theatre of Marcellus and Colosseum at Rome. When they were freestanding, the centres were naturally superposed to maintain a vertical axis; but when they were engaged the centres were successively set back as the diameters diminished, so that the wall behind might be vertical.

To avoid the complication of separate orders for each story, and to obtain more majestic scale, Renaissance architects perfected the giant or colossal order, composed of columns or pilasters running through the height of two or more stories, as on the exterior of St. Peter's at Rome (by Michelangelo and Carlo Maderna) and in the Casa del Diavolo (Palazzo Giulio Porto) at Vicenza (by Palladio).

6. Codification. — The object of such codification of the orders was to furnish exact proportionate dimensions for every feature, large or small, so that, being given the diameter of the column or any other dimension, even so trivial as the width of a dentil, the entire order might be constructed mechanically. While pushed by the Renaissance theorists to such an extreme that all dimensions were predetermined in modules, parts, and minutes, down to $\frac{1}{144}$ column diameter, yet it must not be imagined that these, or the more liberal systems advocated by Vitruvius, were the earliest codifications. For even Greek architects, besides writing special monographs on their own buildings, necessarily discussing the proportional systems, also published theoretical discussions of the orders, the Doric by Philon, the Ionic by Hermogenes, and the Corinthian by Arcesius. While these books have been lost, some of their rules may be recovered from measurement of the buildings themselves. See also GREEK ARCHITECTURE; ROMAN ARCHITECTURE.

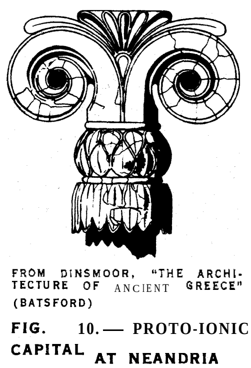
III. HISTORY

1. Origins. — Both the Doric and Ionic orders originated more or less simultaneously on opposite shores of the Aegean sea, so that the conventional idea that the Doric was the earlier is true only if consideration is limited to developed forms. Both originated in wooden construction, as was clearly recognized by Vitruvius.

Doric can be traced, on the Greek mainland, back to Aegean prototypes. The typical column was of wood, the shaft tapering downward to rest on a simple flat stone base; the wide-spreading wooden capital was formed by a concave necking separated from the shaft by an astragal, with a bulging echinus and a square abacus above. While only charred remains of these wooden columns have survived (with evidence for their lower diameters in sockets at Cnossus and Pylos), they are represented in wall paintings in the palace at Cnossus, and particularly important are the stone replicas (known to the Greeks of historic times) carved in the relief over the Lion Gate and the pairs flanking the doorways of the tombs of Agamemnon and Clytemnestra, all at Mycenae and dating from the 13th century B.C. The Aegean entablature, on the other hand, with its serried row of round beam-ends resting on an architrave, does not seem to have impressed the Dorian Greeks as worthy of imitation.

When these prototypes were imitated by the historic Greeks in wooden columns, to which we have literary references at Olympia (Heraeum and house of Oenomaus) and at Metapontum, and actual traces at Olympia and the Argive Heraeum, it seems evident that the taper was reversed, diminishing upward in the conventional manner. The columns were widely spaced as shown by the traces of their bottoms; but the capitals can only be restored on the analogy of Mycenaean and early archaic examples in stone, with actual pieces of bronze necking revetment at Olympia. For the entablature the evidence of archaic examples is combined with the statements of Vitruvius. The architrave represented the original wooden beam running from column to column or post to post. The taenia, a board above this, gave a bearing for the crossbeams, of which the fibrous ends were protected by terra-cotta slabs with the characteristic triple grooving (whence the name triglyphs), held in place by pegs through the taenia board, later translated into guttae. The metopes, literally, "between the beam-holes," were merely the panels, often of sun-dried brick faced with terra cotta, filling the intervals between the beams. The sloping undersides of the roof rafters, supported on a timber or plate above the crossbeams and projecting beneath the cornice, appeared as mutules decorated with the heads of pegs (guttae) which secured the terra-cotta corona above.

The Ionic order had manifestly an Asiatic origin. Beginning with mere wooden posts which may at first have been square, these were soon translated into stone as circular posts. They supported elongated bracket capitals, with pairs of large vertical volutes imitated from the pier and stele capitals of Phoenicia (reflected in Cyprus and Carthage), with influence also from Assyria, all these ultimately derived from Egyptian lily designs. This Proto-Ionic form, occurring at Neandria and Larisa on the Asiatic mainland and at Mytilene and Nape on the Island of Lesbos, usually lacked a formal abacus, and might have below the volutes a lofty torus decorated with interlaced ornament (another Assyrian form) and a garland of pointed leaves drooping down over the shaft.



FROM DINSMOOR, "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

FIG. 10.— PROTO-IONIC CAPITAL AT NEANDRIA

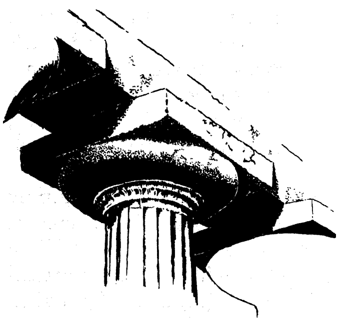
From the Acropolis at Athens and from Delos come examples of the intermediate stages between the vertical volutes and the horizontal but still disconnected volutes, with the drooping leaves gradually becoming the egg-and-dart ovolo. The primitive wooden entablature is reproduced in stone copies on rock tomb fronts in southwestern Asia Minor (Lycia), showing the architrave of three fasciae, originally overlapping planks, supporting a serried row of round beam-ends (at this stage recalling the Mycenaean) which were later squared and more widely spaced, becoming large dentils. See also PRE-HELLENIC ARCHITECTURE.

2. Greek Doric. — In the Heraeum at Olympia (c. **600** B.C.),

the columns, originally of wood, were replaced in stone one by one over nearly eight centuries; late replacements of wood by stone occurred also at Thermon. Both examples retained their old wooden entablatures with terra-cotta revetments. The evolution of the stone Doric column may be traced in Greece, Sicily and South Italy, where it was the chief order for monumental buildings (with a few intrusions in Asia Minor! as at Assos and Pergamum) during eight centuries. The Greek Doric column always lacked a base (cylindrical protrusions at the bottoms of columns at Syracuse and Acragas were left merely for completion of the fluting) except in the Olympieum at Acragas and a few late Hellenistic examples. The shaft normally has 20 flutes: though early examples vacillated between 16 and 24, or even 32. Even in the Periclean period 16 flutes appeared under special conditions inside the Parthenon and at Sunium: unfluted columns resulted only from lack of completion. In secular buildings of the Hellenistic period fluting often appeared only in the upper two-thirds, the lowest third being faceted (polygonal) to avoid wear.

The outline of the shaft was often slightly convex as it rose from bottom to top, in a gentle curve known as entasis (*q.v.*). The capital for a long time was much heavier than that employed by the late codifiers; early examples show a tremendous width of abacus and a heavy bulging echinus; the necking might be concave, enriched with overhanging petals and separated from the shaft by an astragal (like the Mycenaean), while carved patterns might appear even on the lower part of the echinus (Paestum?. With increasing strictness, the necking became no more than a continuation of the fluted shaft, separated from it by three incisions, later by one. The projection of the abacus was reduced, the echinus refined to a hyperbolic curve. Finally, the echinus was deadened to a conical, quarter-round, or *cyma* recta profile, and crowning moldings began to appear on the abacus.

The entablature, in early examples at Syracuse, had triglyphs only above the columns with horizontal oblong metopes between; as triglyphs were inserted midway between the columns (monotriglyphic), the metopes became vertical oblongs, then with increasing lightness tended to become square (though exactly square metopes were rare). The face of the triglyph was always in the architrave plane, befitting its structural derivation from a principal beam; the metope was countersunk. The latter was often enriched with relief sculpture, either on façades or all around temples; in the Peloponnesus the tendency was to confine sculptured metopes to inner porches of temples.

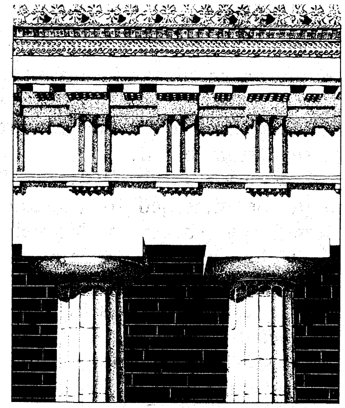


FROM R. KOLDEWEY AND O. PUCHSTEIN, "DIE GRIECHISCHEN TEMPEL IN UNTERITALIEN UND SIZILIEN" (JULIUS SPRINGER)

FIG. 11.—DORIC CAPITALS AT PAESTUM

On the architrave, some early western colonial examples employed carved Ionic moldings of sandstone rather than the normal taenia, regulae and guttae. One example even more closely approached Asiatic Ionic in omitting the frieze (Kardaki on Corfu), and in another the triglyphs became pentaglyphs (Locri in South Italy). The mutules of the cornice (always sloping up toward the back like rafter ends) were at first of full width only above triglyphs, those above the narrow metopes being of half or two-thirds width; by 540 B.C. this restless alternation was replaced by uniform widths. At Paestum (temple of Ceres) coffered panels were substituted for mutules. The primitive terra-cotta cornice revetment survived in the earliest buildings (as at Selinus), but nailed to an upper stone member, thus doubling the height of the cornice; this was soon replaced by a stone hawks beak molding. Bed moldings made their first appearance in the Propylaea at Athens (437 B.C.). Entablatures were richly decorated in colour, blue triglyphs, red and blue on cornice soffits, and also green and gold on all moldings.

As for proportions, larger columns (after the translation into stone) were at first stumpy, but showed a general tendency to increase with the passage of time, in terms of the lower diameter, from 4 to $7\frac{1}{4}$ diameters; the proportion of 8 diameters (or more) was reached only in late house courts, as at Delos. But it must be emphasized that this variation was not solely chronological, being affected also by scale: small columns, even in the early archaic period, might be $6\frac{1}{2}$ diameters high at the same moment that large columns were no more than four. Yet a chronological sequence of large columns of about the same height (33–34 ft.), this height being about $4\frac{1}{4}$ diameters at Paestum, $4\frac{5}{8}$ at Olympia, $5\frac{1}{2}$ in the Parthenon, 63 at Nemea, illustrates the general tendency. The sudden change before the Parthenon is due to another factor, material; in the western colonies, where marble was not available, the height (except in two sporadic examples) did not rise above $4\frac{3}{4}$ diameters even by the end of the 5th century. The Periclean gamut ranged only from $5\frac{1}{2}$ diameters in large buildings (Parthenon) to $5\frac{3}{4}$ in small (Sunium and Rhamnus), in a fairly regular gradation according to size.



FROM DINSMOOR, "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

FIG. 12.—EARLY DORIC ENTABLATURE AT SELINUS

Heights of entablatures showed a corresponding tendency toward lightness, beginning with more than half the column height (temple C at Selinus), two-fifths (Olympia), one-third (Parthenon and other Periclean works), one-fourth (Nemea, there attaining the standard of the codifiers), and even one-fifth (Pergamum).

As for column spacings, the intervals were at first even less than the diameter (Syracuse), because of timidity as to the strength of stone architraves; but during most of the archaic period (except where wooden entablatures survived) they ranged from 1 to $1\frac{1}{2}$ diameters, rarely to $1\frac{3}{4}$ or $1\frac{7}{8}$; in other words, the closest pycnostyle spacing of Vitruvius was normally the maximum. Further complications resulted from the early tendency to vary the spacings on fronts (usually greater, as well as column diameters) and flanks of temples (the latter sometimes greater in the west), gradually. tending toward uniformity. An additional disturbance was corner contraction, narrowing the last column interval (sometimes two intervals in the west) partially to counteract the distortion caused by the corner triglyph. In Periclean Athens the normal spacing was organized into a regular system, the intervals ranging from $1\frac{1}{4}$ diameters in the largest buildings (Parthenon) to $1\frac{2}{3}$ diameters in the smallest (Rhamnus), so that the interval exceeded the column diameter by $1\frac{1}{2}$ Greek feet ($19\frac{5}{16}$ in.), the width of a man across the shoulders, giving a scale relation. As thus co-ordinated with the height, Doric columns were heavier and more closely set together as they increased in size, emphasizing the majesty of the Doric style.

3. Roman Doric.—The Romans, adopting late Hellenistic Doric forms, with some influence from Etruscan, reserved their use for small-scale columns or secondary positions. except in the colossal column monuments of Trajan and Marcus Aurelius. Apart from small temples of the Republican period (at Cori, and that of Spes in the Forum Holitorium at Rome), Doric appeared primarily in house courtyards as at Pompeii, and as engaged columns between arches in the lowest of superposed stories (see Roman Arch Orders and Superposed and *Giant* Orders, above). The base was omitted (as in Greece) in early buildings in Pompeii and in the theatre of Marcellus at Rome; a simple circular disk was inserted below the shaft in Pompey's theatre, a fillet with apophyge at Albano. A simple torus formed the base at Cori, a large torus with plinth in the column of Trajan, a full Attic base with plinth in the Colosseum. Shafts were frequently unfluted (Colosseum, also the colossal columns with spiral friezes). Capitals were usually of the conventional type of the codifiers, though the quarter-round echinus was sometimes flattened conically, or replaced by a cyma recta (temple on the

Aventine, baths of Diocletian).

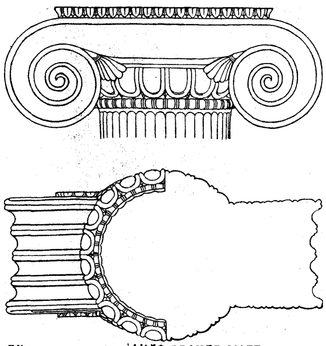
In the entablature, contrasting with Greek usage (when the triglyphs were in the architrave plane, the metopes countersunk), the Romans placed the metopes in the architrave plane with the triglyphs projecting as if they were mere applied decorative panels, misunderstanding their structural function, and sometimes even heretically breaking the epistyle taenia out around the protruding triglyphs. In many cases the architrave was Ionic nith three fasciae, and in the Colosseum triglyphs were omitted. As used in rectangular buildings (as at Cori) a triglyph was placed at the corner in the Greek manner. The mutules of the cornice, while sloping up toward the back at Cori and in the theatre of Marcellus, were usually horizontal, again misunderstanding their origin as roof rafters; and there might even be Ionic dentils below the mutules.

4. **Greek** Ionic.—The most representative example of the archaic Greek Ionic type appears in the Croesus temple at Ephesus (c. 550 B.C.); but numerous other examples illustrate various phases of the development in Asia Minor, after which the scene shifts to Athens in the 5th century, back to Asia Minor for the Ionic Renaissance of the 4th century.

Bases, in the east, were usually of the form known as Asiatic Ionic, with a spool-shaped disk (trochilus) adorned with many shallow, or later, two deeper, horizontal hollow moldings (scotias) separated by fillets or astragals; above this was a torus, usually fluted horizontally. An exceptionally early appearance of a square plinth below the trochilus occurred at Ephesus. The mainland tendency was to simplify the base, first with a bell-shaped molding (*cyma* recta upside down) resting on a diminutive torus and carrying a larger torus (Athenian Stoa at Delphi), and then at Athens itself the typical Attic base with a single scotia between two tori. The upper torus might continue to be fluted horizontally or, as in the Erechtheum's north portico, decorated with a carved guilloche; the plain lower torus also became larger than the upper. A peculiar flaring type of base occurs at Bassae. Later in Asia Minor the square plinth reappeared under the Asiatic profile (the latter extremely varied on the façade at Didyma); and finally the Attic profile was adopted also in Asia Minor, now combined with the square plinth.

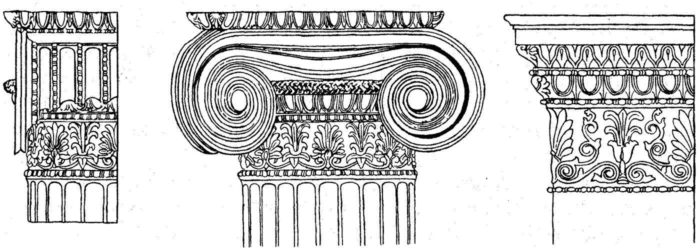
Shafts were at first adorned with shallow flutes, 18 to 36 in smaller columns. 40 to 48 in the largest, separated by sharp arises as in Doric. Exceptional were the sculptured lower drums at Didyma and in the successive temples at Ephesus. Gradually the flutes were deepened as ellipses or semicircles, and reduced in number to 20, 24 (the canonical number) or 32, with wide fillets between.

Capitals, with the volutes now united by the horizontal cushion, were at first extremely long in proportion to their depth, befitting their bracket origin. The cushion and volutes were formed at first by convex surfaces, later concave (the true canalis), and they might- at first wind up indefinitely (Ephesus), an awkwardness soon concealed under the decorative "eye." Some volutes were completely concealed behind rosettes (archaic front at Ephesus), or contained heads of divinities or were replaced by foreparts of winged horses and lions (corner capitals at Didyma). Unusually enriched forms of cushion and volutes appeared in the Erechtheum (*q.v.*), where also the exceptional anthemion (*q.v.*) necking, already foreshadowed in some archaic examples, reached its highest development. The total length was gradually contracted as the abacus tended to become square in plan, but did not attain an actual square until the 4th century. Volutes gradually became smaller, and in the Hellenistic period the echinus was pushed upward (as in the works of Hermogenes) to obliterate the drooping lower curve of the cushion. The Greeks never succeeded in overcoming the awkward treatment at the corner of a portico, with volutes on two adjacent faces curved out together at 45°, back to back (see above, Corner Treatments), thus causing two half volutes to meet abruptly at the opposite corner inside the portico. Not only were the outer faces unsymmetrical and lopsided as seen in direct elevation; but the interior corner problem was differently solved in every example, sometimes even to the extent of forcibly pulling out the half volutes to make them complete, albeit squeezed (Priene). Experimentally, in the half capitals at Bassae, all the volutes were canted at 45°, making the capital concave in plan (foreshadowing the Scamozzi type), the resulting optical illusion of sagging being corrected by arching the cushion upward, which in turn caused the omission of the horizontal abacus. Such canted capitals, though with an abacus, later became popular in minor structures such as the stage building at Epidaurus (2nd century B.C.) and the palace at Palatitza (Macedonia).



BY COURTESY OF JAMES CRAMER WATT

FIG. 13.— ARCHAIC IONIC CAPITAL AT EPHESUS



FROM LETHABY, "FRAGMENTS FROM GREEK BUILDINGS" (BATSFORD)

FIG. 14.— IONIC CAPITAL OF THE ERECHTHEUM

Entablatures, like bases. differed on opposite sides of the Aegean sea. The Asiatic form consisted of the architrave with three fasciae and a bold egg-and-dart, supporting directly a row of large dentils (the primitive beam-ends) instead of a frieze, while the cornice might be surmounted by a very high parapet carved with reliefs like a frieze (Ephesus), in later examples replaced by a cymatium. The low friezeless entablature continued in use in Asia Minor through the 4th century B.C. When the order was imported to the Greek mainland, the entablature height was increased by introducing a frieze, usually sculptured, between architrave and cornice as a substitute for the dentils, now omitted. and the parapet-sima was reduced in size. The fasciae were omitted from the architrave lest there be too many horizontal lines. Earlier Attic examples followed this scheme with a frieze but without fasciae on the architrave (temples at Sunium and on the Ilissus, interior at Bassae); the inner architrave face, however, retained the fasciae below the ceiling (Ilissus temple, Propylaea); and fasciae soon emerged again on the exterior (temple of Athena Nike, Erechtheum), thus yielding the normal Attic type. But even in Athens the Asiatic entablature was reproduced in the caryatid porch of the Erechtheum, with small dentils instead of a frieze, to give lower proportions.

In Asia Minor, the same architect who still retained the friezeless entablature at Priene (340–334 B.C.) seems already to have effected a compromise in the Mausoleum at Halicarnassus (355–350 B.C.), with a frieze inserted between architrave and dentils under the influence of mainland sculptors. This compromise type was adopted for the Ionic Philippeum at Olympia (338 B C.), as also for the Corinthian monument of Lysicrates at Athens (334 B C.), and thereafter also in Asia Minor (works of Hermogenes, etc.). After these many vicissitudes, the Asiatic and Greek mainland types coalesced. In minor works of the Hellenistic period, however. Doric triglyphs sometimes appeared in Ionic friezes (upper storys of Pergamene stoas, and a palace at Ptolemais in Cyrenaica).

As for proportions, there is little exact information for the archaic period as a whole. At Ephesus the columns are reported to have been 8 diameters high (Vitruvius, Pliny, quoting the original architect); also at Samos the restored height is 8 diameters; while in the little Athenian Stoa at Delphi it is $8\frac{2}{3}$ diameters. Athens in the age of Pericles developed a graduated scale of column heights, ranging from 8 (only $7\frac{7}{8}$ in the temple of

Athena Nike) diameters in the smallest to 10 in the largest, exactly like the Vitruvian. During the Ionic Renaissance in Asia Minor the proportions were more uniform, $8\frac{3}{4}$ to $9\frac{3}{4}$ diameters. The return to the Periclean system appears to have been due to the Attic tendencies of Hermogenes, perpetuated by Vitruvius. The entablature height might be only one-sixth of the column height in the friezeless type of Asia Minor, increased to more than one-third under Doric influence when the frieze was first introduced on the mainland, but finally was stabilized as about one-quarter of the column height.

In column spacings, however, there is wide variety, especially in Asia Minor because of the propensity for employing one or three uider spacings at the centres of façades (up to $28\frac{1}{4}$ ft. on centres), nith other variations on the flanks. In Periclean Athens the spacings formed an organized system, the intervals ranging from 2 to $2\frac{4}{5}$ diameters, from the smallest to the largest columns, thus being exactly the opposite not only of the Doric but also of the system advocated by Vitruvius. This increase in slenderness with enlargement of size emphasized the delicacy of the Ionic, by contrast with neighbouring Doric buildings, but, because of the rapid increase in the lengths of lintels, would have been impossible to construct if there had been columns much larger than in the north portico of the Erechtheum. Consequently, for the great temples of the Ionic Renaissance in Asia Minor, a more compact system was devised, with intervals ranging only from $1\frac{5}{8}$ to $1\frac{3}{4}$ diameters. The final Vitruvian return to a graduated scale, but with the intervals diminishing from wide to narrow in accordance with the availability of lintels, seems to have been invented by Hermogenes.

5. Roman Ionic.—Like the Doric, the Ionic order was inherited by the Romans from late Hellenistic Greek examples and employed chiefly on a small scale (as in the Republican temple in the forum *boarium* known as "Fortuna Virilis," or the Augustan rebuildings of the temples of Janus and Juno Sospita in the forum *holitorium)* or in secondary positions (as in superposed stories). Vitruvius, who belatedly advocated the use of Ionic as the primary order, copied the forms and proportions established by Hermogenes. Thus Attic bases on plinths, and capitals with small compact volutes, are characteristic of most Roman examples. Shafts were frequently unfluted, as in the theatre of Marcellus and the Colosseum, or in other cases because of the use of variegated coloured marble or granite or other hard stone (often monolithic), this applying also to Corinthian. Capitals might be enriched aith foliage in the canalis, even with human heads replacing the eyes of volutes, as in capitals now in Sta. Maria Maggiore at Rome. Volutes canted at 45° occur in houses at Rome and Pompeii. in the colonnade around the temple of Apollo at Pompeii, and later in the temple of Saturn on the Roman Forum, predecessors of the Scamozzi type. The entablature, normally orthodox Ionic, sometimes in the Republican period (as in Greek Hellenistic) showed triglyphs in the frieze (colonnade around the temple of Apollo at Pompeii, the Roman tomb known as the Oratory of Phalaris at Acragas), a practice condemned by Vitruvius.

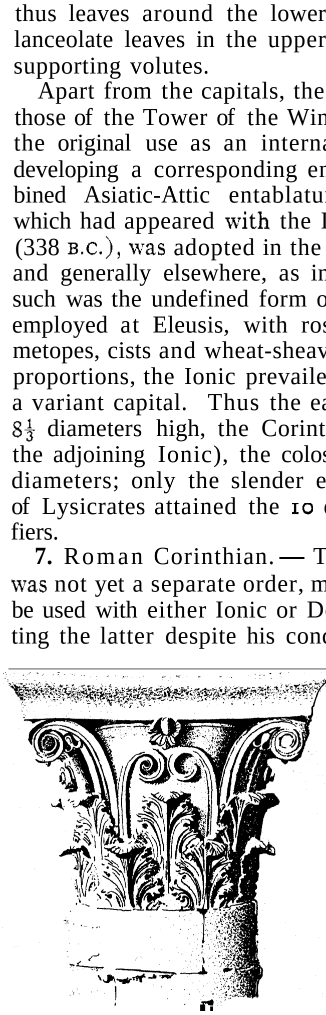
6. Greek Corinthian.— The Greeks regarded this as no more than a special capital substituted for the Ionic. Its prototypes, however, were the bell-shaped Aeolic capitals with vertically fluted petals curling over to support a square abacus, appearing on fronts of 6th-century treasuries of Ionic type at Delphi (these later imitated on interior columns of stoas of the Pergamene school, at Pergamum itself, Aegae and Athens). The true Corinthian capital, with tiers of acanthus leaves and scrolls carved in relief on the bell, was a purely Greek invention of the second half of the 5th century B.C. (for the charming story of its creation by Callimachus see Vitruvius, Bk. IV). The modern idea that it was derived from the so-called "composite capitals" of Egypt is fallacious, since all these Egyptian examples are later, of the 30th dynasty and the Ptolemaic period after Greek contacts.

The capital was long a monopoly of sculptor-architects, Callimachus himself (possibly at Bassae), Theodorus (at Delphi), Scopas (at Tegea and perhaps Nemea) and Polyclitus (at Epidaurus), and at first was used only in interiors. The early forms were yet uncanonical, as at Bassae and Delphi (two rows of small acanthus leaves, 20 in each row, both in the lowest third of the capital). Scopas at Tegea used larger leaves, but only eight in each row, without the central scrolls. The beautiful capitals at Epidaurus foreshadow the normal type.

The capital first emerged on an exterior in the jewellike choragic monument of Lysicrates (334 B.C.) but so attenuated at mid-height as to be acceptable only because engaged to the wall. Monumental examples began to appear in the east after Alexander's conquests: at Didyma near Miletus (in the unroofed cella); externally in the temple of Zeus at Diocaesarea in Cilicia (c. 290 B.C.); and at Lagina. They appeared in Syria as well, and so also in a Syrian gift to Athens, the temple of Zeus Olympius (174 B.C., designed by the Roman Cossutius, working for a Syrian king long before the capital was known at Rome itself); by a coincidence, the importation of capitals from this unfinished temple to Rome by Sulla provided models for the early Roman Corinthian. A particularly rich variant, in the propylon built for Appius Claudius Pulcher at Eleusis (c. 50 B.C.), is hexagonal, with one row of acanthus leaves in the lower part and winged horses instead of volutes under the three most prominent corners of the abacus. A simplified but popular type was invented for the Tower of the Winds at Athens (48 B.C.), with one row of acanthus leaves around the lower half of the bell, and one row of lanceolate leaves in the upper half, the square abacus having no supporting volutes.

Apart from the capitals, the columns generally had Attic bases; those of the Tower of the Winds had no bases at all. Because of the original use as an internal order, the Greeks were slow in developing a corresponding entablature. On exteriors, the combined Asiatic-Attic entablature with dentils above the frieze, which had appeared with the Ionic in the Philippeum at Olympia (338 B.C.), was adopted in the monument of Lysicrates (334 B.C.) and generally elsewhere, as in the Olympieum (174 B.C.). But such was the undefined form of the order that a Doric frieze was employed at Eleusis, with rosettes and bucrania carved on the metopes, cists and wheat-sheaves on the triglyphs. As for column proportions, the Ionic prevailed since it was a question merely of a variant capital. Thus the early Aeolic columns at Delphi were $8\frac{1}{3}$ diameters high, the Corinthian at Bassae $8\frac{4}{5}$ diameters (like the adjoining Ionic), the colossal columns of the Olympieum $8\frac{5}{6}$ diameters; only the slender engaged columns of the monument of Lysicrates attained the 10 diameters of the Renaissance codifiers.

7. Roman Corinthian.— To Vitruvius, as to the Greeks, this was not yet a separate order, merely a variant capital which might be used with either Ionic or Doric entablatures (strangely admitting the latter despite his condemnation in the case of the Ionic order). So in the temple of Peace on the forum at Paestum (as rebuilt in Sulla's time), the temple of Roma and Augustus at Philae in Egypt, and the arch of Augustus at Aosta, just as at Eleusis in Greece. it was combined with the Doric triglyph frieze. Usually, however, the entablature was denticulated Ionic, with the gradual addition of modillions. The capital seems to have reached Italy by various routes. The bronze Corinthian capitals said by Pliny to have been used for the portico erected by C. Octavius (168 B.C.) after his victory in Macedonia may have been direct importations from Greece. A few rustic examples in soft stone appeared in Italy, under Alexandrian-Sicilian influence, in the 2nd century B.C. But the chief inspiration probably came from the marble capitals sent by Sulla in 86 B.C. from the Olympieum at Athens for the temple of Jupiter Capitolinus at Rome. The capitals of the temple of Magna Mater at Rome, also



FROM LETHABY, FRAGMENTS FROM GREEK BUILDINGS" (BATSFORD)

FIG. 15.— CORINTHIAN CAPITAL AT EPIDAURUS

of temples A and B (the round temple) in the Piazza Argentina, and of the temple of Jupiter at Pompeii, executed in soft travertine or hard peperino, all show the usual two rows of large acanthus leaves, but with a horizontal joint cutting through the upper row at mid-height, a technical peculiarity occurring also in the Olympieum capitals.

In the Augustan age, and so in the very lifetime of Vitruvius, the Corinthian was organized as a distinct order and executed in marble. as in the Regia of the Roman forum (36 B.C.), the portico of the Pantheon (27 B.C.), the portico of Octavia (after 27 B.C.), the round temple of Hercules by the Tiber (c. 25 B.C.), the temples of Mars Ultor (3 B C.). of Castor and Pollux (A.D. 6) and of Concord (A.D. 10), all at Rome, and the temple of Minerva at Assisi (c. A.D. 20); in the Maison Carrée at Nîmes (AD. 4) it is still of limestone.

The Roman Corinthian capital is found in infinite variations. The height of the lower row of acanthus leaves is generally greater than that of the upper (despite the equality advocated by Vitruvius and the theorists). The acanthus usually has sharp lobes (*acanthus spinosus*), but in a series of the Sullan period (Tivoli, Praeneste. Pompeii and Cori) the leaves are of a more fleshy and curly variety (*acanthus mollis*). The central spirals on each face, rather than merely meeting, are sometimes interlaced (temple of Castor and Pollux. Rome). The corner volutes may be replaced by rampant foreparts of animals, winged horses (pilasters of the temple of Mars Ultor) or rams (interior columns of the temple of Concord). In some simplified varieties the corner volutes rise from only one tier of leaves, and the central scrolls may be replaced by a human head, as in the forum temple at Paestum. In others, both the central and the corner volutes may be suppressed, the whole height of the bell being occupied by two tiers of acanthus leaves, eight belom and four above, the latter curving out to support the corners of the abacus, with a central winged chimaera head or other animal or human form, usually flanked by rosettes (West Shops at Corinth and a large series of similar capitals at Athens—including the sunken shipload at Mahdia—, Eleusis, Tarentum. Pompeii and Rome). Another simple type of capital, common in pilasters, substitutes for the cauliculi and double scrolls merely an S-scroll on either side, turned inward belom and outward above to support the abacus corners (imitated in the early Renaissance).

Bases might be of the normal Attic type without plinths (at Tivoli). or the Attic type with plinths (at Assisi. and temples of Mars Ultor and Antoninus and Faustina at Rome); but especially favoured was the double-scotia type with intervening astragals and fillets (Pantheon, portico of Octavio, Basilica Aemilia, temples of Castor and Pollux and of Concord). In the entablature, the middle fascia of the architrave is richly carved in the temple of Castor and Pollux, the face of the corona vertically fluted in this as well as the temples of Concord, Vespasian, and Antoninus and Faustina. The cornice has neither dentils nor modillions in the portico of Octavia or the temple of Antoninus and Faustina; but usually both dentils and modillions (the latter an important creation of the imperial period) appeared together, as in the Maison Carrée at Nimes, the Regia, the Portico of the Pantheon (the dentils uncut), the temples of Castor and Pollux, Concord and Vespasian. In the temple of Venus and Roma. and that of Serapis (or the "Sun") at Rome, dentils were omitted and the modillions were replaced by great rectangular brackets, the form specified in the Renaissance for the Composite. Most exceptional are the tremendous vertical consoles occupying the whole height of the frieze, below the modillions, in the temple of Jupiter at Baalbek.

8. Roman Composite.—Vitruvius made no mention of this, since the Composite capital was apparently not invented until after his time. Even to the Romans of the later empire this was only one of many variations of the Corinthian, its elevation into a fifth order being a purely Renaissance idea. Its essential elements, an Ionic capital with volutes canted at 45° set on the lower part of a Corinthian bell with a single row of acanthus leaves occupying half of the height of the capital, are first encountered in a temple of Roma and Augustus at Mylasa near Halicarnassus in Asia Minor (12 B.C.–A.D. 14; not seen since 1740).

A fully developed monumental type is that of the arch of Titus on the Roman forum, in which the exquisite Composite capitals with two rows of leaves support a normal Corinthian entablature with modillions (completed A.D. 82); the Composite pilaster capitals of the top story of the Colosseum may be slightly later. Rich examples of the Composite appear also in the arches of Septimius Severus and Constantine, and in the baths of Caracalla and of Diocletian. A splendid type in the baths of Caracalla is enriched with acanthus leaves carved in the canalis of the volutes, with human figures adorning the middle of each face, standing on the lower leaves and reaching to the top of the abacus.

9. Renaissance and Baroque.—During the 15th century in Italy, before the period of strict codification, the early Renaissance architects Brunelleschi, Michelozzo and Alberti developed modified Corinthianesque orders of extreme delicacy, not only in porticoes but also in connection with doors, tombs and the like. Similar types prevailed during the early 16th century in France. During the high and late Renaissance the orders tended to become more formal but much individuality of design is still present in the work of Bramante, Raphael, Peruzzi, Vignola and Palladio. Typically Renaissance variations are rusticated orders, like those in the gates of Verona by Sanmicheli (1533) and the banded columns developed by Philibert Delorme for the Tuileries in Paris (1564), and followed in the Grande Galerie (1578), and tnisted columns like those of Bernini's baldachino in St. Peter's at Rome (1624–33). *See* also RENAISSANCE ARCHITECTURE.

During the baroque period, especially in Spain and Spanish colonies, all kinds of forms approximating the orders were employed, but they are too broken up, contorted, and varied to be classified. See also BAROQUE ARCHITECTURE.

10. Modern.—The rediscovery of Pompeii in 1748, and the impetus toward travel in Greece from 1750 onward. diverted attention from codifications of the orders to examination of the wide variety of examples in Roman and Greek lands, and inspired two of the modern revival movements, the Roman and the Greek. Pure Roman Corinthian columns appeared at Paris (Pantheon by J. G. Soufflot, 1757 ff.; Madeleine by Pierre Vignon, 1807 ff.), Bordeaux (Grand Théâtre by Victor Louis, 1777 ff.), London (Bank of England by Sir John Soane, 1788 ff.), Liverpool (St. George's Hall by H. L. Elmes, 1838 ff.), and, to save expense, Ionic at Richmond (Virginia state capitol by Thomas Jefferson, 1785), returning to Corinthian at Charlottesville (Rotunda of the University of Virginia by Jefferson, 1821 ff.) and Washington (United States capitol by Thomas U. Walter. 1851 ff.).

On the other hand, pure Greek Doric columns appeared at Baltimore (Washington monument by R. Mills, 1815), Philadelphia (Bank of the United States by W. Strickland, 1819 ff.), Edinburgh (High School by Thomas Hamilton, 1825 ff.), Regensburg (Walhalla by Leo von Klenze, 1830 ff.), and New York (Sub-treasury by Ithiel Town and A. J. Davis, 1834 ff.); pure Greek Ionic at Philadelphia (Bank of Pennsylvania by B. Latrobe, 1799), London (St. Pancras by William and Henry Inwood, 1819 ff.; British museum by Sir Robert Smirke, 1825 ff.), and Oxford (Taylor and Randolph buildings by C. R. Cockerell, 1840 ff); pure Greek Corinthian at London (University college by W. Wilkins and J. P. Gandy-Deering, 1827). Philadelphia (Girard college by Walter, 1833 ff.) and Nashville, Tenn. (lantern of the state capitol by Strickland, 1850). Important phases of these two revivals are the exquisite Roman details by Robert and James Adam in England, the Greek work of James "Athenian" Stuart in England, the "corn capitals" by Latrobe in the capitol at Washington. and the Neo-Greek of J. I. Hittorff and Henri Labrouste in France. After subjection to other eclectic revivals, the pure classical styles reappeared in the monument of Victor Emmanuel II at Rome (by Giuseppe Sacconi, Roman Corinthian, 1884 ff.), the library of Columbia university in New York (by C. F. McKim, Greek Ionic, 1893 ff.), and the Lincoln memorial at Washington (by Henry Bacon, Greek Doric. 1915 ff.).

The 20th century has seen a reaction against the archaeological correctness of the orders of the revival periods. Orders, where occurring, began to be treated with the utmost freedom, and those styles in which a like freedom prevailed, such as the late Georgian style and American colonial with its slimness and attenuation. began to be more popular. In so-called modernist work, the order tended to pass from use as a superfluous ornament. In exceptional cases, however, extremely free and modified orders were still used. as in the concert hall at Stockholm (by Ivar Tengbom). and in portions of the interior of the Nebraska State capitol (by B. Goodhue). An extreme example of modern functionalism is the "dendriform" column of attenuated mushroom shape used inside the Johnson Administration building at Racine, Wis. (by Frank Lloyd Wright. 1936–39), where the slender steel shafts increase slightly as they ascend and the flat conical disks serving as capitals spread almost to the full spacing of 24 ft. on centres and thus nearly touch. With this return to the Mycenaean silhouette, the cycle of evolution seemed to be complete. *See* also MODERN ARCHITECTURE.

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QRDERIC VITALIS (1075–*c.* 1142), the chronicler. was the son of a French priest. Odeler of Orleans, who had entered the service of Roger Montgomery, earl of Shrewsbury, and had received from his patron a chapel in that city. Orderic was sent at the age of five to learn his letters from an English priest, Siward by name, who kept a school in the church of SS. Peter and Paul at Shrewsbury. When 11 years old he was entered as a novice in the Norman monastery of St. Evroul en Ouche. Orderic did not know a word of French when he reached Normandy; his book, though written many years later: shows that he never lost his English cast of mind or his love of England. His superiors rechristened him Vitalis, after a member of the legendary Theban legion. But in the title of his ecclesiastical history he prefixes the old to the new name and proudly adds the epithet *Angligena.* He became a deacon in 1093, a priest in 1107. He left his cloister on several occasions. and speaks of having visited Croyland. Worcester. Cambrai (1105) and Cluny (1132). For many years he appears to have spent his summers in the scriptorium. His superiors (at some time between 1099 and 1122) ordered him to write the history of St. Evroul. The work grew under his hands until it became a general history of his own age. St. Evroul was a house of wealth and distinction. War-worn knights chose it as a resting place of their last years. It entertained visitors from southern Italy. where it had planted colonies of monks, and from England, where it had extensive possessions.

Thus Orderic, though he witnessed no great events, was often well informed about them. His narrative gives us much invaluable information for which we should search the more methodical chroniclers in vain. He throws a flood of light upon the manners and ideas of his own age; he sometimes comments with surprising shren-dness upon the broader aspects and tendencies of history. His narrative breaks off in the middle of 1141, though he added some finishing touches in 1142.

The *Historia ecclesiastica* falls into three sections: (1) Books i and ii. which are historically valueless, give the history of Christianity from the birth of Christ. After 855 this becomes a bare catalogue of popes, ending with the name of Innocent I. These books were added, as an afterthought, to the original scheme; they were composed in the years 1136–41. (2) Books iii–vi form a history of St. Evroul, the original nucleus of the work. Planned before 1122. they were mainly composed in the years 1123–31. The fourth and fifth books contain long digressions on the deeds of William the Conqueror in Normandy and England. Before 1067 these are of little value, being chiefly derived from two extant sources, William of Jumièges' *Historia Normannorum* and William of Poitiers' *Cesta Guilelmi.* For the years 1067–71 Orderic follows the last portion of the *Gesta Guilelmi;* hence this is of the first importance. From 1071 he begins to be an independent authority. But his notices of political events in this part of his work are far less copious than in (3) Books vii–xiii, where ecclesiastical affairs are relegated to the background. In this section. after sketching the history of France under the Carolingians and early Capets, Orderic takes up the events of his own times, starting from about 1082. He has much to say concerning the empire, the papacy, the Normans in Italy and Apulia, the first crusade (for which he follows Fulcher of Chartres and Baudri of Bourgueil).

But his chief interest is in the histories of Duke Robert of Normandy, William Rufus and Henry I. He continues his work, in the form of annals, up to the defeat of Stephen at Lincoln in 1141.

The *Historica ecclesiastica* was edited by Duchesne in his *Historiae Normannorum scriptores* (Paris, 1619). This is the edition cited by Freeman and in many standard works. It is, however, inferior to that of A. le Prévost, *Soc. de l'histoire de France,* 5 vol. (Paris. 1838–55). The fifth volume contains excellent critical studies by M. Leopold Delisle, and is admirably indexed. Migne's edition *(Patrologia latina,* clxxxviii) is merely a reprint of Duchesne. There is a French translation (by L. Dubois) in Guizot's *Collection des mémoires relatifs à l'histoire de France* (Paris, 1825–1827); and one in English by T. Forester in Bohn's Antiquarian library: 4 vol. (1853–56). In addition to the *Historia* there exists, in the library at Rouen, a manuscript edition of William of Jumièges' *Historia Normannorum* which Leopold Delisle assigns to Orderic. *(See* this critic's *Lettre à M. Jules Lair* [1873].) (H. W. C. D.; X.)

ORDER IN COUNCIL, in Great Britain, an order issued by the sovereign on the advice of the privy council: or more usually on the advice of a few selected members thereof. It is the modern equivalent of the medieval ordinance and of the proclamation so frequently used by the Tudor and Stuart sovereigns. In practice it is only issued on the advice of ministers of the crown. who are, of course, responsible to parliament for their action in the matter. Orders in council were first issued during the 18th century, and their legality has sometimes been called in question. Consequently in several cases parliament subsequently passed acts of indemnity to protect the persons responsible for issuing them, and incidentally to assert its own authority. The principle seems generally accepted that orders in council may be issued on the strength of the royal prerogative, but they must not seriously alter the law of the land.

The most celebrated instance of the use of orders in council was in 180; when Great Britain was at war with France. Orders in council are used to regulate the matters which need immediate attention on the death of one sovereign and the accession of another.

In addition to these and other orders issued by the sovereign by virtue of his prerogative, there is another class of orders in council, viz., those issued by the authority of an act of parliament, many of which provide thus for carrying out their provisions. Orders in council have been extensively used by the various administrative departments of the government, which act on the strength of powers conferred upon them by some act of parliament. They are largely used for regulating the details of local government and matters concerning the armed forces. while a new bishopric is sometimes founded by an order in council. They are also employed to regulate the affairs of the crown colonies, and representatives of the sovereign may issue orders in council under certain conditions. In times of emergency the use of orders in council is indispensable to the executive. The Regulation of the Forces act. 1871, empowered the government in a time of emergency to take possession of the railway system by the issue of such an order.

ORDERS AND CONGREGATIONS, RELIGIOUS. According to Roman Catholic canon law the only factor that distinguishes members of religious orders from those of religious congregations, societies of common life and secular institutes is the kind of vow taken. Fundamentally this has no connection with the kind of work performed or the manner of life. but in practice a general relationship can be seen between the kind of work and manner of life and the nature of the vow Vows are either solemn or simple; all solemn vows are perpetual, as are most simple vows, though in some cases temporary simple vows are taken (*e.g.*, in religious orders in which three years of temporary vows must precede solemn profession). Solemn vows are taken in the religious orders (canons, monks, mendicant friars), which are older than the congregations, etc. Solemn vows can be dispensed only with very great difficulty by papal authority and, canonically, acts contrary to the vow are invalid; thus a marriage entered into by a religious in solemn vows is canonically invalid. Simple vows are generally dispensed with less difficulty, and actions contrary to them. though illicit. are canonically valid: but any simple profession in a pontifical institute can be dispensed only by the Holy See. The foregoing applies to the three religious vows of poverty, chastity and obedience. There are technical differences also between the soiemn and simple vow of religious poverty, the latter allowing a certain retention of ownership.

In practice the distinction between the various orders and congregations according to their manner of life is not always easy to perceive. Members of religious orders ali take solemn vows and are all bound to the choral celebration of the breviary offices (see BREVIARY). The canons regular lead a monastic life centred on the service of the church (choral office, administration of the sacraments). Monks: on the other hand, leading a stricter form of life, are concerned more with personal perfection and less with external church work; they may do agricultural or other work in order to live. but primarily they seek contemplation. Mendicant orders (friars) do active work or teaching and preaching, but their life is regulated by monastic rule with choir office, etc. In the 13th century, when most of the friars were founded. they practised not only personal but corporate poverty and begged for alms (hence the term mendicant); nowadays none of the friars does so. All the others (congregations, societies of common life, etc.), while living in community do not usually have the obligation of the choral office but devote their lives to various forms of external ministry and charitable undertakings. Secular institutes are a modern form of religious life the members of which do not permanently dwell in community or wear a distinctive religious habit but live and ivork "in the world," seeking perfection in ordinary life. Members of secular institutes take private vows (which in effect are similar to simple vows). Clerks regular. members of congregations and brothers usually take simple vows. while members of societies of common life make a promise of some kind to remain with their community. Brothers (mostly engaged in teaching and charitable work) are so called because they are not ordained priests.

Most orders and congregations have their counterpart in nuns (solemn vows) and religious sisters (simple vows). though in ordinary speech all women religious are referred to as nuns. And there are many other congregations of women religious entirely independent of the men religious; the organizations (orders, congregations. societies: institutes, etc.) for the religious life of women are far too numerous to be mentioned in detail. but some information about them is given after the list of men religious.

See also separate entries on many orders, and MONASTICISM.

(L. C. S.)

ROMAN CATHOLIC RELIGIOUS ORDERS OF MEN

The list that follows is arranged according to precedence, which is determined by the chronological sequence of the religious bodies' approval by the Holy See. The name of the order or congregation is given first, the more familiar name being sometimes preferred to the more formal; then any alternative name, whether more formal or less; then the abbreviating letters. if these are familiar, by which its members are designated; then the name of the founder. with place and date of foundation (which may be considerably earlier than papal approval); then the seat of its central government if that is not Rome. which is otherwise assumed; then its total membership, if that is available, using the figure given in the *Annuario Pontificio* for 1961. It has not been found practicable in the space available to indicate the nature of the work done by each order, save that in some cases attention is drawn to the broad distinction between active and contemplative religious; almost all active orders do pastoral work, missionary work, teaching. etc. Nor is it practicable to list the countries in which each order is to be found, save in the cases of some which are local in character, or to give details of the religious habit worn. All orders include brothers, who do not become priests. Where these are in the majority this is stated. A separate list of organizations consisting only of brothers is supplied. Diocesan congregations, as distinct from those of pontifical status, are excluded. An order or congregation that is exclusively of some other rite than the Latin is noted; there is no note when there are members of both Latin and Eastern rites.

CANONS REGULAR

1. Canons Regular of St. Augustine (Black Canons; Austin Canons): 4th-century origin; 11th-century revival; confederated 1959.
   a. Canons Regular of the Lateran (C.R.L.). 485.
   b. Austrian Canons Regular of the Lateran. 11th century, Klosterneuburg, near Vienna. 292.
   c. Canons Hospitallers oi the Great St. Bernard. 11th century. On the St. Bernard and Simplon passes, and in Tibet. Grand Saint Bernard, Martigny, Valais, Switz. 84.
   d. Swiss Canons Regular of St. Maurice d'Agaune. 1128. Valais, Switz. 132.
2. Premonstratenaians (Canons Regular of Prémontré, White Canons, Norbertines; C.R.P. or O. Praem.). St. Norbert, Prémontré, Laon, France; 1120. 1,750.
3. Order of the Holy Cross (Crosier Canons; O.S.C., O.S.Cr.). Theodore of Celles, Huy, Belg.; 1211. Xmersfoort, Neth. 670.
4. Crucifers of the Red Star. Agnes of Bohemia; 1237. Prague, Czech. 43.
5. (Canons Regular of the Immaculate Conception: see below, *Religious Congregations,* 38.)

MONKS

A. The Benedictine tradition, stemming from the rule of St. Benedict (*q.v.*), the father oi western monasticism.

1. The Benedictine Confederation (O.S.B.). 1890. 11,500 monks of the following congregations under an abbot primate residing at Sant' Anselmo, Rome (Note: [1] The dates given are those oi the iormation of congregations, which oiten include abbeys of much older ioundation; [2] each congregation elects the abbot of one of its constituent abbeys as abbot president ior a stated term; individual abbeys, a very few oi the better-known among many, are arbitrarily named):
   a. English (1215). Downside, Ampleforth, Douai, Buckfast (1960).
   b. Cassinese (1408). Monte Cassino; San Paoio, Rome.
   c. Hungarian (1500). Pannonhalma.
   d. Swiss (1602). Einsiedeln.
   e. Bavarian (1684; 1858).
   f. Brazilian (1827).
   g. French (1837) (the only congregation that has neither schools nor foreign missions). Solesmes, Ligugé.
   h. American Cassinese (1855). St. Vincent's Archabbey, Latrobe, Pa.; St. John's Abbey. Collegeville. Minn.
   i. Beuronese (1868). Beuron, Sigmaringen, Wiirttemberg; Maria Laach (Rhineland): Seckau. Aus.
   j. Subiaco (1872) (Cassinese Coneregation of the Primitive Observance). Subiaco, near Rome; Montserrat, Spain.
   k. Swiss-American (1881). St. Meinrad's Archabbey, Indiana; Conception Abbey, Missouri.
   l. Austrian (1889).
   m. St Ottilien (1884); for foreign missions, especially in Africa. St. Ottilien, Bavaria.
   n. Belgian (1920). Saint-André, Bruges; Maredsous.
   o. Slavonic of St. Adalbert (1945).
2. Independent Congregations of Benedictines:
   a. Camaldolese (white). St. Romuald, Camaldoli, Arezzo, Italy; 980. Hermits. 300.
   b. Vallombrosians (black). St. John Gualbert, Vallombrosa, Florence; 1015. Contemplative. 105.
   c. Sylvestrines (blue). St. Silvester Gozzolini, Montefano, Fabriano, Italy: 1231. Contemplative. 190.
   d. Olivetans (white). Bernard Tolomei, Monte Oliveto, Siena; 1341. 260.
3. Benedictines of Eastern Rite:
   a. Mckhitarists (Armenian rite). Mekhitar of Sebaste, Constantinople; 1701. (1) San Lazzaro, Venice: 1717. 51. (2) Vienna; 1773. 32.
4. Cistercians. St. Robert of Molesme, St. Alberic and St. Stephen Harding, Citeaux; 1098:
   a. Of the Common Observance (O.Cist). Nine congregations—Austrian, Swiss-German. Italian of St. Bernard. Belgian, French. Hungarian, Bohemian. Italian of Casamari and Polish —with an abbot-general in Rome. 1,623.
   b. Of the Reformed or Strict Observance (Trappists; O.C.R., O.C.S.O.). From the reiorm at La Trappe, Normandy; 1664. Independent contemplative monasteries under an abbot-general in Rome. 4,337.

B. The Carthusian tradition (O.Cart.). St. Bruno, La Grande Chartreuse, near Grenoble, France; 1084. Contemplative hermits with the prior of La Grande Chartreuse as minister-general. The only order that has never required reform. 582.

C. The Eastern traditions.

1. Deriving irom the tradition of St. Paul of Thebes, the First Hermit (4th century). Paulites: (a) Eusebius of Gran (Esztergom), Hungary; 1250. Latin rite, caring for the Polish national shrine of Our Ladv of Czestochowa. Formerly much more widely diffused. Jasna Gova, Czestochowa, Pol. 230. (*b*) 1215. Rome.
2. Deriving from the tradition of St. Anthony the Abbot (4th century):
   a. Maronite Antonians. Three congregations in Lebanon; 1695–1700.
   b. Chaldaean Antonians. Congregation of St. Hormisdas, Alqos, Iraq; 1808.
3. Deriving irom the tradition of St. Basil (4th century).
   a. Basilians of Grottaierrata, near Rome. Italo-Greek; Byzantine rite; 980, 1004, 1579. 50.
   b. Basilians of St. Josaphat. Ruthenian-Ukrainian; centralized under St. Josaphat, 1617.
   c. Melkite Basilians. Three orders in Lebanon; late 17th century.

Mendicant Friars

1. Dominicans (Order of Preachers; Black Friars; O.P.). St. Dominic, Toulouse; 1216. 9,737.
2. Franciscans. St. Francis, Assisi; 1209:
   a. Friars Minor (Grey Friars; O.F.M.). Union (1897) of the Observants (1415), Alcantarins (St. Peter of Alcántara, 1533), Reformed (1332) and Recollects (1595–1629). Second in numbers only to the Jesuits. 26,160.
   b. Franciscan Conventuals (Black Franciscans; O.F.M. Conv.). 4,550.
   c. Capuchins (O.F.M.Cap.). Reform of Matteo da Bascio, *c.* 1525, bearded. 15,624.
   d. Third Order Regular of St. Francis. 13th century. 1,420.
3. Augustinians (Austin Friars):
   a. Hermits of St. Augustine (O.E.S.A.). United 1256. 4,090.
   b. Recollects (O.R.S.A.). Talavera, Spain; 1588. Still predominantly Spanish. 1,420.
   c. Discalced Hermits of St. Augustine. Late 16th century. 165.
4. Carmelites (White Friars). Derived irom the hermits on Mt. Carmel associated with the Prophet Elijah. 1247 (rule approved 1226). 2,904.
   a. Calced (Of the Old Observance; O. Carm.). 2,904.
   b. Discalced (O.C.D.). St. Teresa of Ávila and St. John of the Cross, 1562–68. 4,236.
5. Trinitarians. St. John of Matha, Cerfroid, Soissons, France; 1198. 800.
6. Mercedarians (Order of Our Lady of Ransom). St. Peter Nolasco, Aragon, Spain; 1218. 1,163.
7. Servites (Servants oi Mary; O.S.M.). Seven Holy Founders, Florence; 1233. 1,619
8. Minims. St. Francis oi Paola; 1435. 1,265.
9. Hospitallers of St. John of God (Fate Bene Brothers; O.H. [F.B.F.]). St. John of God, Granada, Spain; 1537. Hospitals. Only a small minority are priests. 2,502.
10. Teutonic Order. Priests of the military Order of the Teutonic Knights, founded at the siege oi Acre; 1190. Reorganized 1834; reformed 1929. Vienna. 99.

Clerks Regular

1. Theatines (C.R.). St. Cajetan (Gaetano) and Bishop Carafa of Chieti (Theatinus), later Pope Paul IV, Rome; 1524. 1,203'.
2. Barnabites (Congregation of St. Paul; C.R.S.P.). St. Anthony Mary Zaccaria, Milan; 1530. 634.
3. Jesuits (Society of Jesus; S.J.). St. Ignatius Loyola, Montmartre, Paris, 1534; Rome, 1540. The largest religious order in numbers. 34,687.
4. Somaschi. St. Jerome Emiliani, Somascha, Lombardy; 1528. 360.
5. Camillians (Ministers of the Sick; M.I.). St. Camillo de Lellis, Rome; 1586. Hospitals. 1,278.
6. Caracciolines (Minor Clerks Regular). St. Francis Caracciolo and Augustine Adorno, Naples; 1588. 50.
7. Clerks Regular of the Mother of God. St. John Leonardi, Lucca; 1574. (Small).
8. Piarists (Poor Clerks Regular of the Mother of God of the Pious Schools; S.P.). St. Joseph Calasanctius, Rome; 1617. Teachıng. 2,417.

Religious Congregations

1. Fathers of Christian Doctrine ("Dottrinari"). César de Bus, Avipnon; 1592. 97.
2. Pii Operai Calechisti Rurali. Charles Caraia, Naples; 1600. Cosenza, Italy. 45.
3. Marian Fathers (Marian Clerks Regular oi the Immaculate Conception). Stanislaus Papczynski, Poland; 1673. 461.
4. Passionists (Discalced Clerks of the Most Holy Cross and Passion of Our Lord Jesus Christ; C.P.). St. Paul oi the Cross, Florence; 1720. 3,919.
5. Redemptorists (Congregation of the Most Holy Redeemer; C.SS.R.). St. Alionso dei Liguori, Naples; 1732. 8,956.
6. Picpus Fathers (Congregation oi the Sacred Hearts oi Jesus and Mary; SS.CC.). Joseph Coudrin, rue de Picpus, Paris; 1800. 1,962.
7. Marist Fathers (Society of Mary; S.M.; distinguish from 16, below, which has the same name and is known by the same initials). John Claude Colin, Lyons; 1822. 2,252.
8. Congregation of the Holy Ghost; (Holy Ghost Fathers C.S.Sp.). C. F. Poullart des Places, Paris; 1703. Foreign missions, especially in Africa. Paris. 5,200.
9. Montiort Fathers (Company of Mary; S.M.M.). St. Louis Grignion de Montfort, Poitiers, France; 1705. Missionaries. 1,722.
10. Oblates of Mary Immaculate (O.M.I.). C. J. E. de Mazenod, Aix-en-Provence, France; 1816. Missionaries. 7,397.
11. Oblates of the Virgin Mary (O.M.V.). G. B. Reynaudi, Carignano. Turin, Italy; 1815. 200.
12. Priests oi the Charitable Schools (Istituto Cavanis). The Counts Cavanis, Venice; 1802. Venice. 145.
13. Basilians (C.S.B.). Ammonay, Viviers, France; 1822. Transferred to Canada, 1852. Toronto. 693.
14. Missionaries of the Sacred Hearts of Jesus and Mary (M. SS. CC.). Gaetano Errico, Naples; 1833. 50.
15. Viatorian Fathers (Clerks of St. Viator; C.S.V.). Louis Joseph Querbes, Vourles, Lyons, France; 1831. Now mainly in Canada and U.S. Coteau du Lac, Que., Can. 1,801.
16. Marianists (Society of Mary; S.M.; distinguish irom 7, above). William Joseph Chaminade, Bordeaux; 1817. 3,200.
17. Rosminians (Institute of Charity; I.C.). Antonio Rosmini-Serbati, Domodoszola, Italy; 1828.
18. Pavoniani (Sons of Mary Immaculate). Louis Pavoni, Brescia, Italy; 1821–47. Brescia. 280.
19. Missionaries of St. Francis de Sales (M.S.F.S.). Peter Mermier, Annecy, France; 1838. Annecy. 311.
20. Society of St. Peter in Chains. 1839. Marseilles. Care of delinquent boys. Marseilles. 55.
21. Stigmatine Fathers (Priests of the Holy Stigmata of Our Lord Jesus Christ; C.P.S.). Caspar Bertone, Verona; 1816. 500.
22. Congregation of Holy Cross (C.S.C.). A union of several foundations at Le Mans, France; 1837. 2,837.
23. Assumptionists (Augustinians of the Assumption; A.A.). Emmanuel d'Alzon, Nîmes, France; 1845. 1,960.
24. Sons of Mary Immaculate (F.M.I.). Louis Baudouin, Chavagnes-en-Paillers. Lucon, France; 1828. Chavagnes-en-Paillers. 200.
25. Company of Mary for the Education of Deai Mutes. 1830. Verona. 36.
26. Congregation of the Blessed Sacrament (S.S.S.). Peter Julian Eymard, Paris; 1856. 1,562.
27. Resurrectionists (Congregation of the Resurrection; C.R.). Bogdan Janski, Peter Semenenko and Jerome Kajsiewicz, Paris; 1836. 472.
28. Claretians (Congregation of Sons of the Immaculate Heart of Mary; C.M F.). St. Anthony Mary Claret, Vich, Spain; 1849. 3,356.
29. Congregation of the Sacred Heart of the Infant Jesus (S.C.J.). 1852. Marseilles. Teaching. 88.
30. Josephites (Sons of St. Joseph; C.J.). C. van Crombrugghe, Grammont, near Ghent, Belg.; 1817. Velm, Belg. 200.
31. Salesians (Society of St. Francis of Sales, Society of Don Bosco; S.D.B.). St. John Bosco. Turin; 1859. Turin. 20.345.
32. Lourdes Missionaries (Missionaries of the Immaculate Conception). 1848. Garaison, France 85.
33. Missionaries oi the Sacred Heart (M S.C.). Jules Chevalier, Issoudun, France; 1833. 3,064.
34. Religious of St. Vincent de Paul. M. Le Prevost, Paris; 1845. Good works among the poor. Paris. 337.
35. Brothers of Charity ("Frati Bigi"). Louis da Casoria, Naples; 1859. 46.
36. Priests of the Sacred Heart (of Bétharram) (S.C.J.). St. Michael Garicoits, Bétharram, near Lourdes. France; 1832. Bétharram. 542.
37. Oblates of St. Francis de Sales (O.S.F.S.). Louis Brisson, Troyes, France; 1871. 1,175.
38. Canons Regular of the Immaculate Conception (C.R.I.C.). Adrian Gréa, Saint-Antoine. France; 1866. 86.
39. Fathers of St. Edmund (S.S.E.). Jean Baptiste Muard, Pontigny, France; 1843. Winooski, Vt. 183.
40. Missionaries of Our Lady oi La Salette (M.S.). Filibert Bruillard, Grenoble, France; 1852. 1,069.
41. Sons of the Holy Family (S.F.). G. Mañanet y Vives, Tremp, Spain; 1864. Barcelona. 390.
42. Priests of the Sacred Heart (of Saint-Quentin) (S.C.J.; distinguish irom 36, above). Leo Dehon, Saint-Quentin, France; 1878. 3,055.

43. Turin Society of St. Joseph ("Giuseppini del Murialdo"). Leonard Murialdo, Turin; 1873. 774.
44. Verona Fathers. (Sons of the Sacred Heart of Jesus; F.S.C.J.). Daniel Comboni, Canario, Italy; 1866. Verona. African missions. 1,440.
45. Mexican Missionaries of St. Joseph (M.J.). Joseph Villaseca, Mexico City; 1872. Mexico City. 224.
46. Priests of St. Mary of Tinchebrai. Charles Duguey, Tinchebrai, France; 1851. Tinchebrai. 40.
47. Scheut Fathers (Immaculate Heart Missioners; Congregation of the Immaculate Heart oi Mary; C.I.C.M.). Theophilus Verbicst, Scheut, near Brussels, Belg.; 1862. Brussels. Foreign missions. 1,916.
48. Society of the Divine Word (Divine Word Missionaries; S.V.D.). Arnold Janssen, Steyl, Neth.; 1875. Foreign missions. 5.345.
49. Religious Tertiary Capuchins of Our Lady of Sorrows. Louis Amigo, Masamagrell, Valencia, Spain; 1889. Madrid. 398.
50. Sons of Mary Immaculate (F.S.M.I.). Joseph Frassinetti, Genoa; 1861. 118.
51. Salvatorians (S.D.S.). Francis Jordan, Rome; 1881. 1,350.
52. Xaverians (S. X.). G. M. Conforti, Parma, Italy; 1898. Parma. Foreign missions. 674.
53. Carmelites oi Mary Immaculate (C.M.I.). South India; 1855. Contemplatives of Syro-Malabar rite. Ernakulam. India.. 812.
54. Scalabriniani (Missionary Society of St. Charles for Italian Emigrants; P.S.S.C.). G. B. Scalabrini, Piacenza, Italy; 1887. 750.
55. Oblates of St. Joseph ("Giuseppini d'Asti"). Joseph Marello, Asti, Italy; 1878. 377.
56. Consolata Fathers (I.M.C.). Joseph Allamano, Turin; 1901. Turin. Foreign missions. 856.
57. Missionaries oi the Holy Family (M.S.F.). John Berthier, 's Hertogenbosch, Neth.; 1895. 1,200.
58. Servants oi Charity. Louis Guanella, Como, Italy; 1908. Como. 515.
59. Little Mission for Deaf Mutes. G. and C. Gualandi, Bologna, Italy; 1890. 45.
60. Mariannhill Missionaries (C.M.M.). Natal, South Africa; 1909; irom the foundation (1882) oi Francis Pianner. Nördlingen, Ger. 685.
61. Missionary Sons of the Sacred Heart (M.F.S.C.). A German separation from 42, above; 1923. Foreign missions, especially in Africa. Ellwangen, Ger. 239.
62. Calasanctians (Congregation of the Followers of St. Joseph Calasanctius). A. M. Schwartz, Vienna; 1889. Vienna. [illegible]
63. Sons of Charity. J. E. Anizan, Paris; 1918. Issy, France. 280.
64. Institute of Missionaries of the Workers (M.O.). Theophilus Reyn, Seraing, Belg.; 1894. Brussels. 116.
65. Missionaries of the Holy Ghost (M.Sp.S.). Felix Rougier, Tepeyac, Mex.; 1914. Mexico City. 375.
66. Missionaries of the Sacred Hearts of Jesus and Mary (Majorca). G. R. Ferra, Palma, Majorca, Spain; 1890. Palma. 190.
67. Society of St. Paul (S.S.P.). James Alberione, Alba, Italy; 1914. Press, cinema, radio, television. 1,049.
68. Sons of Divine Providence (F.D.P.). L. Orione, Tortona, Italy; 1893. 1,010.
69. Congregation oi the Holy Family of Nazareth. G. Piamarta, Brescia; 1900. Brescia. 150.
70. Poor Servants oi Divine Providence. Don Calabria, Verona; 1907. Verona. 180.
71. Canossians (Sons of Charity; distinguish from 63, above). The hlarchioness of Canossa; 1831. Venice. 98.
72. Society of Christ for Polish Emigrants. 1932. Poznan, Pol. 430.
73. Congregation of the Priestly Brotherhood (C.F.S.). M. E. Prevost, Paris; 1901. 210.
74. Franciscan Friars of the Atonement (Graymoor Friars; S.A.). Paul James Francis, Garrison, N.Y.; 1898. Garrison. Work and prayer for Christian reunion. 280.
75. Rogationists (Rogationist Fathers of the Heart of Jesus; R.C.J.). A. M. di Francia, Messina, Italy; 1926. 229.
76. Missionary Servants of the Most Holy Trinity. (M.S.SS.T.). Thomas Aupustine Judge; 1929. Silver Spring, Md. 231.

Societies Living in Common Without Vows

1. Oratorians (Institute of the Oratory of St. Philip Neri; Cong. Orat.). St. Philip Neri, Rome; 1564–75. A confederation (1942) of autonomous houses.
2. French Oratorians. Pierre de Bérulle, Paris; 1611. Paris. 131.
3. Vincentians or Lazarists (Congregation of the Mission; C.M.). St. Vincent de Paul, Paris; 1625. Paris. 5,750.
4. Sulpicians. J. J. Olier, Paris; 1642. Paris. 629.
5. Paris Foreign Missionaries (M.E.P.). François Pallu, Paris; 1660. Paris. 903.
6. Priests of Mercy (S.P.M.). J. B. Rauzan, Lyons, France; 1808. Brooklyn, N.Y. 95.
7. Pallottine Fathers (Society of the Catholic Apostolate, S.A.C.). Vincent Pallotti, Rome; 1835. 2,150.
8. Missionaries of the Most Precious Blood (C.PP.S.). St. Caspar del Bufalo, Giano dell'Umbria, Italy; 1815. 910.
9. Eudists (Congregation of Jesus and Mary; C.J.M.). St. John Eudes, Caen. France; 1643. 585.
10. Pontifical Institute of the Holy Apostles Peter and Paul and of St. Ambrose and St. Charles for the Foreign Missions. Union (1926) of the Milan Foreign Missionaries (1850) and the Roman Pontifical Seminary of the Holy Apostles Peter and Paul (1874). 730.
11. White Fathers (Society of Missionaries of Africa; P.A.). C. M. A. Lavigerie, Algiers; 1868. 4,011.
12. African Missionaries (Society of Missions to the Africans; Lyons Missionaries; S.M.A.). M. J. de Marion-Brdssillac and J. A. Planque, Lyons, France; 1868. 1.778.
13. Mill Hill Fathers (Society oi St. Joseph for the Foreign Missions). Herbert Vaughan, Mill Hill, London; 1866. 1,148.
14. Mar)-knoll Fathers (Catholic Foreign Missionary Society of America; M.M.). J. A. Walsh and T. F. Price, Maryknoll, N.Y.; 1911. Maryknoll. 1,164.
15. Spanish Institute of St. Francis Xavier for the Foreign Missions, Gerard Villota, Burgos, Spain; 1899. Burgos. 155.
16. Maynooth Mission to China (Society of St. Columbanus). Edward J. Galvin, Maynooth, Ire.; 1917. Navan, Ire. 977.
17. Paulist Fathers (Society of Missionary Priests of St. Paul the Apostle; C.S.P.). Isaac Thomas Hecker, New York, N.Y.; 1858. New York. 314.
18. Quebec Missionaries (Society for the Foreign Missions of the Province of Quebec). 1921. Montreal. 320.
19. Portuguese Society for the Catholic Missions. 1930. Cucujães, Port. 129.
20. Society of St. Joseph of the Sacred Heart (Josephite Fathers). Herbert Vaughan, London; 1866. Baltimore, Md. 274.
21. Bethlehem Missionaries (Society of Foreign Missions of Bethlehem in Switzerland). 1921. Immensee, Switz. 375.
22. Yarumal Foreign Missionaries. 1927.' Yarumal, Colombia. 165.
23. Scarboro Foreign Missionaries. J. M. Fraser, Scarboro Bluffs, Ont. 1918. Scarboro.
24. Institute of Our Lady of Guadeloupe for the Foreign Missions. 1949. Mexico City.
25. Society of St. Patrick for the Foreign Missions. Patrick Whitney, Kiltegan, Ire. 1932. Kiltegan. 309.

Brothers

1. Brothers of the Christian Schools (F.S.C.). St. Jean Baptiste de la Salle, Reims; 1679–84. 17.432.
2. Christian Brothers of Ireland. Edmund Ignatius Rice, Waterford, Ire.; 1802. Dublin. 3,500.
3. Brothers of the Holy Family (of Belley) (F.S.F.). Gabriel Taborin, Belmont, France; 1835. Belley, France. 461.
4. Brothers of the Immaculate Conception of Our Lady of Maastricht. 1848. Maastricht, Neth. 985.
5. Brothers of Christian Instruction (F.I.C.P.). J. M. R. de la Mennais, Saint-Brieuc, France; 1817. Jersey, C.I., Eng. 2,190.
6. Brothers of Our Lady of Mercy (F.D.M.). V. G. B. Scheppers, Malines, Belg.; 1839. Antwerp. 355.
7. Brothers of Our Lady Mother of Mercy (oi Tilburg). J. Zwijsen, Tilburg, Neth.; 1884. Tilburg. 1,045.
8. Marist Brothers (of the Schools) (F.M.S.; P.F.M.). Benedict Marcellinus Champagnat, Laval, France; 1817. Saint-Genis Laval, France. 8.974.
9. Sons of the Immaculate Conception (Conceptionists). L. M. Monti. Rome; 1857. 340.
10. Alexian Brothers (of Aachen; Cellites; C.F.A.). 14th century Rhineland origin; reconstituted 1854. Signal Mountain, Tenn. 387.
11. Patrician Brothers (P.B.). Daniel Delaney, Tullow, Ire.; 1888. Tullow. 248.
12. Brothers of Charity (of Ghent). Peter J. Triest, Ghent; 1307. 1,567.
13. Brothers of Mercy. P. Loetschert, Montabaur, Ger.; 1856. Montabaur. 259.
14. Presentation Brothers. Edmund Ignatius Rice, Waterford, Ire.; 1802. Cork. 3.50.
15. Brothers of the Sacred Heart. André Coindre, Lyons; 1821. 2.901.
16. Brothers of Our Lady of Lourdes. M. E. Glorieux. Renoix, Ghent; 1830. Name acquired in 1880. Oostakker. Belg. 936.
17. Brothers of Mercy of Mary Auxiliatrix. P. Friedhofen, Wcitsberg, Coblenz; 1850. Trier, Ger. 340.
18. Franciscan Brothers (Tertiaries) of the Holy Cross (of Trier). 1862. Linz-Rhein, Ger. 180.
19. Brothers of Christian Instruction of St. Gabriel. Derived from the Brothers of the Holy Ghost, St. Louis de Grignion de Montfort, Saint-Laurent-sur-Sèvre, France; 1705. Saint-Laurent-sur-Sèvre. 1,850.
20. Poor Brothers of the Seraphic St. Francis. J. Hover, Aachen, Ger.; 1861. Aachen. 200.
21. Servants of Mary of the Third Order of St. Francis of Penance. 1885. Warsaw, Pol. 84.

22. Brothers of St. Aloysius Gonzaga. W. Hellemons, Oudenbosch, Neth.; 1849. Oudenbosch. 418.
23. Dolorists (Sons of the Sorrowful Mother of God). 1880. Warsaw, Pol. 47.
24. Xaverian Brothers (Brothers of St. Francis Xavier; C.F.X.). Theodore Ryken, Bruges; 1839. 803.
25. Brothers of the Third Order Regular of St. Francis of Assisi of Mount Bellew (Irish Institute of the Franciscan Brothers). 16th century; reconstituted 1818. Mount Bellew, Ire. 181.
26. Missionary Brothers of St. Francis of Assisi. P. Moritz; 1896. Bombay, India. 126.
27. Huybergen Brothers (Brothers of the Immaculate Conception of the Blessed Mother of God). Huybergen, Neth.; 1854. Bergen Op Zoom, Neth. 332.

SECULAR INSTITUTES OF MEN

1. Society of St. Paul. 1920.
2. Opus Dei (priestly Society of the Holy Cross). J. M. Escriva de Balaguer, Madrid, Spain; 1928.
3. Diocesan Priestly Workers of the Sacred Heart of Jesus. Manuel Domingo y Sol, Tortosa, Spain; 1881. Madrid.
4. Society of the Heart of Jesus. 1791; reconstituted 1918. Lyons, France.
5. Institute of Priests of the Prado. Lyons, 1856. Lyons.

(Note: The Little Brothers of Jesus, which grew [1934] out of the Union of Brothers and Sisters of the Sacred Heart of Jesus founded by Charles de Foucauld and the Missionary Brothers of the Country-side founded [1943] at La Houssaye-en-Brie, France, by Father Epagneul, are examples of well-known institutes not listed in the *Annuario Pontificio* for 1961, not yet having that pontifical status which is also the criterion for inclusion in this list.)

ROMAN CATHOLIC RELIGIOUS ORDERS OF WOMEN

The Roman Catholic religious orders and congregations of women number nearly 1.500 even when local diocesan institutes are excluded. Most of the orders and congregations of men have been associated from the first with corresponding foundations for women, and many of these have subdivided in a way that has not characterized the foundations for men. Separate orders of women, to which belong nuns in the stricter sense (*moniales,* taking solemn vows), and congregations, to which belong sisters (*sorores,* taking simple vows), not infrequently derive from the same stem, as with the Benedictines.

The Annuario *Pontificio* for 1961 lists more than 70 separate congregations of Dominican nuns and sisters of the second order and the third order conventual, and there is likewise a very large number of different congregations of women in the Franciscan tradition. Some of the most important of these are of relatively recent origin, as for example the Franciscan Missionaries of Mary, founded by Mother Mary de Chappotin de Neuville in India in 1877, who number well over 10,000 sisters.

It is the number of religious foundations for women made since the Council of Trent (almost all with simple vows, with the notable exception of the Visitation order), and especially of those made during the 19th century, that makes a comprehensive list impossible in the space available. Most of these follow some form of the Augustinian rule, as also do the older orders of the Dominicans and Ursulines. A number follow rules based on that of the Jesuits. The other principal rules by which the orders and congregations of women may be classified are the Basilian, to which tradition belong the Carmelite nuns, the Benedictine, the Franciscan and the Brigittine. Some foundations have divided into active and contemplative branches; in some the active and contemplative lives are combined. Wholly contemplative or enclosed (cloistered) nuns numbered perhaps 80,000 throughout the world in 1960, the most numerous of these being the Carmelites and the Poor Clares, with about 15,000 and 14,000 nuns respectively. The number of active and unenclosed sisters is very much greater, amounting to at least 750,000 in all. See also WOMEN'S RELIGIOUS ORDERS. (M. DK.)

ORDERS OF KNIGHTHOOD: see KNIGHTHOOD AND CHIVALRY.

ORDINANCE, in medieval England, a form of legislation which differed from the statute in that it did not require the sanction of parliament. It was issued by the sovereign by virtue of the royal prerogative, although, especially during the reign of Edward I, the king often obtained the assent of his council to his ordinances. William Stubbs, in volume ii of his Constitutional History of England (1875), defines the ordinance as "a regulation made by the king, by himself or in his council or with the advice of his council, promulgated in letters patent or in charter, and liable to be recalled by the same authority." But after remarking that "these generalizations do not cover all the instances of the use of ordinance," he adds: "The statute is primarily a legislative act, ordinance is primarily an executive one."

Legislation by ordinance was common during the reigns of Henry III and Edward I. Soon, however, legislation by ordinance aroused the jealousy of parliament, especially when it was found that acts of parliament were altered and their purpose defeated by this means. For this and other reasons this form of legislation fell gradually into disuse, becoming obsolete in the 15th century. The modern equivalent of the ordinance is the order in council (*q.v.*), but in the crown colonies legislation is both by orders in council and by local ordinance issued by the governor with the assent of his council.

A more current use of the word ordinance is in describing a body of laws enacted by a body less than sovereign. Examples of this usage are the ordinances issued by a colonial governor with the assent of his council. In the United States the word ordinance is often used to describe laws passed by municipalities.

ORDINARY, in canon law, the name commonly employed to designate a superior ecclesiastic exercising "ordinary" jurisdiction (*iurisdictionem ordinariam*), *i.e.,* in accordance with the normal organization of the church. It is usually applied to the bishop of a diocese and to those who exercise jurisdiction in the name of the bishop or by delegation of his functions. In English law, however, the term ordinary is now confined to the bishop and the chancellor of his court. The pope is the ordinarius of the whole Roman Catholic Church, and is sometimes described as ordinarius *ordinariorum.* Similarly in the Church of England the king is legally the supreme ordinary, as the source of jurisdiction.

In England the only instance of the term ordinary being employed in its civil application was that of the office of judge ordinary created by the Divorce act of 1857, a title which was, however, only in existence for about 18 years because of the incorporation of the divorce court with the high court of justice by the Judicature act, 1875. But in Scotland the ordinary judges of the inner and outer houses are called lords ordinary, the junior lord ordinary of the outer house acts as lord ordinary of the bills, the second junior as lord ordinary on teinds, the third junior as lord ordinary on exchequer causes.

In the United States the ordinary possesses, in the states where such an officer exists, powers vested in him by the constitution and acts of the legislature identical with those usually vested in the courts of probate. In South Carolina he was a judicial officer, but the office no longer exists, as South Carolina has now a probate court.

ORDINATION, a rite of Christian churches for the dedication and commissioning of ministers to administer the sacraments, preach and exercise pastoral care. The essential ceremony consists of the laying on of hands upon the head of the one who is ordained, with prayer for the gift of the Holy Spirit and of grace needful for the exercise of his ministry. The service usually includes also a public examination of the candidate and a sermon or charge concerning the responsibilities of the ministry.

Christianity derived the ceremony from the Jewish custom of ordaining rabbis by the laying on of hands (the *Semikhah*), the practice having biblical sanction in Moses' ordination of Joshua (Num. xxvii, 18, 23; Deut. xxxiv, 9). New Testament examples are the ordination of the 7 by the 12 apostles (Acts vi, 6), and the commissioning of Barnabas and Paul by prophets and teachers at Antioch (Acts xiii, 3). The Pastoral Epistles (I Tim. iv, 14; II Tim. i, 6) associate ordination with the conferral of a spiritual gift of grace.

The oldest ordination prayers extant are contained in the Apostolic Tradition of Hippolytus of Rome (c. A.D. 200). In medieval times, the Latin rites were elaborated by additional ceremonies such as the delivery to the ordinands of symbols pertinent to their office (porrectio *instrumentorum*), the anointing of hands, and clothing in the vestments and insignia pertaining to the rank of ministerial order conferred.

The ordaining minister in episcopal churches is always a bishop. In presbyterian churches, ordination is conferred by ministers of the presbytery; in congregational churches, by persons chosen by the local congregation. Eastern Orthodox and Roman Catholic theology accounts ordination a sacrament essential to the church and the bestowal of an unrepeatable, indelible character upon the persons ordained.

See also HOLY ORDERS; MINISTRY, CHRISTIAN. (M. H. SH.)

ORDNANCE, a military term that includes, in American usage. nearly all combat weapons of the land, sea and air forces. British military usage generally restricts it to guns of artillery calibre. In its broadest meaning the term includes such items as pistols, revolvers, carbines, rifles. machine guns, mortars: recoilless rifles, field guns and howitzers, rocket launchers, bombs, mines! grenades. torpedoes! guided missiles, combat vehicles and related matitriel. In this sense it is nearly equivalent to "munitions" or "materiel." encompassing virtually all fighting equipment.

Chemical warfare equipment is, in the United States, excluded from the ordnance category though it closely resembles ordnance matériel. Weapons mounted on ships. planes or tanks are usually referred to as "armament" rather than as ordnance.

The origin of the word is obscure and its meaning throughout history has undergone changes. In early times it apparently included body armour, bows and arrows, and engines of war (*q.v.*). In later years ordnance was generally taken to mean only heavy weapons such as field guns and howitzers, excluding small hand and shoulder arms. Yet. in an age when the horse was still militarily important, the term also included harness and other horse equipment for the field artillery and cavalry. In the U.S. army the expression "ordnance and ordnance stores" gained currency in the 19th century as a comprehensive term covering nearly everything procured and issued by the ordnance department. including both small arms and artillery.

From this it was but a short step to apply the single word "ordnance" to all types of fighting equipment. By the start of World War I in 1914, U.S. army regulations defined ordnance broadly to include small arms, artillery, ammunition, apparatus for the service and maneuver of artillery. horse equipment, and "all property of whatever nature supplied to the Military Establishment by the Ordnance Department." In the United States there has been a strong tendency over the years to consider as ordnance whatever materiel is issued by the branch of the service with ordnance in its name, whether it be the army ordnance corps or the navy bureau of ordnance. This tendency has been less marked in the British army where the Royal army ordnance corps has functions and responsibilities much different from those of its American counterpart.

For descriptions of the types of fighting equipment collectively known as ordnance. see the articles: AMMUNITION, ARTILLERY; ARTILLERY: MISSILES: MACHINE GUN: PISTOL AND REVOLVER: ROCKETS; SMALL ARMS, MILITARY; and TANK. *See* also Index references under "Ordnance" in the Index volume. (H. C. T.)

ORDNANCE CORPS, the branch of the U.S. army responsible for the design, manufacture and procurement from industry of weapons, ammunition and vehicles, and for their storage. issue and maintenance. In the British army the royal army ordnance corps (see below) has responsibility for storage and issue of nearly all types of military supplies and equipment, but not for their procurement and maintenance.

In the U.S. army the ordnance corps (formerly ordnance department) is one of several technical services that meet the logistical needs of the army and, for certain matters. also serve the navy and air force. The chief of ordnance, normally a major general or a lieutenant general, is appointed by the president for a four-year term but his term may be extended or terminated at the will of the president. The lapel insigne worn by ordnance officers is the flaming bomb, the oldest such insigne in the U.S. army. (See INSIGNIA, MILITARY.)

In the early years of its history the U.S. army functioned without a distinct ordnance branch. During the Revolutionary War the continental congress assigned certain broad responsibilities to a board of nar and ordnance, with artillery officers being charged with ordnance activities in the field. For the first tno decades under the constitution the procurement of military stores was assigned to the treasury department. Not until May 14, 1812, after the outbreak of the second war with Britain. did congress authorize establishment of an ordnance department. The first chief. or commissary general as he was known until 1815, nas Col. Decius Wadsworth. The new department was charged with the inspection, storage and issue of weapons and ammunition; it also operated the government-owned arsenals where munitions nere manufactured or stored. and was soon given power to purchase materiel from private contractors.

Except for a brief period (1821–32) when it was merged with the artillery, the ordnance department continued throughout the 19th century to supply "ordnance and ordnance stores" to the army. As years passed it gradually assumed responsibility for the design of new and improved matériel (see ARTILLERY and SMALL ARMS, MILITARY) and for the development at its arsenals of improved manufacturing processes In the 20th century. keeping pace with advances in weapons, it assumed responsibility for tanks, motor vehicles, rockets and guided missiles.

During World War II, when the United States became the "arsenal of democracy," the ordnance department expended some $34,000,000,000 for procurement of munitions for the U.S armed forces and for allied powers At the peak of its World War II strength the ordnance department had jurisdiction over 8 manufacturing arsenals, 13 procurement district offices, and scores of storage depots, proving grounds, and ammunition plants. In July 1950, shortly after the outbreak of the Korean war, the ordnance department was redesignated the ordnance corps as provided by the Army Organization act of 1950.

Royal Army Ordnance Corps.—As constituted at mid-20th century. the royal army ordnance corps (R.A.O.C.) in the British army was by no means the exact counterpart of the U.S. ordnance corps. It nas a fully combatant technical corps under the quartermaster general's branch of the army council. Her Majesty the Queen was colonel-in-chief of the corps; the active head was the director of ordnance services, a major general, with a staff in the war office. The chief function of the R.A.O.C. nas storage and issue of a wide range of military supplies and equipment, including clothing, tentage, general stares, signal and engineer equipment, weapons, ammunition, tanks, and unit transport vehicles.

The predecessor of the R.A.O.C. was the board of ordnance, a government agency that held responsibility over several centuries for management of the artillery and engineer corps, and for supplying military materiel to the army. The board of ordnance appeared as a corporate body of great power and prestige as early as the Tudor period and lasted for some 400 years until its dissolution in 1855. It supplied guns. powder. shot and associated stores to warships as well as to trains of artillery in the field and to fortresses; but it did not provide clothing, rations, forage, or medical stores. Partly military and partly civil. the ordnance board was headed by a master general of ordnance, a position held by Wellington from 1818 to 1827. Its principal officers were usually members of parliament.

The Crimean War scandals (largely over items for which the board was not responsible) led to widespread army reforms in the midst of which the board was abolished. The war office then took over the supply of war matériel, forming a military stores department in 1857 with headquarters at Woolwich arsenal. This department experienced many changes of title and organization in the years that followed, finally emerging in 1896 as the army ordnance department (officers and civilians) and army ordnance corps (military other ranks) with responsibility for clothing and general stores as well as for war matériel. Because oi their outstanding service during World War I the two organizations were amalgamated in 1918 and granted the honour title "Royal." In World War II the personnel of the royal army ordnance corps expanded from some 8,000 in 1939 to 140,000 by 1945.

See Constance M. Green, Harry C. Thomson and Peter C. Roots, ***The*** *Ordnance Department: Planning Munitions jor War* (1955).

(H. C. T.)

ORDOVICIAN **SYSTEM,** in geology a term introduced by Charles Lapworth in 1879 to include those rocks—well developed in the Welsh region formerly inhabited by the Ordovices—which had been classed by Sir Roderick Murchison as Lower Silurian and by Adam Sedgwick as Upper Cambrian. Ordovician rocks contain representatives of many classes of invertebrate organisms, as well as the oldest strata with abundant fish remains. (See SILURIAN SYSTEM; CAMBRIAN SYSTEM; and Ordovician section of PALAEONTOLOGY; see also GEOLOGY.) The Ordovician system is of rocks formed in the Ordovician period of time, a span of about 75,000,000 years ending about 400,000,000–450,000,000 years ago — duration and age based on interpretations of the depositional record and on the present state of disintegration of radioactive minerals in associated rocks. The Ordovician period in current classification of geologic time followed the Cambrian period and preceded the restricted Silurian or Gotlandian period in the Paleozoic era (*q.v.*), or time of ancient life. The accompanying geologic time chart indicates the position of the Ordovician in relation to other systems and periods. the dates on the chart, which have been schematized to represent all of geologic time, indicate values for the Ordovician alternative to those used in this article, which postulates the longer time span and greater age cited above. (For a more detailed time chart see GEOLOGY: Historical Geology.)

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	1,000 Years
	CENOZOIC ERA		
Quaternary	Recent	Modern man	11
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	70,000
	MESOZOIC ERA		
Cretaceous		Extinction of dinosaurs	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	160,000
Ttiassic		Appearance of dinosaurs	200,000
	PALEOZOIC ERA		
Permian		Reptiles developed, conifers abundant	235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal **forests**	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
Ordovician		First primitive fishes	400 000
Cambrian		Marine invertebrates	500,000
	PRE-CAMBRIAN TIME		
		Few fossils	3,500,000–4,000,000

Naming the Systems.—In the early part of the 19th century all the rocks which lie beneath the Carboniferous limestone were grouped together under the general name of Transition series, and it was not till 1831 that Sedgwick and Murchison made the first serious attempt to reduce them to order. Sedgwick started to work in northwest Wales and Murchison began upon the Welsh borders. By 1835 they had advanced so that Murchison gave the name Silurian system to the sequence of rocks with which he was dealing, while Sedgwick called his the Cambrian series. At the time it was supposed that the Cambrian lay entirely below the Silurian. Subsequently it was shown that the upper part of Sedgwick's Cambrian was the same as the lower part of Murchison's Silurian. **A** prolonged controversy followed which left its effects in some confusion of nomenclature even into the second half of the 20th century. Believing that the Cambrian and Silurian of Sedgnick and Murchison included three natural divisions, Lapworth in 1879 proposed that these be called Cambrian. Ordovician and Silurian. Murchison's terminology was still used to some extent at mid-20th century, especially in Germany, the three divisions being called the Cambrian. the Lower Silurian and the Upper Silurian.

The three systems are universally recognized but there are some differences of usage with regard to their precise limits. Most British geologists adhere to a classification, based largely on original definition and structural considerations, in which the base is drawn above the Tremadoc, which includes the zone characterized by the fossil of Dictyonema *flabelliforme,* whereas in extra-British areas there is general adherence to the Scandinavian practice of placing the base below that zone. There is also some divergence of opinion as to the horizon at which the upper limit should be placed. particularly inasmuch as correlations among the several continents are not conclusive.

Stratified Rocks.—The strata composing the system can be classified in several contemporary lithologic facies (*i.e.,* lateral variations or gradations in rocks developed within a single time span) deposited under differing physical conditions, and inasmuch as these evidence differing environments, each of the lithologies has an associated distinctive fossil assemblage. The lithologies vary continuously, geographically and temporally. Their textures and depositional structures can be related to the velocities of the currents that transported and sorted them and to the depths in which they were laid; their compositions reflect the materials that were carried into their places of deposition and the minerals that were precipitated locally by inorganic or organic processes. (1) Rocks of nonmarine origin include consolidated gravels (conglomerates), sands and clays having particles of sizes that streams were incompetent to carry farther. as well as the original fluviatile structures. (2) Marine rocks ordinarily contain some significant organisms that substantiate recognition of origin from interpretation of their textures and structures. They are broadly separable into those laid in shallow water. of depth of scores of feet or less, and those laid in deeper water where currents and agitation were insufficient to prevent settling of fine particles. Each may be dominantly of inorganic detritus transported from lands, of minerals formed locally, or from the accumulation of organisms and organic detritus. Those of shallow-water origin include shelly limestones (coquinas) and calcite sandstones (calcarenites). grading into quartz sandstones, graymackes (quartz-sandy argillites), shaly and silty argillites deposited in seas receiving detritus eroded from lands and from areas having limited circulation. dense limestones (calcilutites) and dolomites. and evaporites such as gypsum and salt deposits. Rocks of deep-water origin pass through dense and nodular, somewhat cherty and argillaceous (clayey) limestones into dark laminated argillites (black shales) and dense argillaceous limestone interbeds, prevalent in deeply sinking regions in which deposition failed to keep pace with subsidence. (See also SEDIMENTARY ROCKS.) (3) There are additional and significant lavas and volcanic fragmental rocks, prevalent in belts of greatest mobility.

Thicknesses are a measure of the subsidence of the earth's surface. fluctuations of sea level and the rate of deposition. The Ordovician rocks of the several facies are distributed in systematic but changing patterns that reflect the structural development within the areas of deposition, as well as the uplift and erosion of adjoining lands.

The earth had several large, rather stable areas of continental proportions and varying relative elevation (cratons) separated by linear geosynclinal belts of greater mobility. The central parts of the geosynclinal belts had thick sequences of sediments, and volcanic rocks accumulated in rapidly sinking geosynclines (eugeosynclines) that gained detritus from nearby rising narrow islands; the typical Ordovician of Wales is of this facies. Adjoining are belts of nonvolcanic rocks of relatively great thickness (miogeosynclines), commonly decreasing rather rapidly at the margins of the cratons. The North American craton in the Ordovician included the area of the Canadian shield. as well as an extensive area bordering this shield. principally to the west and south. The thicker rocks of the cratons are principally of shallow-water origin, increasing and diminishing in response to warping movements within their area; deeply sinking local regions occasionally gained deposits of geosynclinal proportions (autogeosynclines). This pattern is disturbed or destroyed as orogenies deform and raise the rocks of the linear geosynclinal belts. and streams distribute the detritus into subsiding areas in the borders of the cratons (exogeosynclines).

ORDOVICIAN LIFE

The changing distribution and elevations of lands and the depths of the seas not only influenced the lithologies, but controlled physical and organic environments and restricted migration. Ordovician faunas exhibit changes with time, but also the effects of ecological factors and the isolation of geographic provinces. (See ECOLOGY, ANIMAL.)

The life of the system has several distinctive features; the changes from the older Cambrian and into the younger Silurian are not abrupt but are apparent to those familiar with the refinements of biological classification. Similar contrasts developed within the system not only in successive strata but among varying environments represented in differing present rocks. Few classes of organisms are common to faunas both of quartz and calcite sandstones and calcareous shales deposited in relatively turbid shallow water, and of black shales and dense argillaceous limestones laid in deeper water; and such as are represented in each have distinctive families and genera. Trilobites that dominate Cambrian sediments of many lithologies continue in abundance, but become subordinate in numbers to other groups that had been absent or uncommon. Brachiopods, gastropods and cephalopods, and later bryosoans, ostracodes, cystids, tetracorals and pelecypods, became locally common in the limy and sandy lithologies, the shelly facies. The genera in each class are numbered in scores and hundreds, having smaller or greater temporal (stratigraphic) and geographic ranges; those of abundance in limited stratigraphic range are most useful in classifying and correlating the containing rocks in time. Graptolites, generally free-floating colonial marine organisms having individuals living in small cups (thecae) along raylike threads or branches (stipes) which when compressed seem like miniature deeply cut saw blades, have near relatives in Cambrian rocks, but abound in some laminated Ordovician black shales; their fragile structures were not destroyed in the quiet and rather sterile environment of the clay deposition. Being free-floating (planktonic), they are more cosmopolitan, having many of the same genera and similar or identical species over the whole earth. The appearance of these forms is in fairly consistent order whether in Britain, North America or Australia, permitting rather confident general intercontinental correlation. They are the preponderant fossils in the black-shale facies and will serve as an example of changing life forms, such as might be repeated for any of many other biologic groups, though not with such world-wide prevalence.

Dictyonema, a near relative of the graptolites, is funnel-shaped with connecting bars between the rays and is particularly prevalent in the basal Ordovician of the Scandinavian classification in beds classified as uppermost Cambrian in Britain. Those with wide distribution in the earlier Ordovician are: *Dichograptus,* with eight rays radiating from a central sac; *Tetragraptus,* two rays spreading from each end of a short bar; *Phyllograptus,* leaf-shaped when compressed but originally having an X-shaped cross section as of two interlocking leaves; and Didyntograptus, some of which are horizontally extended, others in the form of an inverted V, and other forms tuning-fork shaped with the cups toward the centre. *Nemagraptus,* having many long branches radiating from an S-shaped central rod, appears for a limited time near the middle of the system, with *Climacograptus,* like a single narrow leaf with cups on both sides, *Diplograptus,* similar but with the cups more at an angle to the stem, Dicellograptus, two branches diverging broadly to form a very obtuse V with exterior cups, and *Dicranograptus,* similar but Y-shaped with exterior cups. *Clima*cograptus and Diplograptus continue into the Silurian with new forms. Graptolites abound in some sequences of the Silurian system, but are rare in younger rocks.

DISTRIBUTION OF ROCKS

The rocks of the system are widely distributed but best known where they have been studied most intensely, in northern Europe and North America (see accompanying correlation chart of Ordovician system). Southern Europe has comparatively limited exposure of rocks as old as the Ordovician. In North America the system has been extensively preserved and penetrated by wells in broad areas where the rocks are concealed deeply. Knowledge in other continents is restricted by such factors as sparse surface distribution and severe deformation of the rocks and by the limited study that they have received over broad regions of the earth.

Europe.—The system was originally described from Wales, where it is of thousands of feet of graywacke and shale having thick lava flows and volcanic fragmental rocks, and is rather widely distributed in northern Europe. The northern European shield or craton has relatively thin sections, principally of carbonates, exposed in southeastern Norway, Sweden, Bornholm (Denmark), Estonia and east to Lake Ladoga in the U.S.S.R., and in southern Poland. Geosynclines having greater thicknesses of argillites, graywackes and volcanic rocks are represented in the rocks of northwestern Norway and of Scotland and Wales, in a belt from Cornwall and Brittany to western Bohemia and probably along the east side of the Ural mountains. Along the coasts of Norway and Scotland are isolated small areas with limestone sections; beyond the geosynclinal belt south of the craton are scattered areas, principally of argillites on the Mediterranean coasts and in the southern Alps.

The section in Britain has been divided into several series having zones with graptolite assemblages named for a distinctive species. (For discussion of classification of stratified rocks into series and zones see PALAEONTOLOGY: Geological Palaeontology; see also FOSSIL.) Authors differ in their delimiting of series, but the geological survey in Great Britain prefers the classification shown in Table I, except that the Tremadoc is excluded from the Ordovician, and retained, following the original definition, in the Cambrian system.

TABLE I.—Classification of Series in Great Britain

Series	*Zones*
Ashgill	15. *Dicellograptus anceps* 14. *Dicellograptus cornplanatus*
Caradoc	13. *Pleurograptus linearis* 12. *Dicanograptus clingani* 11. *Climacograptus wilsoni* 10. *Climacograptus peltifer* 9. *Nemagraptus gracilis*
Llandeilo	8. *Glyptograptus teretiusculus*
Llanvirn	7. *Didyrnograptus murchisoni* 6. *Didyntograptus bifidus*
Arenig.	5. *Didymograptus hirundo* 4. *Didymograptus extensus* 3. *Dichograptus octobrachiatus*
Trernadoc	2. *Bryograptus cambriensis* 1. *Dictyonema socialis*

Some authors add ian and an suffixes to the names of the series. Doubt has been expressed whether zones 2 and 3 are correctly designated; some place the zone of *Clonograptus tenellus* above zone 1 and in the Tremadoc. Some writers prefer placing zone 6 in the Arenigian and zones 7 to 9 in the Llandeilian.

The Ordovician rocks of Britain were laid in a rapidly sinking volcanic geosyncline that passed from southern Ireland and western Cornwall through central Wales and the Lake district of northwest England into southern Scotland. Islands on the northwest furnished the principal detritus, for the Arenigian laps over Cambrian and Pre-Cambrian in Anglesey, northwest Wales; and more than 2,000 ft. of doubtful Llandeilian and Caradocian in the Girvan district, southwest Scotland, overlaps Arenigian and has coarse sediment, whereas equivalent rocks near the English border to the east are the black shales (Glenkiln and Hartfell) with "condensed section" from the lower Caradocian through the Ashgillian totaling less than zoo ft. There are hundreds of feet of Arenigian lavas and volcanic fragmental rocks in the Girvan district. The principal flows in the Lake district, the Borrowdale volcanics, thousands of feet of andesite and rhyolite, are Llanvirnian or Llandeilian. The typical Ordovician of North Wales has similar thickness in rocks ranging from Arenigian to Caradocian; the latter, the Snowdon volcanics, resistant to erosion. form the scenic highest elevations such as Mt. Snowdon. Volcanism continued locally to the end of the Ordovician, there being volcanic tuffs and flows of felsite in the Ashgillian of southwest Scotland.

Ordovician System

British classifications	Southwest Scotland: Girvan	Southwest Scotland: Moffat	Northwest England: Lake district	North west Wales	West England: Shropshire	Norway: Oslo district	Sweden: Västergötland and Öland	Sweden: Skåne	Estonia	Czechoslovakia: Bohemia
ASHGILLIAN	Ardmillian: Drummock shale; Shalloch shale	Hartfell slate	Ashgill shale; Keisley limestone	Conway Castle sandstone; Deganwy shale; Bodeidda shale	absent	Tretaspis limestones and shales	Dalmanitina beds; Staurocephalus shale; Tretaspis beds; Slandrom limestone	Dicellograptus shale	Harju series: Porkuni st.; Lyckholm: Pirgu st., Vormsi st., Saunja st.; Rakvere stage, Vasalemma	Zdice: Kosov quartzite; Kraluv dvůr shale, sandstone
CARADOCIAN	Ardmillian: Whitehouse shale, limestone; Ardwell shale, sandstone. Barr: Balclatchie sandstone, limestone; Benan conglomerate	Hartfell slate; Glenkiln slate	Sleddale: Applethwaite beds; Stockdale lavas; Stile End beds. Roman Fell beds	Cadnant shales; Snowdon lavas; Gwastadnant sandstone; Conway lavas; Glanrafon slates, lavas	Chirbury: Whittery shale, volcanics; Hagley shale, volcanics; Aldress shale; Spy Wood sandstones	Chasmops series: Chasmops limestone and shale; Ampyx limestone	Chasmops limestone: Macrourus limestone; Ludibundus limestone	Dicellograptus shale	Viru series: Keila stage; Jõhvi stage; Idavere stage; Kukruse stage	Bohdalec shale. Záhořany: L[illegible] shale; Kr[illegible] shale
LLANDEILIAN	Barr: Stinchar limestone; Kirkland conglomerate	Glenkiln slate	Roman Fell beds; Borrowdale volcanics	Glanrafon slates, lavas; Maesgwm slates, lavas	Middleton: Rorrington shale; Meadowtown beds; Betton shale; Weston shale, sandstone	Ogygiocaris series: Ogygiocaris shale	Orthoceras limestone: Crassicauda limestone; Schroeteri limestone; Platyurus limestone	Dicellograptus shale	Viru series: Uhaku stage; Lasnamäe stage	Drabov quartzite
LLANVIRNIAN	probably absent	Uncertain	Borrowdale volcanics; Skiddaw slates	Maesgwm slates, lavas	Shelve: Stapeley ash; Hope shale	Ogygiocaris series: Upper Didymograptus shale	Orthoceras limestone: Vaginatum limestone	Didymograptus shale	Aseri stage; Kunda stage	Osek Kvaň: Sv. Dubrotiva shale, lavas; Sarka shale and lavas
ARENIGIAN	chert, slate; Ballantrae volcanics	Uncertain	Skiddaw slates	volcanics and slates; Garth sandstones; Rhobell Fawr volcanics	Shelve: Mytton beds; Stiperstones quartzite	Asaphus series: Orthoceras limestone; Lower Didymograptus shale	Orthoceras limestone: Lepidurus limestone; "Limbata" limestone. Tetragraptus shale: Billingen; Hunneberg	Didymograptus shale	'Megalaspis limestone	Komarov shale, lavas
TREMADOCIAN	unknown	Uncertain	uncertain	slates	Shineton shales	Ceratopyge: Ceratopyge limestone; Dictyonema shale	Ceratopyge limestone, shale; Obolus conglomerate	Dictyonema shale	Iru formation; Pakerort shale and sandstone	Krušná Hora: Olesna shale; Milina shale, sandstone; Třenice cgl
Approximate thickness	*a mile*	*a few hundred feet*	*a few miles*	*a few miles*	*two miles*	*1,000 ft.*	*a few hundred feet*		*1,000 ft*	*a mile*

North American classifications	Central Newfoundland	Vermont-New York: Taconic Mts.	Vermont-New York: Lake Champlain-Hudson river	New York-Ontario: Eastern Lake Ontario	Pennsylvania-Virginia: Appalachian valley	Pennsylvania-Virginia: Appalachian mountains	Mississippi valley	Mississippi valley	Oklahoma: Arbuckle mountains	Oklahoma: Ouachita Mts.	Manitoba: Lake Winnipeg	Nevada: eastern	Nevada: central	Australia: South Victoria	British classifications
CINCINNATIAN	*Present*	*absent*	*absent* Frankfort shale	Queenston red shale Oneida sandstone Lorraine: Pulaski shale, sandstone Whetstone Gulf shale	*absent*	Juniata red sandstone Oneida ss. Reedsville shale	*(Ohio)* Richmond shale Maysville shale Eden shale	*(Iowa)* Maquoketa shale *possibly absent*	Sylvan shale *absent*	Polk Creek shale *absent*	Stony Mountain limestone *absent*	Ely Spr. limestone	graptolite-bearing slates, cherts, graywackes, quartzites, conglomerates and lavas	Bolindian slate, sandstone and volcanics	ASHGILLIAN
MOHAWKIAN: TRENTONIAN	*Possibly absent*	Normanskill shale, sandstone	Utica shale Canajoharie shale Glens Falls limestone	Trenton: Holland Patent shale Cobourg limestone Denmark limestone Shoreham limestone Kirkfield ls. Rockland ls.	Martinsburg shale, sandstone Oranda limestone Mercersburg limestone	Antes shale Coburn limestone Salona limestone Nealmont limestone	Galena ls. Kimmswick ls.	*(Iowa)* Dubuque dolomite, limestone Stewartville dolomite, limestone Prosser limestone Decorah shale, limestone	Viola limestone Simpson: Bromide limestone, shale	Big Fork chert	Red River limestone *(possibly younger)* Winnipeg sandstone	Eureka quartzite Copenhagen shale		Eastonian slate	CARADOCIAN
MOHAWKIAN: BLACKRIVERAN	Bay of Exploits slates, sandstones, conglomerates, lavas		Isle la Motte ls. *principally absent*	Black River: Chaumont limestone Lowville limestone Pamelia limestone	*absent* Shippensburg limest. Edinburg limestone	BOLARIAN: Benner limestone Benbolt limestone Peery limestone Ward Cove limestone	*(Missouri)* Plattin limestone Joachim limestone Dutchtown limestone	*(Minnesota)* Platteville limestone Glenwood shale, sandstone *absent*	Tulip Creek limestone McLish limestone, sandstone	Womble shale, sandstone	*absent*			Gisbornian slate	
CHAZYAN		Deepkill shale	Valcour limestone Crown Point limestone Day Point limestone, sandstone	*absent*	Lincolnshire limestone New Market limestone Whistle Creek limestone	Five Oaks limestone Elway limestone Blackford dolomite	St. Peter sandstone		Oil Creek limestone, sandstone Joins ls.			sandstone		Darriwilian slate	LLANDEILIAN LLANVIRNIAN
CANADIAN or BEEKMANTOWNIAN	slates, cherts, lavas	Schaghticoke shale	Beekmantown dolomite: Bridport dolomite Bascom limestone Cutting dolomite Shelburne limestone		Bellefonte dolomite Axeman limestone Nittany dolomite Stonehenge and Chepultepec limestone and dolomite		Black Rock Smithville ls. Powell dol. Cotter dol. Theodosia dol. Rich Fountain dol., ss. Roubidoux dol., ss. Gasconade dol. Van Buren ss., dol.	*absent* Shakopee dol. New Richmond ss. *absent* Oneota dol. Prairie du Chien dol.	Arbuckle limestone: West Spring creek Kindblade Cool creek Strange McKenzie hill	Blakeley shale, ss. Mazarn shale		Pogonip limestone		Yapeenian slate Castlemainian slate Bendigonian slate Lancefieldian slate	ARENIGIAN TREMADOCIAN
Approximate thickness	*five miles*	*a mile*	*more than a mile*	*a half mile*	*more than a mile*		*a half mile*	*1,000 ft.*	*more than a mile*	*a mile*	*a few hundred feet*	*a mile*	*a few miles*	*a few miles*	

The rocks thin as they enter England, and in southern Shropshire, Caradocian lies locally on pre-Ordovician. These sediments are principally shallow-water types with shelly faunas, deposited on the margin of the gently sinking platform of the midlands and southeastward.

England was along the southeastern border of a great volcanic belt that extended from Wales through the Caledonides (*i.e.*, mountains having structures formed during the Caledonian disturbance) of the Highlands of Scotland and the northwest coast of Norway, where areas such as Trondheim have thick sections of sediments and lavas. Northwest of this geosyncline, limestones at Durness in the north of Scotland and the island of Smolen in coastal Norway are so dissimilar in lithology and faunas to those in the geosynclinal belt to the southeast that they are more readily compared with those in North America; Bear Island and Spitsbergen also have limestone sections. The Ordovician of the geosynclinal belt was severely deformed and thrust-faulted northwestward in Scotland and southeastward in Norway in the Caledonian revolution after the Silurian period; there are some areas having granites intruded within the Ordovician period.

Southeast of this geosyncline was a large area of relatively greater stability and thinner sections, the early Paleozoic craton of Europe. occupying much of the region from the Caledonides and the Barents sea to the Urals and southward toward the Alps. The rocks have become exposed in scattered areas in southern Norway and Sweden, Bornholm, south of the Gulf of Finland, from Oland through Estonia to Lake Ladoga, and in south central Poland. The Tremadocian lies on a slightly eroded surface of Cambrian, commonly with glauconite-bearing beds at the base. Succeeding Ordovician rocks are rather constant in thickness and lithology over considerable areas and are principally limestones with abundant shell facies faunas, Estonia having particularly fine representation. The older series pass into graptolitic shales in Skane, south Sweden, and in the Oslo district. Norway, so that the temporal relations of facies and the correlations with Wales are generally known. The Silurian lies on varying Ashgillian horizons in Scandinavia and on Caradocian in Poland. Throughout the region there were no highlands, nor did uplifts in the adjoining geosynclinal belts contribute significant thicknesses of coarse detritus to the craton.

The Baltic belt of outcrop is rather isolated by the thick younger sediments of the Low Countries and the German and Polish plains from areas of exposure extending from western France through eastern Belgium, Bavaria and Thuringia to Bohemia. Inasmuch as wells have not penetrated the system in this great region, the character can only be induced. In Bohemia is the classic section of nearly a mile of Ordovician studied by Joachim Barrande. The older Tremadocian to Llanvirnian, mostly of graptolitic shales like those in the region along the margin of the Welsh geosyncline, has basic lavas and volcanics above the Tremadocian; coarsening graywackes and sandstones of the Caradocian and Ashgillian seem to have come from rising lands to the south. Similar sections are in southern Thuringia and Bavaria and westward through the Ardennes of Belgium into Normandy, where the Arenigian is the widely distributed Armorican sandstone lapping over pre-Ordovician rocks. To the east, Ordovician calcareous and argillaceous rocks are present sparingly in the southern Urals; the eastern Urals have younger slates, cherts and volcanic sequences thrust westward, and similar rocks may have filled a geosyncline in the Ordovician. Thus the north European craton of the early Paleozoic was margined on the northwest, south and east by more rapidly subsiding geosynclines that were filled predominantly by argillites and graywackes derived from more distant lands or islands, and by volcanic rocks of varying kinds, ages and thicknesses.

The Ordovician of southern Europe is exposed widely only in the Iberian peninsula, which in northwestern Spain and northern Portugal-has overlapping Arenigian sandstone like the Armorican of France under graptolite-bearing shales and graywackes. Elsewhere north of the Mediterranean. outcrops have been so displaced by later structures that a comprehensive portrayal is not possible. Diminishing areas of land are considered to have extended in a belt from Brittany to western Bohemia; but Ordovician is present within the region. and the outline and distribution of the islands is not established. Similarly, the Iberian peninsula had land areas between a geosynclinal belt trending from the Pyrenees to the southern Alps and one through the western Mediterranean region. Shales and sandstones are prevalent in all these sequences.

North America. — The central part of North America in the Ordovician was a great shield or craton. Low-lying land of Pre-Cambrian crystalline rocks persisted in the northern half until late in the period; earlier sediments, principally carbonates with some quartz sandstones, thinned irregularly northward in the southern half. Belts of thicker carbonates (miogeosynclines) surrounded this relatively stable shield, the broadest belt being on the west. The peripheral parts of the present continent had deeply sinking geosynclines of dominantly argillaceous rocks. with interbedded lava flows and other volcanic rocks and thick graywackes and conglomerates that must have come from associated islands; these are the eugeosynclinal belts. These general relations were disturbed in the east in the middle of the period as uplifts in the peripheral areas were eroded, spreading detritus progressively over earlier carbonates, first in the miogeosynclinal belt, subsequently until they extended far into the craton, forming an exogeosyncline. Finally, the Taconian revolution severely folded and thrust-faulted the eastern geosynclines and thrust them toward the craton. The tradition has been that the early Paleozoic North American shield had persisting geosynclines along its borders — Appalachian on the east, Ouachitan, Cordilleran and Franklinian on south. west and north — with great crystalline borderlands, Appalachia, Llanoria, Cascadia and Pearya, respectively, beyond. The marginal geosynclines were of changing form, position and character, however, and the areas of the "borderlands" are known to have very thick sections of metamorphosed Paleozoic sediments; sediments that have been attributed to the borderlands seem to have come initially from within the continent and subsequently also from lands raised in the geosynclinal belts.

The Ordovician, the most widely distributed system in North America, is divided into three, four or five series by different authors; a classification of the series and stages in the typical development is as follows:

Series	Stages
Cincinnatian:	Richmondian Maysvillian Edenian
Trentonian:	Collingwoodian Cobourgian Denmarkian Shorehamian Kirkfieldian Rocklandian
Blackriveran:	Chaumontian Lowvillian Pamelian
Chazyan:	Valcourian Crownian Dayan
Canadian:	Cassinian Jeffersonian Demingian Gasconadian

The term Mohawkian is frequently applied to the Blackriveran and Trentonian together; Champlainian has been applied to the whole system. and to the three middle series of the table. The Canadian formations of the Ozark mountains of Missouri and Arkansas are most frequently used as a basis for time-correlation. The Canadian is commonly considered to be the Lower Ordovician, and the Cincinnatian, the Upper; the intervening beds are commonly called Middle Ordovician, though the Chazyan has also been classed as Lower.

The classification is based principally on shell-facies faunas, but argillitic facies are well known and their relative positions established. The Canadian has Tremadocian to early Llanvirnian faunas from the zone of *Dictyonema flabelliforme* (Shaghticoke) to that of *Didymograptus bifidus* (upper Levis-Deepkill), though the latter may be somewhat older than the European *bifidus* zone. The Chazyan seems essentially Llanvirnian and Llandelian, for the basal Caradocian *Nemagraptus gracilis* zone (lower Normanskill) is about upper Chazyan or basal Blackriveran. Cincinnatian faunas resemble Ashgillian, though precise correlations have not been established, and the Upper Ashgillian may be included in rocks classified as Lower Silurian.

The Canadian is of two principal lithologies—carbonates in the southern part of the craton and in geosynclines along its margins, and, in areas bordering the present continent, argillites and coarser sediments gained from adjoining islands, as well as volcanic rocks on the Atlantic and Pacific coast. The limestones and dolomites are in a narrow belt east of the craton from western Newfoundland to Alabama, a great area in the southern half of the craton where they thin northward, in a broad belt along the west from eastern Yukon and British Columbia through eastern Idaho, western Utah and eastern Nevada, southeastern California and western Sonora, and north as in northwestern Greenland. Sections along Lake Champlain in New York, Vermont and Quebec, and in the Ozark mountains of Missouri and Arkansas, are representative of this facies and have many genera of cephalopods, gastropods, brachiopods and trilobites. The graptolite sequence in the argillitic shales is known from many regions all around the continent, as scattered as central Newfoundland, eastern New York, Oklahoma, Nevada, southeastern Alaska and northern Greenland. Large boulders of carbonate facies of Cambrian and Canadian are found in the graptolite-bearing argillites south of the St. Lawrence river below the city of Quebec, and similar "exotic boulder" conglomerates are known in younger Ordovician strata in western Newfoundland. Some of the blocks being tens of feet long, their transportation has been attributed to submarine slumping in muds of rocks raised and dislodged, possibly by faulting, from the carbonate facies to the northwest. In central Nevada, Canadian and younger graptolitic slates and lavas have been thrust more than 50 mi. on a section of folded sediments including contrasting Canadian carbonates; similar thrusts are known or suggested in many regions where the two facies are in proximity, making the determination of their original relations obscure.

The Middle Ordovician Chazyan and Mohawkian series are typically exposed on the east and west sides of the Adirondack mountains, northeastern New York. The former is limited in distribution or recognition on the continent. A remarkably pure wind-transported, water-laid quartz sand formed the St. Peter sandstone in a sinking embayment from central Michigan through Illinois toward the lower Mississippi river, probably in the Chazyan. The first phase of orogeny in the east was about the end of the epoch. Rising land in the Carolina region produced sands and clays that accumulated to a few thousand feet in a geosyncline in southwestern Virginia and eastern Tennessee; the argillites (Athens) having *Nemagraptus* grade into carbonates that thin rapidly westward. The succeeding Black River limestones are principally within the craton. Uplift east of New York in medial Trentonian produced graywackes (Upper Normanskill-Schenectady) grading westward into black shales (Canajoharie and Utica) that thin rapidly along a northeast-trending axis passing through the present Adirondack mountains into shallow-laid limestones farther northwest. This narrow zone of gradation is recognized from Quebec to Virginia. Mohawkian carbonates of the interior are generally less than 1,000 ft.. thinning irregularly northward so that Trentonian in central Canada lies directly on Pre-Cambrian, blanketing nearly all of the crystalline rocks so extensively exposed from the beginning of the Paleozoic.

The Cincinnatian series has typical development in calcareous and argillaceous shales in Ohio, Indiana and Kentucky; the Edenian and Maysvillian are found only in the eastern states and southeastern Canada. The earlier Cincinnatian is detrital graywacke and shale (Lorraine) laid in a geosyncline, curved like a bow toward and extending into the continental interior, an exogeosyncline. The late Cincinnatian (Richmondian) seas retreated before the advancing deltas of fluviatile sands and gravels (Juniata) and red silts and clays (Queenston) from rising lands to the east. In the rest of the continental interior Richmondian carbonates and shales formed in the most widespread sea in North American history, unless it be that of the latest Trentonian. The Cincinnatian on Anticosti Island in the Gulf of St. Lawrence, has a relatively continuous succession of latest Ordovician (Gamachian) and earliest Silurian fossiliferous shales and limestones. The Taconian revolution at the close of the period folded rocks from eastern Pennsylvania to Newfoundland and may have involved thrust faults of great displacement that brought the argillaceous facies upon the carbonate facies in the east.

Australia and New Zealand.—The Ordovician is well developed in a belt, the Tasman geosyncline, extending from eastern Queensland through New South Wales and Victoria into Tasmania, and a branch spreading to the northwest into western Queensland and Western Australia, where the rock lies nearly flat in carbonate and sandy shallow-water trilobite-bearing facies up to 4,000 ft. thick. Over 12,000 feet of slate and graywacke in Victoria form one of the finest sequences of graptolite-bearing shales in the world; the order of appearances of the genera is quite like that in Britain and America, and most of the forms are found in all continents. Andesitic and rhyolitic lavas and pyroclastics are interbedded in the argillaceous rocks in a number of places, as in eastern New South Wales, southern Victoria and Tasmania; the Upper Ordovician has phosphatic beds and cherts. Intrusions of granite invaded the geosynclinal sediments during the Benambean orogeny near the close of the period. In New Zealand, graptolitic argillites are present in the Alps of the South Island.

Other Continents.—Ordovician sediments are widely distributed in Asia and have been studied considerably, particularly in China and Manchuria, where the preponderant sediments are limestones. Argillites with graptolites are known in several areas, and are associated with volcanics in a belt in western Yunnan, along the Burma frontier. The Ordovician of South America is best known in a rather continuous belt along the west of the Brazilian shield from the Mendoza region, northwestern Argentina, through Bolivia and Peru to Cordillera Oriental of eastern Colombia and southern Venezuela; there are argillites, and limy beds having faunas more similar to those of the Ordovician of Britain and Sweden than those in North America. Ordovician rocks are of limited distribution in Africa and are found principally in the north; in Morocco and northwestern Algiers are thick argillitic sequences. *See* GEOLOGY: *Bibliography.* (*M.* KY.)

ORDU (anc. *Cotyora*, where the "Ten Thousand" embarked for home), the chief town of a Turkish vilayet, on the north coast of Asia Minor, connected with Zara, and so with Sivas, by road. and with Istanbul and Trebizond by steamer. Filberts are exported. Pop. of vilayet (1955) 409,891; town 14,962.

ORDYN-NASHCHOKIN (or ORDIN-), **AFANASY LAVRENTIEVICH** (d. 1680), Russian statesman under the tsar Alexis, was closely associated with the policy of westernizing Muscovite administration and economy while safeguarding the traditions of Muscovite life. The establishment of a postal service between Muscovy, Courland and Poland and the building of Russian merchant ships on the Western Dvina and the Volga were due to him. He negotiated the treaty of Andrusovo with Poland (1667) and hoped to secure for Russia an outlet to the Baltic by wresting Livonia from Sweden. But the tsar's growing opposition caused Ordyn-Nashchokin to retire to a monastery near his native Pskov, where he took vows (1672). His relatively humble origin, his knowledge of European affairs and his diplomatic integrity distinguished him from most of his colleagues; and his policy anticipated that of Peter the Great.

See E. Likhach, article in *Russky Biografichesky Slovar,* vol. xii (1905); V. O. Klyuchevsky, *A History of Russia,* trans. by C. J. Hogarth, vol iii (1913).

ÖREBRO, a town of Sweden, capital of the district (*län*) of Örebro, lying on both banks of the Svartå a mile above its entrance into Lake Hjelmar, 135 mi. W. of Stockholm by rail. Pop. (1955) 66.839. Orebro was in existence in the 11th century. Its castle was erected by Birger Jarl in the 13th century, and 20 diets or important assemblies were held either in the castle or in the town. Such were the Örebro *concilium* of 1537, the diet of 1540 in which the crown was declared hereditary, and that of 1810 when Bernadotte was elected crown prince. In great part rebuilt since a fire in 1854, Örebro has a modern appearance. An ancient castle, however, with four round towers, still remains, and is used as a museum. There may be mentioned also the church of St. Nicholas, of the 13th century; and the King's House (*Kungsstuga*), an old and picturesque timber building. The patriot Engelbrecht (d. 1436) was born there. The Swedish reformers of the 16th century, Olaus and Laurentius Petri, are commemorated by an obelisk. Örebro is the centre of the Swedish shoe industry; trade is carried on, by way of the Örebro canal and lakes Hjelmar and Malar, with Stockholm.

ORE DEPOSITS. Minerals are naturally occurring substances of fairly constant chemical composition and physical properties. They make up ore deposits and rocks. In ore deposits, the minerals that give value to the deposit are the ore minerals, and the valueless minerals are the gangue minerals; the rock in which the ore is found is the country rock. The ore and gangue minerals are mined together—*i.e.*, taken out of the country rock in a mass—manually or mechanically. Thereafter the ore must generally be milled, the ore mineral being separated from the gangue mineral, usually mechanically. Next, the desired metal is extracted from the ore mineral by a chemical or metallurgical process; commonly this is a smelting operation. After this, the metal may be still further purified or alloyed with other metals, as in a copper refinery or a steel mill. Exploration, mining, milling and refining are thus successive steps in the utilization of an ore deposit to yield a metal.

By general agreement, ore deposits should contain metal-yielding minerals, should be of natural origin and should be economically workable. In a given instance, however, any of the three conditions included in this definition may be violated, provided the other two still hold. Thus, "ore deposits" is commonly applied to certain occurrences worked primarily for their nonmetallic elements, like the deposits of pyrite (FeS_2) mined in many industrialized countries as sources of sulphur gases and sulphuric acid. The accumulated waste, once useless, remaining after milling some ores may subsequently become a source of metals that can be extracted with profit; hence, it is at times, though rarely, called an ore deposit. Finally, the disseminated, lean deposits of copper minerals in granitelike rocks, occurring notably in parts of the western U.S., northwestern Mexico and Chile, were called ore deposits even before technologic progress made it possible to work them to economic advantage.

To be economically recovered the metals must be present as elements or compounds in concentrations far higher than normal in limited volumes in the earth's crust. The degree of concentration is shown by Table I, compiled from data by J. F. Kemp and F. H. Hatch; this contrasts the amount of a given metal necessary for profitable mining with the percentage of the metal in the rocks composing the earth's crust, as determined by F. W. Clarke (1924).

Table I.—Metal Concentrations

Element	Average percentage in earth's crust	Approximate percentage needed for profitable working
Aluminum	8.06	30
Iron	5.06	35-60
Manganese	.091	25-45
Chromium	.036	15-30
Nickel	.019	1.5-5
Vanadium	.016	3-8
Copper	.010	0.7-10.0
Zinc	.004	3-8
Lead	.002	2-4

For gold and silver the ratios of natural concentration to make a workable deposit in ordinary rocks are much more than those of the base metals. The figures in the third column require material qualification if by-products are obtainable, as is commonly the case.

As almost every rock contains at least a small quantity of almost every ion, the detection of desired metals is limited virtually by the sensitivity of the analytical method available. extending even to the small quantities of copper, lead and manganese in plant ashes. The widespread occurrence, but rare concentration, of the metalliferous minerals has affected the theories for the genesis of ore deposits and the methods of searching for them.

Classification and Genesis.—Before the 20th century, a favourite classification for ore deposits stressed their composition—iron deposits, gold deposits and so on. This method lacked any genetic significance, for iron-ore deposits can originate in several different ways. Furthermore, it ignored the fact that many ore deposits have two or more metals in abundance; the tin veins'of Cornwall in Britain also yielded copper, the zinc deposits of Silesia carried noteworthy quantities of lead, and Cerro de Pasco in Peru had become by the middle of the 20th century an important source of zinc, though previously known for its copper production. In fact, the practical miner finds it necessary to apply such terms as "argentiferous lead deposits" to mixed ores like the silver-lead deposits in Murcia in southern Spain, or "dry gold ores" to the gold-quartz ores free from base metals.

A second basis for classification, as illustrated by the comprehensive system of Bernhard von Cotta (1808–79) and others, stressed the geometrical form of the ore body. Thus, Albrecht von Groddeck, a follower of Cotta, in 1879 distinguished bedded deposits, massive deposits and clastic deposits (including placers). Classification by form serves well in the search for an extension of a known ore body or for other similar bodies in localities where deposits have been found previously. Understandably, the application of this classification led almost insensibly to a genetic grouping through the schemes presented in 1881 by A. W. Stelzner, in 1903 by Kemp and in 1909 by Richard Beck.

The most scientific mode of classification is genetic. It may be attributed to the great controversy between the "Neptunist" A. G. Werner (1750–1817) on the one hand and the "Plutonists" James Hutton (1726–97) and John Playfair (1748–1819) on the other. This controversy turned on whether most mineral deposits were to be regarded as laid down in the sea, as suggested by Werner, or as injections or fissure fillings essentially from melts or hot solutions, as the "Plutonists" maintained. Despite widely held views to the contrary, both concepts held much truth. Later scientific followers continued this discussion on more quantitative grounds, but the front shifted somewhat; F. von Sandberger (1826–98), Groddeck and others stressed the derivation of the ore ions (*e.g.*, zinc in deposits of the zinc sulphide mineral sphalerite) from the country rock and their deposition in openings of that rock, a concept usually called lateral secretion. The transportation in such a process has been variously assigned to cool surface waters, later laterally moving (as by C. E. Siebenthal for the zinc and lead ores of the Tristate, Missouri-Oklahoma-Kansas district, U.S.) or to waters of the same origin which, though originally cool, had been heated by contact with hot rocks at depth and had subsequently risen, depositing their dissolved matter as they rose and cooled. as urged by C. R. Van Hise. Since it was at first believed that all waters, even the hot ones, were merely reheated surface waters and were, in fact, notably lacking near volcanoes, where molten rock comes to the surface and can be observed, it was generally contended that few or no solutions could have come up from deep inside the earth, carrying valuable metallic or other ions. But between 1910 and 1920 came confirmation of the large quantities of water and other adequate solvents of metals (such as ions of chlorine and fluorine) in the gases given off by certain carefully observed volcanoes, notably those of Hawaii (A. L. Day and E. S. Shepherd, 1913) and Katmai, Alaska (C. N. Fenner, 1920; E. G. Zies, 1924). Thereupon the vieapoint had to be abridged that excluded completely the role of solutions and ions of deep origin, probably related to deeply buried molten lavas; *i.e.*, "magmatic." The volcanic data combined with physicochemical inferences strongly supported the "hydrothermal" school of economic geologists represented by Waldemar Lindgren, J. H. L. Vogt, W. H. Emmons, J. E. Spurr. Paul Niggli and Hans Schneiderhoehn. nho derived both ores and their transporting solutions in large part from magmatic sources.

By 1950, however, there was discernible a swing of the pendulum toaard a modified lateral secretion idea, advanced in England by the writings of H. H. Read (1939), in the U.S. by those of G. E.

Goodspeed (1952), in Australia by those of C. J. Sullivan (1948) and in France by those of R. Perrin and M. Roubault (1939), all of whom suggested or hypothesized that some of the granitic rocks of the earth's crust may be remelted or recrystallized sediments. These or their followers inferred that during granitization, ore minerals may be generated or transferred. Even Niggli thus explained some of the "alpine" mineral deposits. This concept sought to derive the metalliferous minerals for the most part from deeper crustal or subcrustal sources, rather than from local masses of molten rock, and to attribute mainly to heat gradients and ionic diffusion the movements of the metal ions essentially to their present sites. If this process is effective, the ionic radii of the metallic elements concerned may well be a modifying factor.

Certain ore deposits were regarded by Vogt, A. P. Coleman and others as magmatic segregations. The minerals composing these were attributed to separation from the molten rock as a result of partial or complete immiscibility with the other rock constituents. Such ore minerals are generally sulphides or oxides of base metals (such as iron, chromium, copper and nickel) but they include native (elemental) metals of the platinum group and possibly also metallic iron. Many of the great nickel deposits (*e.g.*, Sudbury in Ontario, Petsamo in Finland), most of the known chromite deposits (Selukwe in Southern Rhodesia, the Stillwater deposits in Montana), probably many of the iron deposits made up of the mineral magnetite (Fe_3O_4) whether with or without titanium (as at Kiruna in Sweden, at Tahawus in New York and elsewhere) are generally regarded as of this origin. The original concentration of the platinum in the rocks of the Ural mountains of the U.S.S.R. is best explained in this manner. For some deposits of this general type the origin appears to be a separation in place of the ore from the gangue minerals, such as the feldspars (*q.v.*), quartz (*q.v.*), olivine (*q.v.*), the micas biotite (*q.v.*) and muscovite (*q.v.*) or the amphiboles (*q.v.*) or pyroxenes (*q.v.*)—the major constituents of the once molten (igneous) rocks that contain the ores. For others (*e.g.*, Kiruna) studies at mid-20th century seemed to show that a melt, unusually rich in ore minerals, was separated at depth and subsequently emplaced as a melt, injected into the containing rock after the latter had itself undergone injection and solidification.

Some ore deposits are closely related to intrusions of apparently molten rocks in the sense that they occur in or near such rocks, as a more or less continuous halo around the now solid mass. Such a melt has lost some of its more volatile constituents in the crystallization process (a theory developed by Niggli, Fenner and others), and the volatile matter moved into the adjacent, unmolten rock, usually a limestone or at least generally a rock carrying appreciable quantities of carbonates such as dolomite (*q.v.*) or calcite (*q.v.*). The volatiles reacted with the rock surrounding the igneous intrusion, giving a halo, made of "skarn" or tactite in which the ore minerals may be concentrated. Once interpreted as the effect of mere recrystallization of the materials present in the surrounding limestone or other sediment (W. L. Uglow, 1913) but later recognized as the result of a reaction between intruding and intruded rock, such deposits have been called "contact metamorphic deposits" (the pyrometasomatic deposits of Lindgren). The importance of the process in ore deposition was still being debated at mid-20th century (Harrison Schmitt, 1948).

None of the concepts outlined above is contrary to the nonmagmatic origin of certain clearly sedimentary ore deposits, such as the iron ores of eastern Britain, those of Belgium, Lorraine and eastern France (minette ores), those of the Clinton type in the eastern U.S., and of the Wabana district in Newfoundland. The widespread banded iron ores existing in the older (Pre-Cambrian) rocks of the Crimean region (Krivoi Rog) in the U.S.S.R., and other similar ores of India, the Lake Superior region in North America, the Labrador and Ungava regions in Canada and the Pre-Cambrian terrains of Venezuela and Brazil are likewise clearly sedimentary, as are the great bedded manganese deposits of Nikopol and Chiatouri in the Ukraine and Georgia, U.S.S.R. Sedimentary ores are formed by decay of surface rocks, which contribute the necessary ions to the lakes or the sea, where they may be precipitated by evaporation, chemically or biochemically (by action of bacteria, algae or the like). Evaporation has contributed important salt and potash beds in various regions but seems to have had little part in the formation of ore deposits. Streambed or marine deposition may also take place mechanically, yielding placer deposits if the minerals concerned are sufficiently resistant to the chemical attack of the atmosphere and to impact when carried as particles by streams. Placers of world importance are the titanium-bearing beach sands of Travancore, India; the gold-bearing stream gravels of the Sierra Nevada and Western Australia; the platinum gravels near Sverdlovsk on the eastern slope of the Ural mountains and those of Colombia; and possibly the gold-bearing conglomerate beds of the Witwatersrand, Union of South Africa.

Despite much discussion as to the derivation of the metallic ions in ore deposits (whether from country rock or magma) and their mode of transfer (whether in solution or by diffusion), the general grouping of the resulting deposits is fairly clearly defined and agreed upon, as a result of collective efforts through more than a century by many mineralogists, petrologists and economic geologists. The classes now generally recognized were perhaps best defined by Lindgren (1913), who separated all ore deposits into magmatic segregates, contact metamorphic deposits, pegmatite veins and veinlike deposits of differing degrees of intensity in temperature and pressure (hypothermal, mesothermal, epithermal) and sedimentary deposits. For completeness these classes were modified, in part by subdivisions, and additional kinds of origin were recognized. Lindgren and those previously listed as sharing his views, as well as many later investigators, regarded the magma as containing the metallic ions of the ore minerals while deep down in the crust; the mass, while crystallizing there, loses its volatile constituents; these pass off, chiefly upward, depositing the ore minerals in pre-existing openings, or "fluxing" their way upward by dissolving the superincumbent rocks and finding room for ore deposition by a replacement or metasomatic process. Highly concentrated solutions of volatiles, localized in the igneous rocks from which they separated, give, according to this school, the pegmatite veins or dikes that are of much importance as sources of nonmetallic minerals (mica, gems, etc.) and at times of elements useful in the metal industry (*e.g.*, beryllium).

A fundamental basis for the classification given above is the temperature of formation of the ores. By observing the behaviour of the inclusions in the ore minerals as the temperature is raised (W. H. Newhouse, 1933); by recording the temperatures at which certain minerals in the ore deposits break down when heated (the "decrepitation temperature," F. G. Smith, 1947); by a comparison of textures suggesting the unmixing of solutions at known temperatures; and by means of basic data on inversion temperatures of the minerals present, attempts have been made to set exact limits governing the origin of these deposits. Such evidence, though useful, is admittedly still inconclusive and, like the theories for the genesis of individual deposits, is constantly undergoing revision.

A very striking feature of the primary mineralization of ores is the fact that the contents of a given ore deposit may change upward or laterally. In the tin deposition of southwestern Britain (Cornwall) an ore body which at depth yields chiefly tin-ore minerals, may pass upward into a predominantly cupriferous ore, and at the surface become essentially a zinc or lead deposit (W. R. Jones, 1925). The central, copper-rich part of the Butte, Mont., mining district passes laterally into silver-bearing zinc ores and these give way to silver-bearing manganese veins and even into galena-bearing ore bodies (W. H. Weed, 1897; R. H. Sales, 1908). In fact, L. de Launay (1900), Spurr (1907) and W. H. Emmons (1924) developed in detail the sequence of mineralization from deep to shallow deposits which can be traced through the following ions: tin, tungsten, arsenic, copper, zinc, silver, lead, antimony, mercury; the position of iron and gold, among the common metallic ions, is varied and anomalous. A somewhat similar effect, extending also to certain gangue minerals, is noted with contact metamorphic deposits (V. M. Goldschmidt, 1911; Spurr, Fenner, G. H. Garrey, 1908, 1912). Such compositional changes are called zoning.

Secondary Changes in Primary Ores.—The processes described above yield the ore minerals as freshly deposited (primary), before being acted upon by atmosphere or cold surface waters, circulating downward. Examples of the more common primary ore minerals are given below:

Iron		Copper		Silver	
Fe_3O_4	magnetite	Cu	native copper	Ag	native silver
Fe_2O_3	haematite	$CuFeS_2$	chalcopyrite	Ag_2S	argentite
$Fe_2O_3.nH_2O$	limonite	Cu_5FeS_4	bornite	Ag_9SbS_6	polybasite
$FeCO_3$	siderite	Cu_2S	chalcocite	Ag_3AsS_3	proustite
FeS_2	pyrite	$Cu_8Sb_2S_7$	tetrahedrite	Ag_2Te	hessite
iron silicates		Cu_3AsS_4	enargite		
Aluminum		Zinc		Gold	
aluminum silicates		ZnS	sphalerite	Au, Ag	electrum
alkali alum silicates				Au	native gold
				$AuAgTe_4$	sylvanite
		Lead		Au_2Te	petzite
Tin		PbS	galena		
SnO_2	cassiterite	Nickel		Mercury	
Cu_2FeSnS_4	stannite	$FeNiS_2$	pentlandite	HgS	cinnabar

Most common primary ore minerals are sulphides or oxides; some are, tellurides, native metals, carbonates, silicates or sulpho salts (double salts of the metal sulphides and sulphides of arsenic or antimony). Some of the minerals carry only one metal (*e.g.*, pyrite, FeS_2); others carry two or more metals (*e.g.*, stannite, Cu_2FeSnS_4).

After such primary ores are formed, the surface is slowly lowered by processes of weathering and erosion. At and near the surface, these processes act upon the ore minerals as upon other rock materials; in fact, even at some depth these minerals are attacked by waters, which, moving downward from contact with the air, transport oxygen, carbon dioxide and other materials in solution. Under these conditions the oxides and native metals are generally stable. The other minerals, however, tend to be converted to relatively soluble compounds. This applies especially to the sulphides, which, for the most part, become highly soluble sulphates. Copper sulphides become soluble copper sulphate which generally travels farther down with the descending ground water. Below the level of saturation, however, the oxygen supply to this water is cut off, reducing conditions prevail (especially in the presence of more sulphides of the primary ore, together with the sulphuric acid in the water), and eventually the copper tends to precipitate out as sulphides, such as chalcocite and covellite (CuS). This is characteristic of the zone of secondary sulphide enrichment. As this precipitation is greatest where the descending copper-bearing solutions first come into the zone of reduction, the effects of such reprecipitation of copper taper off downward. If, however, the downward moving, acid waters, while still above the zone of saturation and reduction, encounter a reagent (*e.g.*, the calcium carbonate of a bed of limestone) that neutralizes the acid, a reaction takes place which throws down the copper (generally by replacement) as a copper carbonate, the calcium ions travelling on in sulphate solution; in siliceous rock, the copper may similarly be precipitated as a silicate; or, in the presence of a strong oxidizing agent, the copper may precipitate as copper oxides or native copper. These minerals characterize copper deposits in the near-surface zone of oxidation.

If gold or its compounds occur in the primary ore, the relatively unstable telluride compounds are broken down into metallic gold, and the insoluble gold is concentrated in the oxide zone except in the presence of manganese dioxide and chloride compounds, which together yield the strong solvent, Cl^-.

Iron sulphides on oxidation yield sulphuric acid and the unstable ferrous sulphate. The latter is oxidized to ferric sulphate which then hydrolizes to ferric hydroxide, and eventually a precipitate of limonite or a related mineral is formed. In general, zinc sulphide behaves like copper but primary sulphides are more soluble. Lead sulphide, however, oxidizes rather easily to the poorly soluble sulphate (cerussite). Silver minerals behave like copper minerals but may be stabilized in the zone of oxidation if there are halogens present. Manganese resembles iron in reactions.

A special kind of change in primary ores is summarily described as residual concentration. In this, the effect of solution (leaching) by surface waters in the zone of oxidation is to dissolve and remove the gangue minerals, and in cases to stabilize the desired metallic ions still further. Thus relatively small quantities of iron carbonate in a limestone (composed of $CaCO_3$) may be converted to limonite; meantime the limestone is dissolved, if the surface water is rich in atmospheric carbon dioxide, approximately thus:

$$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2.$$

If the iron content of the limestone was originally only 5%, the removal of all the limestone by solution would yield natural iron ore bearing about 48% iron. Such a process is facilitated by moisture, the presence of vegetation (yielding the solvents humic acids and carbon dioxide), a warm climate (to accelerate the reaction and to permit plant growth), good drainage (at least, periodically, as in a climate with dry and wet seasons alternating) and a topography high enough to promote drainage but not so high that most of the rainwater will run off instead of penetrating to do its important chemical work at the surface and just below it. Examples of such concentration are the secondary manganese ores of the Gold Coast; the bauxitic aluminum ores of the Guianas; the residual iron ores of Moa and Mayari, Cuba; and the gold ores of the southern Appalachians. Inimical to such a process is everything that strips the soil rapidly, such as glaciation or rapid erosion. As applied to the marked enrichment in gold, this process is called eluviation; when applied to iron, manganese and aluminum ores, it is lateritization and the resulting ore is called laterite.

A table, illustrative rather than complete, is included to show the changes in the composition of ore deposits after oxidation and secondary sulphide enrichment.

Table 11.— Depth Zone Below Surface

Metal	Zone of oxidation	Secondary enrichment zone	Primary ore
Iron . .	$Fe_2O_3.nH_2O$ (limonite) Fe_2O_3 (haematite)		$FeCO_3$ (siderite) FeS_2 (pyrite) Fe_3O_4 (magnetite) Fe_2O_3 (haematite) Iron silicates
Aluminum .	$Al_2O_3.H_2O$ (diaspore) $Al_2O_3.2H_2O$ (bauxite) $Al_2O_3.3H_2O$ (gibbsite)		Rock-forming minerals such as clay minerals, feldspars, etc.
Manganese .	MnO_2 (pyrolusite) $Mn_2O_3.nH_2O$ (psilomelane) etc.		$MnCO_3$ (rhodochrosite) Manganese silicates
Copper . .	Cu (native copper) Canner oxides Copper carbonates Copper silicates	Copper sulphides, especially Cu_2S (chalcocite), CuS (covellite)	$CuFeS_2$ (chalcopyrite) Cu_5FeS_4 (bornite) Copper sulpho salts
Zinc . .	$ZnCO_3$ (smithsonite) $ZnSiO_3.Zn(OH)_2$ (hemimorphite)	ZnS? (wurtzite?)	ZnS (sphalerite)
Lead . .	Residual galena $PbCO_3$ (cerussite) $PbSO_4$ (anglesite)		PbS (galena)
Silver . .	AgCl (cerargyrite) and other halides Ag (native silver)	Ag_2S (argentite)	Ag (native silver) Ag_2S (argentite) Silver sulpho salts Silver tellurides
Gold . .	Residual native gold		Ag, Au (electrum) Au (native gold) Gold tellurides

This sequence of alteration may greatly complicate the richness of the ore at changing depth. Many of the disseminated copper ores (*e.g.*, Bisbee, Ariz., and Chuquicamata, Chile) are of moderate richness at the surface, where the once-exposed primary ores have had some of their copper and other, valueless, components removed; at depth, however, in the zone of secondary sulphide enrichment, they become richer, the tenor (grade) rising to perhaps twice the figure for the surface zone. At still greater depths the ore values decline to perhaps half those of the oxidized zone and the metal content may decline from a useable ore to a protore, unprofitable today but perhaps workable in the future after natural enrichment takes place or cheaper working methods are developed or copper prices rise. Abrupt differences in the vertical level of these three zones may result horizontally from movement along fault planes or differences in surface conditions affecting ingress of surface waters, drainage or the like.

Forms, Structures and Textures of Ore Deposits.—In the past, ore deposits were also classified on the basis of form, or other large-scale features, collectively spoken of as structure, but it appeared later that this was not a feature fundamental to genesis and such classifications were abandoned. None the less, the form of a given ore body is of great practical importance in the search for ore extensions or for analogous bodies in near-by localities under similar geologic conditions. Thus, in the early half of the 20th century, stress came to be placed upon the geologic structures (faults and folds in the rocks or dikes [*q.v.*], sills [*q.v.*] and larger intrusions of igneous rocks) that might be the cause for localizing the ore or have exercised structural control on ore deposition. This school of investigators, among whom Canadians such as M. E. Wilson and E. L. Bruce, South Africans such as Ben Lightfoot and Americans such as B. S. Butler and G. M. Fowler merit mention as leaders, stressed the geologic structure rather than the mineralogy of the ore or the country rock—a natural outgrowth of the more intensive search for ore prevailing in a period oi very abrupt rise in consumption rate.

The simplest types of ores from the structural viewpoint are the bedded or stratiform ores. In the strictest sense these consist of ore minerals deposited like any other sediment. If not too greatly deformed they may exhibit intertonguing, channelling, fading out, gradation of grain, ripple marks, fossils and other features of sedimentary rocks. They may be intensely folded, as shown by the Pre-Cambrian iron ores, or suffer thrust or normal faulting, like the minette iron ores of western Europe or those of the Clinton belt in the U.S. Among special types of sediments are the placer deposits already mentioned. The forms and other features of placers particularly resemble those that go with coarser clastic sediments, such as cross bedding and channel deposits. Concentration of the desired mineral may be in the inside of the meanders, the slipoff slope of bars or the lowest part of the bed, yielding accumulations that are locally especially rich (the "pay streak"). If deposition of ore minerals is by replacement of soluble minerals or by filling of pore space in a given stratum, the appearance of the ore may suggest a sedimentary deposit, even though ore deposition was much later than sedimentation. A special case is penecontemporaneous replacement, by which, apparently while falling to the sea bottom or shortly thereafter (during the solidification of a given sediment), such rocks as the limestones may have some or all of their constituents replaced by iron compounds.

Many ore deposits are apparently simple fissure fillings (fissure veins). transverse to pre-existing rock structures (*e.g.,* bedding) or parallel to them, as in bedded veins. If the former, they may indicate planes of shear or of tension, depending on their relation to the tectonic history of the region, which thus becomes of special interest. In closely studied districts (*e.g.,* the Erzgebirge, Saxony; the Mother Lode and Grass valley, California; and Braden, Chile), both the opening and the mineralization have proved to be repeated. This may well account, at least locally, for the wide veins of certain mining districts; other explanations for such veins include (1) a dense, essentially viscous and meltlike mineralizing solution (Spurr's "ore magma"); (2) an opening standing several feet wide, gradually filled with ore that crystallized from dilute solutions; (3) replacement (e g., solution of the country rock, with simultaneous deposition of the ore minerals) rather than open-cavity filling. Fissure fillings include such distinct types as ladder veins, small fissures between two or more bordering fractures; gash veins, several small fissure veins frequently overlapping; sheeted zones, many smaller subparallel veins making up a compound vein that is large but not simply one fracture; saddle reefs, veins in openings where beds separate at the crests and troughs of folds; zigzag veins, the direction or inclination changing as differing rock types are crossed; thinned or thickened veins, the changes taking place in a vein where it crosses from one rock type to another; breccia veins, with numerous fragments of the country rock in the plane of the vein and partially embedded in the vein material; an ore "pipe" or "chimney." a body of ore saturating and cementing a shattered rock mass and having one long dimension and two lesser dimensions. Larger fissures commonly break up into many smaller ones at their ends—upward. downward or laterally. Much attention has been given to the causes for the various forms of fissure veins.

Irregular forms include ore bodies apparently resulting from the filling of irregular caverns (though such cases are probably few); from the segregation of ore within an igneous mass in place; or from replacement, the simultaneous solution of country rock and deposition of ore, especially where ore solutions react with the country rock, as where a granitic rock is irregularly replaced by copper-iron sulphides (*e.g.,* the main ore body disseminated through the granitelike mass at Bingham, Utah) or where a limestone or dolomitic (magnesian) limestone is replaced by irregular masses of zinc and lead sulphides, with diameters ranging from microscopic to tens or even hundreds of feet. Several genetically different classes are thus included among the ore deposits of irregular form. There is not uncommonly a gradation from a fissure vein to an irregular body as a fissure vein enters a rock readily attacked by the ore solution.

The textures of ore bodies are their more minute characteristics. Thus, sedimentary ores are commonly oolitic, with particles like the *Bohnenerz* (bean ore) of many sedimentary iron ores; their texture consists of small spheres, frequently concentrically banded, up to half an inch but generally much less in diameter. A similar feature, though on a larger scale, is common in oxidized ores as in the beautiful concentric (botryoidal, mammillary) banding of head-sized masses of the bright green basic copper carbonate malachite. Such features, especially if characterized by syneresis (dehydration cracks), are regarded by many as evidence of colloidal deposition, hence called colloform textures.

A mineral in a replacement ore may have the crystal form of the preceding (host) mineral and is then known as a pseudomorph of the later. Fillings in open spaces are likely to show a sequence of mineral deposition, the first minerals formed being nearest the wall rock; the centre may remain unfilled. Studies of these and other textural relations yield an idea of the sequence of mineral formation or paragenesis. From 1920 onward; the reflecting (metallurgical) microscope (*q.v.*) proved a valuable tool not only to identify opaque ore minerals but also to study and interpret their microscopic textures in terms of their paragenesis and their origin.

In addition to picturing the larger or smaller features of an ore, the attitude and position of an ore body must generally be described, to aid the mining engineer or miner in extracting it. In the case of irregularly shaped ore bodies, this is generally a matter of citing detailed measurements in many places. Alternatively, a series of sections across the ore body may be presented or a three-dimensional model may be prepared by mapping successively deeper levels on glass planes supported in a frame, or by making a plastic or wooden model.

For tabular ore bodies, such as bedded ores or simple fissure veins of some size, the nomenclature of description is like that applied to a stratum by the geologist. By definition, the strike of a tabular vein or ore bed is the direction in azimuth of the line marking its intersection with a horizontal plane; the dip of the plane of the vein or bed is its angle of inclination measured from the horizontal down the slope of the plane and normal to the strike. A fissure vein may thus be said to strike N. 20° E., with dip 50° S.E., its attitude being thus defined.

Within an otherwise barren fissure vein there may be a richer part, the shoot. If large, the ore shoot is a bonanza, if small, a pocket. If dimensions are given for such shoots, the longest measurement in the horizontal plane is the stope length ("stope" being the cavity ultimately left when the ore body has been mined out), the longest dimension directly down dip is the stope depth and the smallest in the horizontal plane is the stope width or thickness. If the ore body is chimneylike, cylindrical or relatively long for its width, the miner may refer to the dimension down dip along its longest axis as the pitch length.

Exploration for Ore Deposits.—Ore deposits are sought by means of three related methods—geological, geophysical and geochemical. Geological exploration is dependent upon a knowledge of the basic geology of the terrain in which the ore is being sought. This may be carried to varying levels of detail. For example, if exploration were contemplated in Mexico, general geologic facts and previous experience indicate that search for copper might be pursued with best hope for success in the northwestern part of the country, especially in Sonora; search for lead and zinc in the Mesa Central or the Sierra Madre Oriental; and for precious metals in the andesitic lavas of the canyon region, designated by some the Sierra Occidental. Thus are defined certain metallogenic provinces, characterized by ores rich in a specific group of metals, as though the deeper, molten part of the earth in each province had distinctive components. The ancient rocks of the Pre-cambrian shield of eastern Canada bear little zinc or lead but have produced much gold, nickel and copper, suggesting, by this linkage of their age with certain metals, that specific ore types characterize certain periods of the earth's history, distinguishable as metallogenic periods; this concept can be applied also to sedimentary ores such as the siliceous banded iron ores which are virtually confined to the Pre-Cambrian.

The problem may, instead, be one of greater detail. When reason to expect ore in a small area or a mine exists, where shall search be especially pressed? Placer gold may be followed upstream till it stops; the outcrop of the vein from which it was derived should be on the stream bank or in the drainage basin near at hand. Principles of structural control may be used; given ore-bearing fissures, the richest and largest shoots are generally near intersections of two fissures. If present along a vein, ore is commonly found where strike or dip changes abruptly. Ore is common in smaller folds above dome-shaped intrusions. It is generally richest where a mineralized vein passes from shale to limestone, especially under capping beds of shale or other impervious or insoluble rock.

With progressive exhaustion of ore bodies that crop out, methods are continually sought by which subtler criteria can be used to find buried ore. The surface residue, especially the limonitic outcrop (gossan, "iron hat"), has been studied (Augustus Locke, Roland Blanchard, P. F. Boswell, 1926 et seq.) in an attempt to establish colours, textures and the like characteristic of the deeper, primary ore; also gossan is analyzed for traces of deeper elements. Alteration halos marking changes produced by solutions accompanying ore deposition have been recognized for some time as clues; these halos are distinguished by their predominant minerals—tourmalinization, albitization, epidotization, sericitization, kaolinization, sideritization and dolomitization. Special types are greisenization (bleaching and sericite development in an alkali-rich igneous rock), propylitization (the development of certain greenish minerals in intermediate to basic igneous rocks) and the widely distributed development of claylike minerals (argillization, T. S. Lovering, G. M. Schwartz and P. F. Kerr c. 1944) and of silica (silicification) which received particular attention after 1940.

Geophysics (*q.v.*) affords methods also increasingly useful. Many iron ores and some others are magnetic; the compass and dip needle (a vertically suspended magnetic needle) have been used for over a century in search of such ores. Lately modified forms of such instruments (the "flying magnetometer") have been flown over promising terrain. Electric methods depend largely on the electric potential developed as ore bodies oxidize. Conductivity of ore minerals, generally higher than that of gangue, is studied with the aid of sensitive current measurements. Gravity anomalies may be a guide to ore. Uranium-rich ores give counts with a Geiger counter, and many ores, especially those of tungsten, fluoresce with characteristic colour and may thus be sought in the dark.

Tools developed by mid-20th century were geochemical ones. Careful analyses give evidences of ore by traces of the ore elements, whether the traces are in the rock outcrop, the residual soil or in growing plants rooted in that soil, or in water draining across it.

These methods have as object narrowing down the area to be explored. Once thus narrowed. the area may be explored at depth by drilling with auger, churn drill or diamond drill, by pit-hole sinking, tunnelling or shaft sinking. Diamond drilling furnishes a solid cylindrical core (if recovery is good), which can be geologically studied and provides a sample for chemical analysis as well.

Evaluation of Ore Deposits.—Geologists and mining engineers are required at times to evaluate an ore body, quite aside from the equipment that may be on the ground. For this purpose the deposit must be sampled, usually by making a cut into a clean face of typical ore and analyzing (assaying) the material thus obtained. Systematic, large-scale sampling repeats the process at regularly spaced intervals and seeks a weighted average to obtain the grade of the ore. The total volume of the ore is then computed using measured or inferred dimensions. The specific gravity of the ore is obtained, the weight per unit volume determined from this and the total tonnage derived by multiplication. The case is simple if the ore body is a tabular one, such as a simple vein of fairly constant thickness, or a replacement body in a stratum, or a sedimentary ore bed. For such cases E. F. Burchard recommended the formula:

$$\text{Total tonnage} = \frac{\frac{1}{2}(T+t) \times L \times D \times R}{\text{cu.ft. per ton}}$$

in which T is average thickness of ore bed (or vein) at outcrop, t is minimum workable thickness, L is length of outcrop. D is distance from outcrop at which thickness of ore becomes t and R is the percentage of recoverable ore. In complex ore bodies changing in richness and volume from place to place, the body is divided, for the purpose of computation, into geometrical units small enough to be essentially constant in width, thickness and composition; the tonnage and grade of each such unit is then separately determined to give a total for the deposit as a whole. The most comprehensive estimates require consideration of such diverse factors as future metal prices, rates of exhaustion (depletion), probable tax assessments, mining, milling and transportation costs, and even such matters as labour sources, pertinent tariff policies and political and economic stability of the country where the mining is to be carried out.

Special attention in the 20th century has been given to the role of mineral deposits in international affairs and in the economics of development, and much literature dealt with this broad subject, especially after World War I.

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(C. H. Be.)

ORE DRESSING is the art of treating crude ores and mineral products by mechanical means to separate the valuable minerals from the worthless constituents in the crude material. The term "ore dressing" at one time referred only to processes employed in treating ores containing valuable metals such as gold and silver, but as these processes were applied more and more to the recovery of nonmetallic minerals it was also used to describe the methods for treating such materials as graphite, sulphur. mica, feldspar, asbestos and fluorspar. The term "mineral dressing" is becoming widely used instead of "ore dressing" because of its broader meaning. Usually the two terms are considered to be synonymous, but sometimes mineral dressing is intended to include other branches of metallurgy and coal preparation whereas ore dressing always refers to methods of separation of solid inorganic minerals from each other without effecting substantial chemical changes.

The need for ore dressing to produce enriched products or concentrates from low-grade ores arises from the fact that most metals and valuable minerals do not occur in nature in such a form as to be usable directly. The common base metals copper, lead and zinc seldom comprise more than a few per cent of the total rock from which they must be extracted and usually occur combined chemically with other elements. These metal-bearing compounds must eventually be subjected to a chemical treatment to break up the chemical union and liberate the metallic elements. The processes employed to accomplish the chemical separations are expensive as a rule, and the cost depends largely on the bulk of material treated. Thus it would cost as much to smelt a ton of copper ore containing 1% copper as to smelt a ton of concentrated copper ore with 30% copper, and the amount of copper produced in the first case would be only one-thirtieth as much as in the second. It is economically impossible to smelt a copper ore of 1% but, by using relatively cheap ore-dressing processes to make 30% copper concentrates for smelting, the 1% ore can be utilized economically.

Ore dressing is the first process which most ores undergo after they are dug from the ground. It may consist of very simple operations such as washing with water and hand sorting to select the richer ore pieces, or it may involve much more complicated processes using elaborate equipment to effect the separations desired. The primary operations in ore dressing are comminution, or crushing, and concentration, but there are many other important operations involved in modern ore-dressing plants, such as sizing and classification, settling and filtering, drying and heat treating, and agglomerating or pelletizing.

Comminution. — Some ores occur in nature as mixtures of separate mineral particles that are not attached to each other and require no crushing or breaking apart. Examples of this type of ore are the placer deposits found in stream and gravel beds where the ore mineral is native gold or perhaps precious stones such as diamonds or emeralds, or perhaps it is simply gravel to be utilized in concrete highways. These materials are mined and the valuable constituent concentrated directly without crushing, but important as the minerals found in such condition may be they represent only a small portion of the ores treated throughout the world for their mineral content. By far the greater part of the ores mined consist of hard and tough rock masses that must be crushed to free the valuable minerals. This operation is called comminution and sometimes includes the breaking down of the ore from huge boulders to fine powders depending upon the fineness of dissemination of the mineral particles.

Comminution of ores is customarily done in three steps: primary or coarse crushing, secondary or fine crushing and grinding. Primary crushing is usually accomplished with jaw or gyratory crushers. Jaw crushers consist of two steel "jaw plates" one of which is stationary and the other movable. Rock fed between the plates is mashed by the action of the movable jaw and reduced to a size small enough to be taken by the following or secondary crusher. Gyratory crushers are essentially a fixed crushing surface, in the form of an outer steel shell, and an inner spindle that is made to gyrate or to rotate, thus alternately receding from and approaching all the points on the outer shell. These machines in their largest form are capable of taking rock masses up to six feet in their longest dimension and reducing them to as small as one inch in size.

Secondary crushers are numerous, the more commonly used ones being rolls. cone crushers and rod mills. These machines customarily receive rock one to three inches in size and reduce it to about one-fourth or one-eighth inch. Rolls crushers consist of a heavy steel frame on which are mounted two cylindrical steel rolls. These rolls are driven so that they rotate toward each other in the same manner as the rollers on a clothes wringer operate. Rock or ore fed between the moving rolls from above is nipped, crushed and discharged below the rolls. · Cone crushers consist of an inverted bowl-shaped steel crushing surface within which is gyrated a conical crushing head. The conical crushing head is mounted on a shaft and is gyrated by means of a long eccentric which is driven by a gear and motor assembly similar to those used on the larger gyratory crushers. Rod mills formerly were used only for relatively fine grinding but became popular as secondary crushers because of their high capacity and low maintenance costs. They are cylindrical-shaped steel shells loaded with steel rods and rotated about their horizontal axis. Ore and water are fed into one end of the shell, and the ore is crushed by the tumbling heavy rods within the shell. Rod mills are always made of a length greater than their diameter in order that the rods will not become tangled inside the mill.

There is little difference between grinding and crushing except that crushing usually refers to breaking coarse material, and grinding applies to relatively fine material. Originally grinding referred to that method of comminution which involved a heavy object being dragged or rolled over the material being ground. Mortar and pestle grinding is an example of this type of grinding, and there are still some of the early-type commercial machines in use that employ this principle. The arrastra or drag-stone mill grinds the ore by dragging flat stones around a circular stone floor; roller mills employ heavy rollers revolving about a central shaft on a circular ring; buhrstone mills consist of two flat circular stones, either one of which may rotate or they may both rotate in opposite directions with grinding taking place between the stones. However, modern ore-dressing plants almost always employ rotating cylindrical mills for fine grinding. A mill containing iron or steel balls for the grinding medium is called a ball mill; if it contains rods it is called a rod mill, and if it contains lumps of rock, ore or flint pebbles it is a pebble mill. These mills may be operated either wet or dry depending on the character of the ore or subsequent ore-dressing processes to which the ore is to be subjected.

Concentration. — The act of separating the valuable minerals of an ore from the worthless matter (gangue) into one or more enriched or concentrated products is called concentration. In ore dressing this is possible because of the difference of certain properties of the mineral particles. The simplest form of concentration is hand picking, which is used occasionally in modern plants to remove either rich material or waste material by hand from a moving table or conveyor belt. This operation employs the difference in colour or lustre of the lumps of rock so that the picker may distinguish the wanted from the unwanted material. Differences in the density of minerals permit separation by various methods of gravity concentration; magnetic properties are the basis for separation by magnetic methods; electric properties govern the electrostatic separation of minerals, and surface properties are used to effect the almost magic separations accomplished by flotation.

The feed to a concentration process consists of ore crushed and ground to a suitable size and is called the heads. The enriched product derived from the process is known as concentrates, and the waste or unwanted material is called tailings. A third product of the concentration treatment may be produced which requires further treatment before it can be resolved into concentrates and tailings. This product is called a middlings and, theoretically at least, consists of valuable and gangue minerals which are still locked together. When such a fraction is produced it is returped to the grinding equipment for further comminution and retreatment.

In addition to the simple process of hand picking there are other seemingly crude but effective methods of concentration which are widely used throughout the mining industry. For example, many ores such as those containing nodular manganese and iron minerals occur in a matrix of clay. Often the manganese and iron nodules require only washing with water and vigorous agitation to separate them from the soft clay. This results in greatly enriched concentrates which may be utilized by the iron and steel industry. Another simple concentrating device is an ordinary screen which may be used on many ores where the valuable mineral is either finer or coarser than the size of the openings in the screen. The hardness of minerals is sometimes utilized to effect separations by screening. This may be accomplished by first grinding the ore in a ball mill so that the softer minerals are differentially ground, and the harder minerals almost retain their original size. Simple screening of the differentially ground material results in the production of concentrates of the harder mineral on the screen while the softer material goes through the screen.

Gravity concentration processes have been practised by ore dressers to obtain mineral concentrates from the earth throughout the history of mankind. Probably the first gold ever seen by man was obtained from some ancient stream bed by some form of pan-ning that was not much different from that used by prospectors in modern times. The miner's gold pan is simply a device to concentrate heavy minerals in the bottom of the pan while the lighter, worthless minerals are washed off the top. The mechanical jig is a development of the gold pan that utilizes the faster settling rate of heavy minerals through a semistationary bed of crushed ore in water. Essentially a jig is an open box with a perforated bottom through which pulsating water currents are forced. Crushed ore fed into the top of the box is stratified by the action of the water currents, with the heavier minerals settling to the bottom. If the heavy minerals are fine enough, they pass through the perforated bottom and are discharged intermittently through a spigot. If they are too coarse to pass through the perforations, they are removed continuously through a cup or pocket on top of the perforations.

Shaking tables are gravity concentration devices used to treat material too fine for jigging. They consist of a tablelike surface inclined slightly from the horizontal and are operated with a reciprocating action that shakes the table in the direction of the long axis. Fine ore and water are fed to the upper corner of the table and flow across the deck which has shallow riffles running the full length of the table. The reciprocating action of the table causes the heavy minerals to move to the end of the table, while the lighter minerals are washed by the water over the side of the deck. Shaking tables are called sand tables or slime tables, depending upon the size of the material that they treat.

Heavy-medium or sink-float separation processes are concentration methods that depend on the buoyant power of suspensions of fine heavy solids in water. Separating vessels are usually in the shape of a stationary cone, a revolving drum or a stationary tank with a revolving screw conveyor to remove the concentrates. The vessel is filled with a mixture of finely divided particles of some heavy material such as ferrosilicon, magnetite or galena and water. The mixture acts as a fluid with an apparent specific gravity lower than that of the mineral to be concentrated but higher than that of the gangue minerals. Crushed ore fed into the liquid-solid mixture separates into a sink or heavy product and a float or light fraction. The sink product is removed continuously from cone separators by pumps and from drum and screw separators by means of suitable conveyors. The float product overflows the top of the vessel in which the separation is made and both products are separated from the heavy medium by screening and washing with water. The treatment is applicable only to ores coarser than about one-eighth inch because of the relatively high viscosity of the heavy medium. The settling rate of fine particles in a viscous liquid or suspensoid medium is too slow to permit rapid separation, and other gravity concentration methods must be used for the finer portion of an ore.

Gravity concentration processes for treating fine sands include spiral separation which employs a spiral trough with a curved bottom. When fed with a water-sand mixture, the dilute pulp flows by gravity from the top of the spiral to the bottom. The lighter minerals, usually quartz and feldspar, are more easily suspended by the water and are washed to the outside of the spiral, while the heavier particles tend to cling to the bottom and inside of the trough. Ports or outlets are spaced along the bottom of the spiral for removal of heavy concentrates while the lighter tailings are discharged at the lower end of the spiral. Shaking tables accomplish the same separations that spirals do, but require more floor space and have more moving parts. Hydrocyclones, also known as Dreissen cones or Dutch State Mines cyclones, may be used in conjunction with a heavy-medium suspension to effect separations of heavy minerals in fine sizes. The hydrocyclone consists of a cone-shaped vessel in which a separation is made based on the principle of the vortex. A dilute ore pulp is pumped tangentially into the cone near the top with a heavy medium and the heavier ore particles find their way to the bottom of the cone while the lighter gangue minerals are removed at the top.

The foregoing processes involve concentration of ores with water, but there are equivalent processes employing air as the separating medium. Pneumatic jigs and tables operate on the same principles of gravity separation as wet jigs and tables but find use in desert regions where water is scarce and on ores that are best treated dry, such as asbestos, which depends upon the light, fluffy nature of the mineral for efficient concentration.

Magnetic separation is an efficient means for concentrating many minerals which contain iron. The mineral magnetite is both heavy and strongly attracted by a magnetic field and may be separated from its gangue minerals by either gravity concentration or magnetic methods, but magnetic separation of magnetite is so highly efficient that it is almost invariably used to concentrate the mineral rather than other, perhaps less complicated, processes. Originally dry magnetic pulleys were the only separators used for concentrating magnetite, but wet separators were found to produce much richer concentrates.

Minerals such as garnet, ilmenite, wolframite and haematite are not as strongly magnetic as magnetite but are sufficiently attracted by a powerful magnetic field to permit separation from completely nonmagnetic minerals such as quartz, feldspar, rutile and zircon. A number of specially designed magnetic separators were found suitable for concentrating these weakly magnetic minerals. Among them are the induced-roll separator and the crossed-belt separator, both of which are highly efficient and widely used. They differ from each other largely in the manner of conveying the ore particles through the magnetic field. The induced-roll machine utilizes a revolving roll to carry the ore stream through the field, the magnetic particles adhering to the roll while the nonmagnetic particles are thrown by centrifugal force away from the roll. The crossed-belt separator, as the name implies, consists of a conveyor belt which carries the ore through the field and a second belt crossing under a magnet above the first belt and at right angles to it; magnetic particles are attracted upward toward the magnet and are removed to the side by the travelling belt, while the nonmagnetic particles remain on the first belt and are discharged at the end of the machine.

Electrostatic separation is a concentration method that utilizes the force of an electric field to effect separations between minerals with different electrical properties. It is based on the phenomenon of attraction between unlike electrical charges and repulsion between like charges. It is particularly applicable to the separation of some nonmetallic minerals although it may be applied to metallic minerals with equal success. It is the only process that proved successful for separating zircon from rutile, these being commonly found associated in beach sand deposits.

Flotation is perhaps the most important concentration process in the mineral industry in that more ore is treated by this method than by any other. As applied to ore dressing, the process dates back to ancient times when the Greeks reportedly used feathers dipped in pitch to recover gold from the mud of a lake, but large-scale modern use of flotation did not come about until after 1924 when the use of xanthate, to collect metal sulphides in a froth, was patented.

The flotation process depends upon the ability of the ore dresser to wet selectively some mineral particles while other minerals remain unwetted and adhere to air bubbles which float to the surface and are removed as a concentrate in the froth. Certain minerals, such as graphite, talc and sulphur, are called self-floating because of their natural tendency to resist wetting by water, but most minerals require coating with a water repellent to render them floatable. Coating the finely ground mineral particles is accomplished by agitating the mixture of ore, water and suitable chemicals in a conditioner for a short time, during which the chemicals react with the elements at the surface of the particles to form a new surface which is more water repellent than the original surface. Minerals that naturally tend to resist wetting may be treated so that their surfaces will be wetted and they will sink in the water and not be floated with the concentrates. Flotation is most commonly used to concentrate copper, lead and zinc minerals from their ores because of the ease with which they are floated or, not floated as the case may be. These minerals often occur together and the ore dresser is called upon to separate them from each other as well as from the gangue minerals. By using suitable chemicals it is possible to float copper, lead and zinc minerals selectively from each other by preventing the flotation of all minerals, except those containing lead. then floating only the copper minerals and finally only the zinc minerals. This ability of the ore dresser to modify the floatability of minerals at will made possible many seemingly magical separations that are common practice in modern mills. In fact it can be said that any two minerals may be separated by flotation if one contains a substantial amount of one element that is absent in the other.

Sizing and **Classification.**—All ore-dressing concentration processes require that the ore be sized to a certain degree. Often it is the size to which the ore must be ground before the valuable minerals are unlocked that governs the process that will be used to concentrate those minerals. Machines, used to assure grinding to at least unlocking sizes, are called sizers or classifiers. Screens are perhaps the simplest devices used to size ores. and they are widely used in a variety of forms. Fixed screens. for coarse sizing, consist of parallel bars, punched plates or coarsely woven wire. Trommel screens are cylindrical screens revolving slowly about their horizontal axes; vibrating screens are plane surfaces of woven wire cloth which are rapidly vibrated by mechanical or electrical means; and shaking screens are slightly inclined plane surfaces of wire cloth shaken endwise or sidewise. All screens may be used with or without water and some modern screens are heated either by electric current or hot air. Heated screens are less inclined to become blinded by sticky material and thus have greater capacity than unheated ones. Classifiers are made in numerous forms and may be operated either wet or dry. Hydraulic classification depends upon the different settling rates in water of grains of mixed sizes. The water in a classifier may be either in motion or substantially at rest. Air classification is equivalent to the wet operation except that air is used as the medium instead of water. Centrifugal classifiers, net or dry, are devices that utilize centrifugal force to effect separations between coarse and fine particles.

Settling and Filtering.— Settling or thickening is a term applied by the ore dresser to the process of removing nater from a dilute mixture of fine ore and water so that a relatively thick pulp results. Most ore-dressing processes require large amounts of water and the resulting concentrates and particularly the tailings are extremely dilute. The first operation in separating the solids from the water is usually carried out in thickeners. These are large tanks in which the fine solids are allowed to settle. Chemicals are sometimes added to increase the settling rate of the solids. Feed to thickeners usually contains from 5% to 20% solids. and the discharge. nhich is pumped from the bottom of the thickener, varies from about 40% to 80% solids. Thickened pulps may be further dewatered by filtering. Filters for ore-dressing plants are usually rotating cylinders covered with a porous fabric through nhich the water is drawn by means of a vacuum under the cloth. Such machines are called vacuum filters, and there are numerous other forms and types of filtering devices.

Drying and Heat Treating.— Dryers for ores and concentrates consist of some form of container and a means to apply heat to the wet material within the container. Most commonly used dryers are rotary kilns which are slightly inclined rotating cylinders with a burner at one end or the other. Wet ore is fed continuously to the upper end of the cylinder while the dry material is discharged at the lower end. Infra-red lamps are sometimes used to dry small quantities of concentrates. and many kinds of dryers have found use on special types of ores. Roasting is sometimes used in ore-dressing plants to change the form of some mineral in the ore so that it may be more easily concentrated. Roasting of pyrite. for example, to drive off sulphur and render the mineral magnetic is carried out in roasters of various types. Roasting sometimes causes a mineral to expand or decrepitate, as in the case of vermiculite which expands and spodumene nhich breaks into small particles, thus making it more readily separable from unaltered minerals.

Agglomeration.— Some ores, particularly those of iron, chromium and manganese, which are smelted in blast furnaces cannot be utilized as fine particles. They must be agglomerated in some manner so as to form large, tough lumps of material suitable for smelting. This process, variously called sintering, agglomerating, nodulizing, pelletizing and briquetting, may be carried out by fusing the material at high temperature, as is done in sintering and nodulizing, or by mixing a binder such as starch, molasses or bentonite with the fine ore and heating or applying pressure to the mixture. (See also AMALGAMATION; CYANIDE PROCESS.)

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(F. D. L.)

OREGON, popularly called the "Beaver state," is one of the northnestern states of the United States. Its capital is Salem. Oregon is bounded on the north partially by the Columbia river and the state of Washington, on the east by Idaho and partially by the Snake river, on the south by California and Nevada and on the west by the Pacific ocean. Its general coast line extends north and south 297 mi.: its extreme length, east and west, is 383 mi. The total area is 96,981 sq mi (733 sq mi inland water), making it the tenth state in size The origin of the name "Oregon" is unknown; first used in 1765 to refer to a mythical river of the nest, the name was later applied to the entire territory drained by the Columbia river from which the states of Oregon, Washington and Idaho were eventually formed Oregon was admitted to the union in 1859 as the 33rd state. The state flower is the Oregon grape (*Berberis aquifolium*), the state bird the western meadow lark (*Sturnella neglecta*), the song "Oregon, My Oregon."

PHYSICAL GEOGRAPHY

Physical Features and Soils.—Oregon lies between 42" and 46° 18′ N lat and 116° 28' and 124° 34' W long. (extreme points). Its physical features may be described generally under three headings the coastal area, the Willamette valley and the interior plateau country.

Coastal Area—The dominant feature of the 30-to 50-mi -wide coastal area is the irregular Coast range, formed by folding and volcanic intrusions Heavily forested and deeply dissected by sharp ravines and narrow valleys, these mountains range in elevation from 1.500 to 2.000 ft with a slight rise toward the south. The highest point is Mary's peak. 4.097 ft. In the south. the Coast range (*q.v*) merges nith the Klamath mountains (*q.v*), generally 4 000 to 5,000 ft. high, also deeply incised and forest covered. Occasional spurs from these ranges break the othernise regular coast line nith precipitous basaltic headlands such as Neahkanie mountain, Cape Perpetua and Cape Blanco Between these and lesser promontories lie curved sandy beaches. some with shallow bays formed by the sunken mouths of mountain streams Tillamook, Taquina and Coos bays admit ocean-going vessels. The largest rivers are the Nehalem, Tillamook, Umpqua, Yaquina and Rogue.

Willamette Valley—The Willamette valley, about 30 mi. wide, takes its name from the river that flows north about 190 mi. betneen the mountains of the Coast range and the Cascade range. The river meanders across the level valley floor nhich rises gently to the low foothills. It receives from the Coast range the slow-moving Yamhill and Tualatin rivers; from the Cascades it receives the Clackamas, Santiam and Calapooya rivers and the swift white waters of the McKenzie. Early settled and noted for its productivity in diversified farming, the valley soil is composed of residual hill, old valley filling and recent alluvium.

The Cascade range (*q.v.*) forms a north-south boundary of rough and forested mountain country 50 to 100 mi aide along the eastern side of the Willamette valley. Its elevation ranges from 500 ft in the western foothills to 14,410 ft at the summit of Mt Rainier. its highest peak Other peaks in the chain over 10.000 ft are Mt Jefferson and Three Sisters The Cascades were formed during cataclysmic periods of volcanic action and folding, and some of the snow-capped glaciered peaks are extinct volcanoes. Picturesque Crater lake occupies the crater of a great volcano active as recently as 8,000 years ago.

Interior Plateau.—The Cascades slope off on the east into a wide lava-built plateau about 5,000 ft. in elevation and occupying two-thirds of the state's area. The Deschutes river drains 9,000 sq.mi. of the north central part of the plateau, carrying a uniform flow of pure water from the Metolius, White, Warm Spring and Crooked rivers. The soil of this part of the plateau is principally residual and loess and produces hay, grains and potatoes. The rolling lands stretching east from the Deschutes to the Wallowa mountains between the Columbia river (*q.v.*) and the Umatilla range produce the bulk of the state's wheat crop. The Blue-Wallowa-Umatilla mountain complex, with elevations of 2,000 to 10,000 ft., forms a triangular wedge with its base along the Snake river, and divides the northeastern from the southeastern plateau. Cattle graze the slopes and wheat fields are found on bench lands and in rich lowland valleys. The canyoned John Day river, with many geologically important fossil beds, is tributary to the Columbia. The Powder and Grande Ronde flow into the Snake. The Snake river (*q.v.*) forms a part of the boundary between Oregon and Idaho and is one of the principal rivers entering the Columbia. It is remarkable for, among other things, its mile-deep, vertical-walled Hell's canyon.

The southeastern part of the state, bounded by the forested slopes of the Blue-Wallowa, Klamath and Cascade ranges, is high desert plateau. Its 18,500 sq.mi. are geographically part of the great basin region. Topographically it is distinguished by tilted fault-block mountains, rim escarpments and "dry" or saline lakes. Its highest mountain, Steens mountain (9,354 ft.), is a fault-block formation. Abert Rim is a great lava escarpment. The rivers are short, of intermittent flow, and except for the Malheur and Owyhee die out in the plains or dwindle to a trickle before they enter the brackish, periodically dried up, Harney lake or fresh-water Malheur. The latter may cover 125 sq.mi. with water in wet years; in dry, it shrinks to mud holes. On the other hand, the Klamath lakes, just east of the Cascade range, are Oregon's largest bodies of fresh water, covering about 64 sq.mi. The raw "young" soil, composed in part of pumiceous, sandy and alluvial loams, lake peats, silt clay, volcanic ash and diatomaceous earths, is highly productive when water is applied. Livestock is grazed on the nutritious grasses in watered areas.

Climate.—While the climate of Oregon differs from north to south, a striking contrast appears between east and west where the Cascade range divides the humid, marine climate of the coast and valley from the semiarid climate of the plateau. Water-saturated air from the ocean cools and falls in heavy rains in the Coast range. Normal annual precipitation is 75 in., but it increases to more than 130 in. at some higher elevations. The average mean temperatures of January and July vary only about 15° (45°–60°). Snow generally occurs only at the higher elevations. The average growing season is about 248 days. The interior valleys west of the Cascades have slightly shorter growing seasons because of earlier and later frosts. The temperature range, however, is greater. In the Willamette valley the average mean temperature in January is 38°; in July, 66°. Valleys in the Klamath range and southwestern part of the state tend to have lower absolute minimums and higher absolute maximums than does the northern Willamette valley. They also have less rainfall. The mean annual precipitation at Ashland is 20.2 in.; at Portland, 45.6 in.

The eastern slopes of the Cascades lie in a rain shadow where little precipitation falls except as snow. The mean annual rainfall in the plateau country ranges between 11 in. in the southeast and 17 in. in the Wallowa mountains; snowfall in the same areas ranges from 13 in. to 85 in. Extreme temperatures of −31° and 107° have occurred, and the mean maximums for July vary from 78° to 90°. Abundant sunshine compensates for relatively shorter growing seasons.

Vegetation.—The semiarid plateau has a covering of western juniper, sage and salt grasses. Forests cover 30,000,000 ac. in the mountain and coastal areas. On the eastern slopes of the Cascades occur great stands of ponderosa pine in association with ground coverings of bitter brush, green manzanita and herbaceous plants. The western slopes of the Cascade, Klamath and Coast ranges are heavily forested with stands of Douglas fir. Mature forests of Douglas fir have thick understories of vine maple, dogwood, huckleberry and other plants, and admit intrusions of other tree growths such as hemlock, spruce, cedar and varieties of pine and fir. Immature or second growth stands of Douglas fir crowd out both undercover and intrusions. In cleared areas of the damp coastal region are found stands of alder and noncommercial deciduous growth. In the alpine zones of the mountains, larch, mountain hemlock and alpine firs occur in association, and in the Blue mountains stands of mountain mahogany are found.

Animal Life.—Oregon's animal life, like its vegetation, is related to its climatic zones and hence is not peculiar to the state. Varieties of deer and elk flourish in less populated parts; antelope are found in the eastern high plateau, and bear and fox in the mountain forests. The lakes are breeding grounds for water fowl and resting places for many different kinds of migratory birds.

Parks, Forests and Recreation.—Of Oregon's total area of approximately 62,000,000 ac., the federal government holds title to about 32,600,000 ac., consisting largely of public domain used for grazing, national forests, revested forest lands and Indian reservations. The United States forest service administers nearly 15,000,000 ac. of Oregon's forest lands. There are 14 national forests, of which 10 are wholly within the limits of the state. All have camping sites or recreation parks or both. The state maintains more than 130 developed parks, many of which have improved camping facilities. More than 10,000,000 people visit these parks yearly.

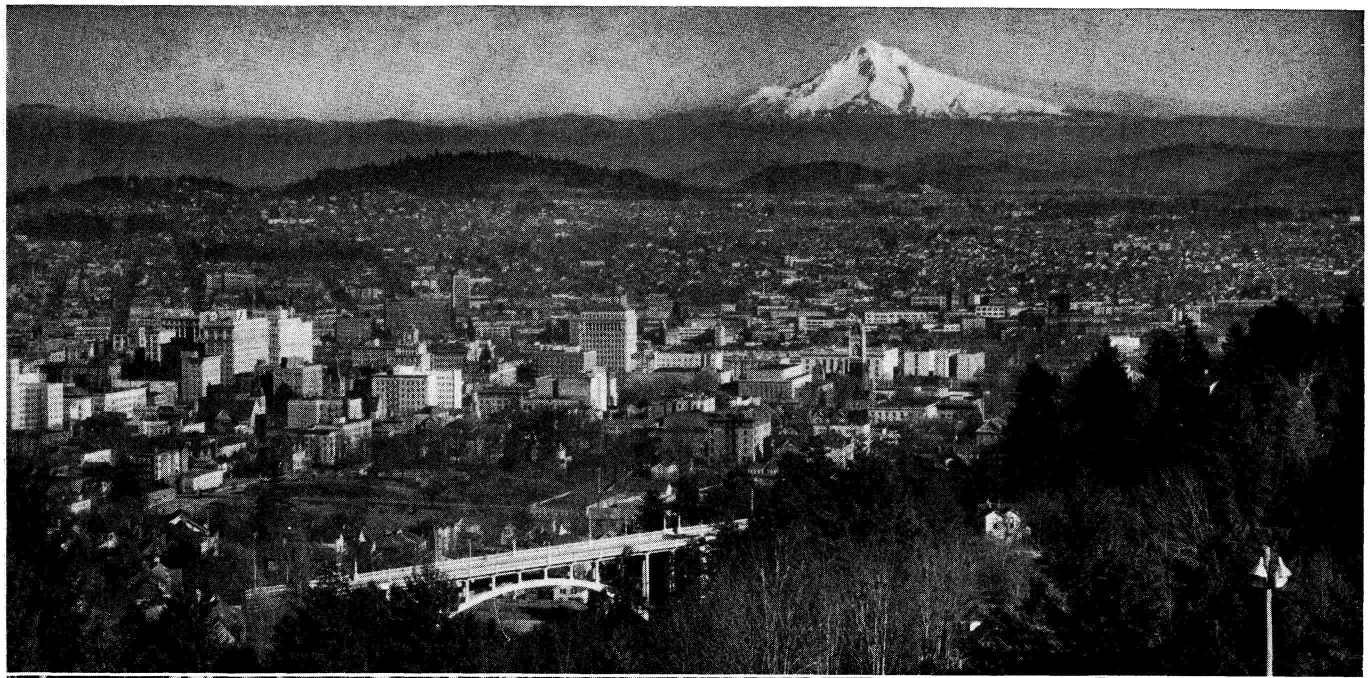
HISTORY

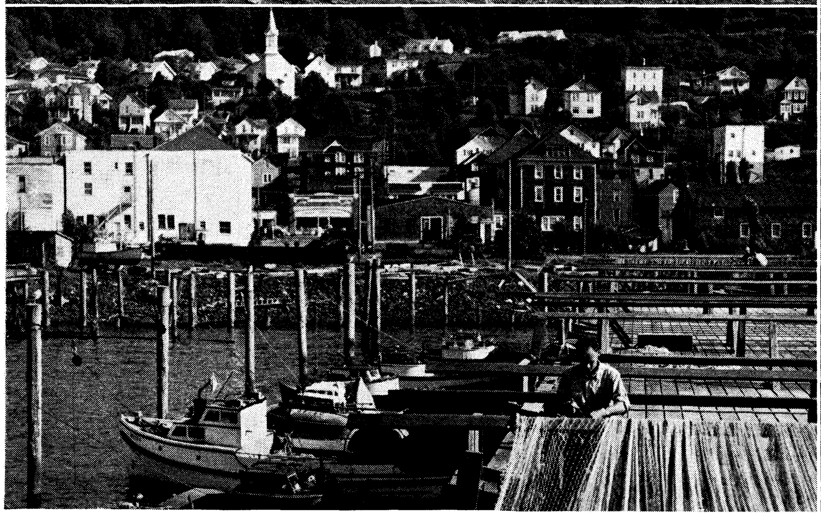
Prehistory and Aboriginal Inhabitants.—At least 10,000 years ago an ancient people lived in caves along the shores of great lakes that occupied the southern part of interior Oregon and along the banks of the Columbia river. By the time the white man came, the villages of the native population crowded the river mouths on the coast, and native villages were found in the valleys of the western ranges and in the interior wherever roots, fowl, game, fish, insects and water supported life. The people of the southern interior were related to the Shoshone-Paiute culture of the Great Basin peoples; the horse-raising northeastern folk had some cultural affiliations with the buffalo hunters of the plains; those who occupied the northern coast, organized in permanent villages, reflected some of the complex culture traits of the Northwest Coast canoe Indians. The peoples of the southern coast, isolated not only from each other by the broken terrain but also from the dominant cultures of their neighbours, shared some of the characteristics of the peoples of northern California.

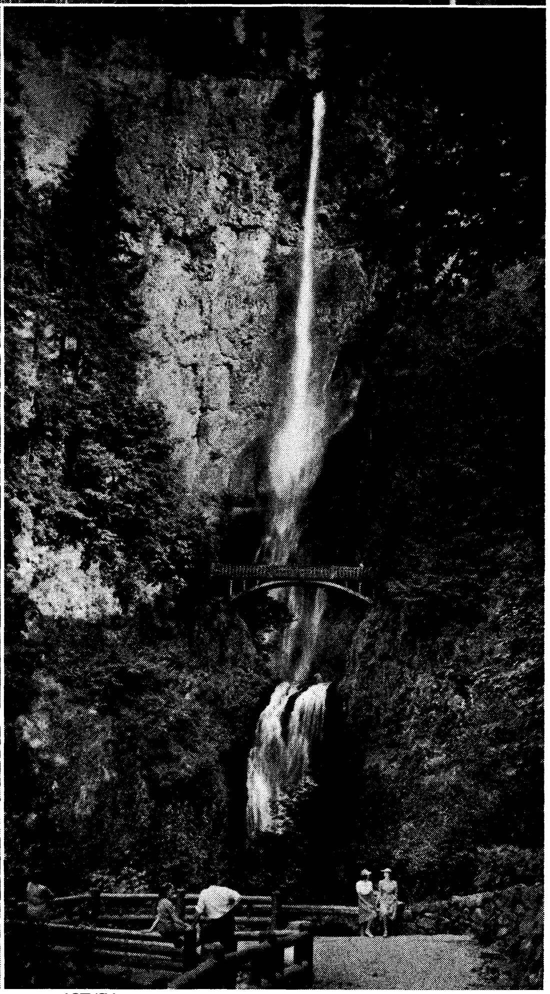
With the exception of the Rogues who occupied the river of that name in the southern part of the coast, the Indians' first response to the white men was friendly, so much so that they quickly succumbed to the white men's diseases. The natives were not a threat to settlement until the interior peoples, finding their lands invaded first by missionaries and then by miners, rose in successive outbreaks of brief duration, in 1847 (Cayuse War), in 1852–53 (Rogue outbreaks) and 1855–58 (Yakima War).

During the 1860s the natives preyed on immigrant trains corning in from southern Idaho, and local troops were sent to hunt them down. The last Indian rising was the famous rising of Chief Joseph in 1877, when he tried to lead his people from the reservation in the Wallowas into Canada.

Exploration.—Spanish navigators may have sighted the Oregon coast as early as 1543. In 1775 Bruno Heceta and Juan Francisco Bodega y Quadra made landings near Point Grenville (Washington) and in a formal ceremony took possession of the northwest coast for Spain. Capt. James Cook of the British Royal Navy sailed along the Oregon coast in 1778–80. An incidental trade for sea otter skins between his men and the Indians to the north led to the opening of a triangular trade between these shores, China and England by 1785. The Americans entered this trade in 1789. On his second voyage to the coast in 1792, Capt. Robert Gray discovered and entered the river which he called Columbia river after his ship. Later, this discovery led the United States to claim the territory the river drained. The overland exploring expedition led by Meriwether Lewis and William Clark (1804–06) reinforced







BY COURTESY OF (CENTRE LEFT) AMERICAN FOREST PRODUCTS INDUSTRIES, INC (BOTTOM LEFT) U S INFORMATION AGENCY, (BOTTOM RIGHT) PORTLAND CHAMBER OF COMMERCE, PHOTOGRAPH, (TOP) RAY ATKESON

SCENES IN NORTHERN OREGON

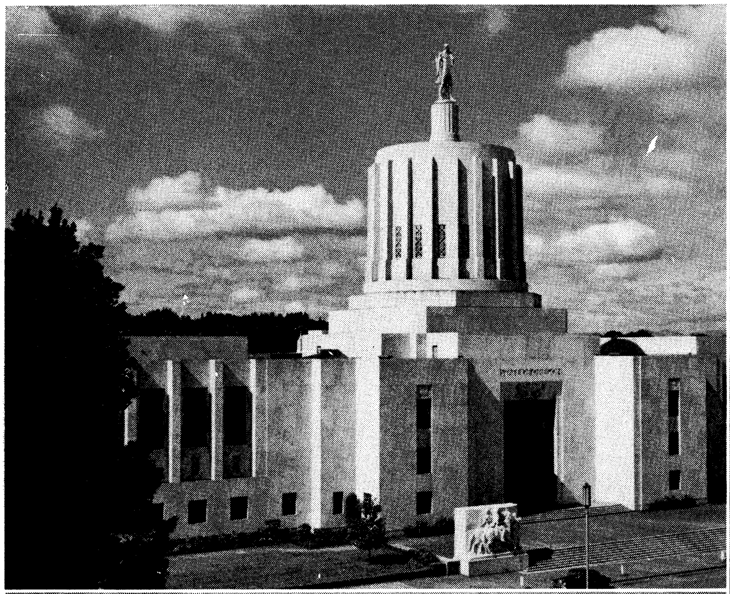
Top: View of Portland with Mount Hood in the background, *50* mi. away

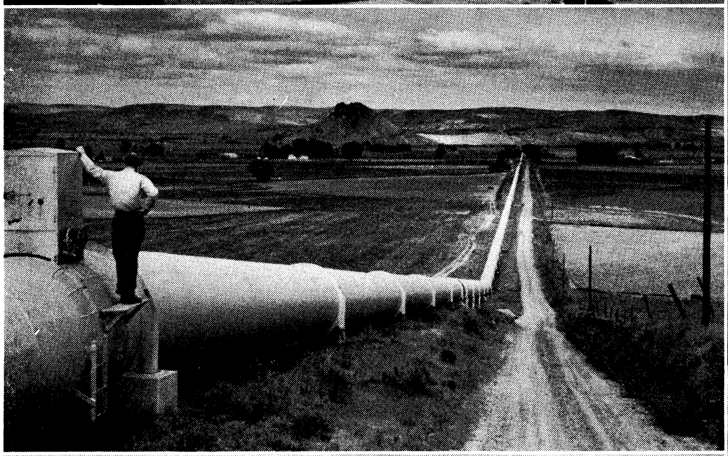
Centre left: Hauling trees from a forest near Portland. More lumber is cut annually in Oregon than in any other state

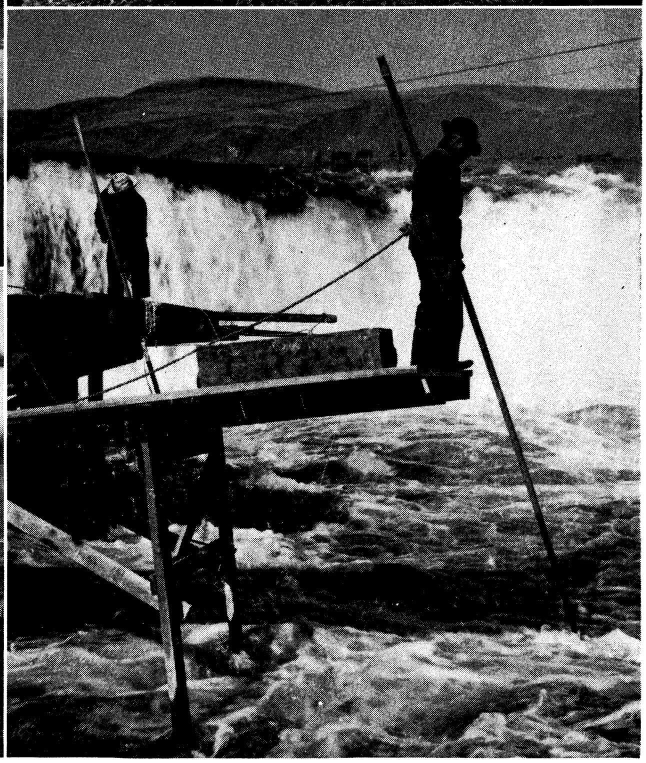
Bottom left: Repairing salmon fishing nets at Astoria in the northwestern part of the state. Astoria was established as a fur-trading post in 1811, and is the oldest white settlement in the northwest

Bottom right: Multnomah falls over which water drops 620 ft. Its source is Larch mountain in the Cascade range

OREGON







BY COURTESY OF (TOP LEFT, CENTRE LEFT) OREGON STATE HIGHWAY COMMISSION, (TOP RIGHT) UNION PACIFIC RAILROAD; PHOTOGRAPHS, (BOTTOM LEFT) AL MONNER, (BOTTOM RIGHT) BLACK STAR

INDUSTRIAL AND LANDSCAPE SCENES OF OREGON

Top left: State capitol at Salem, completed in 1939. A bronze statue atop the dome and two sculptural blocks at the entrance honour early pioneers of Oregon

Top right: Pacific ocean near Devil's Punch Bowl State park

Centre left: Conduit carrying water to farms from the Vale-Owyhee irrigation project in eastern Oregon

Bottom left: Paper mills along the Willamette river, Oregon City

Bottom right: Netting salmon at Celilo falls in the northwestern part of the state. Indians have exclusive permission to fish there

American claims to possession. Lewis and Clark's winter encampment, Ft. Clatsop near the mouth of the Columbia, was made a national monument in 1958.

Fur Trade. — Although the Canadian Northwest company had established fur trading posts west of the continental divide between 1807 and 1810, the first commercial post within the present boundaries of Oregon was built by Americans in 1811 when John Jacob Astor's partners in the Pacific Fur company built Astoria. During the War of 1812, Astor's field partners sold its trading goods and abandoned its posts to'the Canadian company. Subsequently a British war vessel took possession of Astoria. This "act of war" brought the Oregon country into British-U.S. peace negotiations. Astoria was restored to the Americans, who, however, made no effort to occupy it for 30 years. In 1818 the two powers agreed by convention that their nationals could engage in commerce in the Oregon country without prejudice to either nation's claims. Spain surrendered its claims by the treaty of Florida in 1819, but Great Britain and the United States continued until 1846 to argue the relative strength of theirs. The British sought a boundary along the 49th parallel to the Columbia and then down that river to the sea. At no time did they push any claim to the region south of the Columbia in what is now Oregon. The United States consistently argued for a boundary along the 49th parallel to the Pacific.

Following a merger with the Northwest company in 1821, the Hudson's Bay company took over the fur trade in the region, and, to all practical effect, provided the only white occupancy of the region until 1834. Under its chief factor of the Columbia department, John McLoughlin, the company's principal post, Fort Vancouver (Washington), became the wilderness metropolis of the vast Oregon country.

Several futile U.S. efforts to invade the British commercial empire revealed how firmly the Hudson's Bay company controlled the Indian trade.

Settlement. — American immigration began in 1834 with the arrival of Methodist missionaries, Jason and Daniel Lee. Reinforcements for their missions and the arrival of trappers and their families from the Rockies and others swelled the American population to about 150 persons by 1840. Oregon City, at the falls of the Willamette, was the first permanent village settlement in Oregon.

Attracted by widespread reports of the fertile valley, anticipating a prosperous trade with the orient and grants of free land from the government when the boundary issue was settled, immigrants carved out the Oregon trail with the wheels of their covered wagons (see OREGON TRAIL). The first large immigration, occurring in 1843, increased the American population to probably 1,200 persons. Problems incident to their arrival emphasized the fact that there was no government in Oregon except the chartered powers of the Hudson's Bay company over British subjects and a rudimentary "compact" that bound the Americans together for simple purposes of law and order. By 1845 this compact was revised to conform with practices and procedures customarily found in territories of the United States. A provisional government, intended to function until the boundary was decided, it successfully, if tenuously, held the American colony together until 1849.

Oregon Question. — The "Oregon question," the boundary issue, became a campaign issue in 1844 with the slogan "Fifty-four forty or fight" representing an extreme statement of U.S. demands for territory in the northwest. After the election of Pres. James K. Polk, the British government was notified that the United States wished to terminate the convention of joint occupancy and settle the problem of sovereignty in the Pacific northwest. Yegotiations resulted in a treaty (1846) which gave the Americans the line along the 49th parallel they had originally sought. Engaged in domestic controversies over slavery and the Mexican war, congress failed to respond to Oregon's petitions for organization as a territory until the massacre of the Whitmans and inhabitants of their mission in 1847 forced it to act. In Aug. 1848 the bill to organize Oregon territory was signed by President Polk. In 1853 the area north of the Columbia was withdrawn to form Washington territory.

Territorial Period. — Oregon's territorial period was an era of population growth and economic development. Passage of the Donation Land act (1850) which guaranteed to settlers in Oregon 320 ac. of public domain if they had settled before 1852, or 160 ac. if they arrived and qualified before 1855, inspired immigration. The California gold rush gave Oregon's agricultural produce a market, brought its economy out of the doldrums incident to its isolation, and brought much-needed capital into the territory. Oregon had relatively few Indian disturbances. In 1855 a reservation policy mas enforced by federal troops. Restless under territorial administration, Oregonians agitated for statehood. Although unauthorized by any congressional act, they adopted a constitution in 1857, and on Feb. 14, 1859, with its present boundaries and a population of 52,465, Oregon was admitted as a state to the union.

Statehood. — Statehood was ushered in with a gold rush to the northwest. Prospectors from California working their way north had discovered gold in southern Oregon, British Columbia and northern Washington in the middle 1850s. Rich placer diggings were opened up in Montana and Idaho in 1860. Demands from the mines made Oregon and its chief city, Portland, the supply centre for the interior. In 1867–68 surplus wheat was shipped to England and initiated an export trade which made Oregon one of the nation's great wheat exporting states.

The most serious drawback to Oregon's growth between 1860 and 1880 was its isolation. Agitation for railroads began almost with settlement. In the 1860s abortive attempts were made to connect with the Union Pacific, then building to California, but it was not until 1883 that the Northern Pacific gave Oregon its first transcontinental line. During the next two decades railroads were extended through most of the populated areas of the state. Railroad advertising of subsidy land grants contributed to a population increase from 174,768 to 313,716 in the decade of 1880–90.

The basic economy remained agricultural until lumbering, which previously had satisfied mainly local needs, increased at the turn of the century. In 1900 Oregon was third in the nation in lumber production and by 1950 achieved first place. During World War I, spruce from Oregon's mills was used in manufacturing aircraft, and Oregon had a brief period of large-scale wooden shipbuilding activity. Essentially a raw-resource economy, Oregon suffered from the nationwide depression in the 1930s, but not to the degree experienced by more industrialized areas. World War II brought new industries to Portland, particularly metal shipbuilding, which. however, once again declined with the coming of peace. Diversification of the economy began with the building of power dams on the Columbia river in the 1930s, and after World War II the development of industries using large amounts of hydroelectric power introduced a new era in the economy of the western part of the state.

Politics. — During the Civil War, Oregon moved from its traditionally strong affection for the Democratic party to the Republican party. In its first 100 years of statehood, it had 18 Republican governors Yo 10 Democrats and 1 Independent. Between 1932 and 1944 Oregon voted for Democratic candidates for the presidency. In 1954 Richard L. Neuberger, the first Democratic senator in 39 years, was elected. Wayne L. Morse, who had been elected to the senate as a Republican in 1944 and re-elected in 1950, but withdrew from the party in 1952 and two years later became a Democrat, was elected to the senate on the Democratic ticket in 1956. In that year Oregon strongly supported the Republican candidate for president, but, in addition to Morse, elected a Democratic governor — its first in 21 years — and three Democratic representatives.

In 1958 the Republicans regained the governorship and in 1960 the state again supported the Republican candidate for president, but elected another Democratic senator, Maurine B. Neuberger, to succeed her recently deceased husband.

Oregon made political history in the first decade of the 20th century when it instituted governmental reforms and pioneered legislation to bring about popular government. Advanced social legislation, such as workmen's compensation and working mother laws, and woman suffrage were adopted by 1915. Public versus private power development was the principal issue in Oregon politics after 1930.

GOVERNMENT

Oregon's constitution served the state without amendment until 1902. It provided for the usual departments of government A two-house legislature, composed of 30 senators elected for four-year terms, and 60 representatives elected for two-year terms, meets in regular sessions beginning in January of odd-numbered years. The governor serves a four-year term; there is no lieutenant governor. A two-thirds vote of both houses is required to pass a bill over the governor's single-item and general veto He serves as ex officiomember of many departments and boards. With the growth of boards and commissions, the governor's appointive power became increasingly important.

The state's judiciary system consists of an elected supreme court of seven members which holds sessions at Salem and Pendleton; an elected circuit court serving 21 judicial districts; and district, municipal and county courts.

In 1902 the foundation for sweeping reforms in legislative practices was laid with the adoption of the initiative and referendum amendments. These two measures and a direct primary law were the principal features of the so-called Oregon system A peculiar feature of the primary law allowed Oregonians to participate indirectly in the election of their U.S. senators, thus anticipating in practice the federal constitutional amendment permitting direct election.

Outgrowths of these fundamental reforms were such measures as the corrupt practices act, recall, presidential primary and an act requiring the free distribution of a voter's pamphlet giving information on measures and candidates

After 1940 the state collected no real property taxes. Such taxes mere the source of local government revenues, while the state depended upon the graduated income tax, excise, inheritance taxes and income from state-controlled liquor outlets. A tax on gasoline financed highway construction and maintenance. The annual budget for state purposes in the early 1960s exceeded $300,000,000.

Local taxing agencies are prohibited by the constitution from raising a greater amount of revenue from property taxes (for purposes other than meeting bonded indebtedness) than their tax base plus 6%. The tax base is the total amount lawfully levied in any one of the three preceding years. It is possible for a taxing agency to raise its base by a majority vote of its voters.

*Oregon: Places of 5,000 or More Population (1960 census)**

Place	Population 1960	1950	1940	1920	1900
Total state	1,768,687	1,521,341	1,089,684	783,389	413,536
Albany	12,926	10,115	5,654	4,840	3,149
Altamont	10,811	9,419	—	—	—
Ashland	9,119	7,739	4,744	4,283	2,634
Astoria	11,239	12,331	10,389	14,027	8,381
Baker	9,986	9,471	9,342	7,729	6,663
Barnes	5,076	—	—	—	—
Beaverton	5,937	2,512	1,052	580	249
Bend	11,936	11,409	10,021	5,415	—
Coos Bay†	7,084	6,223	5,259	4,034	1,391
Corvallis	20,669	16,207	8,392	5,752	1,819
Dallas	5,072	4,793	3,579	2,701	1,271
Dalles City‡	10,493	7,676	6,266	5,807	3,542
Eugene	50,977	35,879	20,838	10,593	3,236
Forest Grove	5,628	4,343	2,449	1,915	1,096
Grants Pass	10,118	8,116	6,028	3,151	2,290
Hillsboro	8,232	5,142	3,747	2,468	980
Keizer	5,288	—	—	—	—
Klamath Falls	16,949	15,875	16,497	4,801	447
La Grande	9,014	8,635	7,747	6,913	2,991
Lebanon	5,858	5,873	2,729	1,805	922
McMinnville	7,656	6,635	3,706	2,767	1,420
Medford	24,425	17,305	11,281	5,756	1,791
Milwaukie	9,099	5,253	1,871	1,172	—
Newport	5,344	3,211	2,019	580	256
North Bend	7,512	6,099	4,262	3,268	—
Ontario	5,101	4,465	3,551	2,039	445
Oregon City	7,996	7,682	6,124	5,686	3,494
Oswego	8,906	3,316	1,726	1,818	—
Pendleton	14,434	11 774	8 847	7,387	4,406
Portland	372,676	373,628	305,394	258,288	90,426
Roseburg	11,283	8,390	4,924	4,381	1,690
St Helens§	5,022	4,711	4,304	2,220	2,289
Salem	49,142	43,140	36,908	17,679	4,258
Salem Heights	10,770	2,351	—	—	—
Springfield	19,616	10,807	3,805	1,855	353

*Populations are reported as constituted at date of each census †Coos Bay returned in 1940 as Marshfield ‡Returned in 1950 as The Dalles §St Helens Town only In 1910 it consolidated with Houlton

Note Dash indicates place did not exist during reported census, or data not available

POPULATION

Oregon's population grew slowly from 13,294 reported in the first official census in 1850 to 174,768 in 1884. It experienced its largest growth in numbers in 1900–10 and 1940–50. In the latter decade the number of inhabitants increased from 1,089,684 to 1,521.341. In 1960 the population was 1,768,687. Between 1900 and 1940, a population comprising a large proportion of older persons gave Oregon one of the lowest fertility ratios in the United States Population increase has been largely through in-migration Of the 1950 population 92 9% was native white, 5 5% foreign-born white. and 1.6% nonwhite. Oregon in 1960 had 18.2 persons per square mile to the United States over-all 49 6 persons, indicating that Oregon is still relatively underpopulated.

The 1960 census indicated that 62.2% of the state's inhabitants live in urban areas. It has two standard metropolitan statistical areas, which are Eugene and Portland. These areas had a total population of 984,787 or 55.7% of the total population of the state in 1960.

EDUCATION

Public Schools.—Public schools of Oregon are operated by local school districts. Reorganization reduced their number from 2,094 to about 700 in the late 1950s. An appointed state board of education has limited powers of policy making and supervision in such matters as standards, texts and teacher certification. It acts through the state department of education, headed by an elected superintendent. The board has financial and administrative jurisdiction over junior college districts (two in the early 1960s). State funds contribute to local district revenues theoretically on an equalization basis. The number of school-age children (7 to 18 years) increased from 89,500 in 1900 to more than 350,000 in the late 1950s. Total expenditures for school purposes in that period reached over $160,000,000 yearly.

Higher Education.— A state board of higher education operates eight institutions of higher learning: The University of Oregon at Eugene and its dental and medical schools, with teaching hospital, at Portland; Oregon State college (incorporated 1858), a land-grant college, at Corvallis; Portland State college (1955) at Portland; Oregon Technical institute, Klamath Falls (established 1946); and three colleges of education at Monmouth (chartered 1856), Ashland (established 1926) and La Grande (also 1926).

The state board of higher education advises junior college districts on matters of curriculum and staffs them through the services of a general extension division that has its headquarters at Portland. The state college operates an agricultural experiment station at Corvallis and nine branch stations.

The University of Oregon, established in 1872, gave its first instruction in 1876. It comprises schools of liberal arts, architecture and allied arts, business administration, education, health and physical education, journalism, law, military and air science and music, and a graduate school, as well as the medical and dental schools. By the late 1950s the university was enrolling more than 7,000 students annually, and its library totaled nearly 750,000 volumes.

Among the larger of the 13 independent colleges, some with church affiliations, are: Lewis and Clark college (Presbyterian, 1867), University of Portland (Roman Catholic, 1901) and Reed college (nonsectarian, 1911) in Portland; Willamette university (Methodist, 1842), Salem; Pacific university (Congregational, 1849), Forest Grove; and Linfield college (Baptist, 1849), McMinnville.

HEALTH, WELFARE AND CORRECTIONS

The state board of health by law is responsible for all matters relating to the protection of public health, but offers no treatment services. Programs include preventive medical services, sanitation and engineering, local health services and general administration County and district health units are autonomous, but the state may assume jurisdiction if local officials neglect or refuse to comply with state laws and regulations. This has rarely happened, although the state routinely provides direct basic public health services in small counties with insufficient population to maintain adequate local health programs.

The state operates two tuberculosis hospitals, two mental hospitals, homes for the mentally deficient and for the incapacitated aged, and schools for the blind and the deaf. It also supports local school programs of rehabilitation and education for exceptional children. The public welfare commission administers expenditure for old-age and general assistance, aid to dependent children. the blind and the disabled.

The state penitentiary is located at Salem. Oregon also has an institution of correction for first offenders. Hillcrest school at Salem and MacLaren school at Woodburn are operated for underage delinquents.

ECONOMY

The economy of Oregon is based upon the resources of its agricultural and pasture lands, its forests and water power. Of its wage-earning population, roughly 30% is engaged in manufacturing, principally lumbering. Wholesale and retail trades: service and miscellaneous occupations employ an additional 35% of the population. Nonagricultural industries, including lumbering. fall into the category of highly skilled occupations. By the early 1950s, 43.1% of the nonagricultural labour force belonged to labour unions, as compared with 32.6% for the nation. Portland (*q.v.*) is the chief industrial centre, but Eugene (*q.v.*) and the towns in the Coos Bay area are the centres of the lumbering industry.

Agriculture. — Agriculture, on which the state's economy was based until the timber resources began to be exploited in the first decade of the 20th century, remains the second most important industry in Oregon. Wheat is the staple crop, and Portland is one of the leading wheat ports of the United States. Production of fruits, nuts, nursery stock and seeds, however, approximates in value that derived from the staple grain. Dairy products account for about two-fifths of the state's farm income. In the second half of the 20th century the trend was toward a decreasing number of farms and an increasing number of acres in individual holdings; less than 10% of farms were held in tenancy. Where precipitation is not sufficient for dry farming. irrigation has made profitable otherwise unproductive lands. Approximately 1,500,000 ac. are under irrigation in the principal irrigation districts of Owyhee, Deschutes, Umatilla, Klamath and Rogue rivers and in lesser districts.

Lumbering. — Oregon contains the largest body of standing timber in the U.S., and its annual cut of lumber is the largest in the nation. Lumbering is the state's most important industry. lumber and lumber products accounting for about three-fifths of value added by all manufactures in the state. In Oregon's mills, 58% of the U.S. plywood, 30% of its fir doors, 29% of its hardboard, particle board and chip board and 28% of its shingles and shakes are produced. New processes of tree utilization in which waste was markedly reduced increased estimates of the state's usable timber to approximately 469,000,000 bd.ft., largely of softwoods such as Douglas fir and ponderosa pine. Capital attracted to investment in Oregon's forest resources has resulted in the gradual disappearance of small mill operations and the concentration of the industry in larger plants. The automobile also has contributed to revolutionizing the industry and the logger's life. Trucks haul logs to the plants from large and otherwise inaccessible areas; the labour force lives in permanent towns.

Fisheries. — One of the world's great salmon rivers is the Columbia, which bounds Oregon on the north, and during the last three decades of the 19th century fishing was a principal industry along the lower reaches of the river. After that time the catch, especially of quinnat salmon, markedly declined, but the industry survives on catches of other species of salmon, intermittent runs of albacore and increasing catches of bottom fish and shrimp. Sport fishing in mountain and coastal streams is encouraged by conservation and stocking of streams from state-owned and operated hatcheries.

Mining. — Mining was important in the 1850s when some gold mines were productive. After 1925, the principal mineral products were cinnabar (mercury), quarry stone, sand and gravel. Of a total annual value of around $43,000,000 in mineral production, various products including undisclosed quantities of semiprecious stones, diatomaceous earths, tungsten and uranium accounted for about $16.000.000.

Manufacturing. — Manufacturing other than lumbering is only modestly developed in Oregon. Of 5,870 establishments, only 278 employed more than 100 persons, according to the 1954 census of manufactures. Food and food products, pulp and paper products. fabricated and primary metal products, and nonelectrical machinery. transportation equipment and chemicals and chemical products comprise the principal manufactures. Bonneville. The Dalles and McNary dams on the Columbia river and smaller installations on other rivers produce nearly 2.000.000 km. of electric power yearly. Undeveloped hydroelectric power is estimated at close to 6,000,000 kw. The establishment of electrometallurgical industries in Oregon was associated with power development.

Transportation and Communication. — The main steam railway lines serving Oregon are the Southern Pacific, Union Pacific. Great Northern. Northern Pacific and Spokane, Portland & Seattle railways. Development of motorbus and truck lines reduced railroad traffic within the state. Trans-Pacific and transcontinental airline connections are made at Portland, and eight airlines run scheduled flights across the state. Astoria and Portland are river ports for ocean vessels; Coos bay and Yaquina bay serve as shipping ports for the lumber trade.

Portland, Salem and Pendleton are connected with freeways and expressways. Of the state's 62,000 mi. of roads and highways, almost 40,000 mi. are surfaced. There is a registered motor vehicle for every two persons living in the state and a telephone for every three persons. There are more than 60 AM and FM radio stations and 7 television stations. Oregon has more than 20 daily and other newspapers, the *Portland Oregonian* being one of the oldest and having the largest state-wide circulation.

See also references under "Oregon" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (D. O. J.)

OREGON GRAPE (*Mahonia aquifolium*), a North American evergreen shrub of the family of Berberidaceae, closely allied to the barberry (*q.v.*), and found from British Columbia to Oregon. It grows from three to ten feet high and bears large pinnate leaves composed of five to nine thick. spiny-toothed, somewhat hollylike leaflets, bright yellow flowers in erect racemes. followed by showy clusters of small blue berries. The plant is the floral emblem or state flower of Oregon, and is widely grown as an ornamental.

OREGON MYRTLE (*Umbellularia californica*), a North American tree of the laurel family (Lauraceae, *q.v.*), called also California laurel, native to Oregon and California. It occasionally attains a height of 90 ft. and a trunk diameter of 5 ft., but is usually much smaller. The tree features lance-shaped, fragrant evergreen leaves, greenish-yellow flowers, in small clusters, and a somewhat olivelike. dark purple fruit (drupe). The wood is one of the most valuable cabinet timbers of the Pacific states.

OREGON PINE: *see* DOUGLAS FIR.

OREGON TEA TREE (*Ceanothus sanguineus*), a name given to a large shrub of the buckthorn family (Rhamnaceae), called also buckbrush, native from northern California to British Columbia and eastward to Montana. It grows about ten feet high and bears reddish branchlets, thin, smooth, ovate, toothed leaves, and compound clusters, two to four inches long, of small white flowers. As in the case of the New Jersey tea (*q.v.*), its leaves have been used as tea. (See CEANOTHUS.)

OREGON TRAIL, one of the most famous emigrant routes in U.S. history, traversed about 2,000 mi. of all kinds of terrain from Independence, Mo., to the Columbia river country of Oregon. Its greatest popularity as a route to Oregon was in the 1840s when perhaps 12,000 persons traveled the full distance. The trail had been used earlier by a few hundred emigrants and as late as 1900 an occasional traveler could still be seen on it.

Wilson Price Hunt, bound for Astoria, led a party of fur trappers along the western portion of the trail in 1811–12. A year later the returning Astorians under Robert Stuart followed a much longer part of the trail. In the 1820s and 1830s hundreds of mountain men used parts of the route, and some of them, such as James Bridger and Thomas Fitzpatrick, later served as guides for emigrants and soldiers on the trail. In the 1830s missionaries, scientists and sportsmen attached themselves to the fur brigades. Then in 1841 the migration of homeseekers began with the Bidwell-Bartleson party, 32 of whom reached Oregon. More than 100 went to Oregon under the leadership of Elijah White in 1842, and in 1843 Marcus Whitman (*q.v.*) helped guide the "Great Migration" of about 1,000 persons. There were fluctuations in the volume of travel thereafter but by 1848 enough Americans had reached the northwest to warrant the organization of Oregon as a territory (*see* OREGON: History).

Meanwhile, beginning in 1847, the first of many thousands of Mormons began to use a trail across Wyoming. The Mormon trail began at the present site of Omaha, Nebr., and, unlike the Oregon trail, remained on the north side of the Platte river all the way to Ft. Laramie, Wyo., but from that point to western Wyoming, the Mormon trail and the Oregon trail could rarely be distinguished.

In 1849 the homeseekers moving along the eastern part of the Oregon trail were joined by a great flood of gold seekers bound for California. A few thousand California-bound emigrants had used the eastern part of the Oregon trail before 1849 but they were but a small vanguard in comparison with the gold rush hordes. At least 50,000 crowded through South pass in the summer of 1850, almost all of them on their way to the California gold fields, and heavy traffic continued for years thereafter. The eastern half of the Oregon trail might more appropriately be called the Oregon-California-Utah trail inasmuch as the people bound for California and Utah after 1847 outnumbered those who were bound for Oregon by perhaps 50 to 1.

The persistent popularity of the name Oregon trail can be attributed to Francis Parkman's classic volume of the same name. Parkman traveled over no more than the eastern third of the Oregon trail on his famous visit to Ft. Laramie and the Laramie plains in 1846. His book based on his experiences was first called *The* Oregon and California Trail but for later editions the shortened title was adopted.

The Oregon trail in its 2,000-mi. length was rarely a single track. In places it was ten miles wide as emigrants spread out for better grazing or to avoid the dust. Cutoffs and alternate routes multiplied as resourceful pioneers constantly sought for improvements. Starting from northwestern Missouri near Independence the emigrants went west into Kansas and then made almost a beeline to the Platte river in south central Nebraska. They followed the south side of the river to the junction of the South Platte and North Platte. Crossing the South Platte the travelers continued on the south side of the North Platte to Ft. Laramie. Beyond that famous way station in eastern Wyoming the travelers remained on the south side of the river until 1850 after which there was travel on the north side as well. In the vicinity of present Casper, Wyo., all who had not already done so crossed to the north side by ford, ferry or bridge, struck the Sweetwater river and followed that pleasant stream to South pass. Beyond this great natural gateway in the continental divide three main routes diverged. The "Great Migration" of 1843 turned southwest to Ft. Bridger and then northwest to the Bear river, their route forming a V. Most Oregon-bound emigrants, however, did not go to Ft. Bridger, preferring to cross the top of the V along what came to be known as Greenwood's or Sublette's cutoff. A third main route, still farther north, was opened as the Lander road in 1857. All three routes led to the Bear river and on to Fort Hall and the Snake river in the present state of Idaho. Those whose destination was Utah went mainly by way of Ft. Bridger, as did some who were headed for California. The main California trail, however, branched off from the Oregon trail beyond Fort Hall. Emigrants destined for Oregon followed the Snake river for 300 mi., crossing it twice before leaving it to take a more direct route to the Columbia through Grande Ronde valley and over the Blue mountains.

From Independence, Mo., to the Columbia took four to six months in covered wagons drawn by oxen, mules or horses. There were many sharp inclines, dangerous water crossings and long stretches of desert. Occasionally Indians ran off the livestock or attacked the emigrants. Yet many of the travelers found time to pause in Wyoming to carve their names on Register cliff and Independence rock, and their work was still visible more than a century later.

BIBLIOGRAPHY: Federal Writers' Project, *The Oregon Trail* (1939); Walter E. Meacham, *Old Oregon Trail* (1948); Paul C. Henderson, *Landmarks on the Oregon Trail* (1953). (T. A. LN.)

O'REILLY, JOHN BOYLE (1844–1890), Irish-American politician and journalist, was born near Drogheda, Ire., June 28, 1844, the son of a schoolmaster. After some years of newspaper experience, during which he became an ardent revolutionist and joined the Fenian organization known as the Irish Republican Brotherhood, he enlisted in 1863 in a British cavalry regiment with the purpose of winning over the troops to the revolutionary cause. At this period wholesale corruption of the army, in which there was a very large percentage of Irishmen, was a strong feature in the Fenian program, and O'Reilly was successful in disseminating disaffection in his regiment. In 1866 the extent of the sedition in the regiments in Ireland was discovered. O'Reilly was tried by court-martial and sentenced to be shot, but the sentence was commuted to 20 years' penal servitude. After confinement in various English prisons, he was transported in 1867 to Bunbury, Western Australia. In 1869 he escaped to the United States and settled in Boston, where he became editor of *The Pilot*, a Roman Catholic newspaper. He subsequently organized the expedition which rescued all the Irish military political prisoners from the Western Australia convict establishments (1876). He was the author of several volumes of poetry, and of a novel of convict life, *Moondyne* (1879).

He died in Hull, Mass., on Aug. 10, 1890.

See J. J. Roche, *Life of John Boyle O'Reilly* (1891).

OREL (ORLOV), an *oblast* in the Russian Soviet Federated Socialist Republic, U.S.S.R., surrounded by the oblasts of Tula, Kaluzhsk, Bryansk, Lipetsk, Kursk and Voronezh (*q.v.*). Area 9,537 sq.mi. Pop. (1959) 926,000.

Orel forms part of the Black Earth area (central), which was created in 1928. The region consists mainly of dissected plateau, drained by the Oka and its tributaries, flowing into the Volga, and the Sosna. On the water partings between streams, the Kurgans or artificial mounds, some containing burials and some being remains of earthworks, stand out.

In the Bolkhov and Dmitrov districts, the soil is podzol (see RUSSIA: Soils and Their *Influence*), but the rest of the region is covered with black earth. The forests have almost disappeared and a scarcity of wood and fuel exists. Average January temperature 14.8° F., average July 67°.

The chief crops are rye, oats, potatoes, millet and hemp. Very little wheat or sunflower seed is grown. Cattle, sheep and pigs are bred; in pre-World War I times Orel was noted for horse breeding, but their numbers diminished greatly because of war requisitions and they were slow to recover. Livensk and Maloarchangelsk have, however, recovered their former position in regard to horse breeding. Factory industries include the making of chemical manure from the phosphorites of the region, iron mining and smelting in the Zinoviev district, near Dmitrovsk, and at Elets, flour milling, distilling, leather and chalk. Koustar (peasant) industries include the making of plows, rope, makhorka tobacco, carpets and, in Elets, lace. The region suffered much during the civil war 1917–20, and Elets changed hands several times. The chief towns are Orel and Elets.

In the 9th century a Slav tribe, the Vyatichis, was established on the Oka river and paid tribute to the Khazars. They recognized the rule of Rurik from 884 and were later absorbed in the principality of Chernigov. Their wealthy towns and villages were devastated by the Mongols in 1239–42 and the region was reduced to poverty. The Russians erected forts and established colonies in the 16th century. In 1610 Orel then known as the Ukrayna or Ukraine (*i.e.,* "border region") was the scene of civil warfare under the false Demetrius. From 1917 to 1920 it was again the scene of civil struggles.

Orel, the chief town of the *oblast,* situated at the confluence of the Orlik with the Oka river, and at the junction of roads and railways Linking it with Moscow, Bryansk, Kharkov and the east, in 53° N., 36° 8′ E. Pop. (1959) 152,000.

O'RELL, MAX, the *nom-de-plume* of PAUL BLOUET (1848–1903), French author and journalist, who was born in Brittany in 1848. He is chiefly remembered for his once famous book, *John Bull et son ile*. He died in Paris. on May 2j, 1903.

QRELLANA, FRANCISCO DE (c. 1490–*c.* 1546), Spanish soldier and first discoverer of the Amazon, was born at Truxillo about 1490. He sailed for Peru in 1535, and in 1540–41 accompanied Pizarro's expedition from Quito to Napo in the capacity of lieutenant. Early in 1541 he was sent ahead of the main party to obtain provisions, but he deserted his charge, either from necessity or choice, and continued his journey down the Rio Napo to the valley of the Amazon, whose course he explored from its source in the Andes to the Atlantic; he reached the coast in Aug. 1541. He is reported to have encountered a tribe of female warriors, of whom he had been told by the Indians, and from whom the name of the river is derived. On his return to Spain he was granted the right to conquer the newly discovered lands, but an expedition, undertaken in 1544 for this purpose. met with little success. Orellana died, probably in Venezuela, about 1j46.

See "The Voyage of Francisco de Orellana down the River of the Amazons," trans. C. R. Markham, from A. de Herrera's *Historia general de las Indias occidentales,* Hakluyt Society *Publications,* vol. xxiv (1859).

ORELLI, JOHANN CASPAR VON (1787–1849), Swiss classical scholar, was born at Zurich on Feb. 13, 1787. His cousin, JOHANN CONRAD ORELLI (1770–1826), was the author of several works in the department of later Greek literature. From 1807 to 1814 Orelli worked as preacher in the reformed community of Bergamo and published *Contributions to the History of Italian Poetry* (1810) and a biography (1812) of Vittorino da Feltre, his ideal of a teacher. In 1814 he became teacher of modern languages and history at the cantonal school at Chur (Coire); in 1819, professor of eloquence and hermeneutics at the Carolinum in Ziirich, and in 1833 professor at the new university, the foundation of which was largely due to his efforts. He had already published (1814) an edition, with critical notes and commentary, of the *Antidosis* of Isocrates. The three works upon which his reputation rests are the following. (1) A complete edition of Cicero in seven volumes (1826–38). (2) The works of Horace (1837–38; 4th ed., 1886–92). (3) *Inscriptionum Latinarum Selectarum Collectio* (1828; revised edition by W. Henzen, 1856). His editions of Plato (1839–41, including the old scholia, in collaboration with A. W. Winckelmann) and Tacitus (1846–48, new ed. by various scholars, 1875–94) also deserve mention. Orelli died at Zurich on Jan. 6, 1849.

See *Life* by his younger brother Conrad in *Neujahrsblatt der Stadtbibliothek Zurich* (1851); J. Adert, *Essai sur la Vie et les Travaux de Johann Caspar Orelli* (Geneva, 1849); H. Schweizer-Sidler, *Gedächtnisrede auf Johann Caspar Orelli* (Ziirich, 1874); C. Bursian, *Geschichte der klassischen Philologie in Deutschland* (1883).

ORENBURG (CHKALOV), an *oblast* of the Russian S.F.S.R. consisting of the former Orenburg and Orsk districts of the larger pre-1914 province of the same name. Area 47,799 sq.mi. Pop. (1959) 1,831,000. It is a narrow strip between Bashkiria on the north and Kazakstan on the south, widening out to the east and west. The province is hilly, except for the valleys of the Ural river and its tributaries, the Sakmara and the Or. It belongs to the region of perennial drought and dry and desert steppe. The soils are chestnut-brown clays and sands with salt efflorescences, on which crops can be raised successfully if drought is not too severe and if careful attention is paid to manuring and to the type of cultivation. Some fertile black earth occurs in the valleys. The average January temperature is 3.4° F., July 70.9° F., average rainfall 15.2 in. Coal and rich layers of rock salt are found near Iletsk, in the south of the province and phosphorite exists. The peasants are specially skilled in the preparation of leather, and the women knit the famous Orenburg goats' wool shawls.

The district lies on the border region between the territory of the Bashkirs and that of the Kirghiz; the Bashkirs were brought under Russian rule in 1557, and the fort of Ufa was built to protect them from Kirghiz raids. The frequent risings of the Bashkirs and the raids of the Kirghiz led the Russian government in the 18th century to erect a line of forts and blockhouses on the Ural and Sakmara rivers, which were afterward extended southwestward toward the Caspian and eastward toward Omsk, and Chkalov became the central point of these military lines.

ORENBURG (CHKALOV), the chief town of the *oblast* of the same name in the Russian S.F.S.R., on the Ural river in 51° 46′ N., 55° 7′ E. Pop. (1959) 260,000. The opening of the Orenburg-Tashkent railway in 1905 greatly increased its importance, and it has an important railway workshop for this line. Its industries include the making of metal goods and bricks, sawmilling and brewing. Trading caravans from the central Asiatic republics bring carpets, silk, cotton, lambskin, wool and dried fruits to Orenburg to exchange against textiles, metal goods and other products of European Russia. Cattle, horses and sheep from the steppe lands are brought to its market, and animal products including frozen meat, hides, sheepskins, tallow and bristles are sent by rail to Samara and the west. Its population is mixed and includes Russians. Tatars. Kirghiz and Bashkirs, among others. In 1735 a fort was erected at the confluence of the Or and Ural rivers as an outpost of Russia against the Bashkirs and Kirghiz. and was called Orenburg. In 1740–43, the fortress was moved 120 mi. down the Ural river to its present position and the former Orenburg was renamed Orsk. Heavy fighting occurred here after the 1917 revolution, and in that year its population was swollen to 140,588 by refugees. During the famine of 1920–21, the town suffered severely and the population dropped proportionately.

ORENDEL, a Middle High German poem, of no great literary merit, dating from the close of the 12th century. The story is associated with the town of Treves (Trier), where the poem was probably written. The introduction narrates the story of the Holy Coat, which, after many adventures, is swallowed by a whale. Orendel, son of King Eivel of Treves, who had embarked with 22 ships in order to woo the lovely Brida, the mistress of the Holy Sepulchre, is wrecked, and falls into the hands of the fisherman Eise, in whose service he catches the whale and recovers the Holy Coat. The poem exists in a single manuscript of the 15th century, and in one printed version dated 1512. It has been edited by F. H. von der Hagen (1844), L. Ettmüller (1858) and A. E. Berger (1888); there is a modern German translation by K. Simrock (1845).

See H. Harkensee, *Untersuchungen über das Spielmannsgedicht Orendel* (1879); F. Vogt, in the *Zeitschrift fur deutsche Philologie,* vol. xxii (1890); K. Miillenhoff, in *Deutsche Altertumskunde,* vol. i, 2nd ed. (1890), pp. 32 *seq.;* R. Heinzel, *Über das Gedicht von König Orendel* (1892).

ORENSE, an inland province of northwestern Spain, formed in 1833 of districts previously included in Galicia, and bounded on the north by Pontevedra and Lugo, east by Leon and Zamora, south by Portugal, and west by Portugal and Pontevedra. Pop. (1950) 494,253; area 2.695 sq.mi. The province is almost everywhere mountainous. Its western half is traversed in a southwesterly direction by the Mifio river; the Sil, a left-hand tributary of the Miño, waters the northeastern districts; and the Limia rises in the central mountains and flows west-southwest, reaching the sea at the Portuguese port of Viana do Castello. The railway from illonforte to Vigo runs through the province. There are iron foundries. The chief towns (mun. pops.) are Orense (q v.), Allariz (9,847), Carballino (9,958), Viana del Bollo (8.788) and Nogueira de Ramuin (8.174). The province fell to insurgent troops early in the civil war of 1936–39.

ORENSE, an episcopal see and the capital of the Spanish province of Orense, on the left bank of the Mifio river, and on the Tuy-Monforte railway. Pop. (1950) 55,030 (mun.). The river is there crossed by one of the most remarkable bridges in Spain. It was built by Bishop Lorenzo in 1230, but has frequently been repaired. The image of El Santo Cristo in the Gothic cathedral is celebrated throughout Galicia. The warm springs known as Las Burgas attract many summer visitors; the waters were well known to the Romans, as their ancient names, Aquae Originis, Aquae Urentes or perhaps Aquae Salientes, clearly indicate. They named Orense Aurium, probably from the alluvial gold found in the Miño valley. Chocolate and leather are manufactured, and there are sanmills, flour mills and iron foundries.

OREODONT, vernacular name for any member of the extinct family Merycoidodontidae. The oreodonts were piglike in general appearance and structure. but the teeth were like those of ruminants. They were related to both pigs and ruminants. but only distantly. Extremely abundant and varied throughout most of the age of mammals (late Eocene through Pliocene) in North America, oreodonts have not been found on other continents. (G. G Si)

ORESME, NICOLE (c. 1320–1382), French royal chaplain and bishop of Lisieux. a student and translator of Aristotle and the author of a treatise on monetary policy, was born about 1320, at Allemagne, near Caen in Normandy. As a young man, he studied theology, but it is not known when he took his degree. He was a bursar in the college of Navarre in the University of Paris from 1348 to Oct. 1356, when he became master of the college, resigning in Dec. 1361. He was a canon (1362) and then dean (1364) of Rouen and preached before Pope Urban V on Christmas Eve 1363. He had been appointed a chaplain to King Charles V by 1370, and was elected bishop of Lisieux in Nov. 1377 and consecrated in Jan. 1378. He died at Lisieux on July 11, 1382.

At the request of Charles V. Oresme translated the Ethics, Politics and Economics of Aristotle from their current Latin versions. and he wrote against the claims of astrologers to predict the future His treatise De moneta was probably written about 1360. The first printed edition appeared in 1484 and it was frequently reissued in the 17th century. It derived from the Politics and was directed against any debasement of the coinage, such as had been practised in France before 1360. Oresme regarded the coin as a definite weight of precious metal, its fineness guaranteed by the issuing authority; it belonged, in his view, to the public, not to the prince, who had no right to vary its standard, weight or bimetallic ratio. Rather remarkably, he took no account of credit nor of bills of exchange, although they were in general use by the 14th century.

See C. Johnson (ed. and trans.), *The De Moneta of Nicholas Oresme (1956)*; *E.* Bridrey, *La Thedrie* de *la monnaie au XIV^e^ siècle (1906).* (C. J.)

ORESTES, in Greek legend, son of Agamemnon and Clytaemnestra. According to the Homeric story he was absent from Mycenae when his father returned from the Trojan War and was murdered by Aegisthus and Clytaemnestra. Eight years later he returned from Athens and revenged his father's death by slaying his mother and her paramour (Odyssey, iii. 306; xi. 542). For later forms of the legend of his return, see ELECTRA.

In post-Homeric writers, Orestes, after the deed, is pursued by the Erinyes (*q.v.*). He takes refuge in the temple at Delphi. Apollo sends him to Athens to plead his cause before the Areopagus. The Erinyes demand their victim; he pleads the orders of Apollo; the votes of the judges are equally divided, and Athena gives her casting vote for acquittal. The Erinyes are propitiated by a new ritual, in which they are worshipped as Eumenides (the Kindly), and Orestes dedicates an altar to Athena Areia. According to Euripides, some of the Erinyes were not satisfied, so Orestes mas ordered by Apollo to go to Tauris, carry off the statue of Artemis which had fallen from heaven, and bring it to Athens. He repairs to Tauris with Pylades, the son of Strophius and the intimate friend of Orestes, and the pair are at once imprisoned by the people, among whom the custom is to sacrifice all strangers to Artemis. The priestess of Artemis, whose duty it is to perform the sacrifice, is his sister Iphigeneia (*q.v.*). A recognition is brought about, and all three escape together, carrying with them the image of Artemis. After his return to Greece, Orestes took possession of his father's kingdom of Mycenae, to which were added Argos and Laconia. To gain possession of Hermione, whom Neoptolemus had married, he murdered the latter at Delphi. He is said to have died of the bite of a snake. The development of the legend is the result (a) of the post-Homeric horror of bloodshed (Erinyes; to Homer. Orestes does nothing which is not entirely admirable); (b) of the growing interest in cases of conscience (conflict of the duty of revenge and the sacredness of his mother's person); (c) of the development of modern ideas of ethics and jurisprudence (the Areopagus consider motive and mitigating circumstances, instead of merely regarding the act); (*d*) of the replacement of blood-feud by state intervention and formal trial.

See Jebb, introduction *to* Sophocles, *Electra;* Hofer in Roschera *Lexikon,* art. "Orestes." (H. J. R.)

ORFE or GOLDEN ORFE, a variety, originating in Germany, of the ide (*Idus idus*), one of the Cyprinidae and allied fairly closely to the roach (q v).

ORFILA, MATHIEU JOSEPH BONAVENTURE (1787–1853), French toxicologist and chemist, was by birth a Spaniard, having been born at Mahon in Minorca on April 24, 1787. After studying medicine at the universities of Valencia and Barcelona, he settled in Paris to study under the chemist L. N. Vauquelin. In 1811 he graduated and immediately became a private lecturer on chemistry in the French capital. In 1819 he was appointed professor of medical jurisprudence, and four years later he succeeded Vauquelin as professor of chemistry in the faculty of medicine at Paris. In 1830 he was nominated dean of that faculty. He died in Paris on March 12, 1853. Orfila's fame rests on his *Traité* des poisons, or *Toxicologie générale* (1813).

ORFORD, ROBERT WALPOLE, 1st EARL OF (1676–1745), generally known as SIR ROBERT WALPOLE. prime minister of England from 1721 to 1742, third son of Robert Walpole, M.P., of Houghton in Norfolk. was born at Houghton on Aug. 26, 1676. He was an Eton colleger from 1690 to 1695 and was admitted at King's college, Cambridge, as scholar on April 22, 1696. At this time he was destined. as a younger son, for the church, but the death of two elder brothers made him heir to an estate producing about £2,000 a year, whereupon he resigned his scholarship and was withdrawn from the university.

Walpole sat in parliament at first for the family borough of Castle Rising (1701) and then for King's Lynn, which he represented until he was raised to the peerage. In June 1705 he was appointed one of the council to Prince George of Denmark, the inactive husband of Queen Anne, and then lord high admiral of England. On Feb. 25, 1708, he succeeded Henry St. John as secretary at war, and was thus brought into immediate contact with the duke of Marlborough and the queen, With this post he held for a short time (1710) the treasurership of the navy, and was admitted to the inmost councils of the ministry. He could not dissuade Godolphin from the impeachment of Henry Sacheverell, and when the committee was appointed in Dec. 1709 to draw up the impeachment Walpole was nominated one of the managers for the house of commons. Walpole shared in the general wreck of the Whig party, and in spite of the flattery, followed by the threats, of Sir Edward Harley he took his place with his friends in opposition. Both in debate and in the pamphlet press he vindicated Godolphin from the charge of peculation, and in revenge for his zeal his political opponents brought against him an accusation of personal corruption. On these charges he was in 1712 expelled from the house and spent a short time in the tower.

His prison cell became the rendezvous of the Whigs, while his praises were sung in popular ballads. In the last parliament of Queen Anne he defended Sir Richard Steele against the attacks of the Tories.

After the accession of George, the Whigs for nearly half a century retained the control of English politics. Walpole, who had supported the Hanoverian succession, obtained the lucrative post of paymaster-general of the forces in the administration which was formed under the nominal rule of Lord Halifax, but of which James Stanhope and Townshend were the guiding spirits. Walpole was chairman of the committee appointed to inquire into the acts of the late ministry, and especially into the Peace of Utrecht. with a view to the impeachment of Harley and St. John. Halifax died on May 19, 1715, and after a short interval Walpole became first lord of the treasury and chancellor of the exchequer (Oct. 11, 1715). Jealousies, however, prevailed among the Whigs, and the German favourites of the new monarch quickly showed their discontent with the heads of the ministry. Townshend was forced to resign his secretaryship of state for the vice-royalty of Ireland, but he never crossed the sea to Dublin, and the support which Sunderland and Stanhope. the new advisers of the king. received from him and from Walpole was so grudging that Townshend was dismissed from the lord-lieutenancy (April 9, 1717), and Walpole on the next morning withdrew from the ministry. They plunged into opposition with unflagging energy, and in resisting the measure by which it was proposed to limit the royal prerogative in the creation of peerages (March–December 1718) Walpole exerted all his powers. This display of ability brought about a partial reconciliation of the two sections of the Whigs. To Townshend was given the presidency of the council, and Walpole reassumed the paymastership of the forces (1720).

On the financial crash which followed the failure of the South Sea scheme. Walpole was regarded by the general public as the indispensable man. Stanhope and James Craggs, the two secretaries of state, died. John Aislabie, the chancellor of the exchequer, was committed to the tower, and Sunderland, though acquitted of corruption, was compelled to resign. Walpole, at first lord of the treasury and chancellor of the exchequer (April 1721), became with Townshend responsible for the government (though for some years they had to contend with the influence of Carteret), the danger arising from the panic in South Sea stock was averted by its amalgamation with Bank and East India stock, and during the rest of the reign of George I they remained at the head of the ministry. The hopes of the Jacobites, which revived with these financial troubles, were disappointed. Atterbury, their boldest leader, was exiled in 1723; Bolingbroke sued for pardon and was permitted to return to his own country. Peace was assured by a treaty between England, Prussia and France concluded at Hanover in 1725.

In 1727 George I died, but the confidence which the old king had reposed in Walpole was renewed by his successor, after a brief period of coldness. and in Queen Caroline the Whig minister found a faithful and lifelong friend. For three years he shared power with Townshend, but quarrelled with him in 1730, and Townshend retired into private life. Walpole's administration was based on two principles, sound finance at home and freedom from the intrigues and wars which raged abroad. On the continent congresses and treaties were matters of annual arrangement, and England enjoyed many years of peace. Walpole's influence received a serious blow in 1733. The enormous frauds on the excise duties forced themselves on his attention, and he proposed to check smuggling and avoid fraud by levying the full tax on tobacco and wine when they were removed from the warehouses for sale. His proposals met with violent opposition and had to be dropped. Several of his most active antagonists were dismissed from office or deprived of their regiments, but their spirits remained unquenched, as the incessant attacks in the *Craftsman* showed, and when Walpole met a new house of commons in 1734 his supporters were far less numerous. The Gin Act of 1736 led to disorders in the suburbs of London; and the imprisonment of two notorious smugglers in the Tolbooth at Edinburgh resulted in the Porteous riots described in the *Heart of Midlothian*. These events weakened Walpole's influence in the country, but his parliamentary supremacy remained unimpaired, and was illustrated in 1737 by his defeat of Sir John Barnard's plan for the reduction of the interest on the national debt, and by his passing of the Playhouse act, for the regulation of the London theatres.

That year, however, heralded his fall from power. His constant friend Queen Caroline died on Nov. 20, 1737, and Frederick, prince of Wales, whose request for an increase in his official allowance had been refused, became his active opponent. The prince controlled many boroughs within the duchy of Cornwall, and he attracted Pitt, the Grenvilles and others to his cause. The leading orators of England thundered against Walpole in the house of commons, and the press resounded with the taunts of the poets and pamphleteers, illustrious and obscure, who found abundant food for their invectives in the troubles with Spain over its exclusive pretensions to the continent of America and its claim to the right of searching English vessels. Walpole long resisted the pressure of the opposition for war, but at the close of 1739, as the king would not allow him to resign, he was forced into hostility with Spain. The Tory minority known as "the patriots" had seceded from parliament in March 1739, but at the commencement of the new session, in Nov. 1739, they returned to their places with redoubled energies. The successes of the troops brought little strength to Walpole's declining popularity, and in the new house of commons of 1741 political parties were almost evenly balanced. Their strength was tried immediately on the opening of parliament. Walpole was defeated. On Feb. 9, 1742 he was created earl of Orford, and two days later he ceased to be prime minister. A committee of inquiry into the conduct of his ministry for the previous ten years was ultimately granted, but its deliberations came to nothing. Walpole died at Arlington street, London, on March 18, 1745, and was buried at Houghton on March 25. With the permanent places, valued at £15,000 per annum, which he had secured for his family, and with his accumulations in office, he had rebuilt the mansion at great expense, and formed a gallery of pictures within its walls at a cost of £40,000, but the collection was sold by his grandson for a much larger sum in 1779 to the empress of Russia.

Walpole was twice married—in 1700 to Catherine Shorter (d. 1737) and in March 1738 to Maria Skerret.

Sir Robert Walpole's life has been written by Archdeacon William Coxe in 3 vol. (1798 and 1800), A. C. Ewald (1878) and John Viscount Morley (1889). *See* also Edward Jenks, *Walpole, a Study in Polittcs* (1894); *English Hist. Rev.* xv, 251, 479, 665, xvi, 67, 308, 439 (his foreign policy, by Basil Williams); Walter Sichel, *Bolingbroke,* 2 vol. (1901–02); the histories, letters and reminiscences by his son, Horace Walpole; and the other lives of the chief political personages of the period.

ORFORD, a small town on the River Alde, Suffolk, England, 20 mi. E.N.E. of Ipswich by road. Pop. (1931) 706. In the 12th century a thriving port, it had declined by the 16th century owing to the increase of the shingle spit known as Orford Ness which had pushed the mouth of the river farther down the coast. Of Orford castle the Norman keep remains, built of flint and Caen stone.

ORGAN. In music. organ is the name given to the familiar wind instrument played from keyboards (from Gr. ὄργανον; Lat. *organum,* instrument). It may be defined as a musical instrument gaining sound from pipes, these pipes being set on wind chests supplied with air under constant pressure. The flow of air to the pipes is controlled by intermediary mechanisms from one or more keyboards.

The name implies pipes; thus the designation "pipe organ" is redundant, as would be the term "string violin." A reed organ is more properly called a harmonium. Electronic devices devoid of pipes and reeds do not qualify for the name.

Early History: to 1500.—Music has been called the youngest of the arts, but among devices for the expression of music the organ is one of the oldest. and it was the first of the keyboard instruments. It is mentioned in the Old Testament. but the Greek word in Genesis translated "organ" is used in the same general sense that we use the term "instrument." Ancient fable ascribes the invention of the organ to Pan, the sylvan god, and relates that it was made from reeds that grew by the river. Considering the organ superior to the lyre of Apollo, Pan challenged Apollo to a trial of skill, which Midas, the umpire, decided in favour of Pan's pipes.

In principle of musical speech, the beginnings of the organ may be seen in primitive flutes, fashioned from reeds or hollow sticks. These were grouped together into a syrinx, or pan pipe, a collection of hollow tubes of various lengths, bound side by side, raft fashion, and blown from the top. Some time later came the discovery that tone could be produced by blowing from the base of a tube and by deflecting the flow of air out of a slot cut in the side of the tube just above a partial obstruction. Possibly the next phase in the development of the organ resembled the modern bagpipes, when some inventive genius assisted human lung power by devising a wind reservoir out of a skin, leading to a handful of pipes, all of them stopped by the fingers except the one intended to speak.

This led to the first organ of which there is an actual record. Ctesibius, a Greek engineer of the 3rd century B.C., living in Alexandria, is credited with the evolution of the *hydraulis,* an instrument with the essential characteristics of the modern organs. It had a set of pipes, each of a different pitch and controlled in their speech by keys or levers, which admitted or shut off the wind as desired. The *hydraulis* gained its descriptive name from the method by which a supply of wind was provided. A reservoir of air under the necessary constant pressure was obtained by the immersion in water of a large cup or bell, on the principle of a diving bell, within a large container. The water compressed the air upward within the bell, and as the air was drawn off by the speech of the pipes it was replenished by bellows, connected to the bell. The blowing arrangement was ingenious in its simplicity for. if the bell was kept full so that a surplus of air constantly escaped from the bottom, the pulsation of air from the bellows was evened out bv the constant weight and upward thrust of the water.

Hero in his *Pneumatica (c.* 3rd century B.c.) and Vitruvius in his De *Architectura (c.* 14 B.C.) describe the workings of this instrument. A clay model of a *hydraulis* was discovered in 188 j in the ruins of Carthage, and portions of an actual instrument were found in 1931 in Aquincum, near Budapest. Pictorial representations and writings of those centuries indicate that the *hydraulis* played a large part in the life of the period. Cicero .relates that it was used at banquets and speaks of its sound as being as de-

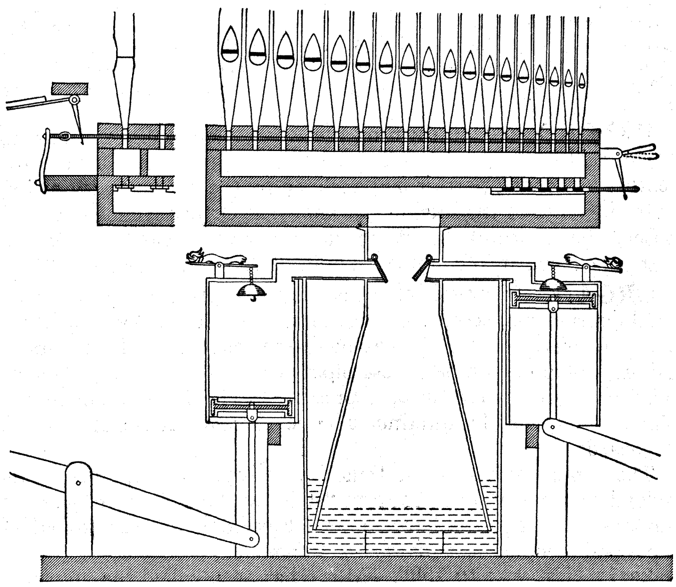

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FIG. 1.—HYDRAULUS BY AUDSLEY

lectable to the ear as the most delicious fish to the palate. Other writings indicate that the *hydraulis* was used in the arena to accompany fights and circus performances. A notable performer on this early organ was the Roman emperor Nero (37–68 A.D.), and it is related that on an occasion of particular danger, from an insurrection of the Gauls under Vindex, Nero summoned his political advisers to a meeting. but after a brief conference spent most of the day showing them a new type of *hydraulis.*

Over the next few centuries the *hydraulis* evolved into the pneumatic organ. an instrument in which bellows supplanted the hydraulic mechanism as the source of wind supply. The first representation of such an organ dates from the 4th century A.D., on an obelisk at Constantinople, erected by the emperor Theodosius (died 39 j A.D.). An earlier passage, even, in Pollux' *Onomasticon* from about the year 120 refers to "brazen pipes blown from below . . . by bellows." Descriptive references to the organ occur in an epigram by Julian the Apostate (331–363) and in the writings of St. Augustine (354–430). References to the organ occur fre-

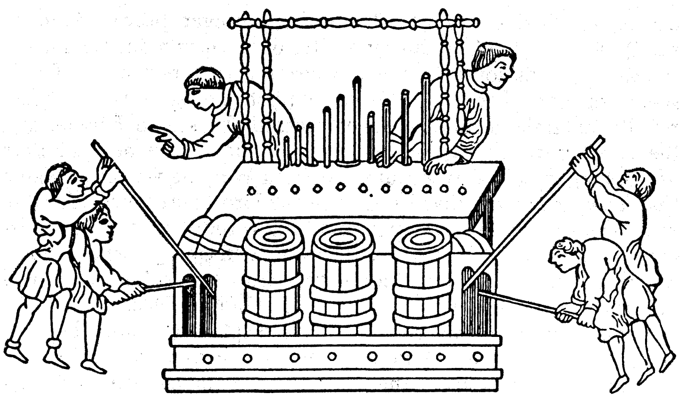

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FIG. 2.— ORGAN OF THE 11TH CENTURY

quently during the next few centuries, and the event of the year 757 for many writers was the arrival in Compiègne of an organ, a gift to King Pippin from the Byzantine emperor Constantine Copronymus. Around 950, a giant organ was constructed in England for the Old church in Winchester. It is vividly described by the monk Wulstan: "Twice six bellows are ranged in a row, and fourteen lie below . . . worked by seventy [seven?] strong men . . . the music of the pipes is heard throughout the town, and the flying fame thereof is gone out over the whole country. . . ."

It would be interesting to know just what music was played on such instruments, but no manuscripts of organ music appear to have survived from these early centuries. No doubt music played on the rather sketchy keyboards was purely vocal in character and probably of just one melodic line, though the presence of two players in the illustration of the Utrecht Psalter of about 800 prompts the speculation that the melody was occasionally embellished with a second part.

Around 1100 the cathedral of Magdeburg acquired a notable organ, and in 1360 a large instrument was built by the priest Nikolaus Faber for the Halberstadt cathedral. Michael Praetorius notes that it had three keyboards and pedals, and it was the first organ to have a complete scale of semitones. Most of the organs to that time had been constructed by priests or monks, but one Albert van Os, who lived during the 12th century, has the distinction of being the first professional organ builder on record.

The Organ from 1500.—By 1500 organs had evolved in size and in refinement of tone. Principles of voicing and ensemble became generally understood. Certain reeds, flutes and other solo stops mere added, expanding the tonal spectrum of the organ. and these new timbres nere developed into complete tonal families, grouped on different manuals. The pedal organ was gradually evolved. its compass was extended, and its musical possibilities began to be realized. The mechanism of keyboards and pedals and of stop control became more readily workable. Progress to this point is summarized in Arnolt Schlick's *Spiegel der Orgelmacher und Organisten* (1511). At the same time smaller instruments known as *Positivs* and *Portativs* came into general use. They were instruments of varying degrees of sonority; the *Positivs* were made small enough to be moved as occasion required, and the Portativs were occasionally used, as the accompanying illustrations show, in processions. Both types played a large part in music of the home, and much keyboard music of this period is interchangeable between the harpsichord and these small organs. Writing in 1676, Thomas Mace of Trinity college, Cambridge, describes and illustrates a small "table organ" that he built himself for his home. It included seven stops: diapason, principal, 12th, 15th, and "two-and-twentieth," regal and a "hooboy stop."

The expanding skill of the organ builder was matched by the growing imagination of the composer. From the 14th century on, a new style of writing developed at a great pace, exploiting the possibilities of the organ; and it was on organ manuals that keyboard music graduated from the imitatively vocal to the purely instrumental. The Reformation lent enormous impetus to organ composition, for the inspired and compelling chorales provided a musical treasure which composers later elaborated into countless chorale preludes and fantasies. Forms of composition took shape. the toccata, the various types of fugal writing; and the flowering of musical composition that took place over a period of almost four centuries centred largely around the Organ. Not only was the organ an expressive medium, but for musicians of those davs it was also the grandiose in music. Since most composers were also organists, they understood the nature of the instrument and set down some of their finest musical thoughts for the organ.

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FIG. 3.—MEDIAEVAL PORTATIVE

The progress of these centuries was described in its instrumental aspect by Praetorius in his *Syntagma musicum* of 1618; the musical side nas typified by the towering organ compositions of Johann Sebastian Bach (1685–1750). After 1750 the position of the organ in musical activity began to be challenged by the developing orchestra and by the newly invented pianoforte. The trend of musical composition was away from contrapuntal writing and toaard a percussive and chordal type of texture not suited to organ performdnce. Though some organ builders valued and preserved the classic traditions of the instrument. others attempted innovations of questionable merit. Wind pressures were raised in order to obtain greater volume of sound from pipes with the unfortunate result that mixture and mutation stops, which become shrill on high mind pressure. were gradually omitted in organ specifications. A variety of soloistic stops designed to imitate orchestral instruments were substituted for stops of the basic ensemble. In quest of .'expression" it became the habit to enclose practically all of the pipes in swell boxes with shutters which could blanket the tone in varying degree. With some notable exceptions, organ builders of the 19th century pursued the goal of a "romantic expressiveness," but frequently succeeded only in producing instruments of thickened sonorities embellished nith imitative orchestral stops, yet lacking in authentic organ ensemble.

During these years players tended to forget their unequalled heritage of music and spent much effort in attempting to imitate the orchestra and to play the orchestral repertoire on the organ. In the 20th century, the motion picture theatre organ made its entrance and its exit. Perhaps this sort of instrument, at its best only with the poorer types of music. may represent the culmination of this less fortunate phase of organ building, which bears little relation to the centuries-old tradition of the instrument.

On the other hand. the 20th century also saw a reawakening on the part of musicians and organ builders to the fundamentals of their art. In many modern organs practices of classic design and voicing became re-established, and this progressive trend restored the musical prestige of the instrument. Principles of ensemble—the blending of stops of different pitches into a homogeneous sonority—were carried out with increasing success. Low wind pressures were again recognized as essential, and many progressive organ builders left the mouths of most pipes unnicked, thus preserving a slight and agreeable accent in the speech. Moreover, it was realized anew that an organ ideally must be placed completely in the open, for undue enclosure will restrain and damage the tone. A pipe in the open is worth two in a box, for a soft sound, unenclosed, has presence and beauty, but a louder tone blanketed in a swell box, or even in the recess of an organ chamber, loses presence and is by no means a satisfactory substitute. Through modern ingenuity a good organ touch has the responsive character of the keys of a grand piano, with the particular difference that the speech of a pipe is unaffected by the degree of force with which a key is depressed. A more readily playable pedal board of radiating and concave design came into general use, replacing the previous flat and parallel pattern of keys.

The organ remains an instrument best suited to the horizontal rather than the vertical type of music—that is, to flowing contrapuntal lines rather than chordal structures—and an instrument of individual colours and a variety of ensembles not imitative of any of its musical relatives, but of a musically architectural character strictly its own. This return to the authentic tonal texture of the organ was paralleled by a new awareness of the instrument on the part of contemporary composers, and it is notable that the best of modern composition is closely allied to classic models, though harmony and idiom may be modern.

GENERAL DESCRIPTION

The sounds of an organ are produced by pipes of various lengths and shapes, set into musical speech by the flow of air under pressure. The sounding of these pipes is determined by the use of the keys, some of which are played by the hands. some by the feet. In appearance, the keys of an organ resemble those of a piano, but whereas a piano has one keyboard an organ may have several, each governing a division of pipes. in addition to a keyboard of pedals. played by the feet. The criterion of musical excellence inevitably resides in the voicing of the pipes, rather than in the size of the organ, and an instrument even of two manuals, with pedals, provides an adequate medium for by far the greater part of the organ repertoire, though instruments of three and four manuals offer advantages, and organs of as many as seven manuals have been built.

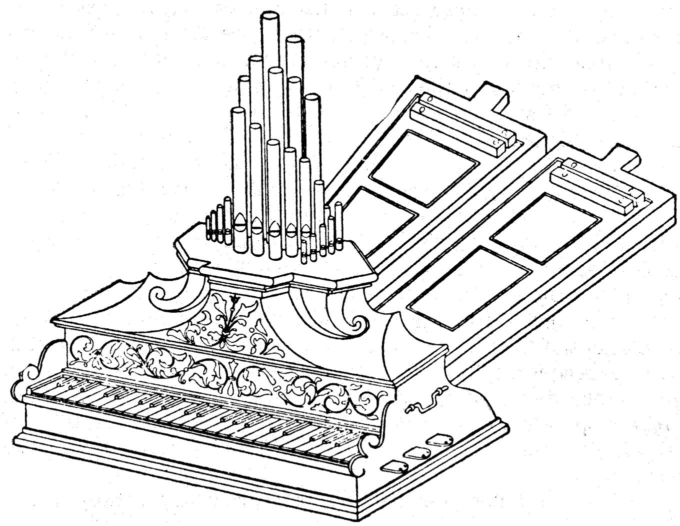

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FIG. 4 — POSITIVEORGAN OF THE 16TH CENTURY

Stops.—Organ pipes differ in two essentials from other wind instruments. A flute player, for example. obtains different notes by altering with his fingers the speaking length of his instrument and by blowing at different pressures. An organ pipe speaks one note only and is voiced for an unvarying wind pressure. Even were it mechanically possible to alter the effective speaking length at will, and to vary the pressure of the wind supply, no musical advantage would be gained, for it would be impossible to play more than one note at a time.

An organ stop, set, register or rank, of pipes necessarily comprises one pipe (or more: see Mixtures, below) for each note of the keyboard. Each stop is a member of a section or division, controlled from one of the keyboards, and each manual division is in turn a part of the complete organ. To an organ builder a stop implies a set of pipes, though the same name is also given to the knob or tablet at the console which actuates the valve or slider, admitting or shutting off wind to the rank of pipes. Each stop has a separate knob or tablet. just as each note has a separate key, and unless one or more of the stops be drawn no sound will result when the keys are played. The pipes of a given stop all produce sounds of similar quantity, but naturally of different pitches. No two stops are exactly alike in musical timbre; on the contrary, they are designed to differ. Some have a thin, some a full quality of tone, and, moreover, some stops are of high pitch, some of low.

Divisions, Compass. — From the grouping of pipes into a stop, we pass next to the grouping of several stops into a section or division. Each of these "organs" is played from its own keyboard or manual and has its own characteristic timbre and utility. Briefly, these divisions are: The great organ, the positive or choir organ, the swell organ, the solo, orchestral, or bombarde organ, and the echo or antiphonal organ. Moreover, on all but the smallest instruments, there is a pedal organ. The assignment on different manuals of these various divisions varies among builders and among different countries; but certain basic principles have become established. A one-manual organ will have the character of the great. A two-manual is best designed as a great and positive, or choir, though a two-manual will often be made up of a great and swell. A three-manual will almost invariably consist of a great. positive or choir, and swell, while the remaining divisions will be controlled from a fourth or from additional manuals.

The usual compass of organ manuals is 61 notes, five octaves, from C in the bass to C'''' in the treble. The customary pedal compass is 32 notes, just over $2\frac{1}{2}$ octaves, from CC in the bass (lowest C on the pianoforte) to the G above middle C. Thus a manual stop ordinarily comprises 61 pipes and a pedal stop 32 pipes, offering between the pedals and manuals a tonal compass of six octaves. However, the total compass of the organ is often larger by three or more octaves than the six octaves mentioned, for in addition to the normal 8-ft. stops (see Pitches of *Stops* below) there may be others speaking one or two octaves higher or lower than implied by the controlling note on the keyboard. Thus a 32-ft. pedal stop carries down the pitch an octave lower, low C having a frequency of 16 vibrations a second, while a 2-ft. manual stop will extend the upward pitch two octaves higher, giving high C a frequency of more than 8,000 vibrations a second.

Pipes. — Organ pipes fall chiefly into the two categories of flues and reeds. The flue pipe in principle is similar to a tin whistle, except that a flue pipe is designed to sound one note only. In reed pipes, the wind vibrates a curved brass tongue held over the cut and flattened side of a brass tube called a shallot, so that the oscillations of the tongue cause the speech of the pipe. Associated with the reed is a cylindrical cone or pipe which acts as a resonator, giving security of pitch and adding quality to the tone. Such an organ stop is known as a beating reed and differs considerably in sound from the free reed employed without a resonator in the harmonium.

The pitch of a flue pipe is set by its length and, generally speaking, the width of the pipe determines the volume and quality of the tone, a wider diameter giving a fuller tone and a narrower diameter producing a keener sound. This relation of width to length is referred to as the scale of the pipe. On the other hand, the pitch of a reed pipe depends on the length of tongue set into vibration and is also affected by the thickness and tension of the tongue and the length, shdpe and scale of the resonator.

Flue pipes may be open, with the top of the pipe open to the air; or they may be closed or stopped with a stopper or cap covering the pipe at the top. The diapasons and principals are all open pipes; gedeckts and bourdons are stopped. A stopped pipe will sound a note an octave lower than an open pipe of the same length; and the even-numbered harmonics of the tone become minimized, giving a light and rather transparent quality to the sound.

Another type of flue pipe is made of double length, open at the top, pierced about midway with a small hole. Known as harmonic pipes and having a very bright tone, these give a sound an octave higher than open pipes of the same length.

Stops of the same name vary considerably in character and strength among different organs and in work of different builders. Names of organ stops, therefore, denote a general character rather than a specific quality and volume of sound. In the case of stops bearing the names of orchestral instruments the resemblance is only approximate.

Flue Stops. — Flue stops fall into three general categories: flutes, principals and viols. Flutes themselves divide into open and closed pipes. There are the half-length and stopped pipes (gedeckts, bourdons — also occasionally called stopped diapasons); the normal length and open (melodia, claribel, concert flutes) or double length (the harmonic flute).

Another class of flutes (the Koppel flute, Ger. *Rohrflöte,* Fr.

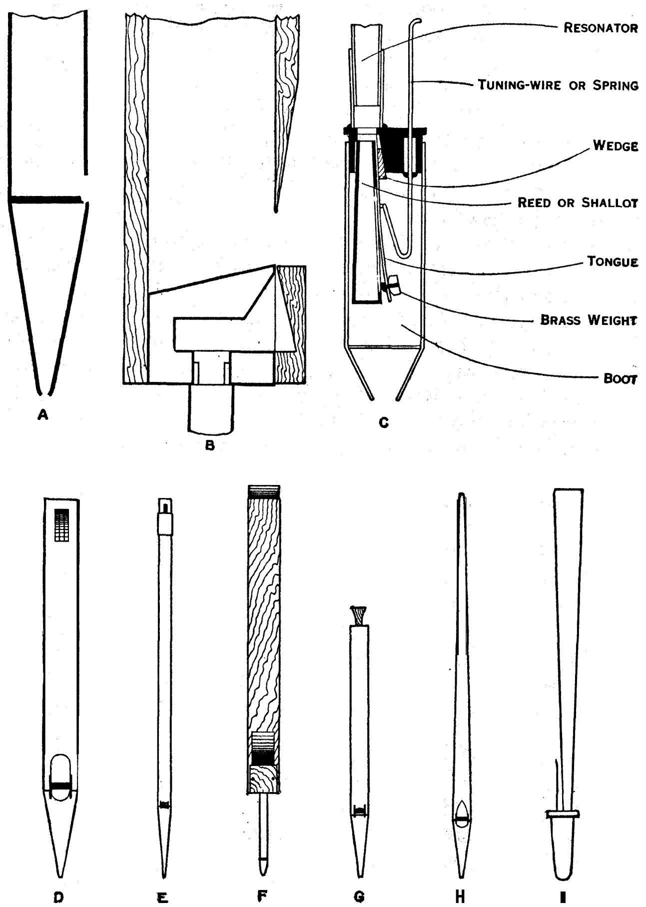
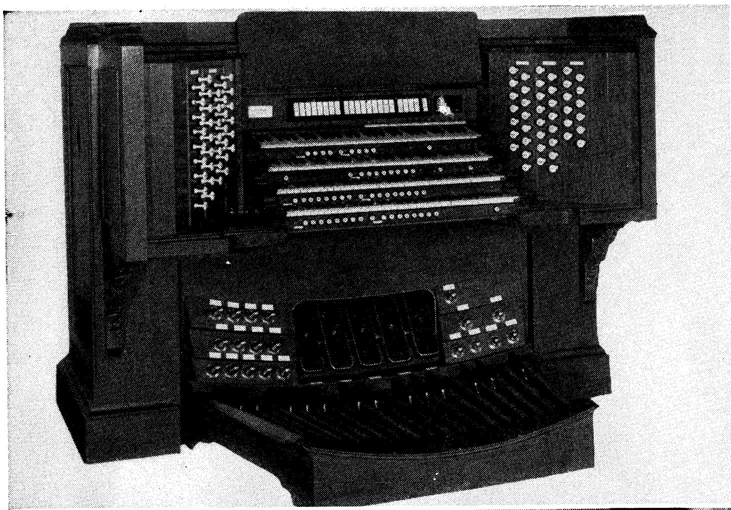


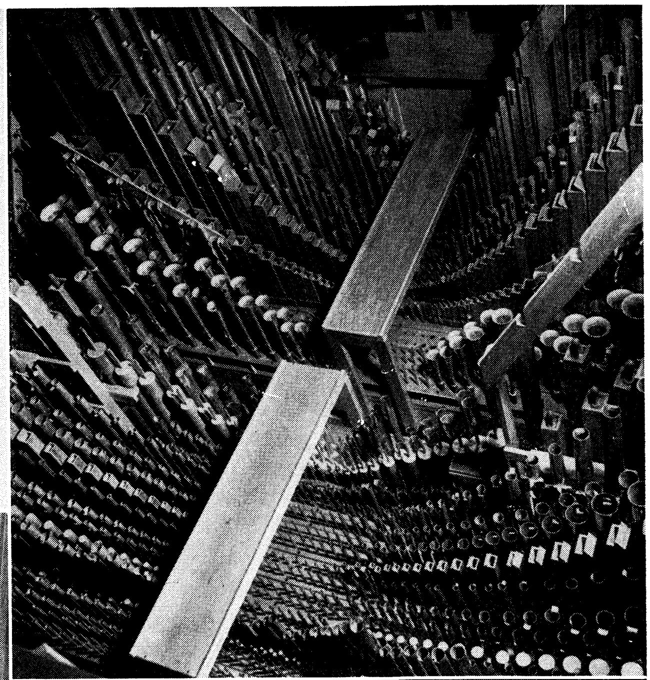
FIG. 5.— VARIOUS TYPES OF ORGAN PIPES

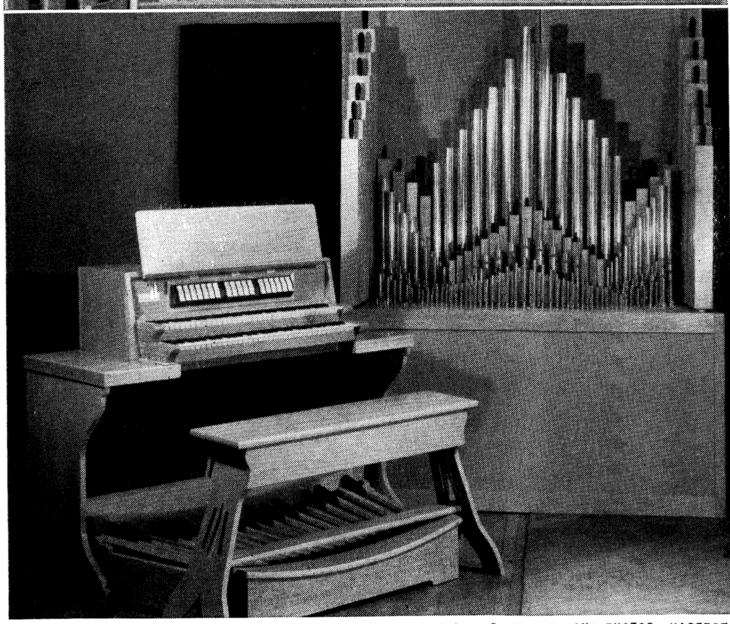
(A) Section of metal flue pipe; (B) section of wooden flue pipe; (C) section of reed pipe (trumpet) and its component parts; (D) open diapason; (E) Viola da gamba; (F) clarabeila, or *Hohlflöte;* (G) Gedeckt; (H) Gemshorn or *Spitzflöte;* (I) trumpet or cornopean (reed). (Not to scale)

flûte à cheminée) is given a high harmonic development by being half stopped, with a small chimney of some form incorporated into the stopper.

Principals (Eng. diapason or Fr. montre) have the sound typically associated with the organ and are open pipes of medium scale. The principal-type stops of different pitches which furnish the ensemble of the organ are identified merely by their pitch:







BY COURTESY OF (TOP LEFT) THE M. P. MOLLER ORGAN CO., PHOTO BY RAUP PHOTOS, HAGERSTOWN, MD., (TOP RIGHT, BOTTOM RIGHT) METHUEN MEMORIAL MUSIC HALL, (CENTRE LEFT) HOLTKAMP ORGAN CO., PHOTO BY WILLARD BLUM, (BOTTOM LEFT) SCHLICKER ORGAN CO., PHOTO BY WITTKOWSKY STUDIO, NORTH TONAWANDA, N.Y.

Top left: A typical modern console
Top right: Pipes and tuning boards in the old Boston Music Hall organ, Methuen, Mass.
Centre left: An example of modern organ design and placement
Bottom left: A modern portative organ
Bottom right: The old Boston Music Hall organ, Methuen, Mass.

octave, 12th, 15th, etc. Mixture stops are usually of principal character.

Viols, or string-toned stops such as the salicional, gamba, dulciana, etc., are made of pipes similar to the principals except that the scale is much reduced (*i.e.*, they are of smaller diameter in relation to length), and they are usually somewhat lighter in construction.

A tempered or muted tone, in various degrees of compromise, may be obtained by making the pipe in the shape of a long inverted cone. Thus the *Spitzflöte* and the gemshorn present a mixture of the species and have certain useful tonal characteristics.

Reed Stops.—Reed stops, which in all organs are far outnumbered by the flues, fall into three general divisions.

First there are the natural organ reeds, nonimitative in character, which have descended from the classic period of organ building. The krummhorn (or cromorne), regal, schalmei, and rankett are in this class. They have an authentic organ sonority, appropriate to organ music and are invaluable as solo stops or in ensemble. Resonators of these reeds are often made of fractional length, being half, a quarter or even one-sixteenth of the length implied by the note sounded.

Next are the reeds of the trumpet family (trumpet, trompette, trombone, clarion, cornopean, etc.) often known as chorus reeds. If not voiced too broadly, they serve a useful function in the chorus or ensemble, particularly on the pedals, and they are distinctive as solo stops.

The third group of reeds comprises the modern and frankly imitative stops—such as the clarinet (which is not unlike the older krummhorn), the oboe, orchestral oboe, the bassoon, English horn and French horn. Many of the imitative reeds require considerably higher wind pressures than the authentic organ reeds and flues.

Tuning.—Flue pipes are tuned by lengthening or shortening the effective speaking length, and this is accomplished by various methods according to the type of pipe in question. Some are tuned by moving up or down a metal slide or extension which fits over the top of the pipe. Others, particularly the smaller "upperwork" pipes, have to be coned in (closed) or expanded slightly at the top, according to whether it is desired to flatten or sharpen the pitch. Wooden pipes of some types are tuned by pressing in or pulling out a metal shade affixed in or near the top of the pipe. In the case of stopped pipes the caps or stoppers afford a ready means of altering the pitch.

Reeds are tuned by altering the position of a tuning wire or spring, which can be made to increase or diminish the length of reed allowed to vibrate. The length of the resonator must also be brought into sympathetic adjustment.

Pitches of Stops.—Organ pipes that speak at the pitch implied by the particular manual key played are called 8-ft. or unison stops, because an open pipe sounding the lowest note of the keyboard (that is, CC) is about 8 ft. in length. Gedeckts and reeds of half this length and harmonic pipes of double length, sounding the indicated pitch, are still referred to as 8-ft. stops.

On the manuals, then, a 16-ft. stop will sound notes one octave below normal pitch. Of stops sounding higher than 8-ft. pitch, 4-ft. stops give the octave, $2\frac{2}{3}$-ft. stops the 12th, 2-ft. stops the superoctave or 15th, $1\frac{3}{5}$-ft. stops the tierce or 17th, $1\frac{1}{3}$-ft. stops the larigot or nineteenth, 1-ft. stops the aznd and so—in theory at least—ad infinitum, according to the natural law known as the harmonic series. Practical considerations, however, set arbitrary limits, and in this case they rule: (1) ranks above the 15th are too small and acute to be carried through the whole compass of the keyboard in an unbroken form; (2) no rank more dissonant than a minor seventh—or at most a major third—is tolerable in the tonal economy of the organ; (3) for most ordinary purposes, ranks sounding octaves, thirds and fifths sufficiently represent the harmonic series. As a matter of practice, all stops above the 15th form a part of what are called the mixtures, and except for special purposes are employed collectively as upper work. Manual stops of 16-ft., 8-ft. and 4-ft. pitches are termed foundation work (Fr. fonds). The 12th and 15th are usually independent ranks but are sometimes part of the mixtures. Thus foundation work and upper work complement each other into a complete tonal texture or ensemble.

Mixtures.—The mixture stops (fourniture, *plein-jeu, Zimbel,* etc.), also known as compound stops, are a grouping together of two, three or more ranks of pipes (usually but not necessarily of the principal type, though never of reeds) speaking a selection of the harmonics of the fundamental note. The essential and important difference between a mixture and a harmonic stop is that the latter (for example, as 12th or 15th) continues in unbroken note sequence right to the top of the keyboard, while a mixture will "break back" in the composition of its harmonics at frequent intervals. Thus the partials of a mixture, which on low C of the keyboard may be spread over a band beginning two octaves higher than 8-ft. pitch, will be gradually changed as the scale ascends, the higher partials being replaced by lower ones. The result is a brightening of the lower and tenor registers, a broadening of the middle and treble registers and—if the mixture is well voiced—a smoothing out of the upper registers. In the design and voicing of mixture stops lies the most difficult part of the organ builder's art, and experience proves that mixtures cannot be given satisfactory musical speech save on the lowest of wind pressures.

MANUALS

Great.—The great organ (Ger. *Hauptwerk,* Fr. grand *orgue*), as its name implies, represents a grouping of the most important stops of the organ. The typical great division of a large instrument will contain a principal chorus, the 8-ft. principal providing the basis. The double open principal 16 ft., the octave or principal 4 ft., the 12th $2\frac{2}{3}$ ft., the 15th 2 ft. and the mixture or mixtures are equally essential and may be likened to the root, branches and twigs of the principal trunk. The gedeckts (bourdon 16 ft., stopped diapason 8 ft., flute couverte 4 ft.) will be present, and in addition to their own solo usefulness will combine well with some of the upper principal stops. Open flute stops of several pitches may be included in the scheme under a diversity of shapes and names (clarabella, wald flute, melodia, etc.). Viols blend less readily with other stops, and thus may be little represented. Reeds are sometimes included; trumpets at 16-, 8- and 4-ft. pitches.

It may be remarked that the tonal individuality of an organ is set very largely by the character of the great ensemble, which musically—though illogically—might therefore be compared to the string section of a modern orchestra. National characteristics in organ design vary on this point. The German great is often designed on lines minimizing the proportion of the 8-ft. principal stops.

The French great tends to a thicker and more flutey tone for its 8-ft. basis, while the Spanish great sometimes appears to depend on a foundation of 8-ft. flute and viol tone.

Positive.—The division of the positive (Ger. Oberwerk, Positiv or *Brustwerk;* Fr. *positif*) comes next in musical importance. It may be placed above the great as an Oberwerk, below the great as a Brustwerk or as a *Rückpositiv* projecting from the gallery, quite apart from the main organ. Ideally it is a miniature great, of considerably smaller scale, with a gedeckt possibly replacing the 8-ft. diapason as the ensemble basis, and containing a reed such as the krummhorn. The positive should be totally unenclosed and placed well to the front (as stated above) where its tone will be distinguished from that of the great. The use of the positive is called for in practically all organ compositions, in episodic contrast to the great.

Swell.—The swell organ (Ger. *Schwellwerk,* Fr. recit), as implied by the name, is a grouping together of stops all enclosed within a large box. This box is faced on one or more sides with a set of shutters, not unlike the louvers of a venetian blind. By means of a swell pedal, connected to the shutters by mechanical or electrical means, the player may vary the volume of sound allowed to issue from the box. A typical swell division will contain a series of principal stops somewhat lighter than the great, flutes, salicionals and other viol-type stops, and some hybrids. A distinctive feature of the swell is the inclusion of a full representation of reed stops of the chorus type; an oboe, and a trumpet (trompette) or cornopean at 16-, 8- and 4-it. pitches. The swell mixtures are frequently designed to blend with these reeds.

Choir. — The choir organ is often included in place of the positive. though this is not a desirable substitution. In its general form it will have a collection, which ideally should be a complete ensemble, of mild flutes and viols, with the addition of a clarinet and perhaps other imitative reeds, the whole division being enclosed in a box on the same principle as the swell. Occasionally, large choir divisions will contain a complete flue and reed chorus.

Solo. — Whereas all divisions so far have been designed with the aim of building up a harmonious whole, the solo organ is frequently considered to be successful only in so far as it contains stops foreign to the rest of the instrument. On the solo manual are grouped imitative stops of all types, often representing extremes of scaling and voicing useful mainly in a solo capacity. On this manual, too. will be found the bombarde organ. a family of large scale reeds reinforced perhaps by mixtures. Here also will be placed the echo organ, or the antiphonal organ, gaining contrast by the placement of the pipes at a distance.

Pedal. — Included in the pedal organ should be stops continuing downward all types of tone included on the manuals, so that a suitable bass may be found for any stop, or combination of stops, piano to fortissimo. The pedal stops are pitched an octave lower than those of the same name on the manuals. Thus the characteristic pitch is 16 ft.. rather than 8 ft., and the length of low C on the pedal open principal will be 16 ft. A well-equipped pedal organ will include stops of various pitches from perhaps 32 ft. to 4 ft , 2 ft. or even 1 ft. and some mixture stops. In general, the pedal organ should hold its own against the full manual divisions without having to be coupled to them, and it should be able to carry a melodic line at any of several pitches independently of the manuals. Reed stops are particularly effective on the pedal and may be present at unison pitches from 32 ft. to 2 ft. They may often be played with fine effect against the full flue ensembles of the manuals.

Wind Chests, Blowing Apparatus.--In addition to supporting the pipes, a wind chest contains the mechanism for distributing wind to each pipe. The usual chest is a large wooden box divided into as many longitudinal compartments as there are stops to be accommodated. Over its top surface are the upper boards on which the pipes rest, the foot of each pipe fitting exactly into a hole through which wind from the chest may pass, as permitted by a pallet or valve. Above the upper boards are the rack boards, which support the pipes at a point several inches higher and thus maintain their vertical position.

The supply of air to the wind chest is delivered by a rotary blower, spun at high speed by an electric motor. Air under pressure may also be provided by the operation of large bellows, by hand or by mechanical means. From one of these originating sources, the wind passes to a reservoir — a shallow box which can expand upward, concertina fashion, but contained by springs or by weights on the top. The reservoir smoothes out the supply of air from the primary source and passes it along to the wind chest under an even and predetermined pressure.

An organ is said to have a certain number of inches of wind pressure. The figure is determined by applying the wind supply, from a pipe hole of the wind chest, to one side of two even columns of water in an anemometer, or open U-shaped glass tube. If the two columns are displaced to the extent of say, $2\frac{1}{2}$ in., the pipes are said to be speaking on $2\frac{1}{2}$ in. of nind pressure.

The interior mechanism of the wind chest consists in principle of a valve, or pallet, at the foot of each pipe; nith which the player, through connecting mechanisms between the keyboards and the wind chest. may by the playing of the key admit or shut off air to that pipe. There have been four general types of such organ action. All older organs depended on a mechanical or tracker action, consisting of a series of rods and levers by which the actual physical motion of the finger and the key was transmitted, pulling doun the pallet under the pipe. Certain musical advantages are claimed for this method as well as a basic simplicity and it still has a certain vogue. The 19th century saw the invention of the Barker lever, a small pneumatic bellows which by expansion assisted the player in the chain of effort and movement. Electropneumatic action, coupled with the Pitman chest is by far the most widely used method among organ builders of the 20th century, though other electropneumatic actions have been evolved, and some all-electric actions have been devised.

As the name implies. the electropneumatic action depends for its motive power both on electricity and wind pressure. If we may regard all intermediate mechanisms which join the fingers of the organist with the sounding of the pipes as links in a chain, the first such link will be the completion of an electric circuit by the depression of a key at the console. This actuates an electric magnet which in turn opens a small valve. This allows pneumatic pressure to pull down the pallet underneath the pipe, allowing pressure wind in the chest to pass up through the foot of the pipe and to cause the pipe to speak.

The method of the stop action, by which any one rank of pipes, or any combinations of ranks, may be played at will, is readily understood by considering the method employed in the older slider chests. Underneath each row of pipes on these chests is a strip of wood (or slider) bored with a row of holes corresponding to the foot holes of the pipe. In this position, the stop is "on," but by levers extending from the stop knobs at the console the board may be pulled slightly to one side. so that the holes do not coincide and the passage of air from the wind chest past the pallets to the pipes will be blocked.

In the Pitman chest, sliders are not employed, and the same end is achieved by the provision of an individual valve for each pipe, these valves being controlled by electric or electropneumatic means from the stop knobs or stop tablets at the console.

Console.—At the console the player may have before him several manuals, each controlling one or more divisions of the organ. From the lower to the upper manuals the sequence is usually: positive and/or choir; great; smell; solo (bombarde, orchestral, echo, antiphonal). Beneath his feet is the pedal board, with keys similar to those of the manuals but of larger size, to be played by the feet. To the right and left on the stop jambs, and possibly in front above the top manual, are the stops (knobs or tablets) ranged according to their groupings on the manuals. With a knob pulled out, or a tablet tilted down, a stop is said to be on (*i e.*, at the ready). Certain stops are called couplers. These are not connected to pipes, but provide for the coupling of almost any one manual to another, either at unison or at sub- or superoctave pitch. Moreover, some manuals may be duplicated on themselves at sub- or superoctave pitches, though this is a device sometimes expedient but rarely desirable and should not be necessary in the ensemble of a well-voiced instrument. Buttons under or above the manuals, which may be preset or adjustable in their action, enable the player to pull out or push in stops and couplers en masse or in various groupings. These buttons are frequently duplicated by toe studs placed just above the pedal board. Above and to the centre of the pedal board will also be found balanced "expression" pedals, controlling the opening and closing of the shutters of enclosed divisions. The crescendo pedal, usually to the right of any "expression" pedals, is a rough and ready means of bringing on the stops in sequence by electrical means, without actuating the stop knobs. German organs have a roller device (*Rollschweller*) which achieves the same end. Mechanical connections in a tracker action necessitate placing the console as near to the wind chests as possible, but with modern action it is an advantage to be able to place the console at a convenient distance from the organ, where the player may better judge the balance of sound, connection between console and wind chest being made by electric cable.

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ORGANICISM, the biological and philosophical doctrine which declares that an organism is a functional unity whose parts cooperate for the good of the whole and that therefore its properties are to be understood only from this vienpoint. According to this doctrine the manifestations of the whole organism cannot be understood by analyzing its chemical, physical or morphological elements. Although this view approaches vitalism. it is as strongly opposed to the rigid vitalism of the late 19th and early 20th centuries as it is to the physico-chemically oriented mechanism.

See VITALISM: MECHANISM.

ORGANIC SENSATIONS, a term for all the bodily sensations except those derived from the skin. In addition to the four special senses, sight. hearing, taste and smell, there is the common sensibility or somesthesia, which includes cutaneous sensations and also organic sensations. Organic sensations may be subdivided into kinesthetic sensations, vestibular, or static, sensations and visceral sensations.

The deep sensibility that comes from the tissues immediately beneath the skin may also be included under this class term (see SENSATION).

ORGANIZATION FOR EUROPEAN ECONOMIC COOPERATION (O.E.E.C.), established in April 1948, was a body formed by the European nations participating in the European Recovery program to co-ordinate the United States supported economic reconstruction in Europe following World War II.

See FOREIGN AID PROGRAMS; PAN-EUROPEAN MOVEMENT; EUROPE: History.

ORGANIZATION OF AMERICAN STATES: see AMERICAN STATES, ORGANIZATION OF; PAN-AMERICAN CONFERENCES

ORGANIZATION OF CENTRAL AMERICAN STATES: see CENTRAL AMERICAN FEDERATION.

ORGANOMETALLIC COMPOUNDS are chemical substances containing a metal or metalloid in direct association with one or more hydrocarbon radicals. These compounds never arise by natural processes in nature, being produced synthetically by the art of the chemist. They have played an important part in the development of modern chemistry. and among them are an ever growing number of substances or classes of substances of great practical utility.

Tetraethyllead (see below), a most effective antidetonant in motor gasolines, and salvarsan, a specific remedy in syphilis. are outstanding examples of organometallic compounds of proven worth. The silicones (q v) and the Grignard reagents (*q.v.*) are two classes of organometallic compounds whose utility has been demonstrated.,

Brief references to organometallic compounds have been given under the headings of certain of the metals and metalloids, and the present article affords a general survey of the whole group of compounds.

The arrangement below follows the natural sequence of elements according to the periodic law (*q.v.*), with a major division being made betueen the transitional and nontransitional elements.

NONTRANSITIONAL ELEMENTS

In the organometallic compounds of the nontransitional elements the carbon-metal bond is usually either a classical covalent, localized two-electron bond (as in tetramethyltin) or an ionic bond (as in benzylsodium).

Group I.—Although organosodium compounds were prepared as early as 1858 (J. Wanklyn), the existence and properties of these substances remained doubtful until early in the 20th century (W. Schlenk and co-workers. 1913–17). Ethyllithiurn. LiC_2H_5, is prepared by the action of diethylmercury on metallic lithium; it crystallizes from benzene in colourless plates melting at 95" C. Methyllithium. $LiCH_3$. and phenyllithium, LiC_6H_5. are crystalline powders obtained by double decomposition between ethyllithium and dimethylmercury and diphenylmercury respectively (Schlenk and J. Holtz). Later, lithium alkyls and aryls were prepared from lithium metal and alkyl and aryl halides (K. Ziegler, 1930; H. Gilman. 1932). The simple sodium alkyls are prepared by the action of sodium metal on a mercury alkyl (Schlenk) or zinc alkyl (A von Grosse. 1936) Methylsodium, $NaCH_3$, is a white powder which burns in air uith explosive rapidity. Triphenylmethylsodium. $NaC(C_6H_5)_3$, a bronnish-red solid, is obtained by the action of 1% sodium amalgam on a solution of triphenylchloromethane under an atmosphere of oxygen-free nitrogen. Cyclopentadienylsodium, NaC_5H_5, is conveniently prepared by the reaction of a sodium metal dispersion with cyclopentadiene in tetrahydrofuran solution; an orange solution of the product is obtained (G Wilkinson and F. A. Cotton. 1954). Alkyls of potassium, rubidium and cesium have been similarly prepared (H. Gilman, 1940–41). Alkyl and aryl alkali metal compounds are usually prepared in solution as intermediates for use in further reactions uithout being isolated.

Organic derivatives of IB subgroup elements are also known. Phenylcopper. CuC_6H_5, obtained by the reaction of cuprous iodide and phenylmagnesium bromide in ethereal solution. is a white powder decomposing at 80° C , to give copper and diphenyl. Phenylsilver, an even more unstable substance, is obtained from phenylmagnesium bromide and silver bromide. It is a yellow solid, exploding on rubbing or on gentle warming. An ethereal solution of gold (III) bromide and ethylmagnesium bromide yields on evaporation colourless crystalline diethylgold bromide, melting at 58° C. and exploding at 70° C. Bromine in chloroform converts this monobromide into the ruby-red ethylgold dibromide, $C_2H_5AuBr_2$ (W. J Pope and C. S. Gibson, 1907).

Group 11.—The organic derivatives of beryllium are referred to under this metal and the organomagnesium compounds are described in GRIGNARD REAGENTS. The organozinc compounds were discovered by E. Frankland in 1849, and from his study of organometallic compounds he was led to the conception of chemical valency. Dialkylzinc compounds were applied by Frankland and B. F. Duppa (1863) and others in many chemical syntheses, but were later supplanted by the more versatile and less hazardous Grignard reagents. Dimethylzinc (boiling point 46° C.) and diethylzinc (b.p. 118° C.) are colourless malodorous liquids, spontaneously inflammable in air. They are prepared by distilling the products of the interaction of methyl and ethyl iodides with a zinc-copper couple. Phenylzinc bromide and diphenylzinc have been obtained from the reaction of phenylmagnesium bromide and anhydrous zinc chloride (E. Blaise, 1911; A. Job and R. Reich, 1923). The dialkylcadmium compounds are procurable in good yields from anhydrous cadmium bromide and the appropriate alkylmagnesium bromide. Dimethylcadmium, $(CH_3)_2$ Cd, is a colourless liquid boiling at 105° C. (E. Krause. 1917). Mercury possesses a remarkable capacity for forming organic derivatives. Sodium amalgam acts directly on ethyl iodide and bromobenzene, giving respectively diethylmercury, $(C_2H_5)_2Hg$ (b.p. 159° C.), and diphenylmercury (melting point 120° C.). With certain reactive substances such as aromatic amines, phenols, ferrocene (see below) and certain olefins,mercury derivatives are obtained merely by boiling with mercuric acetate. In addition to the foregoing methods, organomercury compounds are conveniently prepared through the agency of Grignard reagents. Alkylmercury chlorides are used as lawn fungicides.

Group III.—Trialkyl and triarylaluminum compounds have been reported. The reaction of ethylmagnesium bromide and anhydrous aluminum chloride in dry ether gives triethylaluminum etherate, $(C_2H_5)_3Al\,O(C_2H_5)_2$, as a colourless mobile liquid boiling at 112° C /16 mm. It fumes in air, takes fire spontaneously and is decomposed explosively by cold water (E. Krause and B. Wendt, 1923). Triphenylaluminum, prepared in a similar manner, loses the co-ordinated ether in *vacuo* at 150° C. Trialkylaluminum compounds are most conveniently prepared by the reaction of an olefin, hydrogen and aluminum under pressure at 120° C. (K. Ziegler, 1955), and they find use as cocatalysts in the preparation of linear polyethylene at low pressures. Diethylaluminum iodide and ethylaluminum diiodide, both high-boiling liquids. were obtained by V. Grignard and R. L. Jenkins (1925) from the liquid product of the reaction of aluminum and ethyl iodide.

Organic derivatives of gallium, indium and thallium are obtainable through the Grignard or organolithium reagents. Thallium (III) bromide, but not thallium (I) bromide, yields both dialkyl and diaryl derivatives such as dimethylthallium bromide, $(CH_3)_2$-TlBr, in the form of silvery white leaflets (R. J. Meyer and A. Bertheim, 1904), and diphenylthallium bromide, in the form of colourless microscopic needles (D. Goddard and A. E. Goddard, 1922). The reaction of alkyllithium compounds with thallium (I) halides gives high yields of trialkylthallium compounds (H. Gilman and R. G. Jones, 1950). Trimethylindium (m.p. 88° C.) and trimethylgallium (b.p. 56° C) can be obtained by reaction of the respective metal with dimethylmercury. Higher trialkylindium compounds are conveniently prepared via the Grignard reagent.

Group IV.—Organic derivatives are known of silicon (*q.v.*), germanium (*q.v.*), tin and lead. Organic compounds of tin have found increasing commercial utilization since 1950, first as stabilizers for polyvinyl chloride plastics, later as fungicides, bactericides, etc.

Stannous chloride and ethylmagnesium bromide give diethyltin (II) as an oxidizable, evidently polymeric water-insoluble oil (P. Pfeiffer, 1911). whereas diphenyltin (11), $(C_6H_5)_2Sn$, a bright yellow powder melting to a dark red liquid at about 130° C., is obtained from phenylmagnesium bromide and stannous chloride. When excess of phenyl Grignard reagent is added to stannous chloride, the diphenyl compound loses part of its tin and passes into hexaphenylditin, $3(C_6H_5)_2Sn = Sn + (C_6H_5)_3SnSn(C_6H_5)_3$, obtained in colourless plates melting at 237° C.

Tetramethyltin (b.p. 78° C.) is most advantageously prepared by the Grignard method in a dibutyl ether solvent, while tetravinyltin (b.p. 161° C.), tetraethyltin and higher homologues are obtained in high yield by the Grignard method when tetrahydrofuran is used as the solvent. The disproportionation of a tetraorganotin compound with tin (IV) chloride is an excellent method for preparing organotin chlorides (K. A. Kocheshkov, 1933), while the reaction of methyl chloride with molten tin-copper alloy serves to produce dimethyltin dichloride (E. G. Rochow, 1953). Tin halides react with diazomethane in solution to give chloromethyltin compounds (A. Yakubovich, 1952; D. Seyferth, 1954), *e.g.*, $(CH_3)_2Sn$-$Cl_2 + CH_2N_2 = (CH_3)_2(CH_2Cl)SnCl + N_2$. Organotin hybrides, such as triphenyltin hydride, $(C_6H_5)_3SnH$, add to the double bond of olefins such as acrylonitrile, $CH_2{:}CHCN$, to give, in the case of the compounds cited, β-cyanoethyltriphenyltin, $(C_6H_5)_3SnCH_2$-CH_2Cn (G. J. M. van der Kerk and co-workers, 1956).

The most common and stable organolead compounds are the tetraalkyls and tetraaryls, which are obtained by interaction of lead chloride or bromide with the appropriate Grignard reagent, $4RMgBr + 2PbBr_2 = Pb + R_4Pb + 4MgBr_2$. Tetramethyllead, $(CH_3)_4Pb$, tetraethyllead, $(C_2H_5)_4Pb$, and other tetraalkyllead compounds have been prepared in this manner, as have tetraaryls such as tetraphenyllead, $(C_6H_5)_4Pb$. Treatment of these compounds with acids or halogens converts them to alkyllead salts, such as $(C_2H_5)_3PbCl$ and $(C_6H_5)_2Pb(NO_3)_2$.

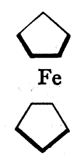
Tetraalkyllead compounds containing different alkyl groups are readily prepared by the interaction of two different tetraalkyllead compounds in the presence of aluminum chloride (G. Calingaert and co-workers, 1939). The lower tetraalkyllead compounds are relatively stable, colourless liquids, while the tetraaryls are colourless solids. Organolead compounds such as hexamethyldilead, $(CH_3)_3PbPb(CH_3)_3$, and diphenyllead (11), $(C_6H_5)_2Pb$, have also been prepared; on being heated these decompose to the corresponding R_4Pb compounds and metallic lead.

The commercially important tetraethyllead is manufactured by the action of ethyl chloride under pressure on a powdered alloy of lead and sodium contained in an autoclave. The tetraethyllead is steam-distilled from the reaction mass, leaving sodium chloride and metallic lead as by-products. It is a colourless liquid, stable in air, soluble in gasoline and quite volatile, although it decomposes at temperatures below its boiling point. For use as an antidetonant, it is added to gasoline in quantities not exceeding 3.0 c.c. per gallon; a small quantity of ethylene dibromide, and sometimes ethylene dichloride, is added to prevent formation of lead deposits in the engine.

Group V.—Certain outstanding examples of organic derivatives of arsenic and antimony are described in the articles on these metalloids. Both trialkyl and triarylbismuth compounds have long been known and were formerly prepared by the reaction of alkyl or aryl halides and sodium- or potassium-bismuth alloys. The use of the Grignard reagents has considerably enlarged the bismuth series of organic compounds. The reaction of triphenylbismuth dichloride and phenyllithium at −75° C. resulted in pentaphenylbismuth, $(C_6H_5)_5Bi$, the only bismuth compound containing five organic groups (G. Wittig and K. Clauss, 1952).

TRANSITIONAL ELEMENTS

While there are some known organic derivatives of the transitional metals in which the carbon-metal bond is a classical two-electron covalent bond, an entirely different class of compounds has been discovered involving "delocalized covalent bonds." In these compounds a metal atom is bonded jointly to several (usually five or six) carbon atoms belonging to the same highly symmetrical molecule or radical (*e.g.*, benzene or cyclopentadienyl). An outstanding example is ferrocene [bis-cyclopentadienyliron, $(C_5H_5)_2Fe$], the first-discovered member of this class (S. A. Miller, J. A. Tebboth and J. F. Tremaine; T. J. Kealy and P. L. Pauson, 1951). (See Group VIII below.) Ferrocene has a molecular geometry in which the iron atom is located symmetrically between two cyclopentadienyl radicals in a sandwichlike structure



The extreme stability which results from this structure is illustrated by the facts that (1) ferrocene itself is stable to over 400° C., while all efforts at preparing compounds containing ordinary covalent carbon-iron bonds have failed, and (2) in ferrocene and some other similar compounds the metal-carbon bonds are stable to a number of rather strong reagents; indeed ferrocene undergoes a variety of aromatic-type substitution reactions, just as benzene does. Dibenzene metal compounds similarly have a sandwich-type structure, and some, such as dibenzene chromium, $(C_6H_6)_2$-Cr, are unusually stable.

The advances in the field of cyclopentadienyl- and benzene metal chemistry made during the 1950s were due principally to E. O. Fischer and his collaborators and G. Wilkinson and co-workers.

Group 111.—The reaction of cyclopentadienylsodium with the appropriate metal chloride in tetrahydrofuran solution yields the tricyclopentadienyl derivatives of the type $(C_5H_5)_3M$, of scandium, yttrium, and of the rare-earth metals lanthanum, cerium, praeseodymium, neodymium, samarium, gadolinium, dysprosium, erbium and ytterbium. These compounds are crystalline, air-sensitive ionic solids and are the only derivatives of this group that have been characterized.

Group IV.—Phenyltitanium triisopropylate, $C_6H_5Ti(OC_3$-$H_7)_3$ (m.p. 88°–90° C.), was the first stable organic derivative of titanium to be isolated (D. F. Herman and W. K. Nelson, 1952). Similar compounds containing more than one organic group appear to be unstable.

Many cyclopentadienyl compounds have been reported. Bis-cyclopentadienyltitanium dichloride, $(C_5H_5)_2TiCl_2$ (m.p. 289° C.), results from the reaction of cyclopentadienylsodium with titanium tetrachloride. Reaction of bis-cyclopentadienyltitanium dichloride with phenyllithium yields diphenyl bis-cyclopentadienyltitanium $(C_5H_5)_2Ti(C_6H_5)_2$, in the form of orange-yellow crystals (m.p. 146°–148° C.) that decompose slowly at room temperature (L. Summers and R. H. Uloth, 1954), while reduction with zinc dust in nonaqueous solution gives green crystals of bis-cyclopentadienyltitanium chloride. $(C_5H_5)_2TiCl$. Bis-cyclopentadienyltitanium. $(C_5H_5)_2Ti$, obtained as dark green crystals from the reaction of titanium dichloride with cyclopentadienylsodium in tetrahydrofuran, is extremely air sensitive and decomposes before its melting point is reached.

Bis-cyclopentadienylzirconium dibromide, $(C_5H_5)_2ZrBr_2$, colourless crystals melting at 260° C. with decomposition. has been prepared by the cyclopentadienylsodiurn method. No organic compounds of hafnium have been reported, but evidence for the existence of unstable cyclopentadienylthorium compounds has been presented.

Group V.—The reaction of an excess of cyclopentadienylmagnesium bromide aith vanadium (IV) chloride in an oxygen-free system gives good yields of bis-cyclopentadienylvanadium, $(C_5H_5)_2V$, violet-black crystals (m.p. 167°–168° C.). Treatment of this compound with carbon monoxide under pressure yields orange crystalline cyclopentadienylvanadium tetracarbonyl, C_5H_5-$V(CO)_4$ (m.p. 138° C.). Bis-cyclopentadienylvanadium dichloride, pale green crystals decomposing without melting at 250° C., has been prepared by the cyclopentadienylsodium method.

Dibenzene vanadium, $(C_6H_6)_2V$, red-brown. air-sensitive crystals (m.p. 277°–278° C.) which decompose at 330° C., is obtained by the reaction of vanadium (IV) chloride, aluminum chloride, aluminum metal and benzene at atmospheric pressure. followed by hydrolytic disproportionation of the initially formed complex, $[(C_6H_6)_2V]\ AlCl_4$.

Bis-cyclopentadienylniobium tribromide, $(C_5H_5)_2NbBr_3$, reddish-brown crystals which decompose without melting at 260° C., and bis-cyclopentadienyltantalum tribromide. $(C_5H_5)_2TaBr_3$, a rust-coloured crystalline solid (m.p., with decomposition. 280° C.), have been prepared by the cyclopentadienylsodium method.

Group VI.—The products obtained by the action of phenylmagnesium bromide on chromium (III) chloride at low temperatures, thought to be polyphenyl derivatives of chromium in the IV. V and VI valence states. were investigated by F. Hein. who discovered them in 1919. It was shonn by H. H. Zeiss and M. Tsutsui (1954) that previous conceptions of their structure were incorrect and that these compounds nere "sandwich" compounds of chromium, the so-called triphenylchromium salts being benzene (biphenyl) chromium (I) salts and the tetraphenylchromium compounds being dibiphenylchromium(I) salts. Di-benzenechromium (readily oxidizable black-brown crystals, m.p. 284°–285° C.) is prepared by the reaction of chromium (III) chloride, aluminum chloride, aluminum metal and benzene under pressure at 150° C., followed by reduction of the $[(C_6H_6)_2Cr]\ AlCl_4$, which is formed initially. Other aromatic hydrocarbons such as toluene, mesitylene and biphenyl yield similar complexes of chromium.

The reductive Grignard procedure used for the preparation of bis-cyclopentadienylvanadium also can be applied to the preparation of bis-cyclopentadienylchromium, $(C_5H_5)_2Cr$ (red crystals, melting at 173° C.).

This compound reacts with carbon monoxide under pressure to give blue-green di-(cyclopentadienylchromium tricarbonyl), $[C_5H_5Cr(CO)_3]_2$ (m.p. 163°–168° C.), and with a mixture of carbon monoxide and hydrogen under pressure to give yellow cyclopentadienylchromium tricarbonyl hydride, $C_5H_5Cr(CO)_3H$ (m.p. 57°–58° C.). Treatment of the product of the interaction of cyclopentadienylsodium and chromium (III) chloride with nitric oxide gas produces cyclopentadienyldinitric oxide-chromium chloride. $C_5H_5Cr(NO)_2Cl$. Reaction of the latter with methylmagnesium iodide gives cyclopentadienylmethyldinitric oxide-chromium. $C_5H_5Cr(NO)_2CH_3$, while treatment of $C_5H_5Cr(CO)_3H$ with diazomethane results in cyclopentadienylmethylchromium tricarbonyl, $C_5H_5Cr(CO)_3CH_3$.

Bis-cyclopentad~enylmolybdenum dichloride is prepared from molybdenum pentachloride by the cyclopentadienylsodium method, nhile derivatives of the bis-cyclopentadienyldichlorotungsten ion are obtained in a similar manner. Carbonyl derivatives analogous to those described for chromium have been reported for molybdenum and tungsten. Dibenzene molybdenum and dibenzene tungsten have been reported.

One organic derivative of uranium, tricyclopentadienyluranium chloride, $(C_5H_5)_3UCl$ (dark-red crystals that are extremely air-sensitive, m.p. 260°–265° C.). has been prepared by the cyclopentadienylsodium method.

Group VII.—Bis-cyclopentadienylmanganese, an ionic compound, is best prepared by the cyclopentadienylsodiurn method from manganous bromide. The amber crystalline $(C_5H_5)_2Mn$, which is extremely air and water-sensitive, reacts readily with ferrous chloride to give ferrocene. Treatment of bis-methylcyclopentadienylmanganese, $(CH_3C_5H_4)_2Mn$, with carbon monoxide gives air-stable yellow methylcyclopentadienylmanganese tricarbonyl, which is useful as an antidetonant additive in aviation gasoline. The sodium salt derived from dimanganese decacarbonyl, $NaMn(CO)_5$, reacts with methyl iodide to give methylmanganese pentacarbonyl, $CH_3Mn(CO)_5$, and with acetyl chloride to yield acetylmanganese pentacarbonyl, $CH_3COMn(CO)_5$ (R. D. Closson and co-workers, 1957); the nature of the bonding in these last two compounds is not understood.

Bis-cyclopentadienylrhenium hydride, $(C_5H_5)_2ReH$, results from the action of cyclopentadienylsodiurn on rhenium pentachloride. This compound (yellow crystals, m.p. 161°–162° C.) forms a unipositive cation. $[(C_5H_5)_2ReH_2]^+$, in aqueous solution.

Group VIII.—Bis-cyclopentadienyliron (ferrocene) (orange-yellow crystals, m.p. 173°–174° C.) is conveniently prepared either by the Grignard or cyclopentadienylsodium methods, as well as by the amine method. In the latter method. ferrous or ferric chloride and cyclopentadiene are heated in the presence of a strongly basic amine which functions as a hydrogen chloride acceptor (J. Birmingham, D. Seyferth and G. Wilkinson, 1954). Oxidizing agents convert ferrocene to the blue ferricinium cation, $[(C_5H_5)_2Fe]^+$, many salts of which are known.

Ferrocene behaves like an aromatic compound toward many reagents and undergoes a variety of aromatic substitution reactions such as Friedel-Crafts acylation and alkylation, arylation, mercuration and metalation to yield substituted ferrocenes. These substituted ferrocenes are then capable of taking part in a large number of organic reactions without disruption of the ferrocene structure.

Cyclopentadiene reacts with iron pentacarbonyl at 135° C. to give di-(cyclopentadienyliron dicarbonyl), $[C_5H_5Fe(CO)_2]_2$ (m.p. 192° C.), decomposition of which at 220° C. yields ferrocene. Oxidation in hydrochloric acid gives cyclopentadienyliron dicarbonyl chloride (red crystals decomposing at 87° C.) which reacts with methylmagnesium bromide to yield cyclopentadienylmethyliron dicarbonyl, $C_5H_5Fe(CO)_2CH_3$.

Bis-cyclopentadienylcobalt (almost black crystals melting at 171°–173° C.) is readily oxidized to the $[(C_5H_5)_2Co]^+$ cation, which is extremely stable, being unaffected by fuming nitric acid or aqua regia. It also reacts with carbon monoxide to give a red liquid carbonyl derivative, $C_5H_5Co(CO)_2$ (b.p. 75° C./22 mm.). Green bis-cyclopentadienylnickel reacts with nitric oxide to yield C_5H_5NiNO (red liquid, b.p. 49° C./27 mm.).

Of the other Group VIII elements the following cyclopentadienyl derivatives, prepared by standard methods, can be mentioned: bis-cyclopentadienylruthenium (light yellow, m.p. 195.5° C.) readily oxidizable to the ion, $[(C_5H_5)_2Ru]^+$; bis-cyclopentadienylosmium (m.p. 218°–219° C.); bis-cyclopentadienylrhodium bromide, $(C_5H_5)_2$ RhBr; the corresponding iridium derivative, $(C_5H_5)_2IrBr$; cyclopentadienylrhodium-1:5-cyclo-octadiene, $C_5H_5RhC_8H_{12}$ (m.p. 108° C.).

Trimethylplatinum iodide, $(CH_3)_3PtI$, has been obtained by interaction of platinum chloride and methylmagnesium iodide. The corresponding chloride is tetrameric, indicating that bonds of fractional order are involved in the electronic structure of the molecule. Tetramethylplatinum, $(CH_3)_4Pt$, has been prepared from trimethylplatinum iodide and methylsodium. and hexamethyldiplatinum, $(CH_3)_3PtPt(CH_3)_3$, has been obtained by heating trimethylplatinum iodide with potassium in benzene (H. Gilman and M. Lichtenwalter, 1936).

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ORGANON, the name given to Aristotle's logical treatises (Gr. *organon,* "instrument"). They are so called because logic is itself neither a speculative science nor a practical art in the ordinary sense, but an aid or instrument to all scientific thought. Francis Bacon gave to his own treatise the name *Novum Organum* in the belief that he had discovered a new inductive logic.

ORGANUM, the name given in the 10th and 11th centuries to a style of polyphonic singing and in the 12th and 13th centuries to a musical form. In the organa found in the manuscripts from the monastery of St. Martial at Limoges (11th century) the drawn-out plain chant melody has a richly melismatic upper part in free rhythm. The later flowering of organa in Paris coincided with the building of Nôtre Dame (1163–1235). The 12th-century composer Léonin was the first master to write two-part organa for the cathedral. He was followed *c.* 1200 by Perotin whose three- and four-part organa are of the highest musical quality.

See A. Hughes (ed.), "Early Medieval Music," vol. II oi *The New Oxford History of Music* (1954). (E. J. Wz.)

ORGY. This is a modern philological blunder, for the Greek *orgia,* adopted by the Romans, existed only in the neuter plural. Properly it was the post-Homeric word for religious rites, probably meaning "operations," "performances." It is chiefly used of those rites which involve an initiation; *e.g.,* the Eleusinian mysteries (*see* MYSTERY), the worship of the Cabeiri and especially of Dionysus (*qq.v.*), hence presumably its modern connotation of wildness and lawlessness. Metaphorically, it meant studies which involved training, such as philosophy. (H. J. R.)

ORHAN VELI KANIK (1914–1950), Turkish poet. exercised an important influence on Turkish literature. Born at Beykoz on the Bosporus in 1914, the son of an orchestra conductor, he was educated in Ankara and studied philosophy at Istanbul university. His slight volume of poems *Garip* (1941), published in collaboration with two other poets, Oktay Rifat and Melih Cevdet, revolutionized Turkish literature. It created a break with everything hitherto associated with Turkish poetry, conventional metre, rhyme, language and themes being all discarded. He encountered violent opposition from conservative circles, but by the time he died, he was firmly established. He introduced everyday spoken Turkish, with its rich idiom, into poetry and made use of folk poems and popular song motifs. Influenced by contemporary French literature, he made translations, and a verse adaptation of La Fontaine's fables. Other works included *Yenisi* (1947) and *Karshi* (1939). He died at Istanbul, Nov. 14, 1950. (F. I.)

ORIBI (OUREBI), *Ourebia ourebi,* a pigmy antelope (*q.v.*) of South Africa, standing about 24 in. at the shoulder, and characterized by a bare glandular spot below the ear; the upright horns of the bucks, ringed for a short distance above the face; and the tufted bushy tail. The name is extended to include other members of the genus. The steinbok and grysbok are closely related.

ORIEL, in architecture, is a projecting bay window carried by corbels or moldings. It is usually polygonal or semicircular in plan, but at Oxford, in some of the colleges, there are examples which are rectangular and rise through two or three stories. In Germany it forms a favourite feature, and is sometimes placed at the angle of a building, carried up through two or three floors and covered with a lofty roof. The oriel is also said to have been provided as a recess for an altar in an oratory or small chapel.

In the 15th century, oriels came into general use and are frequently found over entrance gateways. The earliest meaning of the word seems to be a gallery, portico or corridor, and the application of the term to a particular form oi window apparently arose from such a window being in an "oriel" *See* BAY; WINDOW.

ORIENT, THE: *see* FAR EAST.

ORIENTALE PROVINCE. REPUBLIC OF THE CONGO: *see* EASTERN PROVINCE: REPUBLIC OF THE CONGO.

ORIENTAL JEWS are the descendants of those Jews who, folloning their exile from Palestine in the 1st century AD., or even prior to that date, settled in the middle east and north Africa. *See* SEPHARDIM, ASHKENAZIM AND ORIENTAL JEWS.

ORIENTATION is a term expressing the position of any object relative to the points of the compass; in architecture. it is used to express the main dimensions of a building, with reference to the compass points. The word orientation derives from orient, meaning the east. In Mesopotamia and Egypt, as well as in primitive Central America, the important features of the buildings, such as entrances and passages were pointed east. in the direction of the rising sun. Early Jews and Moslems turned in their prayers toward Jerusalem and Mecca respectively Mosques are oriented so that the mihrab or prayer niche faces toward Mecca. Christian churches are usually oriented, with the apse or altar placed at the east end. Orientation has come to express relationships to any compass point. In architecture, the word is used in reference to the positioning of buildings relative to environment.

Orientation for sun takes into consideration the daily and seasonal variations of the sun's radiation. In the northern temperate zone the south side receives the largest amount of the sun's radiation in winter. The north side gets the least all year round, while the east and west sides receive the most in summer. Living areas usually are arranged to face south. Solar houses, which utilize solar rays for heating in winter, have large glazed surfaces oriented south. Skylights for factories or studios, where steady illumination without direct sunlight is preferable, face north. Sol-air orientation includes the factor of air temperature as well as solar radiation. This factor shifts the orientation from the south toward southeast in proportion to regional temperature differences. Orientation also may be affected by prevailing winds. Optimum wind orientation may not necessarily coincide with the solar orientation. The final orientation of a building is a compromise of the above factors. (A. OY.)

ORIENTE, the easternmost and largest province of Cuba. Area 14,132 sqmi. Pop. (1961 est.) 2,268,561. It has the most vigorous relief of Cuba in the Sierra Maestra (to 6,578 ft.) but also contains large plains in the northwest. Both the northern and southern coasts have excellent bays. Sugar cane is grown on the plains. Manganese is mined in the south and chromite. nickel and iron ore in the north. The capital is Santiago de Cuba, pop. (1953) 163 237 (*see* SANTIAGO DE CUBA). Other major cities are Guantánamo, Holguin and Manzanillo.

The province was established in 1879 and was called Santiago until 1905. Population growth has been very rapid, especially after 1900 with the development of transportation and the large-scale utilization of the eastern plains of Cuba. Oriente has been the scene of major Cuban revolts. (D. R. D.)

ORIENTE, Ecuador: *see* EL ORIENTE.

ORIGEN (c. 185–*c.* 254). the most distinguished and most influential of all the theologians of the ancient church. with the possible exception of Augustine, was born, perhaps at Alexandria, of Christian parents in 185 or 186. At an early age, about the year 200, he listened to the lectures of Pantaenus and Clement in the catechetical school. This school, of which the origin is unknonn. was the first and for a long time the only institution where Christians were instructed simultaneously in the Greek sciences and the doctrines of the holy Scriptures. Asia Minor and the west developed the strict ecclesiastical forms by means of which the church closed her lines against heathenism and especially against heresy; in Alexandria Christian ideas were handled in a free and speculative fashion and worked out with the help of Greek philosophy. The line between heresy and orthodoxy was less rigidly drawn there than elsewhere.

In the vear 202 a uersecution arose. in which the father of Origen perished. Origen began about the same time to teach; in 203 he was placed, with the sanction of the bishop Demetrius, at the head of the catechetical school. He regularly attended the lectures of Ammonius Saccas, and made a thorough study of the books of Plato and Numenius, of the Stoics and the Pythagoreans. At the same time he endeavoured to acquire a knowledge of Hebrew, in order to be able to read the Old Testament in the original.

He commenced his great work on the textual criticism of the Scriptures; and at the instigation of his friend Ambrosius, who provided him with the necessary amanuenses, he published his commentaries on the Old Testament and his dogmatic investigations. He norked at Alexandria for 28 years (until 231–232). This period, however, was broken by many journeys to Rome, to Arabia, to Antioch and, in 216, when the imperial executioners were ravaging Alexandria, to Palestine. There the bishops of Jerusalem and Caesarea got him to lecture in the churches. In the east it was still no unusual thing for laymen. with permission, to address the people in the church. In Alexandria, however, this custom had been given up, and Demetrius took occasion to express his disapproval and recall Origen to Alexandria

Probably the bishop was jealous of the high reputation of the teacher; and a coolness arose between them which led, fifteen years later, to an open rupture. On his way to Greece (apparently in the year 230) Origen was ordained a presbyter in Palestine by his friends the bishops. This was undoubtedly an infringement of the rights of the Alexandrian bishop; at the same time it was simply spite on the part of the latter that had kept Origen so long without orders. Demetrius convened a synod, at which it was resolved to banish Origen from Alexandria. A second synod, composed entirely of bishops, determined that Origen must be deprived of his status as a presbyter. This decision seems to have been justified by referring to the self-mutilation of Origen and adducing objectionable doctrines which he was said to have promulgated. No formal excommunication of Origen appears to have been decreed; the sentence of deprivation was approved by most of the churches, in particular by that of Rome. At a later period Origen sought to vindicate his teaching in a letter to the Roman bishop Fabian, but, it would seem, without success.

In these circumstances Origen retired from Alexandria (231–232) to Palestine, where his condemnation had not been acknowledged by the churches. He settled in Caesarea, and established a flourishing school there. Enthusiastic pupils sat at his feet (see the *Panegyric* of Gregory Thaumaturgus), and the methodical instruction which he imparted was famous all over the East. He made frequent journeys. He was for two years together at Caesarea in Cappadocia, where he was overtaken by the Maximinian persecution; here he worked at his recension of the Bible. We find him again in Nicomedia, in Athens, and twice in Arabia. He was called there to combat the unitarian christology of Beryllus, bishop of Bostra, and to clear up certain eschatological questions. As he had formerly had dealings with the house of Alexander Severus, so now he entered into a correspondence with the emperor Philip the Arabian and his wife Severa. But through all situations of his life he preserved his equanimity, his keen interest in science, and his indefatigable zeal for the instruction of others. In the year 250 the Decian persecution broke out, Origen was arrested, imprisoned and maltreated. But he survived these troubles and lived a few years longer in active intercourse with his friends. He died, probably in the year 254 at Tyre.

Writings.—Origen is probably the most prolific author of the ancient church. "Which of us," asks Jerome, "can read all that he has written?" The number of his works was estimated at 6000, but that is certainly an exaggeration. Owing to the increasing unpopularity of Origen in the church, a comparatively small portion of these works have come down to us in the original. We have more in the Latin translation of Rufinus; but this translation is by no means trustworthy, since Rufinus, assuming that Origen's writings had been tampered with by the heretics, considered himself at liberty to omit or amend heterodox statements. Origen's real opinion, however, may frequently be gathered from the *Philocalia*—a sort of anthology from his works prepared by Basil the Great and Gregory Nazianzenus. The fragments in Photius and in the *Apology* of Pamphilus serve for comparison. The writings of Origen consist of letters, and of works in textual criticism, exegesis, apologetics, dogmatic and practical theology.

1. Eusebius (to whom we owe our full knowledge of his life) collected more than a hundred of Origen's letters, arranged them in books, and deposited them in the library at Caesarea (*H.E.* vi. 36). In the church library at Jerusalem (founded by the bishop Alexander) there were also numerous letters of this father (Euseb. *H.E.* vi. 20). But unfortunately they have all been lost except two—one to Julius Africanus and one to Gregory Thaumaturgus. There are, besides, a couple of fragments.

2. Origen's textual studies on the Old Testament were undertaken partly in order to improve the manuscript tradition, and partly for apologetic reasons, to clear up the relation between the LXX and the original Hebrew text. The results of more than twenty years' labour were set forth in his *Hexapla* and *Tetrapla*, in which he placed the Hebrew text side by side with the various Greek versions, examined their mutual relations in detail, and tried to find the basis for a more reliable text of the LXX. The *Hexapla* was probably never fully written out, but excerpts were made from it by various scholars at Caesarea in the 4th century; and thus large sections of it have been saved. He worked at the text of the New Testament, although he produced no recension.

3. The exegetical labours of Origen extend over the whole of the Old and New Testaments. They are divided into *Scholia* (σημειώσεις, short annotations, mostly grammatical), *Homilies* (edifying expositions grounded on exegesis), and *Commentaries* (τόμοι). In the Greek original only a very small portion has been preserved; in Latin translations, however, a good deal. The most important parts are the homilies on Jeremiah, the books of Moses, Joshua and Luke, and the commentaries on Matthew, John and Romans. With grammatical precision, antiquarian learning and critical discernment Origen combines the allegorical method of interpretation—the logical corollary of his conception of the inspiration of the Scriptures. He distinguishes a threefold sense of scripture, a grammatico-historical, a moral and a pneumatic—the last being the proper and highest sense. He thus set up a formal theory of allegorical exegesis, not quite extinct in the churches even yet, and in his own system of fundamental importance.

4. The principal apologetic work of Origen is his book κατὰ Κέλσου (eight books), written at Caesarea in the time of Philip the Arabian. It has been completely preserved in the original. This work is invaluable as a source for the history and situation of the church in the 2nd century; for it contains nearly the whole of the famous work of Celsus (Λόγος ἀληθής) against Christianity. What makes Origen's answer so instructive is that it shows how close an affinity existed between Celsus and himself in their fundamental philosophical and theological presuppositions. The real state of the case is certainly unsuspected by Origen himself; but many of his opponent's arguments he is unable to meet except by a speculative reconstruction of the church doctrine in question. Origen's apologetic is most effective when he appeals to the spirit and power of Christianity. In details his argument is not free from sophistical subterfuges and superficial reasonings.

5. Of the dogmatic writings we possess only one in its integrity, and that only in the translation of Rufinus, Περὶ ἀρχῶν (On the Fundamental Doctrines). This work, which was composed before 228, is the first attempt at a dogmatic at once scientific and accommodated to the needs of the church. The material is drawn from Scripture, but in such a way that the propositions of the *regula fidei* are respected. This material is then formed into a system by all the resources of the intellect and of speculation. Origen thus solved, after his own fashion, a problem which his predecessor Clement had not even ventured to grapple with. The first three books treat of God, the world, the fall of spirits, anthropology and ethics. "Each of these three books really embraces, although not in a strictly comprehensive way, the whole scheme of the Christian view of the world, from different points of view, and with different contents." The fourth book explains the divinity of the Scriptures, and deduces rules for their interpretation. It ought properly to stand as first book at the beginning. The ten books of *Stromata* (in which Origen compared the teaching of the Christians with that of the philosophers, and corroborated all the Christian dogmas from Plato, Aristotle, Numenius and Cornutus) have perished, with the exception of fragments; so have the tractates on the resurrection and freewill.

6. Of practical theological works we have still the Προτρεπτικὸς εἰς μαρτύριον and the Σύνταγμα περὶ εὐχῆς. For a knowledge of Origen's Christian estimate of life and his relation to the faith of the church these two treatises are of great importance. The first was written during the persecution of Maximinus Thrax, and was dedicated to his friends Ambrosius and Protoctetus. The other also dates from the Caesarean period; it mentions many interesting details, and concludes with a fine exposition of the Lord's Prayer.

7. In his own lifetime Origen had to complain of falsifications of his works and forgeries under his name. Many pieces still in existence are wrongly ascribed to him; yet it is doubtful whether a single one of them was composed on purpose to deceive. The most noteworthy are the *Dialogues* of a certain Adamantius "de recta in Deum fide," which seem to have been erroneously attributed to Origen so early as the 4th century.

Outline of Origen's View of the Universe and of Life.—

The system of Origen was formulated in opposition to the Greek philosophers on the one hand, and the Christian Gnostics on the other[1]. But the science of faith, as expounded by him, bears unmistakably the stamp both of Neo-Platonism and of Gnosticism. As a theologian, in fact, Origen is not merely an orthodox traditionalist and believing exegete, but a speculative philosopher of Neo-Platonic tendencies. He is, moreover, a judicious critic. The union of these four elements gives character to his theology, and in a certain degree to all subsequent theology. It is this combination which has determined the peculiar and varying relations in which theology and the faith of the church have stood to each other since the time of Origen. That relation depends on the predominance of one or other of the four factors embraced in his theology.

As an orthodox traditionalist Origen holds that Christianity is a practical and religious saving principle, that it has unfolded itself in an historical series of revealing facts, that the church has accurately embodied the substance of her faith in the regula fidei, and that simple faith is sufficient for the renewal and salvation of man. As a philosophical idealist, however, he transmutes the whole contents of the faith of the church into ideas which bear the mark of Neo-Platonism, and were accordingly recognized by the later Neo-Platonists as Hellenic[2]. In Origen, however, the mystic and ecstatic element is held in abeyance. The ethico-religious ideal is the sorrowless condition, the state of superiority to all evils, the state of order and of rest. In this condition man enters into likeness to God and blessedness; and it is reached through contemplative isolation and self-knowledge, which is divine wisdom.

As a means to the realization of this ideal, Origen introduces the whole ethics of Stoicism. But the link that connects him with churchly realism, as well as with the Neo-Platonic mysticism, is the conviction that complete and certain knowledge rests wholly on divine revelation, *i.e.*, on oracles. Consequently his theology is cosmological speculation and ethical reflection based on the sacred Scriptures. The Scriptures, however, are treated by Origen on the basis of a matured theory of inspiration in such a way that all their facts appear as the vehicles of ideas, and have their highest value only in this aspect. That is to say, his gnosis neutralizes all that is empirical and historical, if not always as to its actuality, at least absolutely in respect of its value. The most convincing proof of this is that Origen (1) takes the idea of the immutability of God as the regulating idea of his system, and (2) deprives the historical "Word made flesh" of all significance for the true Gnostic. To him Christ appears simply as the Logos who is with the Father from eternity, and works from all eternity, to whom alone the instructed Christian directs his thoughts, requiring nothing more than a perfect—*i.e.*, divine—teacher. In such propositions historical Christianity is stripped off as a mere husk. The objects of religious knowledge are beyond the plane of history, or rather belong to a supra-mundane history.

On this view contact with the faith of the church could only be maintained by distinguishing an exoteric and an esoteric form of Christianity. This distinction was already current in the catechetical school of Alexandria, but Origen gave it its boldest expression, and justified it on the ground of the incapacity of the Christian masses to grasp the deeper sense of Scripture, or unravel the difficulties of exegesis. On the other hand, in dealing with the problem of bringing his heterodox system into conformity with the *regula* fidei he evinced a high degree of technical skill. An external conformity was possible, inasmuch as speculation, proceeding from the higher to the lower, could keep by the stages of the regula fidei, which had been developed into a history of salvation. The system itself aims in principle at being thoroughly monistic; but, since matter, although created by God out of nothing, was regarded merely as the sphere in which souls are punished and purified, the system is pervaded by a strongly dualistic element. The immutability of God requires the eternity of the Logos and of the world. At this point Origen succeeded in avoiding the heretical Gnostic idea of God by assigning to the Godhead the attributes of goodness and righteousness. The pre-existence of souls is another inference from the immutability of God, although Origen also deduced it from the nature of the soul, which as a spiritual potency must be eternal. From this follows the necessity for the created spirit, after apostasy, error and sin, to return always to its origin in God.

The actual sinfulness of all men Origen was able to explain by the theological hypothesis of pre-existence and the premundane fall of each individual soul. He holds that freedom is the inalienable prerogative of the finite spirit; and this is the second point that distinguishes his theology from the heretical Gnosticism. The system unfolds itself like a drama, of which the successive stages are as follows: the transcendental fall, the creation of the material world, inaugurating the history of punishment and redemption, the clothing of fallen souls in flesh, the dominion of sin, evil and the demons on earth, the appearing of the Logos, His union with a pure human soul, His esoteric preaching of salvation, and His death in the flesh, then the imparting of the Spirit, and the ultimate restoration of all things. The doctrine of the restoration appeared necessary because the spirit, in spite of its inherent freedom, cannot lose its true nature, and because the final purposes of God cannot be foiled. The end, however, is only relative, for spirits are continually falling, and God remains through eternity the creator of the world. Moreover the end is not conceived as a transfiguration of the world, but as a liberation of the spirit from its unnatural union with the sensual.

The old Christian eschatology is set aside; no one has dealt such deadly blows to Chiliasm and Christian apocalypticism as Origen. It need hardly be said that he spiritualized the church doctrine of the resurrection of the flesh. But, while in all these doctrines he appears in the character of a Platonic philosopher, traces of rational criticism are not wanting. Where his fundamental conception admits of it, he tries to solve historical problems by historical methods. Even in the christology, where he is treating of the historical Christ, he entertains critical considerations; hence it is not altogether without reason that in after times he was suspected of "Ebionitic" views of the Person of Christ.

Although the theology of Origen exerted a considerable influence as a whole in the two following centuries, it certainly lost nothing by the circumstance that several important propositions were capable of being torn from their original setting and placed in new connections. It is in fact one of the peculiarities of this theology, which professed to be at once churchly and philosophical, that most of its formulae could be interpreted and appreciated in *utramque partem*. By arbitrary divisions and rearrangements the doctrinal statements of this "science of faith" could be made to serve the most diverse dogmatic tendencies. This is seen especially in the doctrine of the Logos. On the basis of his idea of God Origen was obliged to insist in the strongest manner on the personality, the eternity (eternal generation) and the essential divinity of the Logos[1]. On the other hand, when he turned to consider the origin of the Logos he did not hesitate to speak of Him as a *κτίσμα*, and to include Him amongst the rest of God's spiritual creatures. A *κτίσμα*, which is at the same time **ὁμοούσιον τῷ Θεῷ**, was no contradiction to him, simply because he held the immutability, the pure knowledge and the blessedness which constituted the divine nature to be communicable attributes.

In later times both the orthodox and the Arians appealed to his teaching, both with a certain plausibility; but the inference of Arius, that an imparted divinity must be divinity in the second degree, Origen did not draw. With respect to other doctrines also, such as those of the Holy Spirit and the incarnation of Christ, etc., Origen prepared the way for the later dogmas. The technical terms round which such bitter controversies raged in the 4th and 5th centuries are often found in Origen lying peacefully side by side. But this is just where his epoch-making importance lies, that all the later parties in the church learned from him. And this is true not only of the dogmatic parties; solitary monks and ambitious priests, hard-headed critical exegetes, allegorists, mys-

[1] The opposition to the unitarians within the church must also be kept in mind

[2] Porphyry says of Origen, *κατὰ τὰς περὶ πραγμάτων καὶ τοῦ θείου δόξας Ἑλληνίζων* (Euseb *H.E.* vi. 19).

[1] "Communis substantiae est filio cum patre; **ἀπόρροια** enim *ὁμοούσιος* videtur, i.e., unius substantiae cum illo corpore ex quo est *ἀπόρροια*."

tics, all found something congenial in his writings. The only man who tried to shake off the theological influence of Origen was Marcellus of Ancyra, who produced no lasting effect on theology.

The attacks on Origen, which had begun in his lifetime, did not cease for centuries, and only subsided during the time of the fierce Arian controversy. It was not so much the relation between *pistis* and gnosis — faith and knowledge — as defined by Qrigen that gave offence, but rather isolated propositions, such as his doctrines of the pre-existence of souls, of the soul and body of Christ, of the resurrection of the flesh, of the final restoration, and of the plurality of worlds. Even in the 3rd century Origen's view of the Trinity and of the Person of Christ was called in question, and that from various points of view. It was not till the 5th century, however, that objections of this kind became frequent. In the 4th century Pamphilus, Eusebius of Caesarea, Athanasius, the Cappadocians, Didymus and Rufinus were on the side of Origen against the attacks of Methodius and many others. But, when the zeal of Epiphanius was kindled against him, when Jerome, alarmed about his own reputation, and in defiance of his past attitude, turned against his once honoured teacher, and Theophilus, patriarch of Alexandria, found it prudent, for political reasons to condemn Origen — then his authority received a shock from which it never recovered.

There were, doubtless, in the 5th century church historians and theologians who still spoke of him with reverence, but such men became fewer and fewer. In the West Vincent of Lerins held up Origen as a warning example (Commonit. 23), showing how even the most learned and most eminent of church teachers might become a misleading light. In the East the exegetical school of Antioch had an aversion to Origen; the Alexandrians had utterly repudiated him. Nevertheless his writings were much read, especially in Palestine. The monophysite monks appealed to his authority, but could not prevent Justinian and the fifth oecumenical council at Constantinople (553) from anathematizing his teaching.

BIBLIOGRAPHY.—Next to the works of Origen (see Redepenning, "Des Hieronymus wiederaufgefundenes Verzeichnis der Schriften des Origens," in Zeit. f. d. *hist.* Theol. [1851], pp. 66 seq.) the most important sources are: Gregory Thaumat., Panegyricus in Orig.; Eusebius, H.E. vi.; Epiphanius, Haer. 64; the works of Methodius, the Cappadocians, Jerome (see De vir. ill. 54, 61) and Rufinus; Vincent. Lerin. Commonit. 23; Palladius, *Hist. Laus.* 147; Justinian, *Ep.* ad Mennam (Mansi, ix. p. 487 seq.); Photius, *Biblioth.* 118, etc. The best of the older editions is that of Delarue (1733–59, 4 vols. fol.; pub. by Migne in Patrol. Gr. vols. xi.–xvii.). A critical edition is being brought out by the Preussische Akademie der Wissenschaften; it is not yet completed. Amongst the older works on Origen those of Huetius (printed in Delarue, vol. iv.) are the best; but Tillemont, Fabricius, Walch (*Historie* d. Ketzereien, vii. pp. 362–760) and Schrockh also deserve to be mentioned. In recent times the doctrine of Origen has been expounded in the great works on church history by Baur, Dorner, Bohringer, Neander, Moller (Geschichte der Kosmologie in der *griechischen* Kirche) and Kahnis (Die Lehre vom h. Geist, vol. i.); compare with these the works on the history of philosophy by Ritter, Erdmann, Ueberweg and Zeller. Of monographs, the best and most complete is Redepenning, *Origenes, eine* Darstellung seines Lebens und seiner Lehre (2 vols., 1841, 1846). Compare Thomasius, Orig. (1837); Kruger, "Über das Verhältnis des Orig. zu Ammonius Sakkas," in the Ztschr. f. *hist.* Theol. (1843), i. p. 46 seq.; Fischer, Comment. de *Orig.* theologia et cosmologia (1846); Ramers, Orig. Lehre von der *Auferstehung des Fleisches* (1851); Knittel, "Orig. Lehre von der Menschwerdung," in the Theol. Quartalschr. (1872); Schultz, "Christologie des Orig.," in the Jahrb. f. protest. *Theol.* (1875); Mehlhorn, "Die Lehre von der menschlichen Freiheit nach Orig.," in Zeitschr. *f.* Kirchengesch. vol. ii. (1878); Freppel, *Origène,* vol. i., 2nd ed. (Paris, 1875). A full list of the later bibliography will be found in Bardenhewer's Geschichte *der* altkirchen litteratur (2nd ed. 2 vols., 1914) and de Faye *Origène,* vol. i. (1923). (A. HA.)

ORIHUELA, a town and episcopal see of eastern Spain, in the province of Alicante; 13 m. N.E. of Murcia and about 15 m. from the Mediterranean Sea, on the Murcia-Elche railway. Pop. (1950) mun., 45,116. It is situated in an exceedingly fertile huerta, on both sides of the river Segura, which divides the city into two parts, Roig and San Augusto, and is spanned by two bridges. Orihuela was captured by the Moors in 713, and retaken by James I. of Aragon, for his father-in-law Alphonso of Castile, in 1265. It was sacked during the disturbances at the beginning of the reign of Charles V. (1520), and again in the War of Succession (1706). Local annals specially mention the plague of 1648. the flood of 1651 and the earthquake of 1829. The university of Orihuela, founded in 1568 by the archbishop of Valencia, was closed in 1835. The trade in fruit, cereals, oil and wine is considerable. There are also tanneries, dye and silk works, linen and woollen fabrics, leather and starch.

ORINOCO, the third largest river system in South America, rises in the Parima mountains in southern Venezuela and empties into the Atlantic ocean south of Trinidad island. Several expeditions have attempted to determine the exact source of the Orinoco. The 1951 Venezuelan expedition, led by Maj. Risquez Iribarren, located the source at lat. 2° 19′ N., long. 63° 22′ W., almost on the Brazilian border.

The main river flows westward from its source, skirting the Parima mountains. Upon turning north, it forms the boundary of Venezuela and Colombia for nearly 200 mi. The river then swings eastward along the edge of the Guiana highlands and forms the southern edge of the llanos (*q.v.*). It finally enters the ocean through a great delta, covering approximately 5,000 sq.mi. of islands formed by the many distributaries.

The Orinoco is 1,281 mi. long. Approximately 100 mi. from its source, the main river is about 170 ft. wide and widens to nearly $\frac{1}{4}$ mi. at the junction of the Casiquiare in the upper basin. The width of the main stream as it turns north upon receiving the waters of the Atabapo and Guaviare tributaries is about a mile. The river divides and braids itself throughout its course, and islands are particularly numerous in the middle course. The river widens considerably upon receiving the waters of the Meta, and islands are large and long. Just below Ciudad Bolivar, the chief city on the Orinoco, the river widens to about 5 mi.

The flow of the Orinoco shows marked seasonal variations. The greatest flow occurs from May to October, the rainy season, with the maximum usually reached in July and August. The long dry season from November to April causes considerable reduction in the flow. At Ciudad Bolivar the difference between high and low water averages 50 ft. and has been known to reach 60.

The drainage basin of the Orinoco system covers more than 360,000 sq.mi., encompassing about four-fifths of Venezuela and one-fourth of Colombia. Seven large tributaries enter the Orinoco in its middle and lower courses. Three of these rise in the highlands of Venezuelan Guiana close to the Brazilian border. The Caroni river, the farthest downstream, has the largest basin of the three, covering much of southeastern Venezuela. The Caura and Ventuari basins are separated by a high massif that forms the boundary between Bolivar state and the federal territory of Amazonas.

The major left bank tributaries of the Orinoco are the Apure, Arauca, Meta and Guaviare. All four are long streams following somewhat sluggish but relatively straight courses from the base of the Andes across the gently sloping llanos to the Orinoco. The Apure has several long, parallel affluents; its numerous northern tributaries, chief of which is the Portuguesa, drain the southern slopes of the Venezuelan Andes. The Arauca parallels and is close to the Apure; their waters commonly mingle by means of lateral channels during the rainy reason. The Meta rises high in the Colombian Andes south of Bogotá. The Guaviare, southernmost of the great western tributaries, marks the dividing line between the savannas of the western part of the llanos and the higher and more varied topography of the south.

From its source at 3,523 ft. elevation the Orinoco rushes downward across numerous rapids and little falls. In its first 30 mi. it descends to 1,000 ft. elevation and in the next 50 mi, cascades to 500 ft. elevation; then the gradient lessens and the river descends only 100 ft. in the next 100 mi. to Esmeralda. In the middle course the rate of descent is about six inches per mile, but rapids are still common.

About 50 mi. above the junction of the Meta, about 700 mi. from the ocean, are the Atures rapids, which limit the navigation of large river steamers. The lower Orinoco has been dredged to a minimum depth of 26 ft. for a distance of 178 mi. from the mouth of Puerto Ordaz on the Caroni.

The value of the Orinoco for navigation lies in the transport of iron ore from the tremendous deposits south of the river. Ore is transported by railways from the iron mountain of Cerro Bolivar and El Pao. west and east of the Caroni, respectively, to the mouth of the Caroni for loading on barges and ships. A large hydroelectric plant was completed at the lower falls of the Caroni in 1958. Most of the power was destined for steelmaking at a large steel mill near Puerto Ordaz and the remainder for the region's future industrial growth. (D. R. D.)

History. — Europeans have had an interest in the Orinoco ever since Columbus wrote Queen Isabella that the river's mouth was the gateway to the Celestial Paradise. In 1531–32 Diego de Ordaz went upstream far enough to find that that was not true, but many Spanish adventurers continued to believe that in the valley would eventually be found Eldorado (*q.v.*). Sir Walter Raleigh paid with his life when the Orinoco failed to yield what the English adventurer had assured his sovereigns it would. During the 17th century Jesuits established missions along the banks of the river, but by the mid-18th century their hold was still tenuous, as the Indians periodically laid waste buildings and fields. In 1744 Jesuit missionaries discovered the unusual Casiquiare connection between the Orinoco and Amazon (*q.v.*) systems. Alexander von Humboldt (*q.v.*) took an expedition up the river in 1800. Simon Bolivar envisioned a city on the banks of the Orinoco as one day being the chief port of entry for all of South America. Tradition has it that the first steamship was on the river as early as 1812. but it was not until the late 1860s and after many efforts and much expense that steamship navigation became a continuous part of the river's history.

Herbert Spencer Dickey in 1931 headed an expedition that claimed to have established the exact source of the river; a Brazilian boundary-settling expedition claimed a slightly different location of the source in 1933; the Venezuelan expedition 1951 (*see* above) claimed the final settlement. Meanwhile, as for nearly four centuries: gold seekers combed the valleys of the river's tributaries in search of wealth. (J. J. J.)

ORIOLE, the name applied in America to several birds of the genus *Icterus*, grouped with blackbirds and troupials in the family Icteridae. They were called orioles by the early American settlers because the black and yellow patterns of these birds was reminiscent of the true orioles (family Oriolidae) of Europe. (*See* ICTERGS.)

The true orioles, of which there are about 26 species. chiefly in Asia. Africa and northern Australia! is represented in Europe by the golden oriole (*Oriolus oriolus*). The golden oriole is an occasional spring visitor to the British Isles, but rarely breeds there. In Europe it is a well-known bird; its range in summer extends east to Irkutsk, U.S.S.R., while in winter it is found as far south as the Union of South Africa. In India it is replaced by an allied form, *0. kundoo*, the mango bird. and both in Asia and Africa are several other species, some of which have a black head) or even a glowing crimson. instead of the ordinary yellow colouring, while others exhibit the dingy type of plumage seen in the female of the more usual form.

Mimeta and *Sphecotheres* species are orioles peculiar to the Australian region; the former are drab in colour and mimic friarbirds (*q.v.*), the latter are distinguished by a bare space round the eyes.

Orioles are shy and restless birds, frequenting gardens and woods, and living on insects and fruit. Most of the species have loud, clear, flutelike melodious songs. *Oriolus* species are not gregarious, but some of the Australian forms tend to keep in loose but sizable flocks. The nest is pocket-shaped, composed of bark, grass and fibres, and the eggs are white or salmon-coloured with dark spots in most species, greenish in *Sphecotheres*. *See* also BIRDS. (HT. FN.)

ORION, in Greek mythology, son of Hyrieus or Poseidon, a mighty hunter of great beauty and gigantic strength. He is also sometimes represented as sprung from the earth. He was beloved of Eos, the dawn-goddess, who carried him off to Delos; but Artemis slew him with her arrows (*Odyssey*, v, 121). According to other accounts which attribute Orion's death to Artemis, the goddess herself loved him and was deceived by the angry Apollo into shooting him by mistake; or he paid the penalty of offering violence to her. or of challenging her to a contest of quoit-throwing. In the lower world his shade is seen by Odysseus driving the wild beasts before him as he had done on earth (*Odyssey*, xi. 572).

After his death he was changed into the constellation called by his name. It took the form of a warrior wearing a girdle of three stars and a lion's skin and carrying a club and a sword. When it rose early it was a sign of summer; when late. of winter and stormy weather; when it rose about midnight it heralded the season of vintage.

Orion is one of the most conspicuous constellations, containing many bright stars.

Of these Betelgeuse is easily distinguished by its yellowish-red colour in contrast to all the other important stars of the constellation. which are white B-type stars. Betelgeuse is an irregular variable sometimes above and sometimes below the first magnitude. It was the first star for which the apparent diameter was measured by Michelson's interferometer method (1920). Rigel at the opposite corner of the quadrilateral is rather brighter; and the third brightest star is Bellatrix. The Orion nebula can be seen with the naked eye just below the belt: faint extensions of it have been photographed filling practically the whole constellation. The multiple star Theta Orionis is near the centre of the nebula.

There is no doubt that the principal stars of the constellation form a single system and are involved in the nebulosity whose luminescence is stimulated by their intense radiation rich in light of short wave length. The distance of the nebula from the solar system is estimated at 1.500 light-years.

ORION and **ORUS,** the names of several Greek grammarians, frequently confused. The following are the most important.

1. Orion of Thebes in Egypt (5th century A.D.), the teacher of Proclus the neo-Platonist and of Eudocia, the wife of the younger Theodosius. He taught at Alexandria. Caesarea in Cappadocia and Byzantium. He was the author of a partly extant etymological Lexicon (ed. F. W. Sturz. 1520). largely used by the compilers of the *Etymologicum Magnum*, the *Etymologicum Gudianum* and other similar works; a collection of maxims in three books: addressed to Eudocia, also ascribed to him by Suidas, still exists in a Warsaw manuscript.

2. Orus of Miletus, who, according to Ritschl. flourished not later than the 2nd century A.D., and was a contemporary of Herodian and a little junior to Phrynichus. His chief works were treatises on orthography; on Atticisms; on the names of nations.

See F. Ritschl, *De Ouo et Ouione Commentatio (1834)*; R. Reitzenstein, *Geschichte* der *griechischen Etymologika (1897)*; and article "Orion" in Smith's *Dictionary of Greek and Roman Biography*.

ORISKANY, a village of Oneida county, N.Y., U.S., is located about midway between Utica and Rome, on the State Barge canal. It was founded in 1802 by Col. Garrett Lansing near the site where, on Aug. 6, 1777, Gen. Nicholas Herkimer stopped the advance of Col. Barry St. Leger and contributed to the failure of the British northern campaign. Marching from Ft. Dayton (now Herkimer) with 800 militiamen to relieve Ft. Schuyler (also called Ft. Stanwix, now Rome), Herkimer was ambushed in a ravine by British and Indians under Joseph Brant. Though wounded, he continued to direct his forces in what developed into one of the bloodiest hand-to-hand battles of the American Revolution. Victory came when part of the British forces were drawn off by a sortie from Ft. Schuyler led by Lieut. Col. Marinus Willet. Herkimer died on Aug. 16, seven days before St. Leger, hearing exaggerated reports of American reinforcements, withdrew permanently. The site of the battleground is a state park marked by a memorial shaft erected in 1883. The state's first woolen cloth factory was founded in Oriskany in 1811 and an iron foundry in 1856.

Oriskany, whose population has always been less than 2,000, was incorporated in 1911.

The name comes from an Indian village, Oriska, which once occupied the site. (V. C. C.)

ORISSA, a state in northeastern India with an area of 60,250 sq.mi. and a population (1961) of 17,565,635. Bhubaneshwar is the capital of the state; and Puri, with its temple of Jagannath, is world famous.

The Oriyas trace their traditions back to the ancient kingdom of Utkal. They have always been opposed to the breaking up of Oriya-speaking tracts for political reasons. At the time of the Mogul conquest the Orissa country was broken up, and race consciousness became less intense; but it was revived under the British regime, especially after the famine of 1866. Agitation for the unification of Oriya tracts began to receive official recognition in 1903 and was sustained by the Utkal Union conference.

In 1912 the area of modern Orissa was separated from Bengal and united with Bihar to form the province of Bihar and Orissa. The status of the Oriyas was much improved by this step, but they still continued their agitation for the formation of Orissa into a separate administrative unit on the basis of common language and race. In Jan. 1936 an order in council was issued by the British government constituting Orissa as a separate province. The new province was formed from: (1) the Orissa division of the former province of Bihar and Orissa; (2) areas transferred from the presidency of Madras including (a) the Ganjam Agency tracts, (b) parts of the Ganjam district and (c) parts of the Vizagapatam district; and (3) areas transferred from the Central Provinces including (a) the Khariar zamindari in the Raipur district and (b) the Padampur tract in the Bilaspur district. The state consists of six districts; viz., Sambalpur, Koraput, Ganjam, Cuttack, Puri and Balasore, the latter three constituting the delta of the Mahanadi, Brahmani and Baitarani rivers. In 1866 Orissa suffered from famine, followed by destructive floods, during which 1,000,000 persons are estimated to have perished, largely because of its isolation.

The danger of the recurrence of such a famine was averted by the Orissa canal system and the railway, as well as by the increased prosperity of the people. The occurrence of floods still occasionally causes distress. The beds of the deltaic rivers have been raised by deposits of silt and their outlets obstructed by sand bars until flood waters are not discharged by natural channels but are liable to burst the embankments and inundate the low-lying country on either side.

Orissa is still a backward region from an industrial and agricultural standpoint. There are no big factories but there are a number of cottage industries producing hand-loom products and metalwork. Production of jute and sugar cane as commercial crops is being steadily increased. There are forest resources of valuable timber. Mineral resources include iron ore of excellent quality, coal, limestone: manganese and mica. Orissa provides more than 60% of the iron ore extracted in India.

In 1948 the 39 minor states; formerly under the Chhattisgarh and Orissa agencies, were merged into the Central Provinces (Madhya Pradesh) and Orissa. In the following year, Mayurbhanj, the last surviving state in the area, was absorbed into Orissa.

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ORISTANO, a town and archiepiscopal see of Sardinia, Italy, 23 ft. above sea level, 3 mi. from the eastern shore of a gulf on the west coast, to which it gives its name, and 59 mi. N.W. of Cagliari by rail. Population (1951) 12.183. The town has remains of the walls (1290) and two gates, the Porta Manna with a lofty square tower (Torre S. Cristoforo) and the Porta a Mare. The houses are made of sun-dried bricks. Two miles south of Oristano is the village of S. Giusta, with a beautiful Romanesque church of the Pisan period dedicated to this saint, containing several antique columns. The lagoons on the coast are full of fish, but are a cause of malaria. In the environs garden produce is grown; good wine (*vernaccia*) is made, as well as ordinary pottery. It is also a centre of the cattle trade. A mile south of the mouth of the river Tirso is the landing place for shipping. The large orange groves of Milis lie 13 mi. N of Oristano at the base of Monte Ferru. The inhabitants of Milis manufacture reed baskets and mats, which they sell throughout Sardinia

Oristano occupies the site of the Roman Othoca. the point at which the inland road and the coast road from Carales to Turris Libisonis bifurcated. The mediaeval town (1070) was the seat onward of the *giudici* (judges) of Arborea, one of the four divisions of the island. Almost the last of these judges was Eleonora (1347–1403); after her death Oristano became the seat of a marquisate. which was suppressed in 1478.

ORIZABA, a city in the Mexican state of Veracruz. Pop. (1950) 55,531, 82 mi. W.S.W. of the port of Veracruz, 203 mi. S.E. of Mexico City, on main roads and the two railways connecting those points. Founded by Spaniards in the 16th century to guard these critical routes, Orizaba's strategic importance made it a centre of Mexican history, to which was added its economic development in a favourable habitat. It stands at 4,211 ft. in a fertile, well-watered and temperate valley of the Sierra Madre Oriental, over which towers the Pico de Orizaba, a famous snow-capped extinct volcano (18,696 ft.) 18 mi. N. Midway between the tropical lowlands on one side, the semiarid plateau on the other, Orizaba's sufficiency of water and temperate conditions make its district an important agricultural and industrial area. Crops include tobacco, maize, sugar. cereals and rum. The Rio Blanco furnishes hydroelectric power for numerous textile mills, tobacco factories and light industry, among which is one of the principal breweries of Mexico. The picturesque vegetation and pleasant climate make it a popular tourist place. Its citizens are famed for literature and business ability.

Though a garrison post of Aztecs, called by them *Ahuaializapan* ("pleasant waters"), Orizaba had a negligible native population. Its public edifices recall a long colonial past. It was chartered as a city in 1774 and was licensed under crown monopoly to produce tobacco. It was one of the first textile centres of Mexico. (HD. C.)

ORIZABA, in Aztec, Citlaltepetl, "star mountain," an extinct or dormant volcano on the boundary between the Mexican states of Puebla and Veracruz and very nearly on the 19th parallel. It rises from the southeastern margin of the great Mexican plateau to an elevation of 18.696 ft. It is the highest peak in Mexico, probably third highest in North America. Its upper timber line is about 13,500 ft. above sea level, and Hans Gadow found patches of apparently permanent snow at an elevation of 14,400 ft. on its southeast side in 1902.

The first ascent of Orizaba was made by Reynolds and Maynard in 1848.

Its last eruptive period was 1545–66, and the volcano is now considered to be extinct.

ORJONIKIDZE (DZAUDZHIKAU, formerly VLADIKAVKAZ), a town of the Russian S.F.S.R.. in the North Ossetian A.S.S.R., in 43° 3' N., 44° 42' E. Pop. (1956 est.) 159,000. The former name Vladikavkaz meant "Key of the Caucasus"; the town stands on a plateau 2,345 ft. high on both sides of the Terek river, where the latter issues from the Darial gorge. Towering above the town is the famous Kasbek peak. A small fort was established there in 1784, but the expansion of the town dates from the completion of the great Georgian military road southward through the gorge to Tiflis, which was begun in 1811 and opened in 1864. Later a railway link was made through Beslan to the Rostov-Baku line to the north.

The great gorge has much historic importance for the region; through it came Persian armies and, later, Timur and his Mongol hordes, and its military road brought about the pacification of the warring Caucasian frontier tribes and gave Russia her foothold in the Caucasus. The town was renamed Orjonikidze after the famous soviet leader.

ORKHON INSCRIPTIONS, ancient Turkish inscriptions of the 8th century A.D., discovered near the river Orkhon to the south of Lake Baikal in 1889. They are written in an alphabet derived from an Aramaic source and recount the history of the northern branch of Turks or Tu-kiue of Chinese historians. (See TURKS OR TURKIC PEOPLES.)

ORKNEY, EARL OF, a Scottish title held at different periods by various families, including its modern possessors the Fitzmaurices. The Orkney Islands (*q.v.*) were ruled by jarls or earls under the supremacy of the kings of Norway from very early times to about 1360, many of these jarls being also earls of Caithness under the supremacy of the Scottish kings. Perhaps the most prominent of them were a certain Paul (d. 1099) who assisted the Norwegian king, Harald III Haardraada, when he invaded England in 1066; and his grandson Paul the Silent, who built, at least in part, the cathedral of St. Magnus at Kirkwall. They were related to the royal families of Scotland and Norway.

In its more modern sense the earldom dates from about 1380, and the first family to hold it was that of Sinclair. Sir Henry Sinclair (d. *c.* 1400) of Roslin, near Edinburgh, was recognized as earl by the king of Norway, his mother being Isabella, daughter of Malise, the last of the ancient line of earls. He ruled the islands almost like a king, and employed in his service the Venetian travellers Nicolo and Antonio Zeno. His son Henry (d. 1418) was admiral of Scotland and was taken prisoner by the English in 1406, together with Prince James, afterward King James I; his grandson William, the 3rd earl (c. 1404–So), was chancellor of Scotland and took some part in public affairs. In 1455 William was created earl of Caithness, and in 1470 he resigned his earldom of Orkney to James III of Scotland, who had just acquired the sovereignty of these islands through his marriage with Margaret, daughter of Christian I, king of Denmark and Norway.

In 1567 James Hepburn, earl of Bothwell, was created duke of Orkney on his marriage to Queen Mary. In 1581 her half-brother Robert Stewart (d. 1592), an illegitimate son of James V, was made earl of Orkney. Robert, who was abbot of Holyrood, had joined the party of the reformers and was afterward one of the principal enemies of the regent Morton. His son Patrick acted in an arbitrary manner in the Orkneys, where he set the royal authority at defiance; in 1609 he was imprisoned, and, after his bastard son Robert had suffered death for heading a rebellion, was himself executed in Feb. 1615, when his honours and estates were forfeited.

In 1696 Lord George Hamilton was created earl of Orkney. He married Elizabeth Villiers. and was succeeded by his daughter Anne (d. 1756), the wife of William O'Brien, 4th earl of Inchiquin. Anne's daughter Mary (*c.* 1721–91) and her granddaughter Mary (1755–1831) were both countesses in their own right, the younger Mary married Thomas Fitzmaurice (1742–93), son of John Petty, earl of Shelburne, and was succeeded in the title by her grandson, Thomas John Hamilton Fitzmaurice (1803–77), whose descendants continue to hold the earldom.

See J. S. Clouston (ed.), *Records of the Earls of Orkney, 1299–1664* (1914).

ORKNEY ISLANDS, a group of islands which lies off the north coast of Scotland. They are separated from the mainland by the Pentland firth. which is $6\frac{1}{4}$ mi. wide at the narrowest point between Caithness and South Ronaldsay in Orkney. There are more than 70 islands, of which 20 are inhabited, some by the occupants of a single farm.

The largest island of the group is Mainland. divided into East and West Mainland which are joined by a neck about a mile wide between Scapa on Scapa Flow and Kirkwall, the county capital. On maps. Mainland is sometimes called Pomona — apparently a modern name. Mainland is a comparatively low, undulating land, most of it cultivated but with a considerable quantity of moor and several lochs. Two of these, Harray and Stenness, occupy a large acreage in West Mainland. The fishing for both brown and sea trout is good. There are no rivers.

Kirkwall and Stromness are picturesque towns. The main streets are extremely narrow. St. Magnus cathedral in Kirkmall, though small, is one of the finest and most complete examples of Norman architecture in Scotland. Built of red and gray sandstone it was begun in 1137 and finished in the 15th century except for the tower which is modern, the original being struck by lightning. In Kirkwall, too, there are several fine old houses and the ruins of the Bishop's palace and the palace of the Scottish earls.

The Inhabited Islands. — The islands to the south (1951 pop. in parentheses) are Burray (374), South Ronaldsay (1,128), Snona (3). Flotta (215), South Fara (20), Hoy (957) and Graemsay (83). Burray and South Ronaldsay, lying to the south of East Mainland. are now joined to Mainland by roads built on the barriers which were constructed during World War II to prevent submarines entering Scapa Flow through the sounds. Scapa Flow (*q.v.*) itself is a large expanse of sea almost surrounded by land. It mas an important fleet anchorage in World Wars I and II. In Scapa Flow are several other islands, the only one of which now inhabited is Graemsay, one of the few islands in Orkney where crofting, in the strict sense, is still carried on. It has two lighthouses. It was in the Flow that the German navy was scuttled in 1919. Most of the bigger ships had been salvaged by the middle of the 20th century but work still continued from time to time. The centre and north of Hoy, which lies to the south of West Mainland, is wild and inountainous with precipitous cliffs to the Atlantic on its west coast.

The famous Dwarfie stone, an enormous block of sandstone with rooms hollowed out in it, lies in a valley near Ward hill (the highest hill in Orkney) on Hoy. Lyness, a naval base, lies on the eastern side of the island. Oti the west coast stands a single cliti rock —the Old Man of Hoy. Flotta. east of Hoy, was the home for a long time of the Scandinavian compiler of the *Codex Flotticensis.* Fara also lies east of Hoy. On South Ronaldsay is the village of St. Margaret's Hope where Queen Margaret (the "maid of Norway") died. Burray is famous for the *broch,* or fortified tower, from which the island takes its name (Borgarey, Norse; "island of the broch"). The remaining islands are low-lying and, when inhabited, thoroughly tilled.

To the north of Mainland lie the North Isles, also on the whole flat and agricultural. The climate is mild but windy. There are few trees; the landscape. however, is varied and colourful and the general impression is as much lowland as highland, as the land is heavily cultivated and the soil is good. Place names are mostly of Narse origin. Many of the islands have names ending in *ay* from the Norse *ey,* meaning island, and many of the farms and districts have Norse terminations such as *setter.* The people. too, though now intermarried with the Scots, have Norse traits and traditions, but the Norse language has long been extinct. The most northerly of the islands is North Ronaldsay (pop., 1951, 224). It is almost the last home of a breed of sheep similar to the Shetland sheep, which once was native to all Orkney. The sheep give a peculiarly fine wool which is probably due to the fact that they feed principally on seaweed and sea grasses. There is a wall around the island and. except at certain times of the year, the sheep are kept outside it.

Westray (1,091) has a considerable village at Pierowall, and the ruins of Noltland castle dating from the 16th century. To the northeast of Westray lies the smaller island of Papa Westray. Sanday (866) is the largest of the northern islands and, like the others, split into bays and headlands by the action of the sea. Though fertile, its soil is light (hence its name). There is a pier and a small village at Kettletoft. Stronsay (638) has a considerable pier and harbour at Whitehall. It used to be a station for the summer herring fishing. It is a very fertile island but reduced in population. Eday (308) is largely covered with peat and heather. At Carrick house at the north of the island John Gow, the pirate. was taken in 1725. North Fara is now uninhabited. Rousay (342) also has considerable areas of heather and peat. It has important prehistoric remains from the Stone and Bronze Ages. Off the coast of Rousay lie Egilsay (57), with its ruins of an early church, and Wyre (46). Nearest to Kirkwall is the island of Shapinsay (483).

History. — The Orkhey Islands were the *Orcades* of classical writers and the word may be derived from the Norse for a seal. Seals, both gray and common, are plentiful around the islands. Reindeer hunting is mentioned in the *Orkneyinga* Suga and elk were known until about 1300. There is much evidence of prehistoric occupation of various dates in the form of underground houses, tombs. circles, standing stones and earth houses; the earliest of these date from the Stone and Bronze Ages.

Three of the most famous of these ancient remains are the corbelled tomb at Maeshowe which was later broken into by the vikings; the stone circles at Brogar; and the underground village of Skara Brae (*q.v.*). This last, which nas fully excavated in 1928–31 under the direction of V. Gordon Childe, is one of the most complete and interesting relics of the Stone Age. Its inhabitants are believed to have been originally an Iberian people who came up the west coast of England and Scotland. Later, the islands seem to have been inhabited by the Picts and there are the remains of many *brochs* dating from their time. Eventually, however, the whole county was conquered by the Norsemen in the 9th century and became a Norse earldom. Celtic missionaries brought Christianity to Orkney as early as the 7th century but it was probably not finally converted until much later. It was from Orkney that the Norse forces went south to the battle of Largs and it was during the Norse earldom that most of the Kirkwall cathedral, which dates from the 12th century, was built. It was built in memory of St. Magnus, a claimant to the Norse earldom, who was murdered by his cousin on the island of Egilsay in 1115. The *Orkneying* Saga is one of the great sagas of viking literature.

In 1468 Orkney and Shetland were pledged by Christian I of Denmark in payment of the dowry of his daughter, Margaret. The dowry was never paid and the pledge was therefore forfeited. The islands on the whole played little part in Scottish history, though James Bothwell was created their duke and Montrose raised an army there. The udal succession and mode of land tenure (that is, absolute freehold as distinguished from feudal tenure) still obtain to some extent, a relic from Norse days.

Agriculture and **Industries.**—Orkney lies on beds of gray and red sandstone nith other types of stone on the various islands. As in Caithness, the stone is easily worked and provides excellent material for building. The soil is generally sandy loam and very fertile. Considering its situation and the fact that considerable tracts of the land are under peat. the county is intensively farmed. The main products are beef cattle and eggs, though pigs and milk production have greatly increased. Oats and barley are grown for food, as well as turnips and potatoes, but the county imports feeding stuffs for its own large production of livestock. Lobsters are caught, particularly around the northern islands and Scapa Flow. There are distilleries and a plant for processing seaweed.

Population. — The population of the county in 1951 was 21,255; that of Kirkwall, the county town and a royal burgh, was 4,348. The only other town is Stromness which is a small burgh with a population (1951) of 1,503. Orkney with Shetland sends one member to parliament. Together with Caithness and Shetland it forms a sheriffdom.

See V. G. Childe, *Skara Brae* (1931); H. Marwick, *Orkney* (1951); G. Scott-Moncrieff, *Scottish Islands* (1952); Orkney Record and Antiquarian Society, *An Orkney Miscellany* (Scot., 1954). (J. GD.)

ORLANDO, VITTORIO EMANUELE (1860–1952), Italian lawyer and statesman, was born at Palermo on May 19, 1860. He was first elected deputy for Partinico in Sicily in 1897. He was minister of education in the Giolitti cabinet of 1903–05, and of justice in the Giolitti cabinet of 1907–09, and again under Salandra in Nov. 1914. He was in favour of Italian intervention in World War I. On the resignation of the Salandra cabinet in June 1916 he remained in office under Boselli as minister of the interior, and when the latter resigned he was entrusted with the formation of a new cabinet.

After the armistice he went to Paris as leader of the Italian peace delegation. When Pres. Woodrow Wilson launched his appeal on Fiume to the Italian people over the heads of their delegates, Orlando returned to Rome, where he was triumphantly received, but after his return to Paris without obtaining any satisfactory solution of the Adriatic problem the chamber voted against him, and he resigned on June 19, 1919. On Dec. 2, 1919, he was elected president of the chamber. He at first supported Mussolini, but after the Matteotti affair he withdrew his support, without, however, abandoning the chamber. At the municipal elections of Palermo in Aug. 1925 he mobilized all his adherents in favour of the antifascist list. He resigned from parliament in protest of the fraudulent fascist victory.

After the Allies' entry into Rome in World War II, Orlando resumed public life, was a member of the consultative assembly and president of the constituent assembly elected in June 1946. In 1947 he resigned from the assembly in protest against the Italian peace treaty. He was a member of the Italian senate elected in April 1948 and in May was candidate for the presidency of the republic but was defeated by Luigi Einaudi by 518 votes to 320. He died in Rome on Dec. 1, 1952.

ORLANDO, a city of central Florida, U.S., is located 145 mi. S. of Jacksonville and 97 mi. N.E. of Tampa; the seat of Orange county. Topographical features include low, rolling hills, with over 50 fresh-water lakes, many of them spring fed and surrounded by parks, located wholly or partly within the city limits.

Settlement of Orlando began about 1844 in the vicinity of Ft. Gatlin, a U.S. army post from 1837 to 1848. The first post office, established in 1850, was called Jernigan after Aaron Jernigan, an early settler from Georgia, but was changed to Orlando in 1857, in honour of Orlando Reeves, a soldier who was killed in the vicinity by Indians in 1835. Orlando became the county seat in 1856 and was incorporated as a city in 1875. The South Florida railroad, later part of the Atlantic Coast Line system, reached Orlando from Sanford, a distance of 20 mi., in 1880 and was extended to Tampa in 1883.

Most of the business life of the city centres around the distribution of products throughout the fertile citrus-growing and truck-gardening regions which surround the city. Major industries include citrus processing and packing, boatbuilding and the manufacture of electronic components, clothing, furniture and machinery. Two U.S. air force installations, Orlando air force base (military air transport service) and McCoy air force base (strategic air command), and a navy underwater sound reference laboratory are located in or near the city.

Educational facilities include Rollins college (1885), located in suburban Winter Park, and municipally owned Orlando junior college (1941).

Pop. (1960) 88,135; standard metropolitan statistical area (Orange and Seminole counties) 318,487. (J. E. Jo.)

ORLÉANAIS, a former French province, of which Orléans was the regional capital; its limits changed from period to period. In ancient Gaul, Cenabum (Orléans) and Carnuturn (Chartres) were the chief towns in the civitas of the Carnutes, which, in the 4th century, the Romans divided into two parts, Civitas Carnuturn and Civitas Aurelianorum, the latter corresponding roughly to the later diocese of Orléans and to the 9th-century county of Orléans. This is Orléanais stricto *sensu.* But a larger territory, spreading over Blésois, Vendômois, Dunois, Beauce and Gâtinais, was sometimes administered from Orléans and lay under its economic and cultural influence; for example, in the 17th and 18th centuries, the above-mentioned territories were included in the gouvernement and in the *généralité* of Orléans, which corresponded to the modern departments of Loiret, Loir-et-Cher and Eure-et-Loir.

From the time of Robert the Strong, duke of the country between the Seine and the Loire (861–866), Orléanais was a seat of power of the Robertian family. Hugh Capet was count of Orléans as well as of Etampes and Paris; and under the early Capetians Orleans competed with Paris for the rank of capital. Under the Valois, however, Orléanais became an appanage (see ORLEANS, DUKES OF).

See also R. Crozet, *Histoire de l'Orléanais* (Paris, 1936). (F. CT.)

ORLEANISTS, a French political party which arose out of the Revolution. It took its name from the Orléans branch of the house of Bourbon, the descendants of Philippe, duke of Orléans, younger brother of Louis XIV, who were its chiefs. Its aim was to reconcile the monarchical principle with the "rights of man," as proclaimed by the constituent assembly in 1789. The Orléans princes were traditionally marked out as the leaders in such a policy. Enormously rich, within measurable distance of the succession to the throne, but cut off by the jealousy of the crown from all share in public affairs, they had long been the centres of opposition to the encroachment of the royal power. Louis, duke of Orleans, had headed the protest of the princes against the policy of René Maupeou in suppressing the *parlement* of Paris; his son later earned the style of Philippe Egalité by adopting—with ulterior objects—extreme revolutionary views (*see* ORLEANS, LOUIS PHILIPPE JOSEPH) ; and Egalité's son Louis Philippe (afterward king of the French) fought, as duc de Chartres, at Jemappes, under the republican tricolour. The generation of Orleanists, the immediate supporters of Philippe Egalité, were swamped in the turmoil of the Revolution. But they came naturally to the front when another revolution overthrew the restored legitimate monarchy of Louis XVIII and Charles X. During the Restoration, 1815–30, everything tended to identify the Liberals with the Orléanists. It is true that Louis XVIII had been induced to grant *(octroyer)* a constitutional charter; but he and his successor claimed to rule by divine right and to confer liberties upon their subjects of their own will. The difference between the Legitimists and the Orléanists was thus fundamental. So was that between the Orléanists and the Bonapartists; for the former aimed at securing political liberty, in addition to equality before the law and in social life, while the latter aimed at subjection to a military despotism.

The revolution of 1830 brought the Orléanists into power, and they marked the profound change made in the character of the government by styling Louis Philippe not "king of France and Navarre by the grace of God," but "king of the French by the grace of God and the will of the people." The Orléanists were led by men eminent in letters and in practical affairs—François Guizot, Louis Thiers, the Broglies, the banker Jacques Laffitte and many others—and the 18 years of their rule were, on the whole, profitable to France. That they ended in another "general overturn" in 1848 was mainly because the Orléanist conception of what was meant by the word "people" led the government to offend the deeply rooted love of the French for equality. On the model of the English constitution they instituted a *pays légal* of about 250,000 voters by whom all the rest of the country was to be "virtually represented." But the nation outside of the *pays ldgal* soon discovered that it was being governed by a privileged class, less offensive perhaps, but also less brilliant, than the aristocracy of the old monarchy.

The revolution of 1848 swept the Orléanists from power forever. They continued indeed throughout the second republic and the Second Empire (1848–70) to enjoy a marked prestige, because of the wealth and capacity of some of their members, their influence in the French academy and the ability of their organs in the press. But their weakness was demonstrated when the Second Empire mas swept away by the German War of 1870–71. The country, in its disgust at the Bonapartists and its fear of the Republicans, chose a great many royalists to represent it in the assembly which met in Bordeaux on Feb. 12, 1872. In this body the Orléanists again exercised a kind of leadership by virtue of individual capacity, but they were counterbalanced by the Legitimists. They defeated Thiers on May 24, 1873, as punishment for his dexterous imposition of the republic on the unwilling majority of the assembly. Their real occupation was to endeavour to bring about a fusion between themselves and the Legitimists. As far back as 1850 Guizot had proposed, or had thought of proposing, such a fusion, but it was on the condition that the comte de Chambord would resign his divine pretentions. The fusion arranged in 1873 was on quite another footing. After much exchange of notes and many agitated conferences, the comte de Paris, the representative of the Orléanists, sought an interview with the comte de Chambord at Frohsdorff, and obtained it by giving a written engagement that he came not only to pay his respects to the head of his house, but also to "accept his principle." Orléanists have declared that the engagement was given with mental reservations; but the country believed that the liberal royalists had been absorbed in the divine-right royalists, and returned republicans at by-elections till it transformed the assembly. The Orléanist princes had still a part to play, particularly when the death of the comte de Chambord in 1883 left them heads of the house of France, but the Orléanist party ceased to exist as an independent political organization.

Bibliography.—The Orleanists are necessarily more or less dealt with in all histories of France since 1789, and in most political memoirs, but their principles can be learned and their fortunes followed from the following: A. Sorel, *L'Europe et la révolution française* (1885–1904); F. Guizot, *Histoire parlementaire de la France* (1819–48) and *Mémoires pour servir à l'histoire de mon temps* (1858–67); P. de la Gorce, *Histoire du second empire* (1894–1904); and G. Hanotaux, *Histoire de la fondation de la 3ème République* (192;). For the attitude of the Orleans princes towards the crown under the old regime, *see* Amédée Britsch, *La Jeunesse de Philippe Égalité* (1927).

ORLEANS, DUKES OF. The title of duke of Orléans was first created by King Philip VI in favour of his son Philip, who died without legitimate issue in 1375. The second duke of Orléans, created in 1392, was Louis, a younger son of Charles V, whose heir was his son the poet Charles of Orléans. Charles's son Louis, the succeeding duke, became king of France as Louis XII in 1498, when the duchy of Orléans was united with the royal domain. In 1626 Louis XIII created his brother Jean Baptiste Gaston (d. 1660) duke of Orleans, and the title was revived in 1661 by Louis XIV in favour of his brother Philip. Descendants of this duke have retained the title until the present day, one of them becoming king of France as Louis Philippe in 1830. Two distinguished families are descended from the first house of Orléans: the counts of Angoulême, who were descended from John, a son of Duke Louis I, and who furnished France with a king in the person of Francis I; and the counts and dukes of Longueville, whose founder was John, count of Dunois, the bastard of Orléans, a natural son of the same duke. In addition to the dukes of Orléans the most important members of this family are: Anne Marie Louise, duchess of Montpensier; Francis, prince of Joinville; Louis Philippe Albert, count of Paris; and the traveller Prince Henry of OrlCans. (See Bourbon, table.)

ORLEANS, CHARLES, Duke of (1391–1465), commonly called Charles d'Orléans, French poet, was the eldest son of Louis, duke of Orléans (brother of Charles VI of France), and of Valentina Visconti, daughter of Gian Galeazzo, duke of Milan. He was born on May 26, 1391. He married (June 29, 1406), Isabella, his cousin, widow of Richard II of England. She died three years later. He was already duke of Orléans, for Louis had been assassinated by the Burgundians two years before (1407). He was now the most important person in France, except for the dukes of Burgundy and Brittany, the king being a cipher. He was, however, only nominally one of the leaders of the civil war, the real guidance of his party resting with Bernard VII, the great count of Armagnac, whose daughter Bonne he married, or at least formally espoused, in 1410. Five years of confused negotiations, plots and fightings passed before the English invasion and the battle of Agincourt, where Charles was joint commander in chief. He was taken prisoner and carried to England, where he remained for a full quarter of a century. He hunted and hawked and enjoyed society amply, though the very dignities which secured him these privileges made his ransom great and his release difficult to arrange. Above all, he had leisure, however, for literary work which consisted of short poems in the artificial metres then fashionable in France. Besides these a number of English poems have been attributed to him, but without certainty. For practical purposes his work consists of some hundreds of short French poems, a few in various metres, but the majority either ballades or rondels. Charles d'Orléans is the last representative of the poetry of the middle ages, in which the form was almost everything, and the personality of the poet, save in rare instances, nothing. He has the urbanity of the 18th century without its vicious and prosaic frivolity. His best-known rondels—those on spring, on the harbingers of summer, and others—rank second to nothing of their kind.

The agreement for his release from captivity was concluded on July 2, 1440. He was actually released on Nov. 3, and then married Mary of Cleves, who brought him a considerable dowry to assist the payment of his ransom. After his return to France he maintained at Blois a miniature court, at which the best-known French men of letters at the time—François Villon, Olivier de la Marche, Georges Chastellain, Jean Meschinot and others—were residents or visitors or correspondents. His son, afterward Louis XII, was born in 1462. Charles died on Jan. 4, 1465, at Amboise.

The best edition of Charles d'Orléans's poems, with a brief but sufficient account of his life, is that of C. d'Héricault in the *Nouvelle collection Jannet* (Paris, 1874). For the English poems *see* the edition by Watson Taylor for the Roxburghe Club (1827). *See* also C. Bruneau, *Charles d'Orléans et la podsie aristocratique* (Lyons, 1924).

ORLEANS, FERDINAND PHILIP LOUIS CHARLES HENRY, Duke of (1810–1842), born at Palermo on Sept. 3, 1810, was the son of Louis Philippe, duke of Orléans, afterward king of France, and Marie Amélie, princess of the Two Sicilies. Under the Restoration he bore the title of duke of Chartres, and studied classics in Paris at the Collège Henri IV. At the outbreak of the revolution which in 1830 set his father on the throne, he was colonel of a regiment of Hussars. He assumed the title of duke of Orléans, and was sent by the king to put down the riots at Lyons (1831), and then to the siege of Antwerp (1832). He was appointed lieutenant general, and made several campaigns in Algeria (1835, 1839, 1840). On his return to France he organized the chasseurs *d'Orléans*. He died after an accident at Neuilly, near Paris, on July 13, 1842.

The duke of Orléans had married (May 30, 1837) Helène Louise Elisabeth of Mecklenburg-Schwerin, and had by her two sons, the count of Paris and the duke of Chartres. On Feb. 24, 1848, after the abdication of Louis Philippe, the duchess of Orléans went to the chamber of deputies in the Palais Bourbon in the hope of having her eldest son proclaimed and of obtaining the regency; the attitude of the populace forced her to take refuge in England, and she died at Richmond, Eng., on May 18, 1858.

ORLEANS, HENRI, Prince of (1867–1901), eldest son of Robert, duke of Chartres, was born at Ham, near Richmond, Surrey, Eng., on Oct. 16, 1867. In 1889, at the instance of his father, he undertook, in company with P. G. Bonvalot, a journey through Siberia to Siam. They crossed the mountain range of Tibet, and the fruits of their observations, submitted to the

Geographical Society of Paris and later incorporated in De *Paris au Tonkin à* travers *le* Tibet *inconnu* (1892). brought them conjointly the gold medal of that society. In 1892 the prince made a short journey in East Africa, and shortly afterward visited Madagascar, proceeding thence to Tongking. From there he set out for Assam, and found the sources of the Irrawaddy. which secured the medal of the Geographical Society of Paris and the cross of the Legion of Honour. In 1897 he revisited Abyssinia, and political differences arising from this trip led to a duel with the comte de Turin, in which both combatants were wounded. While on a trip to Assam he died at Saigon on Aug. 9, 1901.

ORLEANS, HENRIETTA, Duchess of (1644–1670), third daughter of the English king Charles I (*q.v.*) and his queen, Henrietta Maria (*q.v.*), was born during the Civil War at Exeter on June 16, 1644. A few days after her birth her mother left England. and she lived at Exeter under the care of Lady Dalkeith (afterward countess of Morton) until the surrender of the city to the parliamentarians, when she was taken to Oatlands in Surrey. In July 1646 she rejoined her mother in Paris. where her girlhood was spent and where she was educated as a Roman Catholic. Henrietta was mentioned as a possible bride for Louis XIV (*q.v.*), but she was betrothed to his only brother, Philip. After the restoration of her brother Charles II (*q.v.*), she returned to England with her mother, but a few months later she was again in Paris, where she was married to Philip, now duke of Orléans, on March 30, 1661. The duchess was popular at the court of Louis XIV and was on good terms with the "grand monarch," but she was soon estranged from her husband, and her conduct was imprudent. In 1670, at the instigation of Louis, but without Philip's consent, she visited England and obtained the signature of Charles II's ministers to the treaty of Dover (*q.v.*). Shortly after returning to France, Henrietta died at St. Cloud on June 30, 1670, and it was asserted that she had been poisoned by order of her husband. She left two daughters. Maria Louisa. later wife of Charles II (*q.v.*) of Spain, and Anne, later wife of Victor Amadeus II (*q.v.*) of Savoy, king of Sardinia (see Savoy, House of).

ORLEANS, JEAN BAPTISTE GASTON, Duke of (1608–1660), third son of the French king Henry IV and his wife Marie de Medici, was born at Fontainebleau on April 25, 1608 Known at first as the duke of Anjou, he was created duke of Orléans in 1626, and was nominally in command of the army which besieged La Rochelle in 1628. On several occasions he was obliged to leave France for conspiring against the government of his mother, of Cardinal Richelieu and of Louis XIII. Orléans stirred up Cinq-Mars to attempt Richelieu's murder, and then deserted him. In 1643, on the death of Louis XIII, Gaston became lieutenant general of the kingdom, and fought against Spain on the northern frontiers of France; but during the nars of the Fronde he passed from one party to the other. Exiled by Jules Mazarin in 1652 he remained in Blois until his death on Feb. 2, 1660. Gaston's first nife was Marie (d. 1627), daughter and heiress of Henri de Bourbon, duc de Montpensier (d. 1608), and his second wife. Marguerite (d. 1672), sister of Charles III, duke of Lorraine. By Marie he left a daughter, Anne Marie, duchesse de Montpensier (*q.v.*); and by Marguerite he left three daughters, Marguerite Louise (1645–1721), wife of Cosimo III, grand duke of Tuscany; Elizabeth (1646–96), wife of Louis Joseph, duke of Guise; and Françoise Madeleine (1648–64), wife of Charles Emmanuel II. duke of Savoy.

ORLEANS, LOUIS, Duke of (1372–1407), younger son of the French king Charles V, was born on March 13, 1372. Having been made count of Valois and of Beaumont-sur-Oise and then duke of Touraine, he received the duchy of Orléans from his brother, Charles VI, in 1392. In 1388 he played an important part in persuading the king to get rid of the tutelage of his three uncles. after which he in fact ruled France, with the help of the *Marmousets* (the former ministers of Charles V). But when Charles VI became insane in 1392 the *Marmousets* were dismissed, and the king's uncles became influential in the government again. Despite an agreement whereby foreign policy was to be controlled by Louis and general policy by Philip (the Bold), duke of Burgundy, a quarrel soon developed between Louis and Philip and became the dominating factor in French politics. Louis was attractive and intelligent; but his private life was dissolute, and he liked extravagant life at court. He thought of politics as a game, cynically. On Jan. 27, 1389, he had married Valentina (d. 1408), daughter of Gian Galeazzo Visconti, duke of Milan, who brought him the county of Asti (this marriage later furnished Louis XII and Francis I with the pretext for their claims on Milan); and soon Louis's foreign policy was involved in Italian affairs. In 1390 and 1393 there were plans of a great expedition to Italy, where the schismatical pope Clement VII offered Louis a kingdom of Adria; and in 1396 Louis arranged the cession of Genoa to France. Meanwhile, he had bought the duchy of Luxembourg. Hostile to England, he led the campaign of 1406–07 in Guienne, but failed before Blaye. The heavy cost of these adventures and of Louis's court life, the increase of taxation and also Louis's rapacity (he acquired Angoumois, Périgord and the county of Blois), as well as his connection with the queen (Isabeau of Bavaria), whose lover he probably was, made him extremely unpopular. Philip the Bold's death had strengthened his position, but later his quarrel with Philip's son John the Fearless became acute. In 1405 both parties prepared for war, but a reconciliation was brought about on Oct. 16. However, on Nov. 23, 1407, Louis was murdered in Paris by John's retainers. Louis had eight children by his wife, including his successor, the poet Charles of Orléans. One of his natural sons was the famous bastard of Orléans, John, count of Dunois.

See E. Jarry, *La Vie politique de Louis de France duc d'Orléans* (Paris, 1889); F. D. S. Darwin, *Louis d'Orléans* (London, 1936).
(F. Ct.)

ORLEANS, LOUIS. Duke of (1703–1752), only son of Duke Philip II. the regent Orléans, was born at Versailles on Aug. 4, 1703. He took very little part in the politics of the time, although he was conspicuous for his hostility to Cardinal Dubois in 1723. In 1730 Cardinal Fleury secured his dismissal from the position of colonel general of the infantry. He retired and spent his time mainly in translating the Psalms and the epistles of St. Paul. Having succeeded his father as duke of Orléans in 1723, he died in the abbey of St. Geneviève at Paris on Feb. 4, 1752. His wife Augusta (d. 1726), daughter of Louis William, margrave of Baden, bore him one son, Louis Philippe, who succeeded him.

ORLEANS, LOUIS PHILIPPE, Duke of (1725–178j), son of Louis, duke of Orléans, was born at Versailles on May 12, 1725, and was known as the duke of Chartres until his father's death in 1752. He served with the French armies in the campaigns of 1742, 1743 and 1744, and at the battle of Fontenoy in 1745, retiring to Bagnolet in 1757 and occupying his time with theatrical performances. He died at St. Assise on Nov. 18, 1785. The duke married Louise Henriette de Bourbon-Conti, who bore him a son Philippe (Egalité), duke of Orléans, and a daughter, who married the last duke of Bourbon. His second wife, Madame de Montesson, whom he married secretly in 1773, was an authoress of some repute. He had two natural sons, the abbot of St. Far and the abbot of St. Albin.

See *L'Automne d'un prince,* a collection of letters from the duke to his second wife ed. by J. Hermand (1910).

ORLEANS, LOUIS BMILIPPE JOSEPH, Duke of (1747–1793), called Philippe Egalité, son of Louis Philippe. duke of Orléans, and of Louise Henriette de Bourbon-Conti, was born at St. Cloud on April 13, 1747. Having borne the title of duke of Montpensier until his grandfather's death in 1752, he became duke of Chartres, and in 1769 married Louise Marie Adelaide de Bourbon-Penthike, daughter and heiress of the duke of Penthièvre, grand admiral of France. Her wealth made him the richest man in France, and he determined to play a part equal to that of his great-grandfather, the regent, whom he resembled in character and debauchery. As duke of Chartres he opposed the plans of René Maupeou in 1771, and was exiled to his country estate of Villers-Cotterets (Aisne). When Louis XVI came to the throne in 1774, Chartres still found himself looked on coldly at court. In 1778 he served in the squadron of the comte d'Orvilliers, but the queen obtained his removal from the navy and he was given the honorary post of colonel general of hussars. He then abandoned himself to pleasure; he often visited London, becoming an intimate friend of the prince of

Wales (afterward George IV). He made himself very popular in Paris by his gifts to the poor in time of famine, and by throwing open the gardens of the Palais Royal to the people. Before the meeting of the notables in 1787 he had succeeded his father as duke of Orléans, and advertised his liberalism so boldly that he was believed to be aiming at becoming constitutional king of France. In November he was again exiled to Villers-Cotterets. He was elected to the states-general and led the minority of 47 noblemen who seceded from their own estate (June 1789) and joined the Tiers Etat. The part he played during the summer of 1789 is one of the most debated points in the history of the French Revolution. The court accused him of being at the bottom of every popular movement, and saw the "gold of Orléans" as the cause of the Reveillon riot and the taking of the Bastille. The best testimony for his behaviour during that summer is that of an English woman, Mrs. Grace Dalrymple Elliott, who shared his affections with the comtesse de Buffon; her statement shotvs that at the time of the riot of July 12 he was on a fishing excursion, and was rudely treated by the king on the next day when going to offer him his services. The marquis de la Fayette persuaded the king to send the duke to England on a mission and he remained in England from Oct. 1789 to July 1790. On July 7 he took his seat in the assembly, and on Oct. 2 both he and the comte de Mirabeau were declared by the assembly entirely free oi any complicity in the events of October. He now tried to avoid politics, but the court suspected him and his friends talked about his being king. He made no attempt to get himself made king, regent or lieutenant general of the kingdom at the time of the flight to Varennes in June 1791, but again tried in vain to make his peace with the court in Jan. 1792. In the summer of that year he was present for a short time with the army of the north, but had returned to Paris before Aug. 10. After that day he ran great risks in saving fugitives; in particular, he saved the life of the count of Champcenetz, the governor of the Tuileries, his personal enemy, at the request of Mrs. Elliott. After accepting the title of Citoyen Egalité, conierred on him by the commune of Paris, he was elected 20th and last deputy ior Paris to the convention. In that body he sat as quietly as in the national assembly, but at the king's trial he had to speak, and then only to give his vote for the death of Louis. Nevertheless, when the news of the desertion of his eldest son, the duke of Chartres, with Charles Dumouriez became known in Paris, all the Bourbons remaining in France, including Egalité, were arrested April 5. He remained in prison until October, when the Reign of Terror began, and was decreed "of accusation" on Oct. 3. He was tried on Nov. 6, and guillotined on the same day. Personally Orléans possessed the charming manners of a polished grand seigneur; he was debauched and cynical, but never rude or cruel, full of gentle consideration for all about him but selfish in his pursuit of pleasure.

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ORLEANS, LOUIS PHILIPPE ROBERT, DUKE OF (1869–1926), eldest son of the comte de Paris, was born at York House, Twickenham, Eng., on Feb. 6, 1869. The law of exile against the French princes having been abrogated in 1871, he returned to France and was educated at Eu and at the College Stanislas, Paris. On the death of the comte de Chambord, the comte de Paris became head of the Bourbons; and in 1886 he and his son were exiled from France by the new law of 1886. He then passed through the Royal Military college, Sandhurst, Eng., and received a commission in the 4th battalion of the 60th Rifles, then quartered in India. In Jan. 1888 the duke joined his regiment for a few months. On attaining his majority, he went to Paris (Feb. 7, 1890), and, proceeding to the *mairie,* expressed his desire, as a Frenchman, to perform his military service. He was arrested in conformity with the law of 1886, tried and sentenced to two years' imprisonment; but he was liberated by Pres. Sadi Carnot after a few months' nominal incarceration (June 4), and conducted to the Swiss frontier. This escapade won for him the title of "Le Premier Conscrit de France." After the comte de Paris's funeral (Sept. 12, 1894) the duke received his adherents in London, and was accepted as the head of his house. On Nov. 5, 1896, he married the archduchess Maria Dorothea Amalia of Austria; there was no issue of the marriage. The duke of Orléans was interested in exploration, and published *Une croisière au Spit-berg* (1905). He died on March 28, 1926.

ORLEANS, PHILIP I, DUKE OF (1640–1701), son of the French king Louis XIII, was born at St. Germain-en-Laye on Sept. 21, 1640. In 1661 he was created duke of Orléans, and married Henrietta, sister of Charles II of England; but the marriage was not happy, and the death of the duchess in 1670 was attributed to poison. Later he married Charlotte Elizabeth, daughter of Charles Louis, elector palatine of the Rhine. Having fought with distinction in Flanders in 1667, OrlCans returned to military life in 1672, and in 1677 gained a great victory at Cassel and took St. Omer. Louis XIV, it was said, was jealous of his brother's success; OrlCans never commanded an army again. He died at St. Cloud on June 8, 1701, leaving a son, Philip, the regent Orléans, and two daughters: Anne Marie (1669–1728), wife of Victor Amadeus II, duke of Savoy; and Elizabeth Charlotte (1676–1744), wife of Leopold, duke of Lorraine. His eldest daughter, Marie Louise (1662–1689), wife of Charles II of Spain, died before her father.

ORLEANS, PHILIP II, DUKE OF (1674–1723), regent of France, son of Philip, I. duke of OrlCans, and his second wife, the princess palatine, was born on Aug. 2, 1674, and fought at the siege of Mons in 1691. His marriage with Mlle. de Blois, the legitimized daughter of Louis XIV, won him the favour of the king. He fought at Steinkerk, Xeerwinden and Namur (1692–95). During the next few years he studied natural science. He was next given a command in Italy (1706) and in Spain (1707–08), where he gained some important successes, but his suspected desire to succeed Philip V on the throne of Spain gained him Louis XIV's disfavour. In Louis's will, however, he mas appointed president of the council of regency of the young king Louis XV (1715). After the death of the king, OrlCans had the will annulled by the *parlement,* and himself invested with absolute power. At first he made a good use of this, counselling economy, decreasing taxation, disbanding 25,000 soldiers and restoring liberty to the persecuted Jansenists. But the inquisitorial measures which he had begun against the financiers led to disturbances. He also countenanced the risky operations of the banker John Law (1717), whose bankruptcy led to a disastrous crisis.

A conspiracy under the inspiration of Cardinal Alberoni, first minister of Spain, to transfer the regency from OrlCans to Philip V of Spain was discovered and defeated in 1718. Dubois, formerly tutor to the duke of OrlCans and now his all-powerful minister, caused war to be declared against Spain, with the support of the emperor, and of England and the Netherlands (Quadruple alliance). Philip V made peace with the regent in 1720.

On the majority of the king (Feb. 15, 1723), the duke of Orleans resigned the supreme power; but he became first minister to the king and remained in office till his death on Dec. 2, 1723 The regent had great qualities. both brilliant and solid. but his dissolute manners found only too many imitators and the regency was one of the most corrupt periods in French history.

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ORLEANS (ORLEANS), a city of France, the chief town of Loiret, on the Loire, 77 mi. S.S.W. of Paris by rail. Pop. (1954) 71,533. Les Aubrais, 1 mi. to the north, is one of the chief railway junctions in the country. An early trading post among the Gauls, Orléans nas known as *Genabum* by the Romans, and its people led the revolt against Julius Caesar in 52 B.C. In the jth century it had taken the name *Aurelianum* from either Marcus Aurelius or Aurelian. It was vainly besieged in 451 by Attila, and by Odoacer in 471, but Clovis took it in 498 and held there in 511 the first ecclesiastical council in France. It then became the capital of a separate kingdom, but was united with that of Paris in 613. In the 10th century the town was given in fief to the counts of Paris, who in 987 ousted the Carolingians. Philip, fifth son of Philip VI, was the first duke of Orléans. After the assassination of his successor, Louis, the people of Orléans sided with the Armagnacs, and thus brought upon themselves the attacks of the Burgundians and the English Joan of Arc relieved the city in 1429. In 1562 it became the headquarters of Louis I of Bourbon, prince of Condé, the Protestant commander in chief. In 1563 Francis, duke of Guise, laid siege to it, but was assassinated. Orléans nas surrendered to the king, who raised the fortifications. It was held by the Huguenots from 1567 to 1568. The St. Bartholomew massacre there in 1572 lasted a week. It was given as a *lieu de sûreté* to the League under Henry III, but surrendered to Henry IV in person in 1594. The town is surrounded by boulevards, and is connected with the suburb of St. Marceau by an 18th century stone bridge of nine arches. The river is canalized on the right, and serves as a continuation of the Orléans canal.

In the Place du Martroi is a statue of Joan of Arc. A simple cross marks the site, on the left bank of the Loire, of the Fort *des Tourelles,* captured by Joan of Arc in 1429. The cathedral of Ste. Croix, begun in 1287, was burned by the Huguenots in 1567 before its completion. Henry IV, in 1601, laid the first stone, the building of which continued until 1829. The church of St. Aignan mutilated by the Protestants consists of a transept and choir of the second half of the 15th century; it contains in a gilded and carved wooden shrine the remains of its patron saint. St. Euverte, dedicated to one of the oldest bishops of Orléans (d. 391), is an early Gothic building dating from the 13th, completely restored in the 15th century. The church of St. Paul (15th and 16th century) has an isolated tower, and Notre-Dame de Recouvrance was rebuilt between 1517 and 1519 in the Renaissance style and dedicated to the memory of the deliverance of the city. The *hôtel de ville,* built under Francis I and Henry II and restored in the 19th century, was formerly the residence of the governors of Orléans, and was occupied by the kings and queens of France from Francis II to Henry IV. The public library comprises among its manuscripts a number dating from the 7th century. The *salle des fêtes,* formerly the corn-market, stands within a vast cloister formed by 15th-century arcades, once belonging to the old cemetery. Among old houses are that of Agnès Sorel (15th and 16th centuries), containing objects relating to Joan of Arc, that of Francis I, of the first half of the 16th century, that occupied by Joan of Arc during the siege of 1429, and that known as the house of Diane de Poitiers (16th century), which contains the historical museum. The anniversary of the raising of the siege in 1429 by Joan of Arc is celebrated yearly. Orléans is the seat of a bishopric under the archbishop of Paris, a prefect, a court of appeal, and a court of assizes and headquarters of the V army corps.

The more important industries are the manufacture of tobacco (by the state), blankets, pins, vinegar, machinery, agricultural implements, hosiery, tools and ironware, and the preparation of preserved vegetables. Wine, wool, grain and live stock are commercial staples, round which there are important nurseries.

ORLEANS CAMPAIGN OF 1870

Orléans was the pivot of the second phase of the Franco-German War, called the "People's War," when the new armies began their attempt to relieve Paris. After the fall of the empire, the Government of National Defense, deciding to remain in Paris, delegated three of its members, Crémieux, Glais-Bizoin and Fourichon, proceeded to the provinces to hasten the levy of troops. General de la Motte-Rouge was appointed to command the "territorial division of Tours." From many scattered units, most of them ill equipped, he formed the XV corps. The Germans, however, were only able to spare the I Bavarian corps and three cavalry divisions (and, 4th and 6th), the investment of Paris and Metz occupying their forces. On Oct. 5 the German 4th cavalry division was forced to retire before a French detachment under Reyau. Von der Tann, commanding the I Bavarian corps, was reinforced by the 22nd infantry and 2nd and 6th cavalry divisions. Reyau was attacked at Artenay on Oct. 10 and was thrown back in disorder, Orléans being captured in the evening of the following day, whereupon the French fell back on Sologne. Meanwhile Gambetta, minister of defense, arriving at Tours by balloon from Paris, assumed virtual control on Oct. 11, being aided by De Freycinet, the deputy minister. He forthwith appointed General d'Aurelle de Paladines in place of La Motte-Rouge. The change gave impetus to the training and reorganization of the troops and by Oct. 23 a further force was concentrated at Blois, which formed the XVI corps.

After the withdrawal of the 22nd infantry division from Von der Tann, its commander, General Wittich advanced to Châteaudun which he captured on Oct. 18. He now made for Chartres, which also fell into his hands. The resistance he had met with led the Germans to believe in the existence of a new army as the French who defended them did not belong to either the XV or XVI corps. The "Army of the West," as they called this phantom force, originated from the defenders of Chbteaudun and Chartres and was never formed into a fighting unit.

The French command decided to advance against the Germans massed around Orléans whom it mistakenly estimated at 60,000 men, whereas they barely numbered 26.000. As a mystification empty trains were run to Le Mans to confirm the Germans in their belief in the existence of an army west of Paris. But the contemplated offensive was postponed owing to bad weather and the discouraging news of Bazaine's capitulation with his 150,000 troops at Metz.

Moltke directed the II army, released from the siege of Metz, towards Bourges, sending it by Chalon-sur-Saône, while he formed a new detachment under the grand duke of Mecklenburg-Schwerin consisting of the I Bavarian army corps, 17th and 22nd infantry and 2nd, 3rd and 4th cavalry divisions. This force was to concentrate between Châteaudun and Chartres.

The French advance began auspiciously, the German cavalry retiring before them on Nov. 8. The following day, moving across the country in battle formation, the French attacked Von der Tann who was drawn up at Coulmiers, forcing him to retreat unpursued. The 2,500 Germans guarding Orléans thereupon evacuated the city and joined Von der Tann at Angerville.

Meanwhile, the grand duke with his detachment had not encountered any strong hostile forces and by Nov. 19 Moltke began to believe that after all the French must still be concentrated in the neighbourhood of Orléans to the number of 150,000 men. He fully realized the gravity of the situation — the expected sortie from Paris coupled with the advance of the army of the Loire. The king of Prussia was prepared, as he said to Waldersee at Versailles, to raise the siege of Paris if the II army sustained a defeat.

The members of the government in Paris urged Trochu, the governor, to attempt a sortie toward Fontainebleau, thereby joining hands with the army of the Loire. The sortie was to begin Nov. 29, but the balloon carrying the message to Gambetta alighted in Norway, which caused a delay. D'Aurelle still remained on the defensive near Orléans though pressed by Freycinet to advance.

The battle of Beaune-la-Rolande took place on Nov. 28, General Crouzat's XX corps attacking the German X corps between Turanville and Beaune-la-Rolande, while Billot's XVIII corps pushed back the Prussian left. In the afternoon Crouzat was himself assailed in the rear from Pithiviers by a cavalry and infantry division. Billot also falling back.

After further operations in which the French sustained defeat, the Germans moved toward Orleans on Dec. 3 in a scythe-like line of battle 40 miles long. Serious resistance was only encountered at Chilleurs. Orléans was entered on Dec. 4th. *(See* further FRANCO-GERMAN WAR.)

ORLEY, BERNAERT (BERNARD, BAREND) **VAN** (c. 1492–1542), Flemish painter of religious subjects and portraits, son of the painter Valentyn van Orley, was born at Brussels about 1490. The date of his birth is estimated from his portrait painted by Dürer in 1521, which represents an attractive and intelligent man of about 30. In 151j he was employed by Margaret of Austria, then regent of the Netherlands. and three years later he was appointed her court painter. He died in 1542.

Orley's earliest important work is the altarpiece of SS. Thomas and Matthew, of which the centrepiece is at Vienna and the wings at Brussels, painted about 1512. The style of the picture seems to be inspired by the school of Autrey. From 1j16 to 1522 Orley imitated Mabuse, but by the latter year the influence of Mabuse had given way to that of Raphael. In the altarpiece representing the "Patience of Job" (1521), now in the Brussels gallery, the two influences are combined. The artist had many opportunities to see designs by Raphael, whose tapestry cartoons were in Brussels for many years. Orley also painted several portraits; the one of Georg Zelle in the Brussels gallery is the only one that is signed and dated (1519). Orley was a designer of tapestries, among them being the "Hunts of Maximilian" in the Louvre and the "Victory of Pavia" at Naples. He is represented in the United States at the Metropolitan Museum of Art, New York city (including the well-known "Virgin and Child With Angels"), and at the National Gallery of Art, Washington, D.C.

ORLON, the trade-mark name registered by the E. I. du Pont de Nemours & Company for a group of synthetic fibres used primarily for making clothing and other textiles.

Orlon, introduced by du Pont in 1948 after 20 years of research, was the first acrylic fibre to be made available in commercial quantities. It is produced from acrylonitrile (CH_2CHCN), a chemical formed by reacting ethylene oxide and hydrocyanic acid. Single molecules of acrylonitrile are reacted with water and a catalyst until the molecules connect in long-chain polymers. After the water is removed, the polymer is solidified and then dissolved into a spinning solution. This solution is forced through the minute holes of a spinneret into filaments of Orlon, which are stretched three to eight times their original length to impart strength by orienting the chains in a parallel arrangement.

Known for its durable wearing qualities and its soft, silklike "hand" or feel, Orlon found extensive use in sweaters, furlike fabrics, socks, jersey fabrics and suiting fabrics such as shetlands, tweeds and flannels. Because of its resistance to acids and alkalis, it was employed in many industrial fabrics and work uniforms. Its resistance to weathering made it suitable for outdoor use, especially in sailcloths. (C. H. Ru.)

ORLOV, ALEXIS FEDOROVICH, Prince (1787–1862), Russian statesman. natural son of Count Theodore Grigorievich Orlov, took part in all the Napoleonic Wars from 1805 to the capture of Paris. For his services as commander of the cavalry regiment of the life guards on the occasion of the rebellion of 1825 he was created a count, and in the Turkish War of 1828–29 rose to the rank of lieutenant general.

Orlov was the Russian plenipotentiary at the peace of Adrianople, and in 1833 was appointed Russian ambassador at Constantinople, holding at the same time the post of commander in chief of the Black sea fleet.. He was one of the most trusted agents of Nicholas I, whom in 1837 he accompanied on his foreign tour. In 1854 he was sent to Vienna to bring Austria over to the side of Russia, but without success. In 1856 he was one of the plenipotentiaries who concluded the peace of Paris, and was rewarded with the dignity of prince and the presidency of the imperial council of state and of the council of ministers. In 1857 he presided over the commission formed to consider the question of the emancipation of the serfs. to which he was altogether hostile.

ORLOV, ALEXIS GRIGORIEVICH, Count (1737–1808), brother of Gregory. Count Orlov (*q.v.*), was remarkable for his athletic strength and dexterity. In the revolution of 1762 he played an even more important part than his brother. He conveyed Peter III to the château of Ropsha and is said to have murdered him there. In 1770 he was appointed commander in chief of the fleet sent against the Turks, whose far superior navy he annihilated at Cheshme (July j, 1770), a victory which led to the conquest of the Greek archipelago. He devoted himself to horse breeding, and produced the finest race of horses then known by crossing Arab and Frisian and Arab and English studs. In the war with Napoleon during 1806–07 Orlov commanded the militia of the 5th district, which was placed on a war footing almost entirely at his own expense. He left an estate worth 5,000,-ooo rubles and 30,000 serfs.

See article, "The Associates of Catherine II," no. 2, in *Russkaya Starina* (1873).

ORLOV, GREGORY (Grigorii) **GRIGORIEVICH,** Count (1734–1783), Russian statesman, was the son of Gregory Orlov, governor of Great Novgorod. While serving in the capital as an artillery officer he caught the fancy of Catherine II, and was the leader of the conspiracy which resulted in the dethronement and death of Peter III (1762). Catherine made him a count and adjutant general, director general of engineers and general in chief. Once the empress thought of marrying her favourite, but the plan was frustrated by N. Panin. Orlov's influence became paramount after the discovery of the Rhitrovo plot to murder the whole Orlov family. Gregory Orlov entered with enthusiasm. both from patriotic and from economic motives, into the question of the improvement of the condition of the serfs and their partial emancipation. He was their advocate in the great commission of 1767. One of the earliest propagandists of the Slavophil idea of the emancipation of the Christians from the Turkish yoke, he was sent as first Russian plenipotentiary to the peace congress of Focsani (1771), but he failed in his mission, partly because of the obstinacy of the Turks, and partly (according to Panin) because of his own insolence. He was superseded in the empress's favour by Vasil'chikov.

See A. P. Barsukov, *Narratives From Russian History in the 18th Century* (1885).

ORLOV, NIKOLAI ALEKSYEEVICH, Prince (1827–1885), entered the diplomatic service, and represented Russia successively at Brussels (1860–70), Paris (1870–82) and Berlin (1882–85). As a publicist he stood in the forefront of reform. His articles on corporal punishment, which appeared in *Russkaya Starina* in 1881, brought about its abolition. He also advocated tolerance toward the dissenters. He wrote a *Sketch* of *Three Weeks' Campaign in 1806* (1856).

ORLOV, THEODORE (Fedor) **GRIGORIEVICH,** Count (1741–1790), Russian general, participated with his elder brothers, Gregory (*q.v.*) and Alexis (*q.v.*), in the coup *d'état* of 1762, after which he was appointed chief procurator of the senate. His naval exploits in the first Turkish War were commemorated by a triumphal column, crowned with naval trophies, erected at Tsarskoe Selo. He retired in 1775.

ORM (Ormin), an Augustinian canon, author of an English book to which he gave the title *Ormulum,* "because Orm made it," consisting of metrical homilies on the Gospels as arranged in the missal. The unique manuscript, Junius 1 in the Bodleian library, Oxiord, is his autograph, and contains abundant corrections and additions in his own hand or by his direction. It is usually held that paleographical and linguistic evidence point to a date *c.* 1200, and that the dialect is east midland, though neither fact has been established beyond doubt. Henry Bradley, on admittedly slender evidence, suggested that Orm and his brother and fellow canon Walter, to whom he dedicated the work, were inmates of the Augustinian priory of Elsham, Lincolnshire. Another suggestion would identify him with Orm. grandson of Earl Gospatric, whose brother Walter was prior of the Augustinian canons of St. Mary's, Carlisle (1150–70), though it cannot be shown that this Orm was a canon. Many scholars would oppose this localization of the text, but there is little material for comparison. There is also an Orm *Skalt* "the skald," (?) mentioned in Yorkshire in a pipe roll of the reign of Henry II.

The *Ormulum* is written without rhyme or alliteration in a monotonous metre based on the Latin *septenarius.* The extant portion, of about 20,000 lines, is probably not more than one-eighth of the work, for only 31 of the 242 homilies referred to in the table of contents survive. A portion has been lost since the 17th century. The work is of little literary interest but is of great value to the linguist, for Orm, who clearly wished to spread sound teaching, derived, perhaps through an intermediate source, mainly from the works of Gregory I, Bede and Ælfric, invented an individual and remarkably consistent orthography to help preachers when reading his work aloud. For example, it shows the quantity of the vowels by doubling a consonant after a short vowel in a closed syllable, and it distinguishes by three symbols sounds which in Old English were all represented by the insular form of g.

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(*um 1200*) (1953). On the author, *see* H Bradley, in the *Athenaeum* (May 19, 1906) and J. Wilson (July 14, 1906); H B. Hinckley, "The Riddle of the Ormulum." *Philological Quarterly*, xiv (1935) The purpose of his spelling is best discussed by K. Sisam, *Review of English Studies*, ix, pp. 1–10 (1933). (D Wk)

ORME, ROBERT (1728–1801), English historian of India, was born at Anjengo on the Malabar coast on Dec. 25, 1728, the son of a surgeon in the East India company's service. Educated at Harrow, he was appointed to a writership in Bengal in 1743. He returned to England in 1753 in the same ship with Clive, with whom he formed a close friendship. From 1754 to 1758 he was a member of council at Madras. His great work was A *History of the Military Transactions of the British Nation in Indostan From 1745* (3 vol.. 1763–78). This was followed by a volume of *Hzstorical Fragments* (1781), dealing with an earlier period. In 1769 he was appointed historiographer to the company. He died at Ealing on Jan. 13, 1801. His valuable collections of manuscripts were placed in the India office library.

ORMEROD, ELEANOR A. (1828–1901), English entomologist, the daughter of George Ormerod. F R S, author of *The History of Cheshire,* was born at Sedbury Park, Gloucestershire, on May 11, 1828. The opportunity afforded for entomological study by the large estate upon which she grew up and the interest she took in agriculture soon made her an authority upon this subject. In 1868, she aided the Royal Horticultural Society in forming a collection of insect pests of the farm for practical purposes, and was awarded the Flora medal of the society. In 1877 she issued a pamphlet, *Notes for Observations on Injurious Insects,* which was distributed among persons interested in this line of inquiry, who readily sent in the results of their researches, and was thus the beginning of the well-known *Annual Series of Reports on Injurious Insects and Farm Pests.* In 1881 Miss Ormerod published a special report upon the "turnip-fly," and she was consulting entomologist to the Royal Agricultural Society from 1882 to 1892. For several years she was lecturer on scientific entomology at the Royal Agricultural college, Cirencester. Eleanor Ormerod died at St. Albans on July 19, 1901.

Her works include: *The Cobden Journals; Manual of Injurious Insects; Handbook of Insects Injurious to Orchard and Bush Fruits;* and her *Autobzography and Correspondence* (1904). *See* also: *Canadian Entonzologist,* vol. 33, 1901; *Royal Agric. Soc. Journ.* vol. 62. 1901.

ORMOLU, an alloy of copper and zinc, sometimes with an addition of tin. The name is also used to describe gilded brass or copper. The tint of ormolu approximates closely to that of gold; it is heightened by a wash of gold lacquer, by immersion in dilute sulphuric acid or by burnishing. The principal use of ormolu is for the mountings of furniture. With it the great French *ébénistes* of the 18th century obtained results which, in the most finished examples, are almost as fine as jewellers' work. The mounts were usually cast and then chiselled with extraordinary skill and delicacy. *(See* also SILVERSMITHS' *AND* GOLDSMITHS' WORK.)

ORMONDE, EARL AND MARQUESS OF, titles still held by the famous Irish family of Butler (*q.v.*), the name being taken from a district now part of co. Tipperary. In 1328 James Butler (c. 1305–37), a son of Edmund Butler, was created earl of Ormonde, one reason for his elevation being that his wife Eleanor Bohun was a granddaughter of Edward I. His son James, the 2nd earl (1331–82), was four times governor of Ireland; the latter's grandson James, the 4th earl (d. 1452), held the same position several times, and won repute not only as a soldier, but as a scholar. His son, James, the 5th earl (1420–*c.* 1461), was created an English peer as earl of Wiltshire in 1449. He was lord high treasurer of England in 1455 and again in 1459, and was taken prisoner by the Yorkists after the battle of Towton in 1461. He and his two brothers were then attainted, and he died without issue, the exact date of his death being unknown. The attainder was repealed in the Irish parliament in 1476, when his brother Sir John Butler (c. 1422–78), who had been pardoned by Edward IV. a few years previously, became 6th earl of Ormonde. John, who was a fine linguist, served Edward IV. as ambassador to many European princes. His brother Thomas, the 7th earl *(c.* 1424–1515), a courtier and an English baron under Richard III. and Henry VII., was ambassador to France and to Burgundy; he left no sons, and on his death in August 1515 his earldom reverted to the crown.

Margaret, a daughter of this earl, married Sir William Boleyn of Blickling, and their son Sir Thomas Boleyn (1477–1539) was created earl of Ormonde and of Wiltshire in 1529. He arranged the preliminaries for the Field of the Cloth of Gold; he was lord privy seal from 1530 to 1536, and served the king in many other ways. He was the father of Anne Boleyn.

Meanwhile in 1515 the title of earl of Ormonde had been assumed by Sir Piers Butler (c. 1467–1539), a cousin of the 7th earl. He was lord deputy, and later lord treasurer of Ireland, and in 1528 he surrendered his claim to the earldom of Ormonde and was created earl of Ossory. Then in 1538 he was made earl of Ormonde, this being a new creation; however, he counts as the 8th earl of the Butler family. In 1550 his second son Richard (d. 1571) was created Viscount Mountgarret, a title still held by the Butlers. The 8th earl's son, James, the 9th earl (c. 1490–1546), lord high treasurer of Ireland, was created Viscount Thurles in 1536. In 1544 an act of parliament confirmed him in the possession of his earldom, which, for practical purposes, was declared to be the creation of 1328, and not of 1538.

Thomas, the 10th earl (1532–1614), a son of the 9th earl, was lord high treasurer of Ireland. He was a Protestant, and threw his great influence on the side of the English queen and her ministers in their efforts to crush the Irish rebels, but he was perhaps more anxious to prosecute a fierce feud with his hereditary foe, the earl of Desmond, this struggle between the two factions desolating Munster for many years. His successor was his nephew Walter (1569–1633), who was imprisoned from 1617 to 1625 for refusing to surrender the Ormonde estates to his cousin Elizabeth, the wife of Sir R. Freston and the only daughter of the 10th earl. He was deprived of the palatine rights in the county of Tipperary, which had belonged to his ancestors for 400 years, but he recovered many of the family estates after his release from prison in 1625.

Walter's grandson, James, the 12th earl, was created marquess of Ormonde in 1642 and duke of Ormonde in 1661 *(see* below); his son was Thomas Butler, earl of Ossory, and his grandson was James Butler, 2nd duke of Ormonde *(see* below).

When Charles Butler, earl of Arran (1671–1758), the brother and successor of the 2nd duke, died in December 1758, the dukedom and marquessate became extinct, but the earldom was claimed by a kinsman, John Butler (d. 1766). John's cousin, Walter (1703–83), inherited this claim, and Walter's son, John (1740–95), obtained a confirmation of it from the Irish House of Lords in 1791. He is reckoned as the 17th earl. His son Walter, the 18th earl (1770–1820), was created marquess of Ormonde in 1816, a title which became extinct on his death, but was revived in favour of his brother James (1774–1838) in 1825, and was retained by his descendants.

See J. H. Round on "The Earldoms of Ormonde" in Joseph Foster's *Collectanea Genealogica* (1881–83).

ORMONDE, JAMES BUTLER, 1ST **DUKE** OF (1610–1688), Irish statesman and soldier, eldest son of Thomas Butler, Viscount Thurles, and of Elizabeth, daughter of Sir John Poyntz, and grandson of Walter, 11th earl of Ormonde *(see* above), was born in London on Oct. 19, 1610. On the death of his father by drowning in 1619, the boy was made a royal ward by James I., removed from his Roman Catholic tutor, and placed in the household of Abbot, archbishop of Canterbury, with whom he stayed until 1625, residing afterwards in Ireland with his grandfather. In 1629, by his marriage with his cousin, the Lady Elizabeth Preston, daughter and heiress of Richard, earl of Desmond, he put an end to the long-standing quarrel between the families and united their estates. He succeeded his grandfather in 1632.

His active career began in 1633 with the arrival of Strafford, whom he supported consistently. In 1640 during Strafford's absence he was made commander-in-chief of the forces, and in August he was appointed lieutenant-general. On the outbreak of the rebellion in 1641 he rendered great service in the expedition to Naas, and in the march into the Pale in 1642, though much hampered by the lords justices, who were jealous of his power and recalled him after he had succeeded in relieving Drogheda. On April 15, 1642, he gained the battle of Kilrush against Lord Mountgarret. He was created a marquess, and lieutenant-general with a commission direct from the king. He won the battle of New Ross (March 18, 1643) against Thomas Preston, afterward Viscount Tara. In September, the civil war in England having meanwhile broken out, Ormonde, in view of the successes of the rebels and the uncertain loyalty of the Scots in Ulster, concluded (Sept. 15) with the latter, in opposition to the lords justices, the "cessation" by which the greater part of Ireland was given up into the hands of the Catholic confederation, leaving only small districts on the east coast and around Cork, together with certain fortresses in the north and west then actually in their possession, to the English commanders. He subsequently, by the king's orders, despatched a body of troops into England (shortly afterward routed by Fairfax at Nantwich) and was appointed in Jan. 1644 lord lieutenant, with orders to keep the Scotch army occupied.

In the midst of all the plots and struggles of Scots, Old Irish, Catholic Irish of English race, and Protestants, and in spite of the intrigues of the pope's nuncio, as well as of attempts by the parliament's commissioners to ruin his power, Ormonde showed the greatest firmness and ability. He assisted Antrim in his unsuccessful expedition into Scotland. On March 28, 1646, he concluded a treaty with the Irish which granted religious concessions and removed various grievances. Meanwhile the difficulties of his position had been greatly increased by Glamorgan's treaty (Aug. 25, 1645) with the Roman Catholics, and it became clear that he could not long hope to hold Dublin against the Irish rebels. He thereupon applied to the English parliament, signed a treaty on June 19, 1647, gave Dublin into their hands upon terms and sailed for England at the beginning of August. He attended Charles during August and October at Hampton Court, but subsequently, in March 1648, in order to avoid arrest by the parliament, he joined the queen and prince of Wales at Paris. In September of the same year, he returned to Ireland to endeavour to unite all parties for the king. On Jan. 17, 1649, he concluded a peace with the rebels on the basis of the free exercise of their religion; on the execution of the king he proclaimed Charles II and was created a knight of the Garter in September. On the conquest of the island by Cromwell he returned to France in Dec. 1650.

Ormonde accompanied Charles to Aix and Cologne when expelled from France by Mazarin's treaty with Cromwell in 1655. In 1658 he went disguised, and at great risk, upon a secret mission into England. He attended the king at Fuenterrabia in 1659 and had an interview with Mazarin; and was actively engaged in the secret transactions immediately preceding the Restoration. On the return of the king he was at once appointed a commissioner for the treasury and the navy, and received other important places, together with an English peerage, and (1661) the dukedom of Ormonde in the Irish peerage. On Nov. 4, 1661 he once more received the lord lieutenantship of Ireland. The Act of Explanation (on land settlement) was passed through the Irish parliament by Ormonde in 1665. His heart was in his government, and he vehemently opposed the bill prohibiting the importation of Irish cattle which struck so fatal a blow at Irish trade; and retaliated by prohibiting the import into Ireland of Scottish commodities, and obtained leave to trade with foreign countries. He encouraged Irish manufactures and learning to the utmost, and it was to his efforts that the Irish College of Physicians owes its incorporation.

Faced by the loss of royal favour, Ormonde declared "However ill I may stand at court I am resolved to lye well in the chronicle." His irresponsible government was no doubt open to criticism. He had billeted soldiers on civilians, and had executed martial law. The impeachment, however, threatened by Buckingham in 1667 and 1668 fell through. Nevertheless by 1669 constant importunity had had its usual effect upon Charles, and in March Ormonde was dismissed. That year, he was, however, elected chancellor of Oxford university. On Dec. 6, 1670, an attempt was made to assassinate the duke by Thomas Blood. He was dragged out of his coach, and taken on horseback along Piccadilly with the intention of hanging him at Tyburn. Ormonde, however, succeeded in overcoming the horseman to whom he was bound, and his servants coming up, he escaped. The king pardoned Blood, and even treated him with favour after his apprehension while endeavouring to steal the crown jewels.

In 1671 Ormonde successfully opposed Richard Talbot's attempt to upset the Act of Settlement. In 1677 he was restored to favour and reappointed to the lord lieutenancy. On his arrival in Ireland he placed the revenue and the army upon a proper footing. In 1682 Charles summoned Ormonde to court. On Nov. 9, 1683 an English dukedom was conferred upon him, and in June 1684 he returned to Ireland; but he was recalled in October in consequence of fresh intrigues. Before, however, he could give up his government to Rochester, Charles II died; and Ormonde's last act as lord lieutenant was to proclaim James II in Dublin. Subsequently he lived at Cornbury in Oxfordshire. He refused the king his support over the Indulgence but James held him in respect. He died on July 21, 1688, and was buried in Westminster abbey.

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ORMONDE, JAMES"BUTLER, 2ND DUKE OF (1665–1745), Irish statesman and soldier, began his career in opposition to the house of Stuart and ended his career in support of it. The son of Thomas, earl of Ossory, and grandson of the 1st duke, he was born in Dublin on April 29, 1665. He was educated in France and afternard at Christ church, Oxford. Having succeeded his grandfather as duke of Ormonde in 1688, he joined William III, by whom he was made colonel of a regiment of horse guards. He commanded a troop of the king's lifeguards in William's army at the battle of the Boyne. He served on the continent under William (1691–95), and after the accession of Anne he was placed in command of the land forces co-operating with Sir George Kooke in Spain. He succeeded the earl of Rochester as lord-lieutenant of Ireland in 1703, a post which he held till 1707 and again from 1710–13.

On the dismissal of the duke of Marlborough in 1711. Ormonde was appointed captain-general in his place. and allowed himself to be made the tool of the Tory ministry, whose policy was to carry on the war in the Netherlands while giving secret orders to Ormonde to take no active part in supporting their allies under Prince Eugene. Though he had supported the revolution of 1668, Ormonde was traditionally a Tory. and Lord Bolingbroke was his political leader. During the last years of Queen Anne he almost certainly had Jacobite leanings. and corresponded with the duke of Berwick. He joined Bolinghroke and Oxford, however, in signing the proclamation of King George I. by whom he was nevertheless deprived of the captain-generalship. In June 171j he was impeached. and fled to France. where he for some time resided with Bolingbroke. His immense estates were confiscated to the crown. though his brother. Charles Butler, earl of Arran, was later enabled to repurchase them. After taking part in the Jacobite invasion in 1; 1j, Ormonde settled in Spain, where he was in favour at court and enjoyed a pension from the crown. He died on Nov. 16. 1745, at Avignon, and n·as buried in Westminster abbey.

See Thomas Carte, *History of tlze Life of James, Duke of Ormonde,* 6 vols. (Oxford, 1851), which contains much information respecting the life of the second duke.

ORMSKIRK, a market town and urban district in the Ormskirk parliamentary division of Lancashire. Eng., 13 mi. N.N.E. of Liverpool by road. Pop. (1951) 20.482. Area 24.4 sq.mi. The name probably refers to a church founded in the 8th century by Orm. a Viking prince. On the dissolution of the monasteries the manor was granted to the earl of Derby, a descendant of the Orms.

The church of SS. Peter and Paul has a tower and a steeple. while builder's marks indicate that it was originally built by the Norsemen. A grammar school was founded about 1614. The town has long been famous for its gingerbread and the baking of cakes, especially in Burscough. It is the centre of an intensively cultivated area specializing in potato-growing.

ORNAMENT, ARCHITECTURAL. Although it would be difficultto cover in any single definition all conceptions, past and present, of what constitutes ornament in architecture, three basic and fairly distinct categories may be recognized: mimetic or imitative ornament, the forms of which have certain definite meanings or symbolic significance; applied ornament. intended to add beauty to a structure but extrinsic to it; and organic ornament, inherent in the building's function or materials.

Mimetic Ornament. — This is by far the commonest type of architectural ornament in primitive cultures, in eastern civilizations and generally throughout antiquity. It is still found. It grows out of what seems to be a universal human reaction to technological change: the tendency to use new materials and techniques to reproduce shapes and qualities familiar from past usage, regardless of appropriateness. We may call this tendency the principle of mimesis. Its operation may be traced in thousands of instances, from the decoration of prehistoric pottery in imitation of clay-covered baskets down to the preservation of the buggy form in early 20th-century automobiles (on which even whipsockets for nonexistent horses were often reproduced). Perhaps the most remarkable of all examples of mimesis occur in architecture. Most common building types in antiquity, both east and west (*e.g.*, tombs, pyramids. temples, towers) began as imitations of primeval house and shrine forms. An obvious example is the dome (*q.v.*), uhich developed as a permanent wooden or stone reproduction of a revered form originally built of pliable materials. In the mature stages of early civilizations, building types tended to evolve past primitive prototypes; their ornament, however, usually remained based on such models. Decorative motifs derived from earlier structural and symbolic forms are innumerable and universal. In developed Indian and Chinese architecture. domical and other originally structural forms occur often and lavishly as ornament. In ancient Egypt, architectural details continued throughout history to preserve faithfully the appearance of bundled papyrus shafts and similar early building forms. In Mesopotamia, brick walls long imitated the effect of primitive mud-and-reed construction. In the carved stone details of Greco-Roman orders. (*e.g.*, capitals. entablatures, moldings) the precedent of archaic construction in wood was always clearly discernible.

The prevalence of mimetic ornament in architecture may be explained in two ways. Some (perhaps most in primitive cultures) is religious in origin. Certain forms and shapes, through long association with religious rites, became sacred and were preserved and reproduced for their symbolic value. These forms continued to be understood even though they were often stylized into abstract or geometric patterns, unrecognizably removed from their naturalistic models. Much mimetic ornament. however, even in early times, can be ascribed simply to inertia or conservatism. People generally tend to resist change; they find it reassuring to be surrounded by known and familiar forms. Reproducing them as ornament on newly introduced forms is a common reaction to the vague feeling of uneasiness that rapid social and technological change induces; it provides a satisfying sense of continuity between the past and the present. Certainly this resistance was a factor in the 19th-century practice of disguising new techniques of construction in metal and glass by an overload of ornament imitating earlier historical styles

Applied Ornament. — Architectural ornament in the 19th century exemplified the common tendency for mimetic ornament, in all times and places, to turn into mere applied decoration. lacking either symbolic meaning or reference to the structure on which it is placed. By the jth century B.C. in Greece, the details of the orders (q *v*) had largely lost whatever conscious symbolic or structural significance they may have had; they became simply decorative elements extrinsic to the structure. The Doric frieze is a good case: its origin (*i.e.*, an imitation of the effect of alternating beam ends and shuttered openings in archaic wood construction) remained evident, but it came to be treated as a decorative sheath without reference to the actual structural forms behind. In losing their mimetic character, the details of the Greek orders acquired a new function. however; they served to articulate the building visually, organizing it into a series of co-ordinated visual units that could be comprehended as an integrated whole, rather than a collection of isolated units. This is the concept of applied decoration which was passed on through the Greco-Roman period. The triumphal arch (*q.v.*) of Rome, with its system of decorative columns and entablature articulating what is essentially one massive shape, is a particularly good illustration; the Colosseum (*q.v.*) is another. Most of the great architecture of the Renaissance and baroque periods depends on it; to a large extent, the difference between these styles is the difference in decoration. The characteristic serenity and balance of Brunelleschi's architecture, for example, is very largely effected by his treatment of applied pilasters and entablatures, whereas in designs like Michelangelo's Medici chapel or the dome of St. Peter's, the same elements are used in different combinations to create a quite opposite effect of tension and release.

Judicious and intelligent use of applied ornament remained characteristic of most western architecture until the 19th century. During the Victorian period. however, the rationale of applied ornament broke down, and an indiscriminate and inappropriate use of decoration became one of the most characteristic and obnoxious features of 19th-century architecture. The reasons for this development are complex. In part it was a reaction to an overly rapid pace of social change during the period; partly, also, it was a logical outgrowth of the increasingly lavish decoration of late baroque and rococo architecture in the 18th century. Also there was an overemphasis on the purely literary and associative values attached to the ornament characteristic of historical architectural styles. But compounding all these factors was the development of machinery, such as multiple lathes and jigs, which provided builders with cheap prefabricated ornament to give their often shoddy and ill-proportioned structures an illusion of elegance. Architectural ornament and architectural forms proper tended to part company. to be designed quite independently of each other. Since it became obvious that ornament so conceived served no good purpose at all, a reaction was inevitable; it began to appear in force by the 1870s.

By the early 20th century a preoccupation with the proper function of architectural ornament was characteristic of all advanced architectural thinkers; by the mid-20th century a concept of architectural ornament had been formulated which we may call organic ornament.

Organic Ornament. — This concept of ornament is by no means peculiar to the 20th century. Its essential principle is that ornament in architecture should derive naturally from, and be a function of, the nature of the building and the materials used. This principle is characteristic of both Christian and Islamic religious architecture of the medieval period. In the architectural ornament of Moslem India or Persia. as in early Christian and Byzantine work, there is a strong mimetic element. The proscription of representational forms in the Koran, and the tendency of both Moslem and early Christian artists to borrow and adapt their formal vocabulary from preceding cultures, led inevitably to their transforming nhat had been meaningful forms into systems of abstract ornament. But basically, this ornament was neither mimetic nor applied. Throughout the middle ages. church buildings mere conceived primarily as tangible symbols of heaven. Their architectural ornament. no matter how various or lavish, was consistently designed to promote this symbolism; whether by gilt. intricacy or multiplicity, it all contributed to an over-all effect of glory, and so was integral to the architectural form. Twentieth-century concepts of the function of architectural ornament, generally speaking, began with an understanding of this medieval usage. Certainly the first movements toward reform of Victorian practice grew out of the Gothic revival writings of Ruskin and Viollet-le-Duc. as interpreted and applied by William Morris (*q.v.*). The immediate influence of these men proved rather unfortunate. The first result of Viollet-le-Duc's disciplined and scholarly investigations into the principles of medieval architecture was a school of slick archaeological architects, capable of decorating all manner of collegiate, civic and domestic buildings with frigidly correct reproductions of the details of medieval cathedrals and châteaus. Out of Ruskin's demonstration of the origins of medieval decoration in natural forms grew the so-called art nouveau (*q.v.*) movement toward exaggerated floral and curvilinear ornament; and out of Morris' insistence on handicrafts, inspired by infatuation with the medieval guild system, developed the Arts and Crafts movement (*q.v.*) a cult devoted to the preference for any handmade ornament (no matter how incompetent) over any machine product (no matter how well designed). But the basic idea involved was sound, and in time came to be better understood.

As early as the 1870s Henry Hobson Richardson adopted the Romanesque style less for its historical associations than for the opportunities it afforded him to express the nature and texture of stone. In mature examples of his architecture from the mid-1880s, ornament in the older, applied. sense has virtually disappeared, and buildings depend for their aesthetic effect mainly on the inherent qualities of their materials. The generation following Richardson saw a further development of this principle everywhere.

In England Edwin Lutyens and C. R. Mackintosh, in the Netherlands H. P. Berlage and in the United States Louis Sullivan were among many contributors to the new architectural expression. It was largely based on intrinsic texture and pattern, but with interspersed bands and patches of naturalistic ornament, applied with studied discipline. With the general reaction against Victorian principles after the Great War of 1914–18, however, leading designers rejected even this kind of applied ornament, and relied for ornamental effect on building materials alone. The so-called international style, in which Walter Gropius and Le Corbusier were the chief figures, dominated advanced design during the late 1920s and 1930s. However, the barrenness that resulted from their reliance on such materials as concrete and glass, along with other factors. resulted in a reaction by the 1940s in favour of the neglected precedent set by Frank Lloyd Wright in his early 20th-century work. It emphasized more visually interesting materials, intricate textural patterns and natural settings as the proper basis of architectural ornament.

It is in Wright's work of the 1940s and 1950s that the 20th-century concept of organic ornament was most characteristically embodied. as in such notable examples as Taliesin West. his home and studio near Phoenix. Ariz.; the campus of Florida Southern college at Lakeland. Fla.; and the Guggenheim museum in New York city. Impressive evidence of the renewed interest in architectural ornament generally. and organic ornament in particular, was provided by the buildings of the 1958 Universal and International exhibition in Brussels. The U.S. pavilion was designed by Eduard D. Stone and made extensive use of ornamental screens characteristic of his uork. Further articles on the several architects and architectural styles and periods mentioned in this article are listed in ARCHITECTURE (ARTICLES ON). See also ANTHEMION; CEILING; GARGOYLE; MOLDING.

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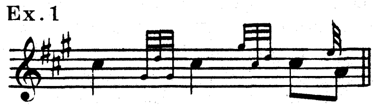
ORNAMENTATION, in music, the embellishment of a melodic line, either by elaboration or by rhythmic modification. In European music, ornamentation is ideally something added to the music in order to make it more pleasing (early writers called it "spice," "salt," etc.). In music, as in the other arts, badly conceived or badly executed ornaments may have the effect of causing confusion and a disintegration of the basic structure.

From at least the middle ages until the end of the 18th century the practice of improvised ornamentation was part of a singer's or an instrumentalist's traditional technique. The composer provided the composition and the performer used all his technical skill—the singer his vocal agility, the instrumentalist the technical potentialities of his instrument—to heighten the expressive power of the music by florid embellishment and sensitive articulation. That ornamentation was sometimes debased by a tasteless display of technical virtuosity is attested by writers of many periods.

In instrumental music some styles of ornamentation are the direct result of the technical limitations of the instrument; *e.g.*, repeated notes of the same pitch are impossible to play on most bagpipes and must be simulated by means of ornamentation.

Ex. 1

Ornamentation was also the result of a natural desire to add variety to the repetition of a section of a work or of a short piece, such as a dance, that was repeated many times. This practice led logically to the variation form.

The apparatus of ornamentation varies greatly from age to age and from country to country. It is a traditional vocabulary that reflects and often influences the development of musical style. In its most creative sense ornamentation is closely linked with improvisation and, therefore, with composition itself.

When a musical work is transferred from one medium to another, as in a keyboard transcription of a vocal composition, the instrumental style and ornamentation appropriate to the new medium may alter entirely the character of the music.

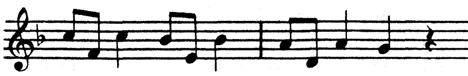
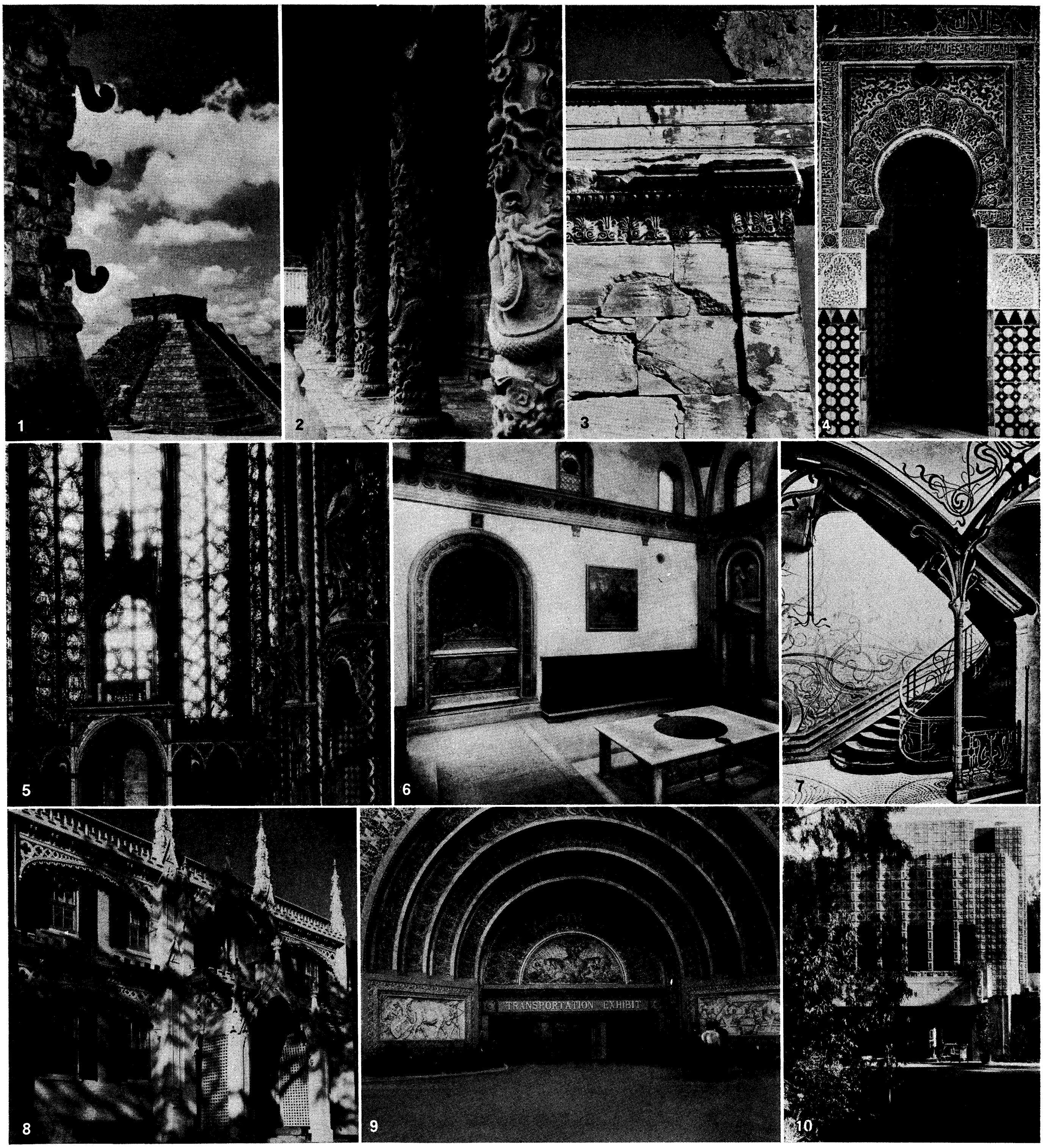
A decorated arrangement is often a creative reworking of the original material and may reflect not only the instrumental style of the new medium but also the personal style of the arranger. This is found in the harpsichord transcriptions by J. S. Bach of violin works by Vivaldi and later in the elaborate arrangements and fantasias for piano made by Liszt of operatic excerpts and orchestral works.

Ancient Civilizations and the Orient.—The European concept of ornamentation as an addition to an already musically complete composition is something foreign to the music of ancient civilizations and to the classical music of many modern oriental countries. In this primarily melodic music the boundaries between ornamentation, improvisation and composition are impossible to define. Cornposition is improvisation, and improvisation is the organization, within the limits of a specific mode, of a traditional vocabulary of melody fragments and ornamentation formulas proper to the mode. (See GREEK MUSIC [ANCIENT].)

Europe: the Middle Ages.—During the middle ages the practice of vocal ornamentation in sacred music was strongly opposed by the church and was prohibited by papal bull and denounced by bishops as being detrimental to the purity of the Gregorian chant. Precise details of early medieval ornamentation were not recorded.

All that is known is that some notational signs signified an ornament and that in vocal music the trill was known from at least the 3rd century. Guido of Arezzo wrote that Italian singers were best fitted to perform the ornaments notated in the plain chant, and that foreigners who were unable to perform these ornaments adequately should rather sing the music undecorated.

Both the monophonic and the polyphonic music of the 13th century contain what appears to be written vocal ornamentation. The first notated dance tunes date from this time and these show certain features of a purely instrumental style of ornamentation:

Ex. 2



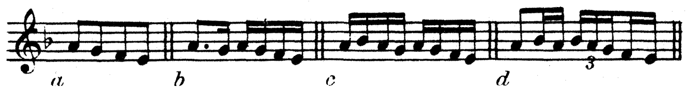
BY COURTESY OF (10) FRANK LLOYD WRIGHT; PHOTOGRAPHS, (1) HAROLD GROSSMAN FROM BLACK STAR, (2) ORIENT AND OCCIDENT, (3) ALISON FRANTZ, (4, 9) EWING GALLOWAY, (5) DE COU FROM EWING GALLOWAY, (6) ALINARI, (8) WAYNE ANDREWS

ORNAMENTAL DETAIL IN ARCHITECTURE

1. **Chichen-Itza,** Yucatan. Characteristic Mayan façade using mimetic ornament, the forms being derived from earlier structural or symbolic shapes
2. Pillars of the Confucian temple at Chu Fu, Shantung province: Yuan dynasty (1280–1368). Mimetic ornament: Chinese dragon and other forms in high relief
3. Detail of molding, Erechtheon, Athens. Typical classical ornament of the 5th century B.C.; originally mimetic forms, imitating structural and symbolic features of archaic Greek architecture, later—as in this exampieproviding visual articulation for the building as a whole
4. Prayer niche in the private mosque, The Aihambra, Granada, Spain; 13th and 14th centuries. Typical of Moorish art in Spain, the ornamentation serving chiefly a symbolic function
5. Interior of La Sainte Chapelle, Paris; 1246–58. Characteristic Medieval decoration, thoroughly integrated with the symbolic function of the building
6. Old Sacristy, Church of S. Lorenzo, Florence, Italy. Designed by Filippo Brunelleschi, typical of the Early Renaissance use of applied decoration for balanced effect
7. Interior of house at 12 rue de Turin, Brussels, Belgium, designed by Victor Horta, 1893. An example of Art Nouveau attempts to reform Victorian excesses of ornament by revefsion to curvilinear designs based on nature
8. "Wedding Cake House," Kennebunkport, Me. A mid-19th century example of ornamentation entirely distinct from the older building to which it has been added; typical of indiscriminate Victorian usage
9. Entrance to the Transportation building, Chicago World's Fair, 1893. Lush areas of applied decoration in studied contrast with the plain surrounding wall surfaces characterized the work of Louis Sullivan
10. Millard house, Pasadena, Calif.; Frank Lloyd Wright, arch., 1923. Ornamental qualities derived from patterns inherent in the nature of the material

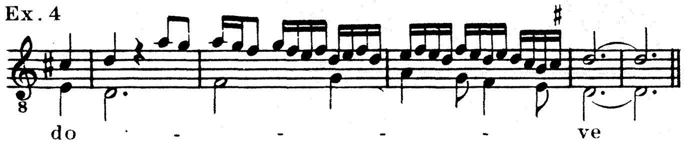
Although no particular instrument is specified, this is typical writing for bowed stringed instruments tuned in fifths and, in fact, was later to become a commonplace of violin figuration.

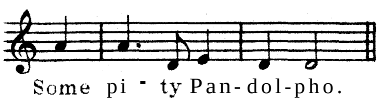
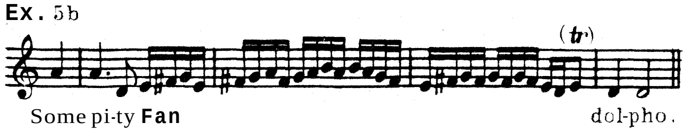
Italian secular music of the 14th century contains much notated vocal and instrumental ornamentation In this music one of the fundamental techniques of ornamentation was established that of "diminution" (the 16th-century English word was "division"); *i.e.*, the dividing of the basic notes of the melodic line into groups of notes of a shorter duration.

Ex. 3

Example *3a* shows the melody undecorated; ex. *3b, 3c* and *3d* show three possible methods of ornamentation.

In the 14th century this technique became codified and the performer could choose one of several diminution patterns to ornament a given melodic phrase. These diminutions were generally performed at certain foreseen developments in the composition, such as at cadences.

The most elaborate diminution was often reserved for the end of a section. as in this florid example from "De'l non fugir" by Francesco Landini (d. 1397):

Ex. 4

This practice of cadential embellishment became a feature of vocal and, later, instrumental ornamentatlon. Example *5a* is the unornamented form of the last two bars of "Pandolpho" by Robert Parsons (d. 1570); ex. *5b* is a contemporary decorated version in which the first bar is significantly extended to three bars in order to give the singer full scope for virtuosity.

Ex. 5a

Ex. 5b

It thus came about that the 18th-century cadenza (*q.v*), from which the cadenzas of the great 19th-century instrumental virtuosos developed. had its origin, as its name implies, in the earlier cadential ornamentation.

The Renaissance. — Despite the codification of diminution in the 14th century, it was not until the following century that the first theoretical works on the subject appeared. One of these, the Buxheim organ book (c. 1460), contains, besides many ornamented keyboard settings of French, German and English vocal music. an additional section of musical examples showing 15th-century methods of improvisation in which appears the sometimes inflexible and stereotyped style of diminution that: was typical of German lute and keyboard ornamentation until the mid-16th century.

In the Renaissance, vocal ornamentation was one of several subjects co-ordinated in a musician's training. Jean Petit Coclico records that Josquin Després taught his pupils singing, vocal ornamentation, improvised counterpoint and composition.

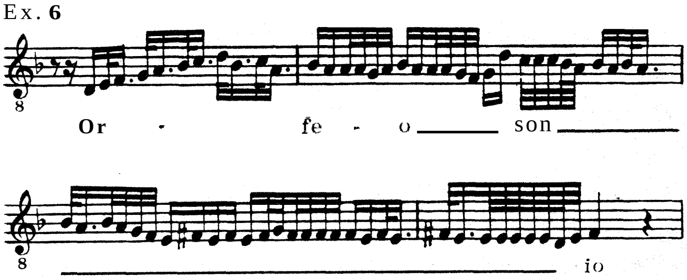
During the 16th century many printed books appeared containing instructions on diminution. These books, mostly by Italian authors, were directed to the amateur musician though they were not necessarily of a popular nature. Among these, *Fontegara* (1535) by Sylvestro Ganassi is one of the most comprehensive ever published on the subject. In common with all writers on ornamentation from the 16th to the 18th century, Ganassi deals first with the ornamentation of intervals. that is to say, a systematic survey of the intervals of the second. third. fourth and fifth in various ornamented forms, and secondly with the ornamentation of conventional cadences. All the treatises on ornamentation from Ganassi to J. J. Quantz in the 18th century follow this principle. A copy of *Fontegara* contained, in Ganassi's own hand, 300 different ways to ornament a single cadence.

Sixteenth-century vocal ornamentation was conceived as an abstract musical expression rather than as an expression of literary ideas. It was primarily concerned not with underlining the words hut with reflecting the mood of the text. Therefore. the singer's approach to diminution was basically the same as that of the instrumentalist. In fact. the title page of Ganassi's work describes it as "teaching . . . diminution suitable to wind and stringed instruments as well as to those who delight in singing."

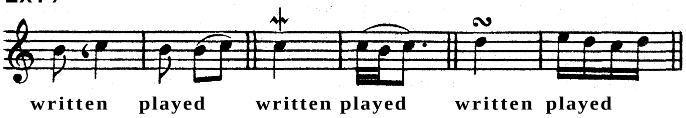
The Baroque: Italian and French Styles.—The early years of the 17th century saw. in Italy and France. a decisive change in vocal and instrumental styles of composition, and also the founding of two distinct national styles of ornan~entation. With the revival of interest in the literature of classical Greece and with the founding of the literary academies, poets and musicians began to collaborate in an attempt to re-create the musico-poetic art of the classical world. Music was to he the servant of poetry and vocal ornamentation was used expressly to heighten the emotional content of the words. To achieve this, a new emotionally expressive style of melodic writing was developed, together with a rhythmically mannered vocabulary of vocal ornamentation.

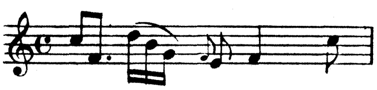
In Italy diminution was still practised in vocal as well as in instrumental music, but the new style of ornamentation was reserved for solo vocal music. The following example. from the opera *Orfeo* (1607) by Claudio Monteverdi, shows the intense dramatic passion conveyed by the early 17th-century Italian vocal ornamentation. with its jerky rhythms and groups of rapidly repeated notes (called *trilli;* trills were known as *gruppi*).

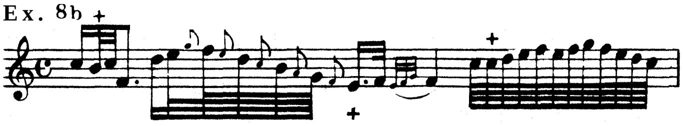
Ex. 6



The principles of diminution were preserved in the 17th-century French style of vocal ornamentation associated with the performance of the *airs de cour*. They also survived in a relatively simple form in the "doubles" or varied repeats found in the harpsichord works of François Couperin In early 17th-century French lute music, a tradition was current using a large number of small ornaments for the purpose of articulation and accentuation as well as rhythmic modifications of the written notes These ornaments became an important stylistic feature of French harpsichord music while the rhythmic modification5 used by the lutenists were incorporated in the latei French instrumental style notabl} in that oi the French overture with its characteristic double-dotted rhythms. Small urnaments such as mordents and turns, deriving from the lute compositions of the Bcole de Paris, in which Denis Gaultier was a prominent figure. were transformed and codified for use in the harpsichord music of Couperin and are set out in his *L'Art de toucher le clavecin* (1717). The following examples are typical of this style of ornamentation:

Ex. 7

Following the ornamented vocal styles of Monteverdi and his contemporaries, the Italian instrumental style remained elaborately florid. The performance of solo works in the mid-18th century required great creative skill in improvisation on the part of the performer as it was customary for the composer to write only the main structural notes of the melody. This led eventually to the debasement of the Italian style with the vocal and instrumental gymnastics practised by virtuosos of the late 18th and early 19th centuries. Example 8 shows the first bar of an adagio from a violin sonata by Guiseppe Tartini (d. 1770), first in its simple form and secondly in a typically elaborate version published about 1788.

Ex. 8a

Ex. 8b



The French and the Italian styles of ornamentation remained distinct throughout the greater part of the 18th century. Thus a composer such as J. S. Bach not born to one or other of these styles could use either of them dispassionately.

In the works of Haydn and Mozart variations of themes incorporated written ornaments in a manner that announces the absorption of ornaments in the accepted musical language. In the 19th century many of the features of ornamentation, such as turns and accented grace notes (which take the form of appoggiaturas or anticipations), became an integral part of the musical language but without being left to the discretion of the performer. Improvisation ceased to form part of the performer's equipment, except in vocal ornamentation (deplored by contemporary critics) in Italian opera, but its spirit persisted in a crystallized form, so to speak, in established harmonic and contrapuntal procedures. Many examples of florid turns, anticipations and suspensions in the works of Chopin and Wagner can be traced back to earlier forms of ornamentation *(see* HARMONY).

In essence the art of ornamentation is dependent on a certain distribution of responsibility between composer and performer. This concept was foreign to 20th-century music, though the ancient tradition reappears in spontaneously conceived examples of ornamentation in jazz music. Here, however, as in the series of stereotyped ornamented cadenzas provided by the composer Quantz in the 18th century, the uninitiated jazz trumpeter is provided with a series of "hot breaks" in the form of cadenzas that have their origin in practices reaching back to the beginnings of music.

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(*M.* Mw.)

ORNAMENTS, PRIMITIVE. The term "ornament." strictly applied to objects worn from a sense of aesthetic value and intrinsic beauty either in gratification of personal taste or in accord with fashion, can also be applied to objects worn for other reasons, as indications of social distinction and status and as amulets and charms or curatives. Classes of ornaments in primitive society mark distinctions of sex and social status. Unmarried people may wear ornaments that differ conspicuously from those of married people. Decorations may be worked on or fashioned to plain materials of dress to make the whole ornamental, such as the beadwork and ornamental ribbons on American Indian clothing. Ornamental and embellishment, external and internal, are applied to architecture in token of social status. To religious zeal is due the wealth of ornament often found in the men's house in some societies in Oceania — the centre of the communal life and the repository of the cult objects of the community.

Ornaments are sometimes very elaborate. Wings of butterflies, gorgeous tropical beetles, seeds, berries, flowers, variegated leaves. bright stones and all sorts of natural products are employed. The manufacture of ornaments as prescribed by the social order is an occupation of importance. Nature provides the materials and the models. The sense of colour is expressed by using different coloured earths, the quest for which is a stimulus toward economic development. Conventionalization, vulgarization and imitations are notable in primitive art but at one and the same time in one community there may be artists of very different capacities.

ORNE, a *département* of northern France, formed in 1790 from districts of ancient Normandy, with adjacent portions of Alençon and Perche. Pop. (1954) 274.862. Area 2,372 sq.mi. It is bounded north by Calvados. east by Eure and Eure-et-Loir, south by Sarthe and Nayenne and west by Manche.

The *département* lies astride the watershed (Collines de Normandie and Collines du Perche) between the Loire tributaries flowing south (Mayenne and Sarthe) and the streams (the chief among which is the Orne) draining into the English channel. Most of the *département* lies above 600 ft. and is hilly country, reaching 1.368 ft. in the Forêt d'Écouves and Les Avaloirs. The western half, lying within the Armorican massif. is built of ancient rocks that yield only poor soils, but the eastern part, consisting of Jurassic and Cretaceous rocks, provides richer country and contains the plains of Alençon and Argentan. These *campagnes,* open tracts of old-established cornland, present a contrasting landscape to the *bocage* in the west, which is broken hilly country with woodlands and much waste, among which farmland presents a discontinuous patchwork of small, hedge-bounded enclosures. The countryside is mainly pastoral, young cattle and dairy produce being the chief products. In the northeast, near Vimoutiers, Camembert cheese has been a noteworthy product since the 18th century, and elsewhere much butter is produced. The district of Perche, in the east of the *département,* is famous for its breed of draft horses. Orne lies outside the northern limit of the vine, but cider-apple orchards are widespread. Iron ore is worked in the southwest and there are scattered stone quarries. Bagnoles is a well-known spa. with a picturesque lake. Old textile, tanning and metal-working industries survive in some of the market towns, notably at Flers, which has cotton and linen mills, and at Laigle, which manufactures pins and needles and hardware. The largest town and *préfecture* of the *département* is Alenqon, famous for its lace, but little of this is now made. Sées, near the source of the Orne, is the seat of the bishopric, and its cathedral is one of the finest examples of the Norman style of Gothic churches. The *département* comes under Caen for the administration both of education and of justice. It is divided into three *arrondissements,* centred upon Alenqon, Argentan, and Mortagne. Among other towns Domfront in the southwest is noteworthy for the magnificent panorama that can be viewed from the castle terrace which overlooks the precipitous Varenne pass. Most of the towns suffered considerable damage during the Allied advance in 1944.

(AR. E. S.)

ORNE RIVER, of northern France, 94 mi. long, flowing through the *départements* of Orne and Calvados to its mouth in the Baie de la Seine, 8 mi. N. of Caen.

The Orne rises near the little cathedral city of Sées in the Forêt d'Écouves, the highest part of the Collines de Normandie, and flows northwest past Argentan and then north across the Campagne de Caen to the sea. Its basin is chiefly devoted to pastoral farming, especially concerned with cattle rearing and dairy farming, but grain growing is important on the plain of Argentan and especially on the extensive arable tracts of the limestone platforms that flank its lower course. The limestone provides an excellent building stone, long famous and widely distributed by sea from Caen for use in many historic buildings in south and east England, including the Tower of London and Norwich cathedral. Iron ore deposits which occur on the margin of the Armorican massif in the south of Calvados are more important now. The short canal which connects Caen with the sea, alongside the estuary of the Orne, serves as outlet and considerable industrial development has taken place along it, with blast furnaces, engineering establishments and cement works. (Ar. E. S.)

ORNITHOLOGY is the science of birds. This article will deal with the development of the study of birds from early historic to modern times; for a detailed account of bird anatomy, physiology, natural history and classification, *see* Bird. The historical record begins with the representations of birds made by Stone Age man during the last glacial epoch of the Ice Age in France and Spain—paintings on the walls of caves, or figures or incisions carved on bits of horn, bone or stone. The birds that have been identified thus far from this remote Paleolithic art include the stork, swan, capercaillie and what appears to be the great auk. From the more recent Neolithic period, outlines of birds are more common. To these archaeologists assign an antiquity of 6,000–8,000 years. The Paleolithic designs are much older.

A structure of the Sumerians of about 3100 B.C., near Ur in Mesopotamia, was decorated with a large copper relief that included an eagle. On the tomb of Nefermaat, of about 3000 B.C., at Medum, in Egypt, is a fresco showing red-breasted, bean and white-fronted geese whose painted colours are said to be like those seen in these species today. Bird designs in following centuries in Egypt were many and varied, depicting at least 90 species, while numerous birds were preserved entire as mummies. Designs of numerous species are also found in the early art of Greece.

Early Writings.—There are many incidental references to birds in the Bible, those in the Old Testament being of considerable antiquity. The writings of Aristotle (384–322 B.C.), though they do not attempt to give a connected account, include statements that concern about 170 species of birds, which he divided into eight groups, an early attempt at classification. He obtained part of his information from still earlier writers whose works are lost. Pliny the Elder (d. A.D. 79), in his *Historia Naturalis,* devoted book x to birds, taking much from Aristotle. The books of Aelian, of the 3rd century, written in Greek, have much on birds, largely in the form of anecdote, folklore or fable, a pattern that continued in the bestiaries and medical treatises through the dark ages. Early Persian, Arabic and Hindustani manuscripts of the Muslim period of learning have references to birds. Avicenna (A.D. 980–1037), writing in Arabic, expanded the accounts of Aristotle with additional material. Averroës (A.D. 1126–98) of Spain was an equally celebrated naturalist whose manuscript writings have been preserved in print.

Early Saxon poets mention the gannet and several other birds of uncertain identity in songs current during the 6th and 7th centuries, and during the latter there came early records of falconry, apparently introduced by the Saxons into Britain. The *Epistolae Sancti Bonifacie,* written about the middle of the 8th century, recorded that Boniface, archbishop of Mons in Belgium, presented to Athelberht, king of Kent, a hawk and two falcons. In the laws of Howel, king of Cambria, supposedly in the 10th century, there is statement of the hunting of the pheasant and an allusion to hawking. Aelfric's *Vocabulary,* prepared in the 10th century, and a similar later work contain names of more than 100 birds, while in the *Colloquy of Aelfric,* a series of dialogues between a master and his pupils, are references to hunting with and training of hawks. In the writings and manuscripts of the 12th and 13th centuries are many references to hawking, descriptions of decoys in which ducks were captured alive, records of heronries and an account of a great flight of crossbills into England in the year 1251.

The earliest printed account of birds is found in the *Sermonum Proprietate* of Rabanus Maurus (A.D. 776–856), archbishop of Mainz; this work, printed in Strasbourg in 1467, contains a chapter entitled *De Avibus.* William Turner published in 1544 the earliest printed book devoted solely to birds entitled *Avium praecipuarum,* a commentary on the birds of Aristotle and Pliny, prepared in accordance with treatment that was the forerunner of modern methods. This was followed in 1555 by Konrad von Gesner's *Icones Avium,* which contained many original observations, as the author traveled extensively and recorded his impressions firsthand. Pierre Belon, whose *Histoire de la nature des oyseaux* appeared also in 1555, had considerable knowledge of the anatomy of birds, and seems to have been the first to compare the various parts of the avian skeleton with those of man.

In the joint observations of Francis Willughby and John Ray, published by the latter in 1676 and 1678 after the death of Willughby, there is a division of known birds into two great groups of land fowl and waterfowl, an arbitrary classification that was current to the end of the 19th century, when it was superseded by a more modern grouping based on structural characters.

Linnaeus, the founder of the modern system of scientific names, began publication of his *Systema Naturae* in 1735, in the first edition of which he included a list of the birds known to him. In 1758, in the 10th edition of his work, Linnaeus proposed that each species of animal, including birds, be designated by two names: the first of generic significance, applying in most cases to a number of somewhat similar allied forms; and the second specific in nature, used in connection with the genus name to designate a particular species. In recent years, a category of subspecies, or geographic races, designated by a third Latin term or subspecific name, has been added where required.

Natural history collections made in connection with the many explorations of the late 18th and early 19th centuries brought to Europe, particularly to England and France, many specimens of birds that greatly broadened knowledge of the birds of the world. In early explorations, paintings or drawings were made of birds and specimens were preserved in spirits or sometimes dried as mummies. After the middle of the 18th century, as travelers increased and interest in natural objects expanded, methods of preparing skins of birds were evolved that led finally to the making of what are known as scientific specimens. Such specimens were, and still are, prepared as follows: the skin, with the feathers intact, was removed from the body, leaving only the bones of the skull, wings, feet and base of the tail. After the inner surface was poisoned, usually with arsenic, the skin was then stuffed with cotton, tow or other light vegetable substance and dried so that the finished object resembled a dead bird. By means of such preparations it became possible to assemble collections of birds, preserved indefinitely, for continued study and examination.

The growth of bird collections and their expansion into museums, where birds were mounted in natural positions, changed completely the style and method of published treatises dealing with ornithology. To this time these had been mainly accounts and descriptions written from hearsay or memory, and involving constant repetition of the writings of previous authors. Such accounts began to be supplanted in large measure by detailed statements regarding specimens secured during voyages, or by monographs that brought together all available knowledge concerning genera, families or larger groups of birds. Many works contained series of coloured illustrations that delineated the bird under discussion more definitely than words. Among earlier writers of such illustrated works or monographs may be mentioned L. Daubenton, whose *Planches enluminées* contained 1,008 plates, most of them of birds; F. Levaillant, who published on hornbills, cotingas, birds of paradise and many others; L. J. P. Vieillot, who produced an array of volumes that dealt with the majority of the known birds of the world; and C. J. Temminck, who wrote on the pigeons, gallinaceous birds and others.

John James Audubon's Birds of America, in four volumes of large folio size, containing 435 plates, was published in London between 1827 and 1838 and was followed by his Ornithological *Biography,* in which, with the aid of William MacGillivray, he gave accounts of the habits of North American birds. The writings of John Gould, which began in 1832, included descriptions and beautiful paintings in colour of birds of all parts of the world; they comprised more than 40 folio volumes illustrated by more than 3,000 plates.

After the middle of the 19th century ornithological publications increased greatly in number. In America increase of knowledge in ornithology subsequent to Audubon and Alexander Wilson (who was a contemporary of Audubon in the study of American birds and published an excellent and painstaking account of them) came rapidly with the appointment in 1850 of Spencer Fullerton Baird as assistant secretary of the Smithsonian institution. Baird's early years in this new position were coincident with the initiation of the great exploratory surveys, including the Hayden surveys and the survey of the 40th parallel of latitude, undertaken by the government to develop the western part of the United States. Baird established the U.S. National museum as a depository for specimens of all kinds belonging to the U.S. government, and arranged to send naturalists with the different survey parties, with the result that large collections, particularly of birds and mammals, came to Washington, furnishing the material for many important reports.

Modern Studies.—Throughout the 19th century and the early years of the 20th emphasis was directed to the search for unknown and unusual birds, by exploration of little-known regions.

Until about 1930 the technical aspects of bird study were the interests of relatively few scholars. More recently, as scientific investigations have diversified, popular interest has increased, until now birds are a concern, casual or important as the case may be, of hundreds of thousands of persons. Most of the species of existing birds have been discovered, except for possibly a limited number in a few regions that have not yet been completely explored. While studies of geographical variation and taxonomic relationships continue to be important fields for investigators, steadily increasing numbers of students are occupied with studies of the living bird in field and laboratory.

Extended programs, through which many thousands of living birds are banded with numbered, lightweight rings and then released, give much information on longevity, distribution and migration (see MIGRATION, BIRD). Studies of anatomy lead to increasing understanding of the relationships of birds; discoveries of fossils add to the knowledge of birds that are now extinct and help to clarify the evolution of the group; and research in physiology and behaviour increases understanding in many directions. Added to these are the data provided by the steadily growing number of bird watchers, who are afield with binoculars, spotting scopes, cameras and notebooks to record the occurrences of birds that they may encounter and to note anything of interest about them. (See BIRD WATCHING.)

Ornithological Societies.—As ornithologists increased in number, desire for discussion of their problems grew, to take shape finally in serial publications devoted to birds alone. Among the early periodicals that continue today may be mentioned especially the *Journal* fur *Ornithologie,* begun in 1853; the Ibis, founded by the British Ornithologists' union in 1859; and the *Auk,* originated by the American Ornithologists' union in 1883. The last-mentioned periodical is a direct continuation of the Bulletin of the Nuttall Ornithological club, established by that organization in April 1876. The Zoological Society of London, especially in its earlier years, had a profound influence on the development of ornithology, particularly through the labours of A. H. Garrod, W. A. Forbes and Frank E. Beddard and through its publications, especially the Proceedings of the Zoological Society of London and its precursor, the Proceedings of the *Committee* of Science and Correspondence of the Zoological Society (1830, et seq.).

In North America there are numerous local amateur societies devoted to birds, in addition to the older ones of wider geographic scope, a part of whose membership is engaged in technical investigations. Similar organizations are found in the countries of Europe, in Australia and in many other parts of the world. Several dozen periodicals are devoted to ornithology alone, and articles on the subject appear in numerous other serial publications, so that an expanding amount of popular and technical literature steadily increases the fund of knowledge of birds. One serial publication alone—the Zoological Record, published annually since 1864 by the Zoological Society of London to list the technical papers in this field—has included in recent years over 2,000 titles in the section on birds, "Aves." (A. WT.)

ORNITHOPTER, a flying machine with flapping wings operated either mechanically or manually. The type is of historic interest only, and represents man's attempt to imitate the flight of birds. *See* FLIGHT (NATURAL).

OROBANCHACEAE, the broomrape family of parasitic flowering plants, containing 14 genera and about 160 species, easily recognized by their nongreen colour, irregularly shaped flowers, scales for leaves and one-celled capsules with numerous, usually minute seeds. These succulent plants are commonly yellowish, brownish, purplish or almost white. Orobanchaceae obtain their nourishment from other plants (angiosperms or rarely gymnosperms) to whose roots they attach themselves, usually by means of haustoria (absorbing organs). Some members are confined to a few or even just one host species; *e.g.,* beechdrops (*q.v.; Epifagus virginiana*) parasitizes only beech trees. Others: especially some species of broomrape (*q.v.;* Orobanche), parasitize a wide range of hosts.

The family is confined largely to the northern hemisphere and is especially well represented in temperate Eurasia. In the United States its representatives, in four genera, include beechdrops, squawroot (*Conopholis* americana), ground-cone (Boschniakia *hookeri*) and broomrape. In Britain are found broomrape and toothwort (*q.v.;* Lathraea *squamaria*). Some broomrapes are troublesome parasites on crop plants such as hemp, tobacco, tomato, cotton and clover. *Aeginetia* indica injures sugar cane in the Philippines. Flowers of Orobanchaceae, which are either variously grouped or rarely solitary, have two to five united sepals, five petals united to form a two-lipped corolla, four stamens and a one-celled ovary. Orobanchaceae, closely related to the figwort family (Scrophulariaceae), are sometimes included therein.

See C. R. Metcalfe and L. Chalk, *Anatomy of the Dicotyledons,* vol. ii, pp. 988–991 (1950). (J. W. TT.)

ORODES (Iranian HURAODHA), the name of three Parthian kings. There was an Orodes, sometimes called ORODES I, ruling in Babylon in 80 B.C. ORODES II (or I), with the help of his brother Mithradates III, murdered his father Phraates III in 57 B.C., overcame Mithradates in 54 and was king of Parthia when the battle of Carrhae (*q.v.*) was won; he was in turn murdered by his son, Phraates IV, in 37. ORODES III (or II) succeeded Phraates V about A.D. 5 and was murdered within two years of his accession.

OROGENY, in geology, is the development of mountain structure by folding and fracturing of the earth's crust, the term coming from the Greek oros, "mountain," and genesis, "birth." In general, orogeny has followed a long period of deposition of sediments in the form of a broad trough, or geosyncline, resulting from slow subsidence as the deposits accumulated. A complex history of deformation has ended the geosynclinal stage and introduced the mountain-building stage, generally accompanied by earthquakes, volcanic activity and the intrusion of massive bodies of granitic rock. For discussion of these processes see GEOLOGY: Structural Geology. See also FAULT; FOLD; ISOSTASY.

ORONTES (Arabic AL'ASI "rebel"), the ancient name of a river of western Syria, also called Draco, Typhon, Axius. It rises north of Baalbek in the Bekaa (Al Biqa') valley fed by springs in the limestone of the eastern side of Mt. Lebanon. Flowing northward between the Lebanon and Anti-Lebanon mountains into the lake of Homs (an irrigation reservoir formed by damming the Orontes) and the swampy depression of Al Ghab, it turns west at Jisr al Hadid on the Turkish border and enters the sea near the small Mediterranean port of Samandag (Seleucia Pieriae). North of Homs it receives numerous small wadies (seasonal rivers). Within Turkey it is joined by the Afrin Suyu and Kara Su upstream from Antakya (Antioch). The mean annual discharge is 2,500,000,000 cu.m., and the seasonal variation is from 10 to 1.6 cu.m. per second near its source and 35 to 230 cu.m. per second at its mouth. It is mainly unnavigable throughout its 355-mi. course. Between Homs and Hamah its waters irrigate about 85.000 ac. of land, and there is projected drainage of Al Ghab. Its valley served as an ancient military and trade route between Egypt and Asia Minor and from blesopotamia to the Mediterranean.

See J. Weulersse, *L'Oronte: Etude de fleuve (1940).* (C. G. SM.)

OROPUS, an ancient Greek seaport on the Euripus which, falling finally to Athens) remained an Attic town under the Roman empire. The oracle of Amphiaraus was there.

OROSIUS, PAULUS (fl. 415), historian and theologian, was born in Spain (possibly at Braga in Galicia) toward the close of the 4th century. Having entered the Christian priesthood, he naturally took an interest in the Priscillianist controversy then going on in his native country. and it may have been in connection with this that he went to consult Augustine at Hippo in 413 or 414. After staying for some time in Africa as the disciple of Augustine, he was sent by him in 415 to Palestine with a letter of introduction to Jerome: then at Bethlehem, the result of his arrival being that John, bishop of Jerusalem, was induced to summon at his capital in June 415 a synod at which Orosius communicated the decisions of Carthage and read such of Augustine's writings against Pelagius as had at that time appeared.

Success, however, was scarcely to be hoped for among orientals who did not understand Latin, and whose sense of reverence was unshocked by the question of Pelagius, *et quis est mihi Augustinus?* All that Orosius succeeded in obtaining was John's consent to send letters and deputies to Innocent of Rome; and, after having waited long enough to learn the unfavourable decision of the synod of Diospolis or Lydda in December of the same year, he returned to North Africa, where he is believed to have died.

The earliest work of Orosius, *Consultatio sive commonitorium ad Augustinum de errore Priscillianistarum et Origenistarum,* explains its object by its title; it was written soon after his arrival in Africa, and is usually printed in the works of Augustine along with the reply of the latter, *Contra Priscillianistas et Origenistas liber ad Orosium.*

His next treatise, *Liber apologeticus de arbitrii libertate,* was written during his stay in Palestine, and in connection with the controversy which engaged him there. It is a keen but not always fair criticism of the Pelagian position from that of Augustine. The *Historiae adversum Paganos* was undertaken at the suggestion of Augustine, to whom it is dedicated.

Nearly 200 manuscripts of the *Historiae* have survived. A free abridged translation by King Alfred is still extant. The *editio princeps* of the original appeared at Augsburg (1471), and has been superseded by C. Zangemeister, who has edited the *Historiae* and also the *Liber*. Besides the Old and New Testaments, Orosius appears to have consulted Caesar, Livy, Justin, Tacitus, Suetonius, Florus and a cosmography, attaching also great value to Jerome's translation of the *Chronicles* of Eusebius.

OROZCO, JOSÉ CLEMENTE (1883–1949), Mexican painter, whose original style was expressive of his strong social convictions, was born on Nov. 23, 1883, at Ciudad Guzman, Jalisco. The family moved to Mexico City where the child often watched José Guadalupe Posada at work. After completing a course in scientific agriculture at the College of Chapingo, he entered the National university with the intention of becoming an architect. Losing his hand in a chemical explosion he abandoned that career and, in 1909, devoted himself to creative art, for which several years of intensive study at San Carlos academy prepared him. The water colours of his first one-man show in Mexico City in 191j revealed his social consciousness.

When the revolutionary government invited outstanding artists to decorate the walls of public buildings, Orozco worked in the medium of true fresco in the patio of the National Preparatory school, 1922–27, also decorating the Industrial school at Orizaba and, as a private commission, the main stairway of the House of Tiles in Mexico City. Rejecting Cubism as well as the imitation of pre-Hispanic art forms, Orozco developed his own powerful style.

BY COURTESY OF THE MUSEUM OF MODERN ART, NEW YORK

"ZAPATISTAS" BY JOSÉ CLEMENTE OROZCO. IN THE MUSEUM OF MODERN ART. NEW YORK

Orozco painted the fresco "Prometheus" at Pomona college, Claremont, Calif., in 1930 and the following year, his prophetic murals at the New School for Social Research, New York. He painted "Epic of New World Culture" at Dartmouth college, Hanover, N.H., 1932–34, and returned to Mexico to paint the fresco "Catharsis" in the Palace of Fine Arts.

Between 1936 and 1939 Orozco worked in Guadalajara; in 1940 he completed fresco murals in the library at Jiquilpan and six movable panels. "The Dive Bomber," for the Museum of Modern Art in New York. In 1941, in Mexico. he decorated the main floor of the supreme court and in 1942 began the murals of the Jesus Nazareno hospital. For the next four years Orozco painted numerous portraits and held several exhibitions. In 1946 he was awarded the national prize of the Institute of Arts and Sciences. Orozco's final works included a large-scale mural in plastic medium in the open-air theatre of the National School for Teachers (1947), completion of the Jesus Nazareno hospital frescoes (1947–48), "Juarez and Reform," Museum of History, Chapultepec (1948), and "The Great Legislation," Chamber of Deputies, Guadalajara, (1947–48). He died on Sept. 7, 1949.

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ORPEN, SIR WILLIAM NEWENHAM MONTAGUE (1878–1931), British painter, was born at Stillorgan, County Dublin. on Nov 27, 1878. and studied at the Dublin Metropolitan School of Art and at the Slade school, London. He was elected an associate of the Royal Academy in 1910 and academician in 1919 He first exhibited at the New English Art club, of which he became a member in 1900, his early work being marked by preoccupation nith spacing and silhouette and the use of quiet harmonies of gray and brown, with a note of vivid red or blue. He soon turned to the use of bright colour and the study of light, seen in a series of brilliant portrait interiors such as the "Hon Percy Wyndham" (1907) and "Myself and Venus" (1910; Pittsburgh, Pa.. gallery). About this time he became well known for his vigorously characterized portraits. During World War I Orpen received an appointment as official artist. and in 1918 an exhibition of his war pictures was held in London. Many of these are now in the Imperial War museum.

Orpen was created K B E. in 1918 He wrote *An Onlooker in France* (1921) and *Stories of* Old *Ireland and Myself* (1924). Orpen was a friend of Augustus John. He died. Sept 29. 1931.

QRPHEUS. The legendary founder of the cult known as Orphism, ὁ Ὀρφικὸς βίος. The derivation of the name is uncertain, possibly from the same root as ὄρφνη, signifying darkness. What original figure, human or divine, lies behind the legend, is unknown; it seems possible, however, that Orpheus is the name or title of Thraco-Phrygian priest-kings, who may have been regarded as incarnating the god Dionysus (*q.v.*) or some similar deity, and were perhaps killed by the worshippers of the god after a period of years (see James Frazer, Golden Bough, 3rd ed., vi, 99).

Legend. — Orpheus was the son, in most accounts, of the Thracian king Oeagrus (sometimes of Apollo), and a Muse, generally Calliope, sometimes Polyhyrnnia. He took part in the Argonautic expedition (see ARGONAUTS), and there was an Orphic. version of that exploit, preserved in a late form in the Orphic Argonautica. The best-known episode of his career is that of his marriage. His wife Eurydice was bitten by a serpent (while fleeing from Aristaeus, according to Virgil, Georg., iv, 457; this detail is not found earlier, but the story itself is old and widespread; see Rose in *Aberystwyth Studies*, iv, p. 21). Orpheus, inconsolable at her death, went down to Hades to get her back. The infernal deities, softened by his music, allowed her to return, on condition that she should walk behind Orpheus and he should not look back. He broke this condition, and she became a ghost once more (Plato, *Sympos.,* 179 D., seems to allude to a slightly different account). He now refused to have anything more to do with women, and consequently the Thracian women, during a Dionysiac orgy, set upon him and tore him to pieces. His head floated down the Hebrus and finally came ashore on Lesbos, where there was apparently an oracular shrine of Orpheus. The legend may be founded on the practice of the omophagia (see DIONYSUS).

Orpheus is represented as a musician so marvellous that the wild beasts, and even trees and rivers, came to listen to him. He is also represented as a seer, a founder of mystic rites, particularly Dionysiac, a magician, and later as an astrologer also. Sometimes his adventures tend to be assimilated to the stock incidents in the career of a philosopher, for he is represented as travelling in search of knowledge (as Plato, for example, is said to have visited Egypt).

Several writers speak of him as a sort of missionary of civilization (*e.g.,* Aristophanes, Frogs, 1032; Horace, A.P., 391). He is also the reputed author of a number of books, some dating from the time of Peisistratus of Athens.

The Orphic Doctrines **and "Life."**—There was no Orphic church but there existed a number of *thiasoi* (conventicles) of initiates into the Orphic mysteries, all having a similar doctrine and rules of life, but lacking any sort of central organization and probably having no common standard of orthodoxy. Orphic initiators (ὀρφεοτελεσταί) were numerous, and are spoken of with the utmost contempt by Plato and others. We hear of Orphism from about the 6th century on, and the doctrine, which seems to have grown out of a combination of the Thraco-Phrygian worship of Dionysus with certain religious speculations characteristic of that age, and probably resulting from the contact of Greece with the east, was in outline as follows. When Zagreus was devoured by the Titans (see DIONYSUS) and they were consumed by the thunderbolt, man sprang from their ashes. Hence, man is partly divine (Zagreus), partly desperately wicked (the Titans). It is his chief end to get rid of the latter element, which is accomplished by a life of ritual and moral purity during the soul's incarnation in a series of bodies. When completely purified, it will be freed from the "circle of birth or becoming" (κύκλος τῆς γενέσεως) and be made fully divine. The rules of purity included abstinence from animal food of all kinds, avoidance of polluting actions, such as contact with death or birth, wearing of white garments and other ascetic practices. There were mysteries of some kind, at which we may conjecture that the death of Zagreus was enacted (see MYSTERY), also various Dionysiac practices, such as the *omophagia.* In some cases, at least, the Orphic dead were provided with extracts from the sacred writings of their sect, inscribed on gold tablets, containing directions for their conduct in the underworld. Several of these have been recovered (see next paragraph). The influence of Orphism on Pythagoreanism was great, so much so that it is often impossible to separate the two, although one mas primarily a religion, the other a system of philosophy.

Orphic Literature. — A great number of books existing in antiquity were ascribed to Orpheus, or his son Musaeus. This literature was well known to Pindar and Euripides, and exercised great influence, directly or through Pythagoreanism, on Plato, and probably on Socrates also (see A. E. Taylor, *Varia Socratica*). It is now lost save for (1) the gold tablets already mentioned, which clearly contain extracts from a poem dealing with the underworld; (2) a collection of hymns of late date; (3) ***Lithica*** (on the virtues of minerals) and the *Argonautica,* also late. 'There are, however, numerous quotations in writers of various dates, which together make up a large collection of fragments, some early and undoubtedly genuine Orphic, others much later, including palpable forgeries. showing Jewish and other foreign influence. A principal source for these is the controversialists. Christian and pagan, of the 3rd and 4th centuries A.D. Among editions may be mentioned E. Abel. *Orphica* (188j); and O. Kern, Orphicorum *fragmenta* (1922). The former contains the hymns, *Lithica* and *Argonautica.*

The story of Orpheus, as was to be expected of a legend told both by Ovid and Boethius. retained its popularity throughout the middle ages and was transformed into the likeness of a northern fairy tale. In English mediaeval literature it appears in three somewhat different versions: Sir Orpheo, a "lay of Brittany" printed from the Harleian manuscript in J. Ritson's Ancient English *Metrical* Romunces, vol. ii (1802); *Orpheo and Heurodis* from the Auchinleck manuscript in David Laing's *Select* Remains of the *Ancient Popular* Poetry of *Scotland* (new ed. 1885); and Kyng *Orfew* from the Ashmolean manuscript' in J. O. Halliwell's *Illustrations of* Fuiry *Mythology* (Shakespeare Soc., 1842). The poems show traces of French influence.

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ORPIMENT, the mineral form of arsenic trisulfide, occurs as lemon yellow, usually foliated masses or veins in hot-spring areas, presumably being deposited by ascending, hot, aqueous solutions. It also occurs as a sublimate near fumaroles and as an alteration product of other arsenic minerals, particularly of its frequent companion, realgar.

Orpiment is used as a pigment in dyeing and in the preparation of some depilatories. It is readily synthesized, the artificial product ('.king's yellow") often being used in place of the mineral. Orpiment's specific gravity is 3.49; hardness 1.5–2 on the Mohs' scale (*q.v.*). The formula is As_2S_3. Diagnostic properties are its colour. pearly lustre (on cleavage surfaces) and associated minerals. *See* also ARSENIC. (F. D. B.)

ORPINGTON, an urban district in the Orpington parliamentary division of Kent, Eng., 14 mi. S.E. of London by road. Pop. (1961) 80,277. Area 32.6 sq.mi. Although Orpinton appears in Domesday Book: the district is almost entirely of modern growth. It includes well-wooded country and large areas of "green belt" land. Apart from a small light industrial area in the north, it is predominantly residential. Manufactures include electrical goods, casks, leather cloth, inks, cables and paper. Down house, Downe, where Charles Darwin wrote his Origin of Species, is now a museum; the R.A.F. station at Biggin Hill is remembered for, the part it played in the Battle of Britain (1940).

ORRERY, CHARLES BOYLE, 4TH EARL OF (1676–1731), British author, soldier and politician, the second son of Roger, 2nd earl, was born at Chelsea and educated at Christ Church, Oxford. He published an edition of the epistles of Phalaris which engaged him in the controversy with Richard Bentley made famous by Jonathan Swift's *Battle* of the Books. He also wrote a comedy, *As You* Find It. He served at Malplaquet and, as envoy to Flanders, prepared the way for the treaty of Utrecht. In 1721 he was imprisoned on suspicion of being concerned in a Jacobite plot. He died on Aug. 28, 1731. (D. TN.)

ORRERY, ROGER BOYLE, 1st Earl of (1621–1679), British soldier, statesman and dramatist. 3rd surviving son of Richard Boyle, 1st earl of Cork, was born on April 25, 1621, created baron of Broghill on Feb. 28. 1627, and educated at Trinity college. Dublin, and. according to Wood, also at Oxford, He travelled in France and Italy. and coming home took part in the expedition against the Scots. He returned to Ireland on the outbreak of the rebellion in 1641 and fought with his brothers at the battle of Liscarrol in Sept. 1642. On the resignation of the marquis of Ormonde, Lord Broghill consented to serve under the parliamentary commissioners till the execution of the king, when he retired from public life.

He was engaged in royalist schemes, however, when Oliver Cromwell visited him, and, explaining that he knew all about his activities, offered him a chance of clearing himself by serving the commonwealth in Ireland. He accepted, and served Cromwell faithfully throughout the Irish campaign.

Orrery was returned to Cromwell's parliaments of 1654 and 1656 as member for the county of Cork. and also in the latter assembly for Edinburgh. for n-hich he elected to sit. He served that year as lord president of the council in Scotland; and nhen he returned to England, he was included in the inner cabinet of Cromwell's council. and was nominated in 1657 a member of the new house of lords. On Cromwell's death he save his support to Richard: but since he saw no possibility of maintaining the government, he left for Ireland, where by resuming his command in Munster he secured the island for Charles and anticipated George Monk's overtures by inviting him to land at Cork. He sat for Arundel in the convention and in the parliament of 1661. and at the Restoration was taken into great favour. On Sept. j, 1660, he mas created earl of Orrery. The same year he was appointed a lord justice of Ireland and drew up the act of settlement. He continued to exercise his office as lord-president of Munster till 1668, when he resigned it because of disputes with the duke of Ormonde. the lord-lieutenant.

On Nov. 25 he was impeached by the house of commons for "raising of money by his own authority upon his majesty's subjects." but the proceedings were interrupted by the prorogation of parliament and were not afterward renewed. He died on Oct. 26. 1679.

In addition to Lord Orrery's achievements as a statesman and administrator. lie gained some reputation as a writer and a dramatist. He was the author of *An Answer to a Scandalous Letter . . . A Full Discovery of the Treachery of the Irish Rebels* (1662), printed with the letter itself in his *State Letters* (1742), another answer to the same letter entitled *Irish Colours Displayed . . .* being also ascribed to him: *Parthenissa*, a *novel* (1654); *English Adventures by a Person of Honour* (1676), whence Thomas Otway drew his tragedy of the *Orphan; Treatise of the Art of War* (1677), a work of considerable historical value: poems, of little interest, including verses *On His Majesty's Happy Restoration* (unprintedi. *On the Death of Abraham Cowley* (1677), *The Dream* (unprinted). *Poems on Most of the Festivals of the Church* (1681); plays in verse, of some literary but no dramatic merit. of which *Henry* Г (1664). *Mustapha* (1665), *Tryphon* (acted 1668), *The Black Prince* (1669), *Herod the Great* (published 1694) and *Altemira* (1702) were tragedies, and *Guzman* (1669) and *Mr. Anthony* comedies. A collected edition was published in 1737, to which was added the comedy *As You Find It. The General* is also attributed to him.

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ORRISROOT (apparently a corruption of iris root), the rhizomes or underground stems of three species of *Iris. I. germanica, I. florentina* and *I. pallida*, closely allied plants growing in subtropical and temperate latitudes, but principally identified with north Italy. The three plants are indiscriminately cultivated in the neighbourhoocl of Florence as an agricultural protiuct under the name of ghiaggiuolo.

In August the rhizomes are dug up and freed of the rootlets and brown outer bark; they are then dried and packed in casks for sale. In drying they acquire a delicate but distinct odsur of violets. They are principally powdered for use in dentifrices and other scented dry preparations.

ORRY, JEAN (1652–1719), French economist who exercised considerable influence in the government of Spain in the first years of Bourbon rule there. was born in Paris on Sept. 4. 1652. He was unknown politically when, at the suggestion of Michel Chamillart, Louis XIV, whose grandson had just succeeded to the Spanish throne as Philip V, sent him to Spain in 1701 to report on the finances of that kingdom. Orry drew up a series of detailed memoranda, advising not only a reorganization of Spanish financial administration. but also a complete remodeling of the system of government. involving the transfer of political power from the royal councils to a number of niinisters like the French secretaries of state. During the War of the Spanish Succession he was too occupied in devising fiscal expedients to pay for troops and provisions to have any opportunity for executing his schemes; moreover. palace revolutions secured his removal from Spain from 1704 to 1705 and from the end of 1706 until 1713. When he did return in April 1713, however, he and the princesse des Ursins (*q.v.*) became the real rulers of Spain; and in the following 20 months he undertook the complete reform of the administration.

By royal decrees in Nov. 1713 and April 1714 Orry swamped the royal councils with new members, so that opposition from this quarter was outvoted. Then, on Nov. 30, 1714, he created four new secretaries of state. whose work he was to co-ordinate as veedor general. Meanwhile, local government was centralized by the division of Spain into 21 provinces, each governed by an intendant responsible to the veedor genera!. Yet before this administration could be properly established Orry was dismissed and ordered to leave Spain (Feb. 7, 1715). He died in France on Sept. 29. 1719.

Orry was hated in Spain for trying to introduce foreign methods of government and disliked by the French for paying insufiicient attention to their interests. Most sources concerning him are therefore biased and unfair; and his successor as *de facto* first minister in Spain, Giulio Alberoni (*q.v.*), misunderstood or misrepresented his attempts at reform. Even so, Orry was first to tackle effectively the powers of the royal councils, and his creation of the secretaries of state and the intendants was an important and enduring achievement.

Orry's son Philibert (1689–1747) became *contrôleur général* of finance in France in 1730. (B. J. R.)

ORSAY, ALFRED GUILLAUME GABRIEL, Comte d' (1801–1852), a famous dandy and wit, was born in Paris on Sept. 4, 1801, and was the son oi General d'Orsay, from whom he inherited an exceptionally handsome person. In his youth he entered the French army and served as a *garde du corps* of Louis XVIII. In 1822, while stationed at Valence on the Rhdne. he met the earl and countess of Blessington (*q.v.*), whose house he had visited when in London a little earlier. At the invitation of the earl he accompanied the party on their tour through Italy. In the spring of 1823 he met Lord Byron at Genoa, and the published correspondence of the poet at this period contains numerous references to the count's giits and accomplishments and to his peculiar relationship to the Blessington family. A diary which D'Orsay had kept during a visit to London in 1821–22 was much praised by Byron for the knowledge of men and manners and the keen faculty of observation it displayed. On Dec. 1. 1827, Count d'Orsay married Lady Harriet Gardiner. a girl of 1j, the daughter of Lord Blessington by his previous wife. 'The union. if it rendered his connection with the Blessington family less ostensibly equivocal than before. was in other respects an unhappy one. and a separation took place almost immediately. After the death of Lord Blessington. which occurred in 1829, Lady Blessington returned to England. accompanied by Count d'Orsay, and her home. first at Seamore place. then at Gore house. soon became a resort of the fashionable literary arid artistic society of London. Count d'Orsay had been from his youth a zealous Bonapartist, and one of the most frequent guests at Gore house was Prince Louis Napoleon. In 1849 he went bankrupt, and the establishment at Gore house being broken up, he went to Paris with Lady Blessington, who died a few weeks after their arrival. His relations with Napoleon were less cordial after the *coup d'état* of 1851, of which he disapproved.

D'Orsay's appointment to the post of director of fine arts was announced only a few days before his death, which occurred on Aug. 4, 1852.

Count d'Orsay was the supreme dandy, and the list of his accomplishments is surprising. In addition to wit, charm and taste in dress and furniture, he was a good shot, a good horseman, a good fencer and even a good boxer. He had considerable skill in painting and sculpture as well. It is more surprising, perhaps, to find him in the light of benefactor to distressed compatriots in England and as the original founder of the Société de Bienfaisance.

Much information as to the life and character of Count d'Orsay is to be found in Richard Madden's *Literary Life and Correspondence of the Countess of Blessington* (1855).

ORSHA (Polish ORSZA), a town in Vitebsk *oblast* of the Belorussian Soviet Socialist Republic, U.S.S.R., is the starting point of shipping on the Dnieper river and also a junction on the Moscow–Minsk railway. Pop. (1959) 64.000. It is an entrepôt for grain and timber and has iron works, a brewery, food processing and meat factories. The Belgres power station at nearby Orekhovsk is one of the largest in the republic.

The town is mentioned in the annals of 1067 as Rsha and was captured by the Lithuanians in the 13th century. A Polish Jesuit college was founded there in 1604. During the 16th and 17th centuries it was several times besieged by the Russians and finally annexed in 1772. It uas occupied (1941–44) by the Germans during World War II.

ORSI, PAOLO (1859–1935), Italian archaeologist who pioneered in the exploration of Sicily and southern Italy, was born in Rovereto on Oct. 18, 1859. A graduate of the University of Padua, he began his distinguished career as one of the founders of modern archaeology in his native Trentino and on Crete. Appointed director of the museum in Syracuse (1888), he devoted himself to the exploration of Sicily. To his excavations and research on sites of every period from the prehistoric to the Byzantine is due a large part of present knowledge of the art and civilization of Sicily, especially in the pre-Hellenic periods. He may be called the discoverer of the Siculan civilization through his numerous excavations of cemeteries all over the island; he laid the groundwork for the chronology of its four periods. His indefatigable and meticulous excavations of Greek cities throughout Sicily and the south Italian provinces of Magna Graecia (his directorship included also Calabria and Lucaniaj greatly extended many known sites and uncovered numerous new ones; *e.g.*, Syracuse, Camerina, Gela, Leontini, Megara Hyblaea and Centuripe in Sicily, and Locri, Hipponium, Medma, Caulonia, Croton and Crimisa on the mainland. Parallel to his excavations were his organization of the finds in the museums of Syracuse and Reggio and his publications (over 300) which, ranging through all branches of archaeology and all periods, interpret the significance of his explorations in the history of art and architecture. He directed the *Bullettino di Paletnologia italiana, l'archivio storico della Calabria e Lucania,* and *Atti e Memorie della Società Magna Grecia.* Orsi died in Roverkto on Nov. 9, 1935. (L. T. SE.)

ORSINI, the name of a Roman princely family of great antiquity. According to tradition the popes Paul I (757) and Eugenius II (824) were of the Orsini family, but the probable founder of the house was a certain Ursus (the Bear), about nhom little is known, and the first authentic-Orsini pope was Giacinto Orsini, son of Petrus Bobo, who assumed the name of Celestin III (1191). The latter endowed his nephews with church lands and founded the fortunes of the family, which alone of the Guelph houses was able to confront the Ghibelline Colonna. In the 13th century the "Sons of the Bear" were already powerful and rich, and under Innocent III they waged incessant war against other families, including that of the pope himself (Conti).

In 1241 Matteo Orsini was elected senator of Rome, and sided with Pope Gregory IX against the Colonna and the Emperor Frederick II. In 1266 the family acquired Marino, and in 1277 Giovanni Orsini was elected pope as Nicholas III.

When Boniface VIII proclaimed a crusade against the Colonna in 1297, the Orsini played a conspicuous part in the expedition and captured Nepi, which the pope granted them as a fief. On the death of Benedict XI (1304) fierce civil warfare broke out in Rome and the Campagna for the election of his successor, and Cardinal Napoleone Orsini appears as the leader of the French faction at the conclave. The Campagna was laid waste by the feuds of the Orsini, the Colonna and the Caetani.

In 1332, during the absence of the popes at Avignon, the feuds between Orsini and Colonna, in which even Giovanni Orsini, although cardinal legate, took part, reduced Rome to a state of complete anarchy. The Orsini were again at war with the Colonna at the time of Rienzi. In 1435 Francesco Orsini was appointed prefect of Rome, and created duke of Gravina by Pope Eugenius IV. In 1484 war between the Orsini and the Colonna broke out once more, the former supporting the pope (Sixtus IV). Virginio Orsini led his faction against the rival house's strongholds, which were stormed, the Colonna being defeated.

The title of prince of Solofra was conferred on the family in 1620, and that of prince of the Holy Roman empire in 1629. In 1724 Vincenzo Maria Orsini was elected pope (Benedict XIII) and gave his family the title of Roman princes.

ORSINI, FELICE (1819–1858), Italian revolutionist, was born at Meldola in Romagna. Implicated, together with his father, in revolutionary plots, he was arrested in 1844 and condemned to imprisonment for life. The new pope, Pius IX, released him, and he led a company of young Romagnols in the first war of Italian independence (1848). He was elected member of the Roman constituent assembly in 1849, and after the fall of the republic he conspired against the papal autocracy once more. Mazzini sent him on a secret mission to Hungary, but he was arrested in 1854 and imprisoned at Mantua, escaping a few months later.

He then formed a plot to assassinate Napoleon III, whom he regarded as the principal obstacle to Italian independence. On the evening of Jan. 14, 1858, while the emperor and empress were on their way to the theatre, Orsini and his accomplices threw three bombs at the imperial carriage. The intended victims were unhurt. Orsini was arrested; on Feb. 11 he wrote a letter to Napoleon exhorting him to take up the cause of Italian freedom. Another letter to the youth of Italy stigmatized political assassination. He was executed on March 13, 1858.

ORTA, LAKE (LAGO D'ORTA, sometimes called LAGO CUSIO) in Novara province. Piedmont, north Italy, lies 24 mi. N N.W. of Novara city just west of Lake Maggiore from which it is divided by the Mottarone mountains. It has an area of 7 sq mi. and is about 8 mi. in length; the width is 2 mi. Its greatest depth is 469 ft. and the surface is 951 ft. above sea level. The chief village is Orta San Giulio, on a peninsula projecting from the east shore of the lake; just west is the island of San Giulio, which has a picturesque church. At the north end of the lake is another village. Omegna. The lake is the remnant of a larger sheet of water by which the waters of the Toce river flowed south toward Novara. As the glaciers retreated the waters flowing from them sank and were gradually diverted into Lake Maggiore. This explains why no considerable stream feeds Lake Orta, uhile at its north end the Agogna torrent flows out of it, ultimately joining the Po river. (G. KH.)

ORTEGA Y GASSET, JOSÉ (1883–1955), Spanish philosopher and humanist who had a pervading and beneficent influence on the cultural and literary renaissance of Spain in the 20th century, was born in Madrid, May 9, 1883, and received a classical training under the Jesuits before studying at Madrid university between 1898 and 1904. He studied in Germany, 1904–08, being profoundly influenced by the neo-Kantian school at Marburg, as he was later by F. W. Nietzsche, G. Simmel, M. Scheler and (particularly from 1929) W. Dilthey. As professor of metaphysics at Madrid (1910), he early diverged from neo-Kantianism in *Adán en el paraíso* (1910), *Meditaciones del Quijote* (1914) and *El tema de nuestro tiempo* (1923; Eng. trans., 1933). He saw man's individual life here and now a5 the basic reality. reason as a function of life ("vital reason" or "historical reason") is substituted for absolute reason, and for absolute truth the perspective of each individual ("I am I, and my circumstance") He shared the preoccupation of his generation with the "problem of Spain" and his writings were deliberately "circumstantial" and published in periodicals (he founded *España,* 1915; *El Sol,* 1917; *Revista de Occiderzte,* July 1923).· In active politics (League for Political Education, 1915; Group at the Service of the Republic, 1931; member of *Corfes)* he could not be partisan and preferred voluntary exile in Europe and in Argentina (1936–45). He returned to Spain at the end of World War II and in 1948 founded the Instituto de Humanidades in Madrid. He died there on Oct. 18, 1955. Of his other works, the best-known are *España invertebrada* (1921; Eng. trans., 1937) and *La Rebelión de las masas* (1929; Eng trans , 1932). Most of his publications are included in *Obras completas,* 6 vol. (1946–47).

See J. Ferrater Mora, *Ortega y Gasset: an Outline of His Philosophy* (1957); "Homenaje a Ortega y Gasset," *Atenea,* vol. 124, no 367–368 (Jan.–Feh 1956). (R. F. B.)

ORTELIUS (WORTELS). **ABRAHAM** (1527–1598), antiquarian, cartographer and geographer. was born on April 14, 1527, at Antwerp. He was trained as an engraver and in 1547 entered the Antwerp guild of St. Luke as *afsetter van kaarten.* About 1554 Ortelius set up as a seller of antiquities and maps. He traveled widely in pursuit of business and among his many friends numbered Gerardus Mercator (*q.v.*). About 1560. under Mercator's influence, he became interested in map-making and within a decade he compiled maps of the world on a heart-shaped projection (1564), of Egypt (1565) and of Asia (1567), as well as the first edition of the *Theatrum orbis terrarum,* his magnum opus, by which he became famous. This edition, published by Gilles Coppens de Diest at Antwerp in 1570, included 70 maps engraved in uniform style by F. Hogenberg. Most of the maps were derivatives and Ortelius acknowledged his authorities in a catalogue of 87 authors. The *Theatrum* was an immediate success. Ortelius's treatment of his material was critical, and he regularly revised the maps and text in the light of new information; in 1573 he published 17 additional maps under the title *Additamentum theatri orbis terrarum*—other additions were made to the editions of 1579, 1584, 1590, 1595 and 1598. Abridgments of the *Theatrunt* in smaller format were published under the title *Epitome theatri orteliani.* After Ortelius' death his heirs continued to publish the *Theatrum* until 1601 when the prints were sold to J. B. Vrients, an Antwerp publisher who issued editions for a number of years. Editions of the *Theatrum* continued to be published throughout the 17th century.

Ortelius formed a fine collection of coins, medals and antiques and in 1573 published a catalogue, *Deorum Dearzrmque capita ex vetustis numismatibus . . . ex museo A. Ortelli.* In 1575 he was appointed geographer to Philip II of Spain. His publications, in addition to those mentioned above, included *Synonymia geographic*(1578): the second edition appeared under the title of *Thesaurus geographicus* (1587); *Parergon* (1579); with J Vivianus, *Itinerarium per nonnullas Galliae Belgicae partes* (1584); *Nomenclator Ptolemaicus* (1584); *C. J. Caesaris omnia quae extant* (1595); and *Aurei saeculi imago, size Germanorum veterum vita* (1595). Ortelius assisted M. Welser with his edition of the Peutinger Table (1598). He died at Antwerp on July 4, 1598.

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(E. M. J. C.)

ORTHOCLASE: *see* FELDSPAR: *Polymorphism.*

ORTHODONTICS is a branch of dentistry concerned with prevention and correction of irregular teeth, abnormal bite (malocclusion) and malrelation of the jaws and its bad effects on mouth health, chewing and facial appearance. Such abnormalities exist in Neanderthal skulls, were mentioned by Hippocrates (460–377 B.C.) and have persisted throughout the ages and show a tendency to increase. Treatment of tooth irregularities by finger pressure was advised by Celsus (25 B.C.–A.D. 50) arid treatment by mechanical means was suggested by Pliny (A.D. 23–79). The methods described by Pierre F'auchard (1728) are the forerunners of modern orthodontics. which was brought to the fore by E. H. Angle (1899). Prevention and treatment of malocclusion did not become widespread until after the beginning of the 20th century. however; orthodontics now is included in government and voluntary public health service programs because of possible personality effects and health hazards in severe conditions.

Some malocclusion is found in over 90% of the population of the United States and severe types requiring treatment afiect about 50%. Malocclusion is almost always present in persons with clefts of the upper lip (harelip) and the palate when the ridge that holds the teeth is involved. Causes of malocclusion include: familial inheritance; delayed dental and systemic development; endocrine disturbances; severe childhood diseases. including bone ailments; muscular weakness; dietary deficiencies: postural faults of the jaws, head and neck; and persistence of pressure habits in the dentofacial zone such as finger sucking. tongue thrusting, nail-biting and incorrect swallowing. Among other causes are consumption of soft foods. tooth decay and loss of deciduous (first) teeth before permanent ones are ready to replace them. Persistence of pressure habits after tooth irregularities are corrected can result in relapse of teeth to the approximate original condition.

The type of abnormality present rather than age is the deciding factor in treatment. The teeth of some children erupt earlier than those of others: and some types of crowding may show self-correction following continued jaw growth. Periodic examination of the young child is necessary to determine the need for treatment. Treatment of adults is more limited than that of the young. Success depends on the health of the jawbones and the soft tissues surrounding the teeth. Correction of crowded teeth alone will not eliminate speech defects, although response to speech therapy is aided by correction of dental irregularities, especially in the condition called open bite. The time when treatment should be undertaken depends on the presence of a correctible irregularity. In young children, irregularities that can interfere with continued normal dental development should be treated early.

Standardized X-ray films of the head, on which measurements are made of the related parts. were introduced about 1930. This makes it possible to study maturity changes; locate the sites of growth abnormality, which is necessary in planning treatment; and estimate success of correction.

"Systems" of appliance therapy are giving way to more rational treatment methods related more closely to the specific abnormalities in the individual patient. Treatment is considered from a biophysical approach. since teeth tend to return to their original irregularity if the muscles cannot adapt themselves to the new positions. Tooth movement is achieved by means of metal bands, wires, springs. elastics and plates. Some appliances are fixed to the teeth. while others are removable by the patient and are worn at night and part of the day only. Resistance to pressure required to move irregular teeth is obtained from other firm teeth or from the skull bones. Success of treatment depends on the skill of the operator more than on the merits of the appliance. Extraction of certain teeth to relieve crowding in the dental arches, and treatment before all permanent teeth erupt. are sometimes required to prevent and to treat irregularities and. abnormal bite. *See* also DENTISTRY; PEDODONTICS. (J. A. SN.)

ORTHODOX CATHOLIC CHURCH: *see* ORTHODOX EASTERN CHURCH.

ORTHODOX CHURCH IN AMERICA. In 1797 the first Orthodox mission was sent to Alaska, then a Russian territory, by the Holy Synod of the Russian church. Eight monks from the Russian monastery of Valamo baptized several thousand Aleuts, and in 1848 the mission was transformed into a diocese with a famous missionary, Innocent Veniaminoff, the future metropolitan of Moscow, as the first bishop of Sitka. After the purchase of Alaska by the U.S. in 1867, the episcopal see was transferred to San Francisco (1872). Thus, at its beginnings, the Orthodox Church in America limited its activity to Alaska and the Pacific coast and had no intention of expanding beyond this missionary area.

The situation was radically changed by massive Slavic immigration to the eastern states, which began in the 1880s and reached its peak in the years immediately preceding World War I. The first wave consisted mainly of Slavs from Austro-Hungary. Although united to Rome since 1596 (Union of Brest-Litovsk), the Galicians and the Carpatho-Russians preserved the Byzantine liturgy in Church Slavonic. Among these immigrant Uniats a movement of return to Orthodoxy was initiated by one of their spiritual leaders, Alexis Toth, who in 1891 joined the Russian diocese with his Minneapolis parish. By the end of the century his example had been followed by no fewer than 225,000 former Uniats. Then, between 1900 and 1914, large groups of Russians, Ukrainians, Greeks, Syrians, Rumanians, Serbians and Albanians settled in various parts of the country. Finally, the expulsion of Greeks from Asia Minor (1921), the Russian Revolution (1917) and World War II with its contingent of displaced persons brought the number of Eastern Orthodox in America to 4,000,000 to 5,000.000.

Prior to 1917 all these groups were under the canonical jurisdiction of the Russian church through its diocese of Xorth America and the Aleutian Islands. All bishops were sent from Russia. One of them, Archbishop Tikhon, who headed the American diocese from 1898 to 1907 and in 1901 transferred his see from San Francisco to New York city, was to become later the patriarch of all Russia (1918–24). Although a pastoral seminary mas opened in Minneapolis in 1905, almost all priests were Russian-born and supported materially from Russia. But after the Russian Revolution of 1917, which led to great confusion in the Russian parishes in America, each national group created its own diocese with direct canonical connection with its national mother church. The first Greek bishop was consecrated by the patriarch of Constantinople in 1922; the patriarchate of Antioch established its archdiocese in 1918. As to the Russian diocese. the impossibility of maintaining normal relations with the patriarch of Moscow led to the proclamation of diocesan autonomy (Detroit, 1924) and to its transformation into a metropolitan district consisting of seven dioceses with a primate residing in New York. Two smaller groups, those who maintained their allegiance to Moscow and those who opposed it on purely political grounds (the Russian Church in Exile), were later to form separate dioceses.

The Orthodox Church in America consists of:

1. Greek archdiocese of the ecumenical patriarchate of Constantinople; eight bishops, 500 parishes.
2. Russian Orthodox Church of North America; eight bishops, 350 parishes.
3. Syrian Antiochian archdiocese; one bishop, 80 parishes.
4. Serbian Orthodox diocese; one bishop, 60 parishes.
5. Bulgarian diocese; one bishop, 30 parishes.
6. Rumanian diocese; one bishop, 40 parishes.
7. Albanian diocese; one bishop, 14 parishes.
8. Russian exarchate of the patriarchate of Moscow; two bishops, 20 parishes.
9. Russian Synod in Exile; seven bishops, 100 parishes.

There exists also a large Ukrainian Orthodox Church (five bishops. 200 parishes). but certain canonical difficulties hinder its recognition by other Orthodox bodies. All these churches. although maintaining their jurisdictional independence from each other. are united in doctrine, liturgical life and canon law. (See ORTHODOX EASTERN CHURCH.)

Though deeply marked by its various national origins, the Orthodox Church in America shows signs of progressive integration into American life. Several states have declared Orthodoxy the fourth major faith. It has an official status in the U.S. armed forces. with a group of chaplains ministering to Orthodox communicants. The majority of churches permit the use of English in worship and preaching, and virtually all jurisdictions conduct tbe religious education of children in English. In 1948 St. Vladimir's seminary, a graduate school of theology for all branches of the Orthodox Church in America, was founded in New York city with a faculty and a student body representative of all national traditions. Other theological seminaries — the Holy Cross Theological school of the Greek archdiocese in Brookline, Mass., and the Holy Trinity seminary of the Russian Church in Exile at Jordanville, N.Y.—maintain the old national traditions. Translations of liturgical texts and Orthodox books are being published at an ever-increasing rate.

In 1960 an important move was made toward closer co-operation of various national jurisdictions when a Standing Conference of Canonical Orthodox Bishops in the Americas was created in order to co-ordinate church activities in all areas of common concern: Sunday schools, chaplaincy, etc. Virtually all Orthodox churches in America are members of the World Council of Churches and the National Council of Churches of Christ in the U.S.A.

See "Orthodoxy **in America," a special issue** of **St.** *Vladimir's Quarterly,* vol. v, no. 2–3 (1961). (AL. S.)

ORTHODOX EASTERN CHURCH (frequently spoken of as the Greek Church and described officially as The Holy Orthodox Catholic Apostolic Eastern Church), the historical representative of the churches of the ancient east. It consists of (1) those churches which accepted all the decrees of the first seven general councils and have remained in full communion with one another, (2) such churches as derived their origin from these by missionary activity, or by abscission without loss of communion.

Origins of the Greek or Eastern Church. — Christianity arose in the east, and Greek was the language of the Scriptures and early services of the church, but when Latin Christianity established itself in Europe and Africa, and when the old Roman empire fell in two and the eastern half became separate in government, interests and ideas from the western, the term Greek or Eastern Church acquired gradually a fixed meaning. It denoted the church which included the patriarchates of Constantinople, Alexandria, Antioch and Jerusalem and their dependencies. The ecclesiastical division of the early church, at least within the empire, was based upon the civil. Constantine introduced a new partition of the empire into dioceses, and the church adopted a similar division. The bishop of the chief city in each diocese naturally rose to a pre-eminence, and was commonly called exarch —a title borrowed from the civil jurisdiction. In process of time the common title patriarch was restricted to the most eminent of these exarchs, and councils decided who were worthy of the dignity. The council of Nicaea recognized three patriarchs — the bishops of Rome. Alexandria and Antioch. To these were afterward added the bishops of Constantinople and Jerusalem.

When the empire was divided, there was one patriarch in the west, the bishop of Rome, while in the east there were at first two, then four. At present there are seven. This geographical fact has had a great deal to do in determining the character of the Eastern Church. It is not a despotic monarchy governed from one centre and by a monarch in whom plenitude of power resides. It is an oligarchy of the great body of bishops, ranging through the various grades of metropolitan, archbishop, exarch and patriarch. Each head of an autocephalous church (whether patriarch, exarch or archbishop) is supreme and not amenable to any of his peers but is within the jurisdiction of an ecumenical council. The schismatic churches of the east have always reproduced the ecclesiastical polity of the church from which they seceded.

The Byzantine Church. like the Roman, soon spread far beyond the imperial dioceses which at first fixed its boundaries, but it was far less successful than the Roman in preserving its conquests for Christianity. This was due in the main to the differing quality of the forces by which the area covered by the two churches was respectively invaded. Byzantine Christianity became the religion of the majority of the Slavs as Latin Christianity became that of the Germans; but the Orthodox Church never conquered its conquerors. The great dogmatic work of the Eastern Church was the definition of that portion of the creed of Christendom which concerns theology proper — the doctrines of the essential nature of the Godhead and the doctrine of the Godhead in relation with manhood in the incarnation.

All the churches of the east, schismatic as well as Orthodox, accept unreservedly the decrees of the first two councils. The schismatic churches protest against the additions made to the creeds of Nicaea and Constantinople by succeeding councils. The Niceno-Constantinopolitan creed declared that Christ was consubstantial (*omoousios*) with the Father and that He had become man (*enanthropesas*). Disputes arose n-hen theologians tried to explain the latter phrase. These diiferences took two separate and extreme types, the one of which separated the two natures so as to assert a union by means of the harmony of the divine and human wills, while the other insisted upon an absorption of the human nature in the divine. The former was the creed of Nestorianism, the latter of Monophysitism. The Nestorians accept the decisions of the first two councils and reject the decrees of all the rest as unwarranted alterations of the creed of Nicaea. The Monophysites accept the first three councils but reject the decree of Chalcedon and all that come after it. They gave rise to numerous sects and to at least three separate national churches,—the Jacobites of Syria, the Copts of Egypt and the Abyssinian Church, which are treated under separate headings. (*See* also NICAEA, COUNCIL OF; COUNCIL; NESTORIUS; NESTORIANS; MONOPHYSITES.)

CONFLICT WITH ROME

The relation of the Byzantine Church to the Roman may be described as one of growing estrangement from the 5th to the 11th century and a series of abortive attempts at reconciliation since the latter date. The estrangement and final rupture may be traced to political and cultural causes as well as the increasing claims of the Roman bishops and to western innovations in practice arid in the doctrine of the Holy Spirit, accompanied by an alteration of creed. In the early church three bishops stood forth prominently. principally irom the 'political eminence of the cities in which they ruled—the bishops of Rome. Alexandria and Antioch. The transfer of the seat of empire from Rome to Constantinople gave the bishops of Rome a possible rival in the patriarch of Constantinople, but the absence of an overawing court and of meddling statesmen did more than recoup the loss to the head of the Roman Church. The theological calmness of the west. amid the violent theological disputes which troubled the eastern patriarchates; and the statesmanlike wisdom of Rome's greater bishops. combined to give a unique position to the pope. which councils in vain strove to shake and which in time of difficulty the eastern patriarchs were fain to acknowledge and make use of. however they might protest against it and the conclusions deduced from it.

But this pre-eminence, or rather the Roman idea of what was involved in it, was never acknowledged in the east; to press it upon the eastern patriarchs was to prepare the way for separation, to insist upon it in times of irritation was to cause a schism. The theological genius of the east was different from that of the west. The eastern theology had its roots in Greek philosophy, while a great deal of western theology was based on Roman law. This gave rise to misunderstandings, and at last led to two widely separate ways of regarding and defining one important doctrine—the procession of the Holy Spirit from the Father or from the Father and the Son. Political jealousies and interests intensified the disputes; and at last, after many premonitory symptoms, the final break came in 1054, when Pope Leo IX smote Michael Cerularius and his adherents in the Eastern Church with an excommunication. There had been mutual excommunications before, but they had not resulted in permanent schisms. Now. however. the separation was final, and the ostensible cause of its finality was the introduction by the Latins of two words *Filioque* into the creed. (After the words "and in the Holy Ghost" of the Apostles' Creed the Constantinopolitan creed added "who proceedeth from the Father." The Roman Church, without the sanction of an ecumenical council and without consulting the easterns. added "and the Son." The addition was first made at Toledo [589] in opposition to Arianism. The easterns also resented the Roman enforcement of clerical celibacy, the limitation of the right of confirmation to the bishop and the use of unleavened bread in the Eucharist.) It is this addition which was and which still remains the permanent cause of separation. Other causes were added later.

Doctrines and Creeds.—The Eastern Church has no creeds in the modern western use of the word, no normative summaries of what must be believed. It has preserved the older idea that a creed is an adoring confession of the church engaged in .warship; and, when occasion called for more. the belief of the church was expressed more by way oi public testimony than in symbolical books. Still the doctrines of the church can be gathered from these confessions of faith. The eastern creeds may thus be roughly placed in two classes—the ecumenical creeds of the early undivided church, and later testimonies defining the position of the Orthodox Church of the east with regard to the belief of the Roman Catholic and of Protestant Churches. These testimonies were called forth mainly by the protest of Orthodox theologians against Jesuitism on the one hand and against the reforming tendencies of the patriarch Cyrillos Lucaris (*q.v.*) on the other. The Orthodox Church adopts the doctrinal decisions of the seven ecumenical councils, together with the canons of the Concilium Quinisextuni or second Trullan council (692); and they further hold that all these definitions and canons are simply explanations and enforcements of the Sicaeo-Constantinopoiitan creed and the decrees of the first council of Nicaea. The first four councils settled the orthodox faith on the doctrines of the Trinity and of the two natures of the one person of Jesus Christ; the fifth supplemented the decisions of the first four. The sixth declared against Monothelitism; the seventh sanctioned the worship of Trullan images: the council supplemented by canons of discipline the doctrinal decrees of the fifth and sixth councils.

The most important later doctrinal testimonies of the Eastern Churches are: (1) the Orthodox profession of faith of Peter Mogila, confirmed by the eastern patriarchs and by the synod of Jerusalem (1643), and (2) the decree of the synod of Jerusalem or the confession of Dositheus (1672). The answer of the eastern patriarchs to Pius I S 11849) may also be included. But none of these is authoritative in the western credal sense.

The Church of Christ is the fellowship of ALL THOSE WHO ACCEPT AND PROFESS ALL THE ARTICLES TRANSMITTED BY THE APOSTLES AND APPROVED BY GENERAL SYNODS. *Without this visible church there is no salvation.*[1] It is under the abiding influence of the Holy Ghost, and *therefore cannot err in matters of faith.* Specially appointed persons are necessary in the service of the church, *and they form a threefold order, distinct jure divino from other Christians, of bishops, priests and deacons.* THE PATRIARCHS HAVE THE HIGHEST RANK AMONG THE BISHOPS, AND THE BISHOPS *united in a general council represent the church and decide,* under the guidance of the Holy Ghost, all matters of faith and ecclesiastical life. But it is only as the decisions of the councils have been accepted by the whole body of believers. clergy and laymen alike, that they become authoritative as living tradition. All ministers of Christ must be regularly called and appointed to their office and are consecrated *by the sacrament of orders. Bishops must be unmarried,* and PRIESTS AND DEACONS MUST NOT CONTRACT A SECOSD MARRIAGE. To all priests in common belongs, besides the preaching of the word. the administration of the SIX SACRAMENTS—BAPTISM, CONFIRMATION. PENASCE, EUCHARIST, MATRIMONY, USCTION OF THE SICK. The *bishops* alone can administer the seventh, the *sacrament* of orders.

Ecclesiastical ceremonies are part of the divine litztrgy; most of them have apostolic origin; and those connected with the sacrament must not be omitted by priests under pain of mortal sin.

Liturgy and Worship.—The ancient liturgies of the Eastern Church were numerous but a strong desire for uniformity led to the almost exclusive use of the liturgy of Jerusalem or of St. James. It is used in two forms. a shorter revised by Chrysostom. and a longer called the liturgy of St. Basil. This liturgy and the service generally are either in Old Greek or in Church Slavonic, and frequent disputes have arisen in particular districts about the language to be employed. Both sacred languages differ from the language of the people, but it cannot be said that in the Eastern Church worship is conducted in an unknown tongue—"the actual

[1] Small capitals denote differences from Roman Catholic, italics differences from Protestant, doctrine.

difference," says J. M. Neale, "may be about that between Chaucer's English and our own." There are 11 chief service books and no such compendium as the Roman breviary. Fasting is frequent and severe. Besides Wednesdays and Fridays. there are four fasting seasons, Lent, Pentecost to SS. Peter and Paul. Aug. 1–15 preceding the Feast of the Sleep of the Theotokos and the six weeks before Christmas. Indulgences are not recognized; an intermediate and purificatory state of the dead is held but not systematized into a doctrine of purgatory. The Virgin receives homage, but the dogma of her Immaculate Conception is not admitted. While icons are found in the churches, there is no "graven image" apart from the crucifix.

Monasticism is. as it has always been, an important feature in the Eastern Church. An Orthodox monastery is perhaps the most perfect extant relic of the 4th century. The simple idea that possesses the monks is that of fleeing the world; they have no distinctions of orders, and though they iollow the rule of St. Basil object to being called Basilians. A few monasteries (Mt. Sinai and some on Lebanon) follow the rule of St. Anthony. R. Lake in Early *Days* of *Monasticism on Mount Athos* (1909) traces the development through three well-defined stages in the 9th and 10th centuries—(1) the hermit period; (2) the loose organization of hermits in lauras; (3) the stricter rule of the monastery, with definite buildings and rules under an *ἡγού μενος* or abbot. (See MONASTERY; MONASTICISM; and related articles.)

The Branches of the Church.—In the early years of the 20th century the Orthodox Eastern Church consisted of 13 mutually independent churches, using their own language in divine service (or some ancient form of it, as in the Greek-speaking churches, Russia and other Slavic churches) and varying not a little in points of detail, but standing in full communion with one another and united as equals in what has been described as one great ecclesiastical federation. However, in using such language it must be remembered that we are not dealing with bodies which were originally separated from one another and have now entered into fellowship, but with bodies which have grown naturally from a single origin and have not become estranged. The most ancient of these divisions depended on the jurisdiction of the four patriarchates. (1) The ancient patriarchate of Constantinople included the imperial dioceses oi Pontus, Asia, Thrace and eastern Illyricum; *i.e.*, speaking roughly, the greater part of Asia Minor, European Turkey and Greece, with a small portion of Austria-Hungary. The ecumenical patriarch, as he has been called since early in the 6th century, was the most exalted ecclesiastic of the eastern churches, and his influence reached far outside the lands of the patriarchate. His jurisdiction extended over all the dominions of the sultan. There were 82 metropolitans under him and the "m'onastic republic" of Mount Athos. He had great privileges and responsibilities as the recognized head of the Greek community in Turkey and enjoyed also many personal honours which had survived from the days of the eastern emperors. (2) The patriarchate of Alexandria, consisting of Egypt and its dependencies, was at one time the most powerful, as it was the most centralized, of all; but the secession of the greater part of the church to Monophysitism, and the Mohammedan conquest of Egypt, have left the patriarch but the shadow of his former greatness. (3) The patriarchate of Antioch has undergone most changes in extent of jurisdiction, arising from the transfer of sees to Constantinople and Jerusalem, from the progress of the schismatic churches of the east and from the conquests of the Mohammedans. The patriarch retains little of his old importance. His jurisdiction includes Cilicia, Syria (except Palestine) and Mesopotamia. After 1899 the native Syrian element secured supremacy. (4) The Patriarchate of Jerusalem was constituted at the council of Chalcedon in 451, with jurisdiction over Palestine. The inroads of the Saracens reduced its importance. At present: the numerically insignificant Greek monastic brotherhood is trying to retain control over the Arabic majority. (X.)

Russian Church.—Although the ancient patriarchates (particularly the ecumenical) still enjoy the highest rank, other Orthodox Churches have far outstripped them in numbers, importance and influence. The Russian Church, for instance, has been, ever since the downfall of the Byzantine empire, the dominant member of Orthodox Christendom. Russia's conversion to Christianity took place in the reign of the grand prince Vladimir (988). It became a metropolitanate of the patriarchate of Constantinople. This situation persisted until 1448, when the Russian Church chose a native for the metropolitan see. By this act it repudiated its dependence upon Constantinople, on the ground that the latter had betrayed orthodoxy by the terms of union with Rome at the council of Florence (1439). It was then the only large Orthodox Church not subject to the Turks. In 1j89 it obtained the patriarchal rank; but what is more important, it had long before regarded itself as possessing hegemony of orthodoxy.

In 1666, as the result of the reforming projects of Patriarch Nikon. the Russian Church suffered a schism. The schismatics (Raskolniki) repudiated the state church as corrupted by the reforms.

Even greater calamity overtook the church in the reign of Tsar Peter. Upon the death of Patriarch Adrian (1700). Peter refused to allow the election of another patriarch. In 1721 he abolished the patriarchate altogether and radically reorganized the church by creating as the highest administrative organ the Holy Governing synod. By this measure he subordinated the church to the state.

The 19th century may be regarded as the flowering of Russian culture; the astounding creativity of the Russian writers and thinkers won for them a dominant place. Two schools of thought developed: the Westernists, who became revolutionaries in politics, materialists in science and philosophy and atheists in religion. The other school, the Slavophils, developed the native cultural elements. A group loosely associated with them created out of the native religious elements the modern Orthodox world view which seems likely to revivify entire eastern orthodoxy. Among the chief figures of this movement—all laymen—were A. S. Khomyakov, F. M. Dostoievski, V. S. Soloviev and N. A. Berdyaev.

Serbian *Church.*—The other Slavic Orthodox Churches comprise the Serbian and the Bulgarian. The former goes back for its autonomy to 1219, when an independent metropolitanate was organized by St. Sava. It gained the patriarchal rank in 1346 during the reign of the mighty tsar Stephen Dushan. But when Serbia fell prey to the Turks at the fateful battle of Rosovo (1389). a chaotic condition set in. For about five centuries the Serbs bore the heavy Turkish yoke. In 1766 the patriarchate of Pech was abolished and the Serbian Church subjected to the ecumenical patriarch. The fateful rule of the Greek Phanariots left its legacy of hatred to this day. Nevertheless, the church succeeded in preserving, during those dark times, whatever national spirit was left among the degraded Serbian peasants.

But a good-sized group of Serbs escaped the domination of the Turks and of the ecumenical patriarch. In 1690 Patriarch Arsen Crnojević (Arsenius III) escaped with about 37,000 Serbian families into the Austrian territory. Emperor Leopold I granted them political and ecclesiastical autonomy. Thus arose the Karlovci patriarchate in southern Hungary (Banat).

The Serbian War of Independence broke out in 1804 and resulted in 1830 in the recognition of Prince Miloš Obrenovid as the hereditary ruler, subject to the sultan's suzereignty. Two years later the Serbian Church won a conditional autonomy. It was not until 1879 that it became fully autocephalous, after Serbia secured political independence (1876).

Besides these two churches, there existed the Serbian metropolitanate in Bosnia-Herzegovina. which was ireed from the jurisdiction of Constantinople in 1880, when the territory became part of Austria-Hungary. Another ecclesiastical unit within the Austrian empire was the metropolitanate of Czernowitz in Bukovina, with which were united the Dalmatian bishoprics of Zara and Kotor. Lastly, the metropolitanate of Montenegro was likewise an independent Serbian church.

Bulgarian Church.—Bulgaria was converted to Christianity in 864 when Tsar Boris was baptized by Byzantine emissaries of Patriarch Photius. The Bulgarian Church became a patriarchate in 917 during the glorious reign of Tsar Simeon. But the

Byzantine emperor Basil II put an end to the independence of Bulgaria in 1018, and the Bulgarian Church was reduced to the rank of an archbishopric. Moreover, the see was gradually Hellenized by Greek appointees. In 1186 Bulgarians revolted and established the second Bulgarian empire. The church recovered the patriarchal rank in 1235. Unfortunately, the Turkish victory over the Balkan allies in 1389 put an end to the political independence of the Bulgars for the next five centuries. In 1767 the ancient patriarchate of Ohrid was abolished altogether and the Bulgarian Church subjected to the harsh rule of the ecumenical patriarchate. It did not regain its autonomy until 1870 when the Turkish sultan granted it against the strenuous objections of the ecumenical patriarch. In consequence, there occurred a schism between the Greek churches and the Bulgarian exarchate which was not terminated until 1945.

Rumanian Church.—The Rumanian Church had its origin in the priricipality of Ugro-Walachia and was at first subject to the Ohrid archbishopric. But in 1359 it passed under the jurisdiction of the ecumenical patriarchate. In Moldavia the first Orthodox episcopal see was organized in the reign of Voivode Peter Musat (1375–91) and acknowledged the supreme jurisdiction of Constantinople (1401). When both these principalities were conquered by the Turks, the two metropolitanates retained a considerable measure of autonomy. But when the Rumanians supported the Russian Peter the Great in his war with Turkey. the latter, upon defeating Peter, imposed upon the Rumanians a harsh rule. The Greek Phanariots then became powerful both in state and church.

As in the other Balkan countries (with the exception of Bulgaria), the independence of the Rumanian Church followed upon the political liberation of the country. In 1858 the autonomy of the two principalities was recognized under a general all-European protectorate. Thereupon, Walachia and Moldavia united to form Rumania. In 1865 the Rumanian Orthodox Church was declared independent of all foreign ecclesiastical rule, but in reality a certain degree of dependence upon the ecumenical patriarchate continued. When Rumania proclaimed itself a kingdom in 1881, the church at last threw off the last vestiges of dependence (1882).

AFTER WORLD WAR I

At the conclusion of World War I, the situation of the Orthodox Churches was greatly changed. For a time, the previous balance of power was radically upset. This was caused by the tragic eclipse of the Russian Church, which had hitherto been the most numerous and powerful (comprising about 110,000,000 members) and the consequent shift of hegemony to the Balkan churches. The victorious soviets as early as Jan. 1918 enacted fundamental ecclesiastical legislation separating the church from the state and from the school. All property, including ecclesiastical possessions, was nationalized. All subsidies ceased. Although in theory full liberty of conscience was granted, in practice the church was treated as the bulwark of the old order and suffered accordingly. Clergy were disfranchized and deprived of the possibility of securing livelihood except by voluntary support of the impoverished congregations. Free use of church buildings was permitted. but later such staggering charges for insurance and other purposes were imposed that many congregations were unable to retain the use of the buildings. All organized teaching of religion to children and youth was forbidden.

Patriarch Tikhon, elected by the sobor of 1917 which had abolished the Holy Governing synod and restored the patriarchate, protested against the spoliation of the church and other inimical acts. He was arrested but a year later was released after he had signed a "confession" promising not to interfere with the new political orientation. In the meantime, there arose schisms within the church, aided and abetted by the government. In 1929 the constitution of the Russian Soviet Federated Socialist Republic reserved the right of "propaganda" only to the antireligious forces and granted to the religious bodies the mere right of "confession." The congregations were restricted to bare liturgical services. Many churches were closed. By the adoption of the five-day week attendance on church services was made extremely difficult. Clergy were singled out for particularly harsh treatment; lay members were discriminated against; children were subjected to antireligious school training. The government went all out for every form of antireligious propaganda.

But all these measures proved inadequate. After the government became aware of the failure of its policy, and at the same time recognized that the church offered no political opposition, it inaugurated a new religious policy in Jan. 1939. Efforts to liquidate religion were discontinued. Antireligious periodicals were restricted or withdrawn. The seven-day week was restored. Many churches were reopened. Even some new ones were built. Group religious instruction was permitted in private. Seminaries for the education of clergy were allowed. In 1946 a theological academy was opened in Moscow. In 1943 the national council for the election of a new patriarch was held, and Metropolitan Sergei was chosen for the post. This was done with the approval of Marshal Joseph Stalin. After Sergei's death, Metropolitan Alexei was raised to the patriarchal throne (1945). The government established two offices for the supervision of religious affairs. Thus, a direct relationship between the church and the state was re-established. In Aug. 1945 the church was recognized as possessing corporate juridical rights. It was officially reported in 1946 that there existed at the time 65 fully constituted dioceses within the U.S.S.R. (10 others abroad), but there were only 59 bishops to serve them. There were about 25,000 parishes, as against 4,225 in 1941. Of the total 46,457 church buildings which had been in existence in 1917, about 57% were in religious use in 1946.

The Balkan churches, during the eclipse of the Russian Church, became the dominant Orthodox bodies. Numerically the largest among them, Rumania, which more than doubled its territory after World War I, consolidated four formerly autocephalous organizations into one, 13,000,000 strong. These four bodies comprised the churches of the old kingdom of Rumania, Transylvania, Bukovina and Bessarabia. In 1925 the process of consolidation was completed. The new constitution proclaimed the Orthodox Church the dominant body, while the Uniates were granted "priority among the cults." The rank of the church was raised to that of patriarchate.

As the result of World War II, Rumania lost Bessarabia and Bukovina; but Transylvania, which had been awarded to Hungary by Adolf Hitler, was restored to Rumania. The postwar government, which was under communist influence, had not by early 1947 made radical changes in the ecclesiastical situation.

The Serbian Orthodox Church was likewise consolidated after World War I in keeping with the great territorial expansion of the kingdom. The six formerly independent ecclesiastical units—metropolitanate of Serbia, patriarchate of Karlovci. Bosnia-Herzegovina, Montenegro, the Dalmatian eparchy and the newly acquired Macedonia—were consolidated into the national Serbian Orthodox Church. The ancient patriarchate of Pech was revived (1920), and the metropolitan of Belgrade, Demetrije, was elected the first occupant of the see.

True to the traditional close relationship bet een the church and the state, Patriarch Gavrilo (1937–) was influential in the coup d'état which placed young King Peter II on the throne in order to nullify the pact with the Germans which had been negotiated by the regent, Prince Paul. When the nazis invaded Yugoslavia (1941), Gavrilo was imprisoned and later sent to a German concentration camp. He returned to resume his office late in 1946.

In the meantime, Marshal Tito (Josip Brozovich) subjected the country to a totalitarian communist regime. He introduced most radical changes in the status of the Orthodox Church. Church and state were separated. Ecclesiastical property was nationalized. All financial support was withdrawn. Antireligious propaganda was legalized. Compulsory civil marriage legislation was passed. Religious instruction in schools was made optional. Even the territory under the jurisdiction of the Serbian patriarch was reduced in size by the creation of an autonomous Macedonian Church.

Similar radical changes occurred in the Bulgarian Orthodox

Church. which in 1945 was restored to communion with the Greek churches. Thereupon, the metropolitan of Sophia, Stephan, was elected exarch (an office which had been vacant from the death of Exarch Joseph, who died in 1915). The country fell under communist domination and in 1946 established a republic. It was planned to separate the church and state. Some of the property of the church had already been nationalized, and the church was faced with the problem of support. A new constitution, which was expected to democratize the administration of the church, was in the process of preparation. The church was forbidden to engage in any social or benevolent service. Religious instruction in schools was suppressed, although it was allowed in private.

The Greek family of Orthodox churches comprises the Church of Greece; the patriarchates of Constantinople, Alexandria and Jerusalem; the Church of Cyprus; the Dodecanese Islands; and Mount Sinai. The Church of Greece, which was constituted in 1833, after Greece had secured political independence from Turkey, did not gain the recognition of the ecumenical patriarchate until 1850. There has always existed a close relation between the Greek Church and the government so that political changes usually were reflected in the ecclesiastical sphere. Under Eleutherios Venizelos, during World War I, the royalist archbishop Theocletos lost his post to the liberal metropolitan Meletios. Rut when in 1920 the political situation was reversed and King Constantine regained his throne, Theocletos likewise was restored to the see of Athens.

During and after World War II, the archbishop of Athens, Damaskinos, exercised great political influence. Although not subservient to the German masters during their occupation of Greece, he escaped being deposed by them as his predecessor, Archbishop Chrysanthos, had been. After the country's liberation, Damaskinos became the regent of Greece and retained the office until the recall of King George II to the throne in 1946.

The patriarchate of Constantinople suffered greater and more lasting damage as the result of World War I than any other Orthodox Church. When the nationalist armies under Mustafa Kemal Pasha gained victory over the invading Greek forces under King Constantine, Mustafa at first intended to abolish the ecumenical patriarchate altogether, for Patriarch bleletios had openly sided with King Constantine. But the British, at the Lausanne conference (1923), persuaded him to moderate his plan. Thereupon Mustafa expelled Meletios and stripped the patriarchal office of all but the strictly ecclesiastical functions. Later, by the exchange of population between Turkey and Greece, 1,500,000 Greeks were forced to leave the country. The patriarchate which in 1914 numbered 1,800,000 members, was reduced to 300,000 Greek residents of Constantinople and the immediate environs. In early 1947 the membership was estimated at 100,000. Nevertheless, the ecumenical patriarch still held the pre-eminence of honour among his peers and exercised jurisdiction among the Orthodox in the dispersion.

The number of autocephalous or autonomous Orthodox Churches after World War I was 21. Since then, the patriarchate of Moscow secured the subjection to its authority of the churches of Estonia, Finland and Czechoslovakin. The churches of Lithuania, Latvia and Poland were perhaps likewise absorbed by the Moscow patriarchate, but an official statement to that effect had not been made by 1950. The total number of Eastern Orthodox Churches therefore was reduced accordingly. The Uniate Church of Western Ukrainia renounced its allegiance to the pope in 1946 and re-entered orthodoxy. The small Czechoslovak Orthodox Church suffered greatly during the nazi occupation of the country because the parachutists who had killed the notorious "protector" of Czechoslovakia, Reinhard Heydrich, had taken refuge in the Prague Orthodox church, Bishop Gorazd-Pavlik and the parish priest were put to death. Moreover, the entire organization of the Orthodox Church was dissolved. After the liberation of Czechoslovakia the Orthodox Church in that country was reconstituted. The Albanian Church was also weak after World War II, having been subjected to much hostile treatment on the part of the Italians.

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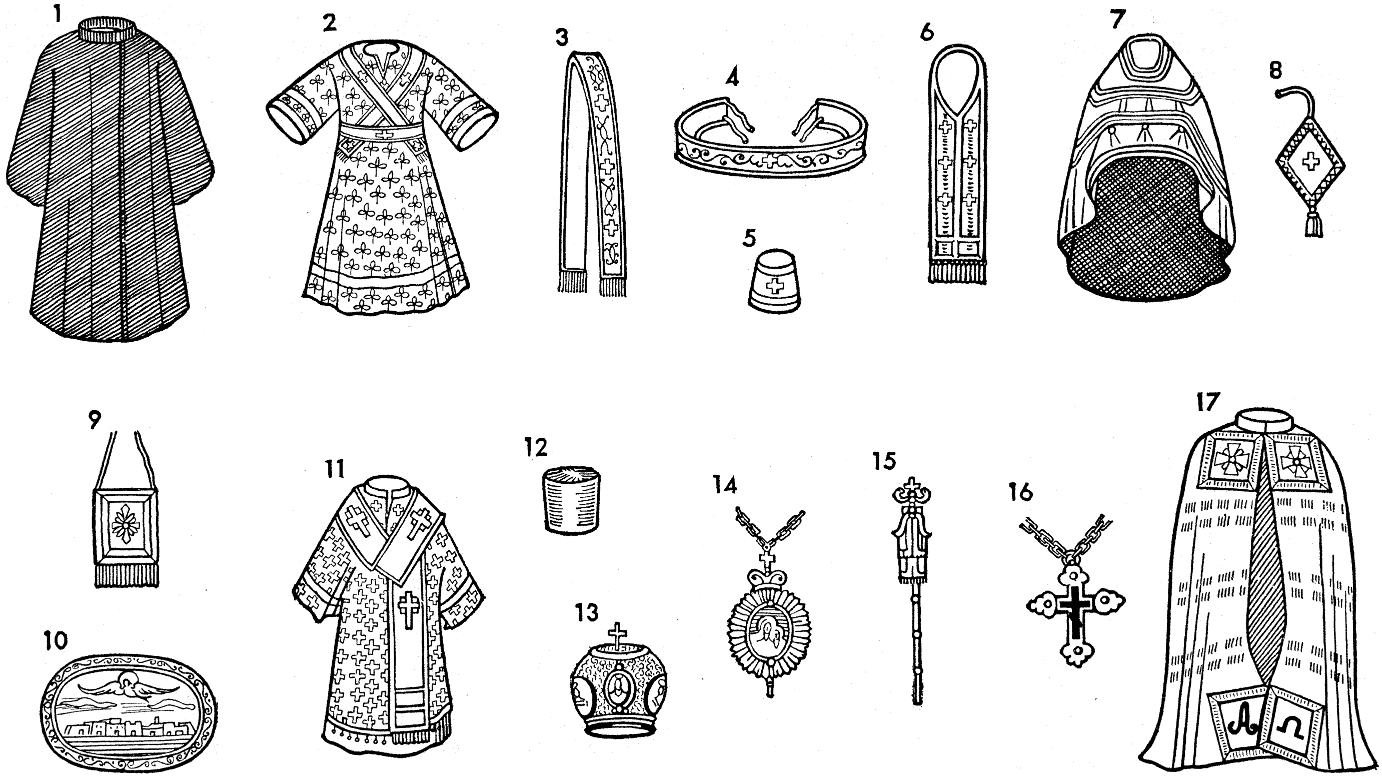
THE EASTERN ORTHODOX CHURCHES IN AMERICA

The beginnings of the Russian settlement of the Aleutian Islands and of Alaska go back to the expedition under the command of Capt. Vitus Bering and Capt. Alexei Chirikov. The latter sighted Alaska on July 15, 1741. Five days later Captain Bering landed on Kayak Island, where he soon afterward died and was buried. The first Russian to baptize some natives was a Cossack, Andreyan Tolstykh, on the islands bearing his name—the Andreanof Islands (1743). In 1759 a Russian merchant, Ivan Glotov, was the first preacher of Christianity to the Aleutians. He baptized the son of a native "toen" or chieftain of the territory of Umnak. Later he took the young man to Kamchatka where the neophyte, named Ivan after Glotov, learned Russian.

Upon his return. he became a chieftain and was active in spreading Christianity. In 1774 Grigori Ivanovich Shelekhov is said to have baptized 40 natives of Kodiak Island. It was he who organized the first permanent commercial settlement on Kodiak, the Shelekhov-Golikov company. It was named Three Saints. after the ship which had brought Shelekhov to the Aleutians. In 1787 Shelekhov returned to St. Petersburg and laid before Empress Catherine II his plans for the commercial exploitation of the northeastern coast of America. The empress sent an Englishman, Joseph Billings, who had visited Alaska, on a tour of exploration. He arrived at Three Saints on June 20, 1790, and apparently found conditions sufficiently promising to report favourably to Catherine. Shelekhov also urged the empress to send missionaries to Kodiak and promised to assume, with his associate, the payment of their travelling expenses as well as their support.

Thereupon: Alexander A. Baranof, a merchant of Kargopol, was appointed manager of the colony. Under his energetic leadership the colony became a powerful factor in the development of the territory. He transferred the headquarters to the northeast part of the island and named the new settlement Paul's Harbor in honour of the heir to the throne, Grand Duke Paul. He likewise requested the home management for priests to evangelize the natives as well as to serve the religious needs of the Russians.

Such a mission, headed by the archimandrite Joasaph Bogolov, who was accompanied by seven monks. arrived in Sept. 1794. The trip lasted ten months. The missionaries came from the Valaam monastery on Lake Lagoda. Along with them arrived 150 administrators and 30 families of settlers. This group laid the foundations of Russian orthodoxy in America. Within two months of their arrival, two of their number. hieromonks Macarius and Juvenal, travelled over the whole island and baptized about 6,000 natives (another account says "all the inhabitants"). The letters of some of these earliest missionaries are extant. They were written to the hegumenos of the home monastery of Valaam. German: for instance, wrote: "The Aleuts greatly surprised us by their dexterity and desire to be baptized." Another monk, Joasaph. wrote: "On Kodiak almost 6,000 were baptized. They accepted the baptism so sincerely that they broke all their shaman paraphernalia and burned it." But "the apostle of the .Aleuts," Bishop Innocent. writing more than 50 years later, complained that Kodiak natives were still half pagan, adhering to their shaman practices, although the Unalaska Aleuts persevered sincerely in their Christianity. During the winter of 1794 the missionaries established the first Russian church and school at Paul's Harbor and consecrated it to the Resurrection of Our Lord. It was destroyed by fire in 1943.



A MANUAL OF THE SACRED VESTMENTS AS USED IN THE HOLY ORTHODOX CHURCH IN AMERICA

1. Robe (*riassa*); 2. Sticharion; 3. Orarion; 4. Zone (girdle); 5. Cuffs; 6. Stole; 7. Phelonion (chasuble); 8. Epigonation; 9. Thigh Shield; 10. Eagle rug; 11. Saccos and the omophorion; 12. Karnalavka; 13. Crown; 14. Panagia; 15. Crozier; 16. Cross; 17. Bishop's mantle

The next spring they extended their missionary labours to other Aleutian islands and within two years claimed to have baptized 12.000 natives and to have built a church or chapel "in every more or less important" community. In 1795 Juvenal left Kodiak for Nuchen and Kenai bay and the following year went to the Alaskan mainland. It is not clear how far north he penetrated, but he met his death near the Iliamna lake. He had persuaded some chieftains to entrust him with their children so that he might educate them; but later they changed their minds, perhaps because he had prohibited polygamy, and after a pursuit caught up with him and killed him as "a deceiver."

The commercial company prospered so yell that Emperor Paul I enlarged it by combining the Shelekhov-Golikov company with the Mylnikox company, renaming the new organization the Russian-American company. It was under obligation to provide for the religious needs of the colonists as well as of the natives. Shelekhov. who then lived in Russia, was not satisfied with the progress of the missionary work. He estimated the number of inhabitants of Kodiak Island at 50,000, of whom only about 6,000 had been baptized. It is possible that Shelekhov's estimate refers to all the natives of the Aleutian Islands and Alaska; but Bishop Innocent, who mentions it twice, plainly applies it to Kodiak alone. At any rate, Shelekhov now urged the authorities to establish an episcopal see for Russian America. In 1799 the Holy synod, heeding this request. raised the archimandrite Joasaph to the episcopal rank. The new diocese comprised Kodiak, Kamchatka and Alaska. Unfortunately, the new bishop, upon his return from Irkutsk, Siberia. where he had received consecration, was drowned when his ship foundered off Kodiak Island. Thereupon, the see remained vacant for 40 years.

Nineteenth Century. — For the next 17 years, the work of evangelisation was largely at a standstill. Shelekhov died in 1800. Only three members of the original mission were left: of these, Athanasius alone was at Kodiak. German outlived the rest, having retired as a hermit to Spruce Island, where he lived in a cave, although he carried on some work of teaching and preaching. He remained there 40 years, dying in his 81st year in 1837. It was not until 1816 that an additional priest, Alexei Sokolov, was sent to join the depleted staff.

Between 1808 and 1816 the success of the Russian-American company was gratifying. Baranov transferred the headquarters from Kodiak to Baranov Island, where Sitka was chosen as the new capital. The natives, Koloshi. were different from the meek and friendly Aleuts. They looked upon the Russians "as their terrible enemies, and only bided their time when they could drive them out," as Father Venyaminov (who later became Bishop Innocent) reported. To deal with them. Baranov requested the Holy synod to send him missionaries. He also established a settlement in California, calling it Ross; but this colonization venture did not succeed. At the time Father Venyaminov visited the place in 1838, there were 216 colonists composed of Russians. Aleuts and those of mixed parentage. besides 39 Indians. In 1841 the land was sold by the Russian government to a certain Mr. Sutter for $30.000.

In 1821 the government gave the company a new charter. This document stipulated that the company must provide adequately for the religious needs of the settlers Thus spurred, the company requested the Holy synod to send them more missionaries. The latter turned to the bishop of Irkutsk with the request that he provide them, but the bishop could find no volunteers. At last a local priest, Father John Venyaminov, offered himself, having learned of the conditions at Unalaska from a colonist Ivan Kryukov who had recently returned from the island after having lived 40 years among the Aleuts. In 1823 Father John moved with his whole family — consisting of his widowed mother, his wife and one-year-old son — to Unalaska. He took a boat to Yakutsk and then travelled on horseback to Okhotsk, about 700 mi. away. From there he took a sailing boat to Unalaska. He arrived there on July 20, 1824. His parish included not only Unalaska, but also other Fox and Pribilov Islands. He lived in an earthen hut but later built himself a wooden house. Having found only one frame chapel on Unalaska, he undertook, first of all, to build a new church. Upon its completion he dedicated it to the Ascension of the Lord. His sermons preached to the natives are still extant and are not exactly "milk for babes."

The zealous young priest — he was only 27 at the time of his arrival — soon extended his missionary efforts to other islands. spending the greater part of the year in sailing in his "haidarka" from island to island. Two other priests who had come about the same time, Father Frumentius Mordovsky and Jacob Netsvyetov, worked at Kodiak and Atlaha.

Father John soon learned the native languages and then composed a primer and translated, with the aid of others, the Gospel of St. Matthew, the catechism and the liturgical books. In order to reduce the language to the written form, he had to invent an appropriate alphabet. After spending ten years in such fruitful labours at Unalaska, he was transferred to the port of New Archangel, or Sitka. There he had to begin his missionary and linguistic labours anew, for there he worked among the Kolosh tribe belonging to the Thlinket Indians. The work among them was much more difficult than that done previously among the Aleuts. Nevertheless, it was crowned with considerable success. Within five years he established schools for native children whom he taught from textbooks of his own composition. He likewise taught them trades. He even introduced inoculation.

However, the nork soon grew so large that he needed help. He left Sitka in 1838 for St. Petersburg "exclusively for the purpose of publishing. under my own supervision, my translation of the holy books into the Aleut language," as he reports in his autobiographical sketch. While he stayed in the Russian capital, his wife died. Upon the advice of Metropolitan Philaret of Moscow. who greatly admired the intrepid missionary, Father John assumed the monastic habit, adopting the name of Innocent on this occasion. He was made an archimandrite. Soon after, the Holy synod chose him for the episcopal see vacant after the drowning of Bishop Joasaph in 1799. He was consecrated on Dec. 15, 1840, in the Kazan cathedral in St. Petersburg. Ten months later he was back in Sitka.

Upon his return, Bishop Innocent ordained several priests and in 1842 began extensive episcopal visitation, which he described with minute detail in his *Diary.* This is a mine of information concerning the condition of the churches. He built the cathedral church of St. Michael in Sitka, which was consecrated in 1848 and which still stands. Also he founded a missionary school and a seminary for the training of the native priesthood. His diocese was enormous, comprising not only the colonies in America, but also Okhotsk and Kamchatka. He travelled on dog sleds, often in temperatures of 20° below zero. His energy and zeal were inexhaustible. For his truly great labours he was made archbishop in 1850.

But this was not the end of his career. The Holy synod further enlarged his diocese by adding Yakutsk in Siberia to the already enormous territory under his care. The archbishop was obliged to transfer his residence from Sitka to Yakutsk. Thereupon, in 1857, he nas granted the aid of two vicars, one for Sitka and the other for Yakutsk When the famous metropolitan Philaret of Moscow died in 1867, it was the intrepid missionary to the Aleuts and the Koloshi, Archbishop Innocent, who succeeded him. He died in 1879.

The period just described came to an abrupt termination when the United States government purchased Alaska from Russia in 1867. The sum paid for it was $7,200,000. Since many Russian settlers thereafter left the country and the Russian government lost interest in those who remained, the missionary work declined. At that time the membership of the Sitka diocese mas in excess of 12,000. Archbishop Innocent had secured, at the time of the sale, the incorporation of a clause guaranteeing the property and rights of the Russian Orthodox Church so that missionary work could be continued. Innocent appointed Bishop Paul to serve the Alaska diocese. His term of service lasted from 1867 to 1870. During this time, Protestant and Catholic missionaries entered Alaska. When it became apparent that more aggressive methods were needed to conserve the gains made by the Russian Church, a new bishop was sent out to replace the nonaggressive Paul.

Such a person was found in Bishop John, who was consecrated "Bishop of the Aleutian Islands and Alaska." He was a scholar and a church historian who published a five-volume work on the history of American Christianity. In 1872 he moved the episcopal see to San Francisco. Calif. A beginning of the Russian. Serbian and Greek colony near San Francisco was made at Ross, the ancient Russian settlement abandoned in 1841. When gold was found in the vicinity. fortune hunters of all nations, including the above-mentioned Orthodox nationals, were attracted to the place. But Bishop John mas recalled to Russia in 1876 and three years later was succeeded by Bishop Nestor.

Under Bishop Nicholas (1891–98) the diocese was enlarged by the inclusion of Canada and the eastern states of the Atlantic seacoast Moreover, his predecessor, Bishop Vladimir, had succeeded in extending his jurisdiction over the Uniate Ruthenians (or Carpatho-Russians), who had repudiated the Roman Catholic jurisdiction and returned to orthodoxy.

During the 1880s, Russian immigration increased greatly. Likewise, other Orthodox immigrants, such as Bulgarians, Rumanians and Albanians. settled in the east and the middle west in large numbers. In such manner, the centre of gravity shifted to the east. Consequently. in 1898 Bishop Tikhon, who had succeeded Nicholas in 1898, transferred the see once more, this time to New York city, where the first Russian parish had been organized 35 years previously.

Twentieth Century. — In 1901 St. Nicholas cathedral was founded. The rank of the American hierarch was raised two years later to that of an archbishop. Moreover, Tikhon was assisted in the administration of his enormous archdiocese by two vicar bishops: Innocent for the diocese of Alaska, and Raphael for the Syrian diocese. The latter, though a Syrian born in Damascus, had been educated at the Kazan Theological academy and had been brought to America, along with two other Syrian as well as many Russian priests, by Bishop Nicholas. Later, two other bishoprics were founded — one in Pittsburgh, Pa., and another in Canada. In 1905 the Orthodox Theological seminary opened its doors. and the folloning year the first Russian monastery was founded By 1916 there were 343 Orthodox churches, comprising 465,000 members under the jurisdiction of the Russian archbishop.

Tikhon, like his illustrious predecessor in the first half of the 19th century. Archbishop Innocent, attained to the high dignity of the metropolitan of Moscow In fact, he rose to the highest post in the gift of his church, the patriarchate. When in 1917 the patriarchal office, abolished by Peter the Great, was restored, Metropolitan Tikhon was elected its first occupant.

The bolshevist revolution of 1917 had a disastrous effect upon the dominant position of the Russian Church in America as well as at home. For the hegemony of the Russians among the other Orthodox communions in America was utterly shattered, and the American Russian archdiocese itself suffered disorganization. Archbishop Evdokim (1914–17), who ruled the archdiocese at the time of the downfall of the tsarist regime, returned to Russia in 1917 to attend the All-Russian Territorial council held in Moscow. Since, however, his sympathies turned prorevolutionary, and he joined the Living Church group, it appeared that he would not return to his American see. One of the suffragan bishops left in charge of the administration in America took steps to terminate the anomalous situation thus created. This was Bishop Alexander (Nemolovsky) of Canada, who in 1919 called an All-American convention to meet at Pittsburgh, Pa. This body declared the Russian Church in America "temporarily autonomous," although within the framework of the dogmatic, canonical and liturgical system of eastern orthodoxy. Furthermore, it elected Alexander the archbishop of the new organization. Henceforth, this body assumed the name the Russian Orthodox Church of North America. In this fashion, a new era of the life of the American Russian Church was begun. The action was taken in line with the policy of Patriarch Tikhon, who had instructed the bishops under his jurisdiction to conduct the administration of their dioceses independently since for the time being the soviet government did not allow him to carry on his constitutional jurisdiction over them. Despite the self-governing status, however, the church "did not sever at all the spiritual ties and communion with the Russian church."

But greater troubles were in store. Upon the imprisonment of Patriarch Tikhon in 1922, a group of clergy of the Living Church seized the patriarchal chancery and usurped the supreme administration of the church. In 1923 after they had purged the episcopal ranks of their opponents, they called a council for the reorganization of the church. This revolutionary gathering reversed the political trend of Tikhon's administration by acknowledging the soviet regime, abolished the patriarchate, deprived Patriarch Tikhon of all his authority and functions and reduced him to the status of a layman. instituted married episcopate and adopted other radical reforms. As far as the American archdiocese was concerned, the council appointed as its head the Rev. John Savitz Kedrovsky. then pastor of All Saints' church in Hartford, Conn., and consecrated him to the archiepiscopal rank.

But Patriarch Tikhon, although in prison, did not cease to exercise his patriarchal functions. In 1922 by a verbal order (since he was prevented from putting it in writing) he appointed Metropolitan Platon, then of Kherson and Odessa, but formerly of the American archdiocese (1907–14), as the head of the Russian Church in America. He was acknowledged as such by the convention held in Detroit, Mich , in 1924 and retained the office until his death in 1934. Archbishop Alexander left for Russia and during World War II was killed by the nazis. Naturally, a struggle ensued between Platon and Kedrovsky. The latter appealed to civil courts to decide the jurisdictional dispute. In the end, the court decided in favour of Archbishop Kedrovsky, who thereupon uas awarded the possession of the Cathedral of St. Nicholas and the archiepiscopal residence. The congregation of St. Nicholas, however, followed Archbishop Platon to a temporary home offered them by the Trinity Episcopal Church.

In the meantime, the Russian Orthodox Church under the leadership of Metropolitan Sergei made its peace with the soviet regime sufficiently to make it possible for him to carry on its administration. In 1933 Sergei dispatched to America Bishop Benjamin as his exarch. The latter demanded not only submission of the American churches to his jurisdiction but also a pledge of loyalty to the soviet government. When this pledge was refused, Sergei laid the American church under suspension, without any formal trial.

After Platon's death, Bishop Theophilus of San Francisco was elected to the vacant see by the convention of Cleveland, held on Nov. 21. 1934. He had come to America in 1891 in the suite of Bishop Xicholas so that he brought to his archiepiscopal task long experience in the American service. The new archbishop visited Patriarch Barnabas of Serbia in 1935 and negotiated an agreement with the Karlovci synod, which claimed jurisdiction over the Russians outside the U.S.S.R in opposition to the Moscow patriarchate. Two years after his return, Archbishop Theophilus called a convention which met in New York city on Oct. 5–8, 1937, and approved the reorganization of the administration. The most important change then instituted was that the so-called Metropolitan council was set up as the permanent executive body. It is composed of both lay and clerical members and acts with the approval of the metropolitan (which title was conferred upon Theophilus).

In the meantime, an astonishing volte-face in the religious policy of the soviet government brought about a great improvement in the outward condition of the Russian Church. An All-Russian council for the election of the patriarch was permitted in 1943; and the *locum tenens,* Metropolitan Sergei, was chosen for that office, the duties of which he had so long performed. However, he died the next year, and on Feb. 2, 1945, Metropolitan Alexei was elected to succeed him. On this occasion, and despite the sentence of suspension still in force, the American metropolitanate received an invitation to be represented at the council. Four delegates were chosen for this purpose, but only three received visas. Furthermore, because of transportation difficulties, the delegates arrived ten days after the conclusion of the council. Nevertheless. they presented their case to Patriarch Alexei, intimating the desire of the American metropolitanate for a renewal of canonical intercourse nith the Moscow patriarchate. The patriarch, a few days later. replied in his *Ukaz* of Feb. 16, in which he laid down the folloning conditions: a new delimitation of the territory of the American metropolitanate; a council was to be called for the settlement of the outstanding issues, to be presided over by the patriarch's representative, Archbishop Alexei of Yaroslav and Rostov; this council must renounce, in behalf of the American Russian Church, all political activities against the soviet government; and it was to elect a new metropolitan; for this office the patriarch recommended Metropolitan Benjamin or Archbishop Alexei, although he permitted the council "to nominate and elect its own candidate"; nevertheless. the patriarch reserved for himself "the right to refuse confirmation of the chosen candidate if considered unsuitable for any motivated reasons whatsoever." Besides. the patriarch reserved to himself the rights of hearing appeals from American bishops and clergy and of confirming all episcopal appointments.

The American Bishops' council met in Chicago, Ill., on May 22–24 and carefully considered the patriarchal Ukaz. The conditions laid down in that document were carefully scrutinized and declared unacceptable on the ground that the autonomy of the American church must be retained. The Russian Church in America "is an American church and an American church it must continue to be." American citizens cannot be ordered by their ecclesiastical superiors what political views they should accept or reject. Nevertheless, this decision did not altogether terminate the negotiations.

The loss of Russian hegemony among the American Orthodox resulted, or greatly aided, in the organization of independent Orthodox churches among the various non-Russian nationalities. Among them, the largest Orthodox Church in the United States was the Greek, comprising, according to the U.S. census of 1936, almost 190.000 members. The earliest Greek Church in the United States was organized in New Orleans, La., in 1867. As the Greek immigration increased, Greek Churches were organized in many American cities. They were left, however, without episcopal supervision by the patriarchate of Constantinople or the Holy synod of Greece, to which bodies they were, in a loose fashion, related. In order to remedy this situation, the patriarchate of Constantinople in 1908 assigned its jurisdiction over American Greeks to the Holy synod of Greece, with the understanding that the latter was to organize the Greek Churches in America into a diocese.

But the actual realization of this plan was delayed another ten years. At last in 1918 the archbishop of Athens, Meletios Metaxakis, came to the United States with the intention of setting up a Hellenic diocese. But soon he realized that the time was not yet ripe for such an action. Accordingly, he created a synodical trusteeship and placed Bishop Alexander of Rodostolos in charge.

However, soon after his return to Athens, Archbishop Meletios was deposed because of the radical political upheaval which had occurred; in 1920 Venizelos was displaced by King Constantine. The latter signalized his resumption of office by a correspondingly radical change in the ecclesiastical policy. The reverberations of this upheaval were felt even in America, for Bishop Alexander was likewise deposed by the Holy synod, along with Archbishop Meletios. In his place a synodical exarch, in the person of Bishop Germanos of Sparta, was sent to the United States.

But the deposed Archbishop Meletios was elected in 1921 to the vacant see of the patriarchate of Constantinople. The next year he issued the so-called Founding tome, whereby he rescinded the tome of 1908, giving the synod of Greece jurisdiction over America, and assumed that jurisdiction himself. He sent Bishop Alexander back to his former charge but with the rank of archbishop of North and South America. Unfortunately, an influential royalist faction among the American Greeks refused to acknowledge him and gave support to Metropolitan Basil, whom they had invited to America in the meantime.

The confused situation remained essentially unchanged until the arrival of Metropolitan Damascenos of Corinth; he came to America in 1928 in order to raise money. Upon his return to Greece, he reported to the patriarch the sad state of American affairs. The latter empowered him to return to America and to bring order out of the existing chaos. In order to accomplish this laudable object, both Alexander and Basil were recalled, along with all American bishops. Damascenos arrived in America in 1930 and succeeded in the difficult task of uniting the existing rival factions into the newly created ecumenical province. The man chosen to head the new archdiocese was Metropolitan Athenagoras of Corfu, who as archbishop of the Greek Orthodox Church (Hellenic) held sway over all American Greek Churches.

The remaining Orthodox communions in America are numerically smaller than the Greek and the Russian. Although the numerical relationship and proportion of these communions has perhaps changed since 1936, for which year the U.S. census reports them, it is the statistical basis given in this official publication which has been followed. The Serbian Orthodox Church, which prior to 1921 was under the Russian jurisdiction, organized itself separately in that year. The first Serbian Church in the United States was gathered in 1894 by the Rev. Sebastian Dabovich in Jackson, Calif., and he became its first pastor. He was born in San Francisco and was educated for the priesthood in his native city and in St. Petersburg, Russia. He died in 1940 in the famous historic Serbian monastery of Zicha and is buried there.

In 1921 it was thought advisable to organize the Serbian Churches in America into an independent diocese. The Serbian patriarchate appointed in 1927, as the first bishop of America, the first hegumenos of the Serbian monastery of St. Sava, which is located near Libertyville, Ill., the archimandrite Mardary Uskokovich.

The Syrian Antiochian Orthodox Church established its independent organization in 1927. Originally, the Syrians were ecclesiastically subject to the Russian archbishop, who had raised their mission to the rank of a diocese in 1905, at which time he had appointed the archimandrite Raphael Gavanini as its first bishop. Ten years later Bishop Raphael was succeeded by Bishop Aftimios, who continued in canonical obedience of the Russian Church until 1027, when he withdrew. Later, when he married, he was excommunicated. Thereupon. the Syrian parishes divided into five groups, each acknowledging a different bishop. Some of the bishops died, others were excommunicated. In order to unify the American parishes under one jurisdiction, the Antiochene patriarch in 1934 appointed the archimandrite Antony Bashir as his vicar and charged him with the task of setting up the Syrian Antiochian Orthodox archdiocese. Two years later, at the request of the archdiocese, Archimandrite Bashir was consecrated by the patriarch of Antioch as the first Syrian archbishop of New York and of all North America.

The Rumanian Orthodox Missionary Episcopate in America goes back to 1918 for its organization. At that time there was a sufficient number of churches in existence to form a diocese. The earliest of these was organized in 1905 in Cleveland, O. In 1918 Bishop Policarp Morusca arrived in the United States with the purpose of uniting the scattered congregations into the first Rumanian episcopal diocese with headquarters in Youngstown, O. But in 1920 the general congress which met in Detroit, Mich., decided to move the headquarters to Grass Lakes, Mich., although this was not actually accomplished until Dec. 1943. The president of the Episcopal council, the Very Rev. S. Mihaltian, reported the number of communicants in 1947 as numbering 80,000, although the census of 1936 gives only a little more than 15,000.

The Ukrainian Orthodox Church of America was recruited from among the Uniates. These immigrants became greatly dissatisfied with the American Roman Catholic hierarchy because the latter objected to the Uniate married priesthood, suspended many Ukrainian priests and in general tried to Latinize them. In the end, the Rev. Dr. Alexis G. Toth of Minneapolis, Minn., went over to the jurisdiction of the Russian bishop Vladimir. This occurred in 1391. He was quickly followed by other Ukrainian priests and congregations.

But many Ukrainians did not favour this method of solving their difficulties for they disliked the Russian jurisdiction as much as the Roman Catholic. In 1927 they cut themselves off from the latter and established an independent Ukrainian Orthodox Church in America. At first they elected an administrator to conduct the new organization. In 1930 Dr. Joseph Zuk was chosen for this office. Under his leadership, the Ukrainian Church submitted to the jurisdiction of the ecumenical patriarch, whose authority was preferred to that of the Russian hierarchy. Dr. Zuk was then consecrated bishop. But he died in 1934 and was succeeded three years later by Bishop Bohdan. The latter was consecrated by Archbishop Athenagoras, the ranking hierarch of the patriarchate of Constantinople in America. But otherwise the Ukrainian Church is administratively quite independent of the Greek archdiocese.

A group closely related racially to the Ukrainian Orthodox Church is the Carpatho-Russian Greek Catholic Diocese of Orthodox Christian Church, U.S.A., for it comprises the Ruthenians from Sub-Carpathian Ruthenia. Uniatism had been imposed on these originally Orthodox people, just as had been the case with the Ukrainians. As has already been mentioned, after 1891 many of these people submitted to the jurisdiction of the Russian Church in the United States. Their numbers were so considerable, that in 1916 the Russian archbishop Evdokim consecrated the Rev. Stephen Dziubay bishop for their parishes. But during the troubles in which the Russian Church became involved after 1917, both in America and abroad, the Ruthenians became dissatisfied. Thereupon, Bishop Dziubay withdrew from the jurisdiction of Metropolitan Platon and decided to lead his flock back into submission to the Roman Catholic Church. But in this plan he was opposed by many of his own people for whom Catholicism was as distasteful as the Russian Church. This group secured the leadership of the Canadian Ruthenian bishop, Adam Philipovsky, who decided to establish an independent Ruthenian Orthodox Church. In this project he was naturally opposed by Metropolitan Platon, who fought against such diminution of his archdiocese on the ground that no separate ecclesiastical jurisdiction should exist for Ruthenians, who are but a branch of the Russian Church. Both parties appealed the case to the Karlovci synod in Yugoslavia. This body decided in favour of Bishop Adam. Accordingly. in 1931 he organized the North American Russian Orthodox Greek Catholic diocese. It is interesting to note that although this group had renounced Uniatism and became Orthodox, yet it retained in its title the phrase "Greek Catholic" which is the usual designation for the Slavic Uniates. Nevertheless, although an attempt was made on the part of the Roman Catholic authorities to restrain them from the use of the term, the court decided in their favour. In 1935 Bishop Adam was raised to the rank of archbishop.

In the meantime. the group which had followed Bishop Dziubay into affiliation with the Roman Catholic Church soon grew dissatisfied with the new arrangement. Many churches repudiated the Roman jurisdiction and sought to effect a separate, independent organization. But for about ten years they were unable to do so, being involved in lawsuits with the Roman Catholic authorities. Finally, in 1937 they declared themselves independent and organized a self-governing body under the cumbersome name of the Russian Greek Catholic Orthodox Diocese of Eastern Rite Church of North and South America. At the same convention they elected the Rev. Orestes P. Chornock as their bishop, and the next year he obtained consecration as such at the hands of the patriarch of Constantinople. Consequently, he was excommunicated by the Roman Catholic Church.

Beside these communions, there exist smaller foreign-language Orthodox bodies in the United States, such as the Albanian and the Bulgarian Orthodox Churches; but their membership is relatively small. In addition, there are in existence three native American Orthodox Churches, the purpose of which is to naturalize eastern orthodoxy among native Americans, give it "a definite place in American life" and integrate it with American Christianity in general. These bodies were organized independently of each other, the oldest among them being the Holy Eastern Catholic and Apostolic Church. Its first congregation was gathered in 1922. Three years later, its first bishop was consecrated in the person of the former Anglican priest, the Rev. Arthur Wolfort Brooks, who assumed the name of Mar John Emmanuel. The consecrator was the Chaldean bishop Mar Antony who was assisted by two other Chaldean bishops.

The second of these communions is the Holy Orthodox Church in America. This body traces its beginnings to the act of the Russian metropolitan Platon, dated Feb. 2, 1927, directing Archbishop Aftimios to establish means and methods whereby Orthodox services would be provided for English-speaking members of parishes or for any "American residents of parishes." The Very Rev. Leonid Turkevich was to be consecrated the first bishop in charge of this work. But for some reason this intention was not carried out. Instead, in 1932 Archbishop Aftimios consecrated the

Rev. William A. Nichols as the first bishop of Washington, D.C. He assumed the name of Ignatius. In 1934 the projected American Orthodox Church was organized, and it was incorporated two years later. The liturgical and other ser ices of this church are in English.

The third of these native Orthodox communions is the American Holy Orthodox Catholic Apostolic Eastern Church, which was instituted in 1932 and incorporated the next year. Three years later the national council of this body created a patriarchate of Washington for the purpose of federating "Christian bodies of other rites who accept or have adopted for themselves the confession of faith of the Orthodox Catholic Eastern Church."

Organization. — Despite the hierarchical organization of the Orthodox Churches, the conduct of ecclesiastical affairs, both locally and on the diocesan and national levels, is quite democratic. Thus, the Russian council which elects the metropolitan is composed of both lay and clerical elements and possesses supreme authority as the governing body. The same is true of the Serbian and Rumanian ecclesiastical organizations; these churches are governed by representative national conventions in which lay members from all local churches and all the priests participate. The Serbian sabor legislates for the church, reviews the work of the local congregations and elects the members of the Diocesan council which is composed of seven priests and nine laymen. The Rumanian Church congress meets annually. Each local congregation sends to it its priest and two laymen so that the lay element predominates. The congress elects the Episcopal council, which consists of four priests and eight laymen, and to which are entrusted the administrative duties. Essentially the same democratic organization, in which the lay membership often is in majority, is characteristic of the other Orthodox communions. An exception to this statement is the Greek archdiocese, which is governed by the archbishop assisted by four bishops. A convention composed of all the clergy and one lay representative from each congregation meets every three years, but its functions are largely advisory.

The most significant characteristic of American orthodoxy is that with the exception of the three native groups, the rest of the communions are aligned with the jurisdiction of their respective mother churches. Their bishops and other hierarchs are usually appointees of the ecclesiastical authorities abroad and often are actually members of such bodies. The chief exception is the Russian Church. which is autonomous. Nevertheless, even in this case a strong effort is made by the patriarch of Moscow to induce it to surrender its autonomy. Accordingly, although the American Orthodox communions are as a rule self-governing, many of them do not possess hierarchical autonomy.

Furthermore, just as there exists such a close bond of union between the American daughter churches and their mother organizations, there is a marked lack of co-operation among the Orthodox bodies in America. Consequently, instead of attempting to solve such common problems as the education of the American-born priesthood, each communion tries to do it separately or depends upon clergy educated abroad. Another consequence of this situation is that every foreign-speaking Orthodox communion attempts to preserve, as far as possible, its native language and culture and opposes by all means possible the assimilation of its members in the American majority. In fact, the church often serves as the chief agency of such a program. The liturgical services are conducted almost exclusively in the language of the respective community — Greek, Rumanian. Syriac or Church Slavonic. There is, accordingly, a need for weekday schools in which the language of the respective group would be taught to the children In this educational program the Greeks are pre-eminently successful, although the Russians in 1947 reported almost 70% of the total number of their children in the weekday schools. The publication of church periodical literature is largely motivated by the same intent.

The above considerations apply to practically all Orthodox communions, with the exception of the three native American bodies mentioned previously. Although necessarily depending for their orders upon one or another of the ancient eastern Orthodox communions, they aim to make eastern orthodoxy an integral part of American Christianity, to make available to the native American the riches of the faith and cultus of the Christian east and to acquaint western Christendom with the spirit of orthodoxy. This is in line with the ecumenical character of the emerging new Christendom as it takes form in the World Council of Churches. Thus. these communions perform a useful and necessary function of helping the eastern Orthodox nationals in America to become integrated as component elements of American Christianity.

It is, furthermore. the declared purpose of these native Orthodox bodies to foster a broad social and civic outlook in keeping with the modern needs of American life. They emphasize practical. Christian living, the establishment of better human relations, as well as the spiritual aspects of Christianity. The missionary work is not proselytizing in intention and spirit.

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(M. SPI.)

ORTHODOXY, PROTESTANT, identifies a phase that both Lutheran and Reformed theology went through after the 16th-century Reformation. The two movements, though discrete, share many accidental features as a result of the largely common political, cultural, social and intellectual matrix that included not only the Lutheran and Reformed communities but also the bulk of European Roman Catholicism at the time. Prominent features of this matrix are the economic decline and political disintegration of the Holy Roman empire, the continuing Muslim-Turkish threat in the east, the Thirty Years' War, territorial-confessional churches intimately linked with the government, the general use of Aristotelian thought forms and the rise of the baroque spirit in art.

Lutheran Orthodoxy. — In the Lutheran Church the era of orthodoxy begins around 1560 with the theological effort to reunite the factions that had developed after Luther's death (see CONCORD, BOOK OF). The "golden age" of orthodoxy ends in 1713 with the death of the last great systematician, David Hollatz. but orthodoxy remained a potent force into the last quarter of the century, although it was beleaguered by pietism (*q.v.*) and the Enligitenment (*q.v.*). In the United States the theology of the most influential 19th-century Lutheran immigrant groups was largely a revival of orthodoxy.

Lutheran orthodoxy discloses wide variations not only from period to period but also from region to region and even from theologian to theologian. Early orthodoxy is represented by the six authors of the Formula of Concord. among others. A general characteristic of their method is the discussion of theology under a series of major heads or "commonplaces" *(loci communes)*, in the tradition of Philipp Melanchthon (*q.v.*), with a minimum of analysis and systematization. The transition to the period of "high orthodoxy" is marked by Johann Gerhard (*q.v.*). This period reveals in general an increasing intellectualization of religion, concern for theological detail and use of analysis. The end of the period is marked by the bitter "syncretistic controversy" between the theologians led by Georg Calixtus and those led by Abraham Calovius. In the writings of a number of theologians of "late orthodoxy," the analytic method triumphs completely; others represent varying degrees of tacit or frank accommodation to the pietist movement that began at Halle with Philipp Jakob Spener and August Hermann Francke. During the latter two periods Lutheran orthodoxy had its greatest influence in Sweden and Finland.

Lutheran orthodoxy has been accused of doctrinaire formalism, narrow and quarrelsome intolerance. sterile neo-Scholastic intellectualism and a divorce between doctrine and ethics. These charges. although true in some cases, are often partisan exaggerations. based on a reading of the dogmatic works of the period to the exclusion of the biblical commentaries and devotional literature produced at the same time and often by the same men. After due allowance has been made for personal differences and for the inescapable influence of the intellectual and political environment, there remains among the orthodox theologians a deep concern for a theology that is simultaneously biblical, Catholic and Lutheran, great intellectual vigour and authentic personal and corporate piety. The central emphases of orthodox Lutheran theology are the primacy of God's Word: the forgiveness of sins exclusively by divine grace for Christ's sake through faith as the core of the biblical message; the vital roles of baptism, absolution, the Eucharist and the sacred ministry; reverence for the inherited expressions of the mind of the historic church, not least in the doctrine of Christ; and a strong polemic-apologetic position over against Roman Catholicism, Reformed Protestantism and Socinianism alike.

Reformed Orthodoxy. — The era of Reformed orthodoxy begins shortly after the death of John Calvin (1564) and ends at the beginning of the 18th century. Reformed theologians originally called themselves "orthodox" in contrast to Roman Catholics and to Lutherans, whom they regarded as only imperfectly reformed. The term soon came to designate a special type of rigid Calvinism which in its severe form stood in conscious opposition to liberal humanism and Socinianism, as well as to Roman Catholicism and Lutheranism. The architects of Reformed orthodoxy are Theodore Beza and Hieronymus Zanchius. It was Beza's concern to preserve the theology contained in Calvin's *Institutes of the Christian Religion* (*see* CALVIN, JOHN). The capstone of this system Beza saw in the doctrine of an absolute decree by which God predestined some men to everlasting life and others to hell. Unlike Calvin, Beza was moved by philosophical rather than biblical considerations. Zanchius gave Reformed orthodoxy its classic formulation of the doctrine of the perseverance of the elect. Other features generally characteristic of Reformed orthodoxy were a symbolistic doctrine of the sacraments, an ethical approach to repentance, a typical "presbyterian" polity, stress on church discipline and practical Christianity and, in comparison with Lutheranism, a more literal approach to the Bible and a greater separation of the divine and human natures in Christ.

The strongholds of Reformed orthodoxy were Switzerland and the Netherlands. In the latter, orthodoxy came into conflict with Arminianism (*q.v.*), which was condemned at the international Synod of Dort (1618–19), convened to resolve the controversy. The *Synopsis purioris theologiae* (1624) by the Leiden theological faculty is a definitive unfolding of Dort orthodoxy.

Driven underground in the Reformed churches, Arminianism exerted a strong influence on 17th-century Anglicanism, and subsequently on Methodism. The short-lived victory of Presbyterianism in England under Cromwell occasioned the formulation of the Westminster standards, including the Westminster Confession (1646) and the Larger and Shorter Catechisms (1647), of which the general thrust is orthodox and anti-Arminian as well as anti-Anglican (*see* CATECHISM; CONFESSIONS OF FAITH, PROTESTAST). The influence of the *Compendium theologiae* of the Basel theologian Johannes Wolleb is particularly apparent in the Larger Catechism. Early American Puritanism is a separatist version of English Reformed orthodoxy.

Huguenot theology provoked a further test of orthodoxy. The French Reformed community formally accepted the canons of Dort, but amid the political confusion of the period a vocal humanistic opposition — influenced both by German Reformed theology and revived Zwinglian ideas — developed, notably at the Academy of Saumur. There the Scottish-born John Cameron and his disciple Moise Amyraut (Amyraldus) attempted a new synthesis of orthodoxy and Arminianism. In the Helvetic Formula of Agreement (1675), drafted chiefly by Johann Heinrich Heidegger and François Turretini, Swiss Reformed orthodoxy vainly condemned the Saumur theology and reaffirmed the traditional orthodox position. Soon after the end of the century Reformed orthodoxy succumbed almost completely to pietism and rationalism.

Meanwhile German Reformed theology — like Anglicanism — was never orthodox in the strict sense. Along with the influence of the Swiss reformers and their Dutch followers, the influence of Martin Bucer and of those more radical disciples of Melanchthon whom the Formula of Concord had forced out of the Lutheran Church also persisted. The result was the relatively mild Calvinism of the Heidelberg Catechism (1563) and the Consensus of Bremen (1598). In general, German Reformed theology affirmed dialectically Melanchthon's doctrine of universal grace and the Swiss doctrine of election.

Lutheran-Reformed Union. — Since the Reformed religion prior to 1648 enjoyed precarious toleration in the Holy Roman empire only under the pretense of commitment to the Augsburg Confession, plans for various types of union between Lutherans and Reformed engaged much of the latter's attention. The two religions had discovered a way to get along peaceably in Poland-Lithuania (Consensus of Sendomir, 1570) and later in France (Synod of Charenton, 1631). It was argued that similar agreement was possible within the empire also. Efforts in this direction were the Leipzig Colloquy (1631) and the Cassel Colloquy (1661). Both disclosed extensive areas of agreement but led to no practical results. Among Reformed champions of Lutheran-Reformed union, François du Jon (Junius), David Pareus and the Scotsman John Durie made particularly significant contributions. By and large, however, all but the most irenic Lutherans viewed these efforts with suspicion on theological, historical and political grounds.

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ORTHOGENESIS, "straight-line evolution," a term descriptive of the phenomenon in which successive members of an evolutionary series become increasingly modified in a single undeviating direction; the word is further used to designate theories framed to explain such phenomena. Ortho-evolution, ortho-selection, aristogenesis, undeviating evolution, rectilinear evolution are synonymous or related terms.

That evolution frequently proceeds in orthogenetic fashion is undeniable. Theodor Eimer, an early exponent of orthogenesis, based his work on butterfly wing venation; fossil invertebrates show many orthogenetic sequences; H. F. Osborn, W. K. Gregory and others cited numerous examples in vertebrate paleontology. In some cases the structural changes concerned are obviously adaptive, and a Darwinian explanation (ortho-selection) is reasonable. An orthogenetic "family tree" presents the picture of a single straight stem rather than a branching structure; this appearance may be because of the fact that side branches, when begun, were vigorously pruned by natural selection.

In many instances: however, the striking features developed in an orthogenetic phylum appear to have little if any adaptive value and may even be markedly disadvantageous. To explain such cases is more difficult. No genetic evidence has been found (despite search for it) of progressive mutation in a given direction. Various theories have been proposed involving an "inner urge" toward a predestined evolutionary goal or some other mystical or theological concept. But many workers feel that more rational explanations are possible. Work in genetics has shown that even very small mutations may have a definite survival value. Further, the action of a gene is not confined to a single character; the growth of disadvantageous structures (as for example the huge antlers of the extinct Irish "elk") may well have been merely unfortunate genetic concomitants of the development of other structural or functional features of great utility.

Related evolutionary phenomena are parallelism and the so-called law of the irreversibility of evolution. Parallel trends are frequently seen in related but distinct evolutionary phyla; these trend- are often orthogenetic in pattern. The "law" of irreversibility is based upon the occurrence of orthogenesis. However, there are many known lion-orthogenetic evolutionary lines, and there are numerous instances of reversibility. *See* EVOLUTION, ORGANIC. (A. S. RR.)

ORTHOPEDIC SURGERY is the medical specialty that includes the investigation; preservation, restoration and development of the form and function of the extremities. spine and associated structures by medical, surgical and physical methods.

History.— –The term orthopedics was given to this specialty in 1741 by Nicholas André, professor of medicine at the University oi Paris. The term was synthesized from the Greek roots *orthos* ("straight": and *pais* ("child"). Although the scope of orthopetiic surgery has gone far beyond the prevention and care of deformities in children. the name lasts. The establishment of the first institute for the treatment of skeletal deformities at Orbe, Switz., by Jean André Venel. a physician of Geneva. was a milestone in the development of orthopedic surgery in the 18th century. During the remaining portion of the century, outstanding work in orthopedic surgery was done by William Hunter, \\-ho contributed to knowledge of the structure of joints, and by John Hunter his younger brother. who contrihuted to knowledge of muscular function and bony growth and development. John Hilton (1804–78) exerted a great influence on the development of orthopedic surgery nith his book *On Rest and Pain,* which undoubtedly helped to influence thinking during the long period in which rest was considered to be the most important part of orthopedic care. G. F. L. Stromeyer (1804–76). a German surgeon of Hanover, developed the operation of tenotom); (cutting of tendons) by which deformities could be more easily corrected. It was to Stromeyer that William J. Little (1810–94) the pioneer of orthopedic surgery in England. himself a cripple with a paralytic deformed foot. went to have the deformity corrected in 1836. Little's studies on the cause.: of clubfoot and his introduction to tenotoniy in England were outstanding steps in the development of orthopedic surgery. Hugh Owen Thomas (1834–91), another outstandirig leader in the development of this specialty, devised, among other outstanding contributions, the Thomas splint, which is still widely used in the treatment of fractures of the long bones of the leg.

The modern era in the development of orthopedic surgery usually is regarded as heginning with the work of Sir Robert Jones (1858–1933). The organization of the orthopedic centres and curative workshops was carried out under his direction, and many orthopedic British and American surgeons came under his influence. 'The introduction of surgical methods which could be used in conjunction with splinting in the treatment of fractures and severe injuries of the extremities may be ascribed to the period of World War I and to the leadership of Jones.

In the United States the names of L. A. Sayre, Henry G. Davis and Charles F. Taylor are outstanding in New York city. while in Boston. Mass., orthopedic surgery was developed by John Ball Brown and Buckminster Brown, to be followed by E. H. Bradford. Robert W. Lo\-ett and others.

One of the modern leaders in the development of orthopedic surgery in the United States was F. H. Albee (1876–1945), whose development of the motor bone saw in 1909 led to an entirely new era in bone-grafting methods which are commonly used in the correction of deformities and disabilities of bones and joints. Robert W. Lovett (1859–1924), a leader in the Boston group, did much to develop knowledge oi the care of patients affected with anterior poliomyelitis and also helped to develop knowledge of scoliosis (curvature of the spinal column) and its treatment. Michael Hoke (1874–1944) of Atlanta, Ga., contrihuted much to the correction of foot deformities and stabilization of joints. Royal Whitman (1857–1946) was an outstanding teacher and orthopetiic surgeon, and Willis Campbell (1880–1941) contributed much to the development of modern orthopedic methods and technique. Russel ;\. Hibbs (1869–1932) devised an operation for stabilization of the diseased or deformed spine and other important operative procedures.

Scope.—In discussing the scope of modern orthopedic surgery. the prevention of disabilities and deformities, as well as their correction. must he stressed. Orthopedic surgery may be divided into two parts, preventive and reconstructive. Deformities may be either congenital or acquired. Of the congenital deformities, thcre are three types: (1) those caused by disturbances in embryologic development and intrauterine growth; (2) those which are actually inherited and transmitted from generation to generation; and (3) those which are based on evolutionary changes in the human species. Examples of the first group are intrauterine amputations; examples of the second group are congenital dislocations of the hip and the related condition known as congenital dysplasia of the hip; examples of the third group are anomalies of the lumbosacral portion of the vertebral column. resulting from man's change from the quadruped to the biped gait. Many developmental changes in the spinal column have taken place and certain anomalies are occasionally seen.

All congenital deformities cannot be classified into these groups in the light of present knowledge, although many of them no doubt may he so classified as that knowledge improves. Prevention of congenital deformities may seem impossible. although the results of work on the influence of certain deficiency diets in pregnant animals seem to indicate that some of the embryologic maldevelopnients may be influenced by nutrition.

Developmental anomalies are likewise a source of troubling and disabling deformities. Among these may be mentioned certain disturbances of growth in the epiphyses (pieces of bone separated from the long bones by cartilage and later becoming part of the long bones) of children which are known as epiphyseal osteochondrosis. Such conditions lead to deformities of the surfaces of the joints and later in life cause painful joints. Severe infections of joints due to pyogenic (pus-forming) organisms formerly were a cause of severe damage which often led to deformities and disabilities. but with the development of chemotherapy these infections were greatly reduced if not prevented. Anterior poliomyelitis is another outstanding cause of disabilities and deformities of adolescence and adult life. but the vaccine devised by Jonas Salk gave promise of diminishing or eradicating this disease.

Deformities with their attending disabilities may follow injuries of the bones, joints, muscles and tendons or skin. Any one of these structurcs. if severely injured and not adequately repaired. will become a potential source of deformity and disability. A fracture that is allowed to heal with iragments of bone in an improper position may cause the patient to walk with the extreniity out of proper alignment and in time may lead to serious disability of the neighbouring joint. In the same way, a fracture of the bones in the region of the ankle not accurately reduced. in time. because of ahnornial wear and tear on the joint surfaces. may lead to traumatic arthritis and severe disability. Injuries of muscles and tendons not adequately cared for may produce an unbalanced function of an extremity or part and lead to deformity and disability. In a like manner, scars from severe burns often cause contractures or shortening of the soft tissues on one side of a joint and lead to severe deformities and marked disability. In all of these instances, the best prevention is early and adequate treatment designed to produce the best possible function with the least possible deformity.

(*See* also BONE, DISEASES AND INJURIES OF: FRACTURES AND DISLOCATIONS.)

Methods and Procedures.— From a specialty which originally depended on the use of heavy braces, splints and methods of treatment n-hich produced rest has evolved an active surgical specialty nhich is concerned with the correction of existing faults and prevention of the later development of deformities and disabilities by surgical procedures. With the availability of such adjuncts to surgical treatment as chemotherapy. whole blood and, at times, blood substitutes. and improved methods of anesthesia. early restoration oi badly shattered parts can be accomplished. 'The achievements of orthopedic surgery in World War II are ample. evidence of this fact.

Reconstructive surgery of the spinal colunin and extremities is of great importance. Fractures which have failed to unite or have united in a faulty position are treated by surgery. Bone grafts' are used widely, and many types of bone grafting have been developed to adapt this useful technique to a variety of purposes.

Tendons may be repaired by tendon grafting and by tendon transplantation where indicated. It is possible, for instance, in the case of hopeless destruction of the musculospiral nerve in the arm, to restore the function of the hand almost to normal by the transplantation of two or three tendons. . Use of skin-grafting procedures to replace extensive scars has greatly advanced reconstructive surgery. The various types of skin-grafting procedures are also used to repair extensive chronic ulcers, which are painful and disabling. (See also TRANSPLANTS. TISSUE AND ORGAN.)

Surgical methods have been developed to equalize the length of a lower extremity in cases in which a marked difference in length of the extremities impairs the patient's usefulness or threatens to cause further disability: This may be accomplished by lengthening the shorter leg. by shortening the longer leg or by retarding growth in the longer leg.

The development of metals for use in the internal fixation and repair of fractures occupied the attention of many orthopedic surgeons and strong metals that produce little reaction in the tissues are available for use. With the improvement in these materials has grown a better understanding of how to use such devices, and better tools for their handling have been invented.

Many diseases of the skeleton are being studied and their relationship to other organs of the body gradually revealed. Deficiency states and bony diseases secondary to tumours of the parathyroid glands and to other glands of internal secretion are gradually becoming better understood, and better means of treating them are being found. 'The importance of prevention of deformities caused by various types of arthritis is well known and the more crippling deformities are much less frequently seen than they were in the past.

Understanding of malignant tumours of bone and of tumours of muscles and tendons is slowly improving. Early recognition of these conditions and the prornpt use of surgical procedures or X-ray treatment have made many patients more comfortable and in many instances have saved lives. The final answer to cancer of bone and other tissues is probably neither surgery nor radiation.

It may be some, as yet undiscovered, chemical or antibiotic agents.

Improvement in knowledge of methods of amputation, and improvement in the types of artificial limbs, greatly reduced the disabling effects of these procedures. Improvements in plastic amputation made practicable this procedure. by which tendons and muscles in amputation stumps can be used to move artificial 'hands. (See also AMPUTATION.) .

Recognition of the fact that long periods of rest in bed, once strongly advocated by orthopedic surgeons. are in many instances deleterious shortened the period of hospitalization for many patients and greatly reduced the long periods of convalescence which frequently were thought necessary in the treatment of diseases and injuries of the spinal column and extremities.

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(R. K. G.; M. CL.)

ORTHOPTERA, the scientific name for the order of insects that, in conventional classification, includes cockroaches, mantids, walking sticks, grasshoppers and locusts, katydids and their allies. (Earwigs were long included, but now a separate order, the Dermaptera [*see* EARWIG], is recognized for them.) About 24,000 species are known; the United States has about 1,300 species and subspecies. Europe about 600 and Britain 35, including 4 established adventives. In some classifications the cockroaches, mantids and walking sticks are each often given ordinal rank (see INSECT: *Classification*). In many parts of the world certain orthopterans are at times serious pests of crops and bothersome pests in households; a few kinds, such as the mantids, help to reduce the numbers of noxious insects.

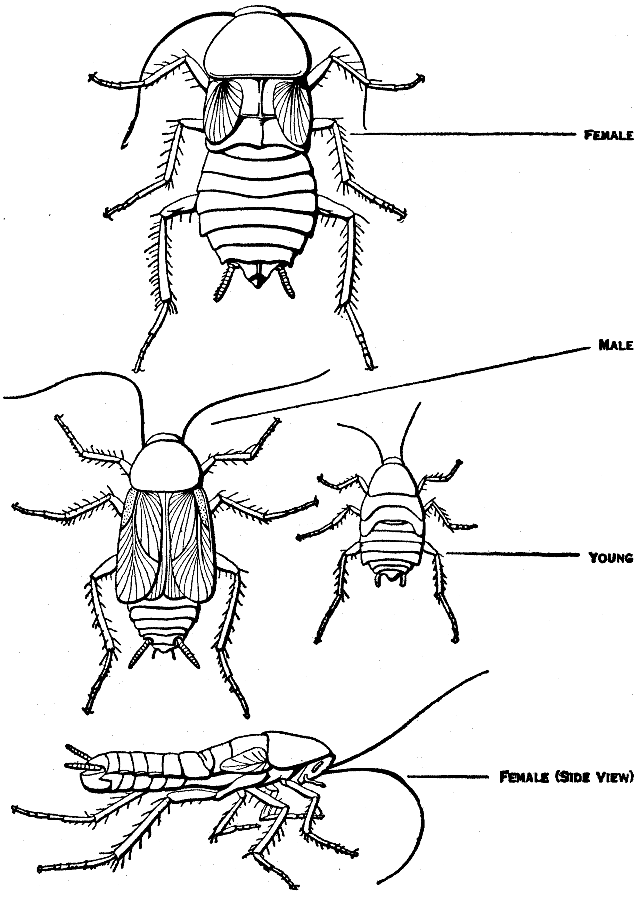
Essentially terrestrial, many Orthoptera run rapidly or jump vigorously. The grasshoppers and locusts include many active fliers. though only a few fly long distances in a migratory sense; other groups of Orthoptera are mainly weak fliers. Most Orthoptera are relatively large, the average size being much greater than most insects; some reach a maximum of 13 in. in length. Many, nearly all in the suborder Saltatoria, possess sound-producing organs and stridulate loudly. Others make crackling noises in flight; the sounds produced by the majority are distinctive for each species, when heard by the trained human ear or recorded on tapes for careful study.

DISTRIBUTION AND GENERAL FEATURES

Range. — The largest families are world wide in range, though all diminish rapidly in number of species as the cooler zones are approached, and very few mantids or walking sticks occur outside the tropics. Most species have limited distributional patterns, and each continental fauna is more or less distinctive. Grasshoppers are excellent indicators of ecological zones; each distinct plant community usually has certain grasshoppers characteristic of that environment. There are few cosmopolitan pests among Orthoptera except in the cockroaches.

Form. — Although the majority of orthopterans are winged as adults, apterism, or the lack of wings, is seen especially in the suborders Notoptera and Cheleutoptera.

The front wings are usually narrow, leathery or parchment-like and are called tegmina (singular, tegmen); venation is well developed. The hind wings are membranous and normally fold on the

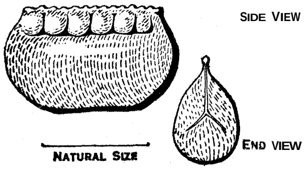


BY COURTESY OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

FIG. 1.—THE COMMON COCKROACH (BLATTA ORIENTALIS), NATURAL SIZE

body with lengthwise plaits, like a fan; they are wider than the tegmina and usually have a large posterior lobe. The mouth parts are for chewing, with strong mandibles, maxillae and a four-lobed labium. Except for the typical grasshoppers and their relatives, the antennae usually are very long and threadlike. The prothorax usually is large and movable the mesothorax and metathorax being more or less fused A pair of pointed appendages (cerci) terminates the abdomen frequently in addition to conspicuous genital appendages

Reproduction and Natural **History.**—Fertilization is usually by means of a spermatophore transferred to the female at mating, but parthenogenesis (development from an unfertilized egg) sometimes occurs, especially in walking sticks. Eggs of Orthoptera are cylindrical to oval; the egg cases (oöthecae) of cockroaches and mantids seldom contain fewer than ten eggs, but those of mantids sometimes enclose several hundred eggs.



BY COURTESY OF THE U.S. DEPT OF AGRICULTURE

FIG 2.—EGG CAPSULE (OOTHECA) OF AMERICAN COCKROACH (PERIPLANETA AMERICANA)

Newly hatched nymph!: of winged species are wingless, the wing pads developing as growth proceeds.

The Saltatoria are famous for their "songs," more correctly called stridulation. which rival the calls of cicadas in loudness; in a few cases their sounds can be heard a mile away. Except for mantids. which capture living insects. and some cockroaches, crickets and katydids. which are scavengers. omnivores and occasionally predators, most Orthoptera are herbivores. The most serious orthopterous crop pests are grasshoppers. but certain other orthopterans are also important, as the Mormon cricket on crops and rangeland in the northwestern U.S., field crickets on cotton in the Gulf states and mole crickets on tobacco and vegetables in the southeastern states and the West Indies. About a dozen species of grasshoppers, especially in Africa and Asia, less frequently in South America and Australia and uncommonly in North America. are called locusts because of their strong migratory habits. While immature they move on the ground as marching bands and later fly long distances as swarms of adults. Their depredations have been notorious since biblical times.

Each major family of Saltatoria has tree-, shrub-. herb- and ground-dwelling species, though long-horned grasshoppers and katydids are more arboreal than grasshoppers or crickets. Many species are more specific in host plant preferences than formerly was thought to be the case. Many cave and camel crickets and mole crickets are subterranean. while the small wingless cricket *Myrmecophila* lives in ant nests. The cricket *Hydropeticus*, one of the very few aquatic Orthoptera, skates actively on streams in Fiji much as do the water-striding bugs (Gerridae). A few cockroaches are capable of considerable periods of submergence in the water in the leaf axils of bromeliads and in other natural receptacles; there are isolated examples of semiaquatic katydids and grasshoppers.

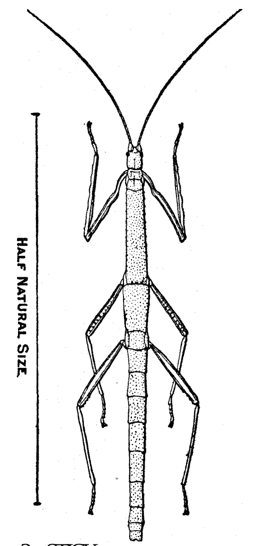


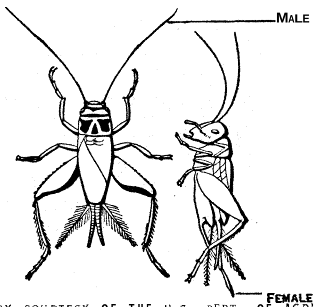
FIG. 3—STICK INSECT (CARAUSIUS MOROSUS)

CLASSIFICATION AND SURVEY

As usually defined. the Orthoptera is an order in a broad sense. It includes only part of the orthopteroid (straight-winged) insects. It is partly for convenience that such diverse groups as the Dictyoptera. Cheleutoptera, Xotoptera and Saltatoria are regarded as suborders of Orthoptera. Cockroaches are more closely related to termites than to grasshoppers, for example, and the development of a classification more correctly representing this and other relationships indicated by comparative morphology is desirable. but thus far none of the many proposed modern classifications has become standard.

Suborder Dictyoptera.—This group includes the cockroaches (superfamily Blattoidea, consisting of several families often grouped as Blattidae in a broad sense) and mantids (Mantoidea; especially family Mantidae), both descended, together with the termites, from Palaeozoic Protoblattoidea. They have five-segmented tarsi (end parts of legs). primitive wing venation. many-segmented cerci, processes called styli iin males and nymphs) and eggs, except in those cockroaches that have the young born alive (ovoviviparous) from the ootheca. The Blattidae are characterized by a flattened body, large shieldlike pronotum, very broad coxae (basal segments of the legs) and running legs. The Mantidae usually are elongate. but little flattened. and only rarely is the pronotum broad; the most distinctive feature is the predatory front legs. equipped with spines and adapted for seizing prey. Except for this latter specialization and the less flattened bodies, the morphology of mantids shows close relationship to cockroaches. (See COCKROACH; MANTIS.)

Suborder **Cheleutoptera.**—This group includes the walking sticks (stick insects, or phasmids), which traditionally were grouped near cockroaches and mantids because they are mainly elongate crawling types. However, they are now regarded as a distinct orthopterous line and are often given ordinal rank. sometimes under the name Phasmida. The great majority. especially those of the family Phasmatidae, are long and slender. but some forms are heavily bodied. with stout bizarre spines on the body; the family Phyllidae includes the leaf insects. Antennae usually have long slender segments. tarsi are five-segmented and the ovipositor is short. Tegmina and wings are often absent. Stick insects are primarily a tropical group; only about 25 species occur in the United States. The largest species occur in Borneo and nearby islands of the East Indian region: specimens of the genus *Pharnacia* 13 in. in body length (exclusive of legs) have been recorded. (*See* LEAF INSECT; STICK INSECT.)



BY COURTESY OF THE U S. DEPT. OF AGRICULTURE

FIG 4 — HOUSE CRICKET (ACHETA DOMESTICUS)

Suborder Notoptera. — This group comprises a single family (Grylloblattidae) containing three genera and about nine species of rare wingless insects. occurring in the mountains of western North America, Japan and eastern Siberia. They are about one inch long. with slender legs for running. five-segmented tarsi and long slender cerci. The long ovipositor resembles that of katydids Grylloblattids are very primitive Orthoptera and probably belong near the base of the line of development leading to the Saltatoria. They frequently occur near the snow line in mountains where they live under rocks. Others live at lower altitudes, sometimes in rotten logs or in caves. Growth is very slow, maturity sometimes requiring several years Their food consists mainly of other insects. The first known species was described in 1913: because of the rarity and primitive character of these insects they are of great scientific interest.

Suborder **Saltatoria.**—This group includes the jumping Orthoptera. the dominant members of the order. comprising the familiar grasshoppers and locusts. the katydids and the crickets, as well as various related but poorer known members. They have hind legs well adapted for leaping and tarsi with fewer than five segments The ovipositor is well developed. Stridulatory organs are often present in the male. and in many species there is a hearing organ in the form of a tympanum. There are six principal superfamilies of Saltatoria grouped in two series, the Ensifera and the Caelifera.

Ensifera are characterized by threadlike antennae usually much longer than the body, three- or four-segmented tarsi, a long ovipositor. a tympanum (when present) near the base of the front tibia and a male tegmen often formed for stridulation. Of the three chief superfamilies, the Gryllacridoidea include cave and camel crickets (family Gryllacrididae). In North America many species of cave crickets are common in woods and caves. The Tettigonioidea includes the family Tettigoniidae. the katydids or long-horned grasshoppers. with four-segmented tarsi and a long, broad ovipositor. which is swordlike in cross section. The Grylloidea, chiefly the family Gryllidae, are crickets. with three-segmented tarsi and a slender ovipositor, which is usually round in cross section.

Caelifera are characterized by antennae much shorter than the body. tarsi with three or fewer segments. a short ovipositor composed of hooklike valves. which open widely in a vertical direction, and a tympanum (when present) near the base of the abdomen, on each side. The Tridactyloidea include pygmy mole crickets (family Tridactylidae) and their relatives; they resemble mole crickets but are closer to grasshoppers in structure. The Tetrigoidea, family Tetrigidae. are pygmy grasshoppers or grouse locusts. They look like miniature grasshoppers with the pronotum greatly developed and covering much of the abdomen. They rarely exceed one inch in length. and there are many strange tropical forms. The Acridoidea includes the family Acrididae, or grasshoppers and locusts, the most important and most universally distributed and abundant Orthoptera. The tarsi have three segments. antennae are short, cerci consist of a single segment and tegmina (usually present) are usually leathery or horny. Many grasshoppers stridulate bv scraping a toothed ridge on the hind femur against a sharp-edged vein on the closed tegmen; some make buzzing or crackling noises in Bight. *See* CRICKET: GRASSSHOPPER; GROUSE LOCUST; KATYDID; LOCUST; *see* also ENTOMOLOGY; INSECT.

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ORTIGÃO, JOSÉ DUARTE RAMALHO (1836–1915), an outstanding Portuguese essayist and journalist, was born on Nov. 24, 1836, in Oporto. He became a teacher of French in the Oporto Colégio da Lapa. and began to write for the *Jornal do Porto* at the age of 19. In 1868 he moved to Lisbon to take up an appointment in the office of the Academia Real das Ciências. In Lisbon he continued writing assiduously for I'ortuguese journals and established contact with the progressive intellectuals and writers. Antero de Quental. Oliveira Martins. Eça de Queiros and others. Ortigão and his lifelong friend. Queirós, together started the satirical review, *As Farpas,* in 1871, and aiter the departure overseas of Queirós late in 1872. Ortigko produced the review alone until 1885. In his hands *As Farpas* gradually became less satirical and more didactic and descriptive.

Throughout his life Ortigão, a robust, athletic figure, traveled widely. His writings reveal his mastery of Portuguese prose, his remarkable descriptive power and his intense love of and concern for the welfare of his native land. But his most outstanding book is probably *A Holanda* (1885) in which fine descriptions of the country are combined with praise for the mode of life and achievements of the Dutch people. With advancing years his political outlook became more conservative; he was opposed to the republican coup of 1910 and. in protest, resigned his public appointments as keeper of the Xjuda library and secretary to the Academia Real das Ciências. He died on Sept. 27. 1915. in Lisbon. Ortigão's complete works were published in 39 volumes (1943–49).

See R. Jorge, *Ramalho Ortigão* (1915); J. De Barros, "Ramalho Ortigão," in *História da Literatura Portuguesa Ilustrada dos Séculos XIX e XX* (1932). (N. J. L.)

ORTLER, the highest point (12.792 ft.) in Tirol. and in the whole of the Eastern Alps. It is a great snow-clad mass. which rises east of the Stelvio pass and a little south of the upper valley of the Adige between the valleys of Trafoi (northwest) and of Sulden (northeast), It was lone considered inaccessible. but was conquered in 1304 by three Tirolese peasants. Many routes to the summit are now known.

ORTNIT (ORTNID, OTNIT, ORTNEID), a figure in German heroic poetry. His story has come down to us in Middle High German as one of those collected in the *Heldenbuch* (*q.v.*). Ortnit ruled at Garda in Lamparten (Lombardy). Helped by a supernatural dwarflike figure. Xlberich, who reveals himself as his father. Ortnit journeys to the east and captures the daughter of the heathen king Machorel whom he brings back to his kingdom as his bride. The bride's father, feigning reconciliation, sends to Ortnit's lands two huge eggs which hatch into two dragons who ravage the country and kill Ortnit. His death is avenged in another story by Wolfdietrich (*q.v.*).

The Ortnit poem is probably an earlier work of the *Wolfdietrich* poet. Versions of the story are found also in Low German and in the Icelandic *Thidrekssaga.*

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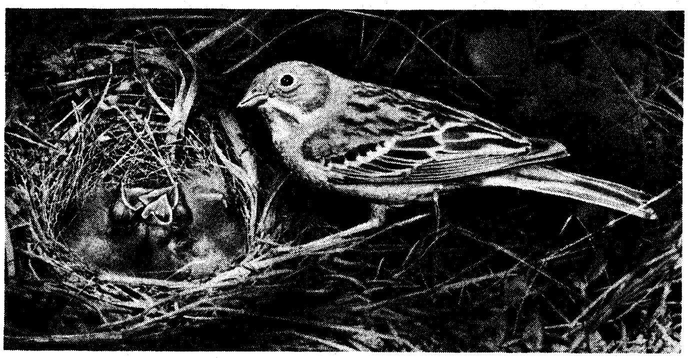
ORTOLAN (ORTOLAN BUNTING), a bird (*Emberiza hortulana*) of the passerine family Fringillidae. It differs from similar buntings in having pinkish-buff underparts and a yellow throat. A native of most European countries—the British Isles excepted—as well as western Asia. the ortolan is celebrated for the delicate



ERIC HOSKING

ORTOLAN BUNTING (EMBERIZA HORTULANA) AT ITS GROUND NEST

flavour of its flesh and is netted in great numbers to be fattened for the table. It is migratory in the north where its reappearance late in April or May is associated with the return of fair weather. It is most abundant in open hilly country but also occurs in the lowlands. The song is much like that of the related yellowhammer (E. *citrinella*), but is slower, more varied and usually of six or seven clear notes followed by an occasional flourish. The nest is placed on or near the ground and may contain four or five glossy greenish-white eggs. variously marked with purple and brown. *See* also BUNTING. (E. R. BE.)

ORTONA, a town of Chieti province in the Abruzzi e Molise region of Italy, lies on the Adriatic coast 13 mi. S.S.E. of Fescara by rail. Pop. (1957 est.) 22.843 (comm.). It is on a promontory 230 ft. above sea level and connected by a funicular railway with the small port below. The population is engaged chiefly in fishing and trade; there are also brick and *pasta* factories (producing spaghetti). Vines are cultivated in the area and grapes are exported in large quantities to northern Europe.

Ortona is an ancient settlement; Strabo and Pliny the Elder place it in the territory of the Frentani. a clan that allied itself with Rome in the 4th century B.C. It was later a Roman municipality. It was several times devastated by earthquakes. In the 18th century, it was annexed to the kingdom of Naples and subsequently absorbed into modern Italy.

Important monuments are the cathedral. with a fine portal by Nicolo Mancini (1312), and the Aragonese castle (15th century), both heavily damaged during World War II. (M. T. A. N.)

ORURO, a department on the Altiplano of central Bolivia, bounded north by La Paz. south by Potosí, west by the Republic of Chile and east by Potosí. Area 20.690 sq.mi. Pop. (1959 est.) 237.907. The department was established in 1826, during the administration of Antonio José de Sucre. It comprises eight provinces: Cercado, Pantaleón Dalence, Carangas, Poopó, Sabaya, Sajama, Abaroa and Ladislao Cabrera. The region has a cold climate and is semiarid, conditions militating against successful agriculture. Lake Poopó, a shallow body of water 02 mi. long by 28 mi. wide, lying at 12.119 ft. above sea level, has a strong salt content and salt deposits are abundant nearby. A small stream, Lacahahuira, is the only outlet and this disappears below the surface within a few miles. The Desaguadero river, which drains Lake Titicaca to the south, flows into Lake Poopó.

Mining is the basis of the economic life of Oruro; in mineral wealth the department is almost as notable as Potosí. Minerals comprise tin (Cercado; Poopó; Abaroa), zinc (Poopó), wolfram (Cercado), silver (Cercado; Poopó; Abaroa), bismuth (Poopó; Cercado), and gold (Cercado). Agriculture and stockraising are carried on in traditional primitive fashion by the rural inhabitants, chiefly Indians. Principal crops cultivated are potatoes, quinoa, cañahui and barley. The llama and alpaca are the important livestock raised there, and to a lesser estent, cattle, sheep and mules.

The capital of the department is the city of Oruro (pop. [1950] 62,975) lying at 12,160 ft. above sea level. Transportation facilities within the department include air, railroad and highway.

(J. L. Tr.!

ORURO, a city of Bolivia, capital of the department of the same name and of the province of Cercado. Pop. (1959 est.) 77,-871. The city was founded by Manuel Castro de Padilla in 1606, with the name "Real Villa de Sau Felipe de Austria" ("Royal Town of St. Philip of Austria"), conferred upon it by King Philip III of Spain. It lies at an elevation of 12.160 ft. above sea level; the annual average temperature is 50° F. The city was notable during the colonial period as a centre of a rich silver mining region. It lost importance with the decline of silver production in the 19th century but regained status with the rise of tin mining, as this ore is abundant there. Wolfram and copper are also worked in the district. Oruro is hub of the Bolivian railway system and lies 141 mi. from La Paz, 131 mi. from Cochabamba and 575 mi. from Antofagasta, Chile. (J. L. Tr.)

ORVIETO (anc. *Volsinii* [*q.v.*], later *Urbs Vetus*, whence the modern name), town and episcopal see, province of Terni, Italy, on the Pagiia, a trihutary of the Tiber, 78 mi. S.W. of Rome by rail. Pop. (1957 est.) 25.050 (commune). It crowns an isolated rock, 1,033 ft. above sea level, 640 ft. above the plain, commanding splendid views, and is approached by a funicular railway. The town has a number of 13th-century houses and palaces. The splendid cathedral dedicated to the Virgin was begun at least as early as 1288 on the site of two older churches erected to commemorate the miracle of Bolsena (*q.v.*). The west facade, of richly sculptured marble from the designs of Lorenzo Maitani of Siena, is divided into three gables with intervening pinnacles. The four wall surfaces that flank the three western doorways are decorated with beautiful sculpture in relief, executed under Maitani's direction until his death in 1330. In the interior, the Cappella del Corporale possesses a large silver shrine, resembling the cathedral façade, enriched with countless figures in relief and subjects in translucent coloured enamels. It was begun by Ugolino Vieri of Siena in 1337, and was made to contain the Holy Corporal from Bolsena (*q.v.*). On the south side is the chapel of S. Brizio. The walls and vault are covered with frescoes—the works of Fra Angelico and Luca Signorelli, painted 1499 to 1504—the latter being of especial importance because of their great influence on Michelangelo in his early days. The choir stalls are specimens of *tarsia* and rich wood carving—the work of Pietro del Minella (1430–41). The cathedral is especially rich in 16th-century sculpture, containing many statues; groups and altar reliefs by Simone Mosca and Ippolito Scalza. The Palazzo dei Papi (1264–1302) contains the Museo Civico, with various medieval works of art, and also objects from the Etruscan necropolis of the ancient Volsni (q .. The Palazzo Faina has another interesting Etruscan collection. The church of S. Domenico contains one of the finest works in sculpture by Arnolfo di Cambio, the tomb with recumbent effigy of the Cardinal de Braye (1282). There are a few buildings by Sammicheli of Verona, architect of the cathedral from 1509 to 1528. The well, now disused, called Il pozzo di S. Patrizio, is one of the chief curiosities of Orvieto. It is zoo ft. deep to the water level and 42 ft. in diameter, cat in the rock, with a double winding inclined plane, so that asses could ascend and descend to carry the water from the bottom. It was begun by the architect Antonio da San Gallo the younger in 1527 for Clement VII and was finished by Simone Mosca under Paul III. *See* Umbria. (T. A.; X.)

ORWELL, GEORGE (pseudonym of Eric Arthur Blair) (1903–1950), English writer whose satirical novels *Animal Farm* and *Nineteen Eighty-Four* are reminiscent of Jonathan Swift in their savage anger and love of liberty, was born at Motihari, Bengal, in 1903. From a preparatory school which, he later claimed, determined his views on the English class system, he won a scholarship to Eton. From 1922 to 1927 he served in the Indian imperial police in Burma. Xfter returning to Europe, he lived in great poverty in Paris and London, and described his experiences in his first hook, *Down and Out in Paris and London* (1933) and in *The Road to Wigan Pier* (1937). He was exceptional among writers of his generation in deliberately living under the social conditions he wrote about.

This singleness of purpose in pursuit of his material and the uncompromising honesty which marked him both as a man and a writer made Or\\-ell sharply critical of intellectuals whose political attitudes seemed to him dilettante. Thus, though a writer of the left, he wrote the most savage criticism of his generation against left-wing writers, and his anti-Communism resulted from experience of Communism and its methods acquired while fighting in the Spanish civil war, and described in *Homage to Catalonia* (1938). From this period also derived both the anti-Stalinism expressed in his fantasy *Animal Farm* (1945) and the distrust of all political parties which inspired *Nineteen Eighty-Four* (1949), an elaborate satire on modern politics prophesying a world perpetually laid waste by warring dictators. His best work was always based on experience and the lessons he had learned from it.

While teaching in private schools and working in a London bookshop and in a village store (1933–35), Orwell was gradually making a literary reputation. Xfter returning from Spain, he lived in Hertfordshire, writing, raising hens and growing vegetables. Rejected as unfit ior service in World War II, he joined the B.B.C.'s Indian service. He died in London, Jan. 21, 1950.

As a prose writer, Orwell is in the radical tradition of Defoe and Cobbett. His criticism (*Critical Essays*, 1946) is revealing and enjoyable. In his essays (*Shooting an Elephant*, 1950, etc.) he shows lightness and grace. (S. H. Sr.)

ORYX, the name of a genus of African antelopes of large size, with long horns present in both sexes, and long tuited tails. They are desert animals. The true oryx is the east and northeast African beisa oryx (*Oryx beisa*), which is replaced in south Africa by the gemsbok (*q.v.*). In northern Africa the group is represented by the scimitar-horned oryx, *O. algazel*, and in Arabia by the very pale *O. leucoryx*. *See* Antelope.

ORZESZKOWA (*née* Pawlowska), **ELIZA** (1842–1910), Polish novelist, born near Grodno, of the noble family of Pawlowski. In her 16th year she married Piotr Orzeszko, a Polish nobleman, who was exiled to Siberia after the insurrection of 1863. She wrote a series of powerful novels and sketches, aealing with the social conditions of her country. *Eli Makower* (1875) describes the relations between the Jews and the Polish nobility, and *Meir Ezofowicz* (1878) the conflict between Jewish orthodosy and modern liberalism. *On the Niemen* (1888), perhaps her best work, deals n-ith the Polish aristocracy, and *Lost Souls* (1856) and *Cham* (1888) are on rural life in White Russia. She died at Grodno on May 18, 1910.

OSAGE, a Siouan-speaking tribe related to the Omaha, Ponca, Kansa and Quapaw. Like other members of this subgroup, they have traditions of an early home in the lower Ohio valley. By 1673 they were living in the Ozark plateau and the prairies of whnt is now western Missouri, with their villages on the Osage river. Intrigues of rival fur traders in the early 19th century split the tribe, part of which moved to the Arkansas river in Oklahoma, hut both factions later united on a reservation established for them in Kansas. In 1872 they were moved to a new reservation in Oklahoma, comprising the present Osage county.

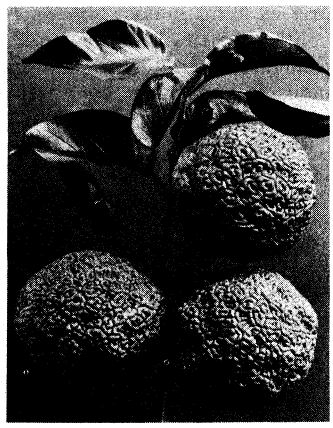
Their culture was of the prairie type, marked by the characteristic alternation of village agriculture and buffalo hunting. Other important game animals were deer, bear and beaver. The villages consisted of longhouses, covered with mats or skins, and arranged irregularly about an open space used for dances and council meetings. Tepees were used during the hunting seasons. Social organization was very similar to that of the Omaha (*q.v.*), with patrilineal clans grouped into moieties symbolizing earth and sky. However, Osage ceremonies were more elaborate and played a greater role in tribal life; and their earth moiety included two subdivisions symbolically representing dry land and water. Each moiety had a hereditary chief concerned with enforcing peace within the tribe.

Even before the discovery of oil on their reservation at the beginning of the 20th century, the Osage were the wealthiest Indian tribe in the United States. Their allotment act, passed in 1906, included a provision that all mineral rights on the reservation remain tribal property, with royalties divided on a per capita basis. As a result, they have become one of the richest communities in the world.

In the early 1960s the Osage numbered about 4,900. See also PLAINS INDIANS.

See Francis La Flesche, "The Osage Tribe: Rite of the Chiefs; Sayings of the Ancient Men," *36th Annual Report* of the Bureau of American Ethnology, pp 39–597 (1921); Carl H. Chapman, "Culture Sequence in the Lower Missouri Valley," in *Archaeology of Eastern United States*, ed. by James B Griffin (1952). (CH C.)

OSAGE ORANGE (*Maclura pomifera*), a thorny tree with large, yellowish-green, somewhat orangelike fruit. The tree, which is the only species of its genus, belongs to the mulberry family (Moraceae). It is native to rich soils in the south central United States from Missouri and Kansas to Texas, but has been planted extensively in the Mississippi valley and occasionally in the eastern states. being hardy in New England. The very hard. strong, flexible, yellow wood. formerly used for bows and war clubs by the Osage and other Indians west of the Mississippi, is utilized for railway ties (sleepers) and fence posts.



J HORACE MCFARLAND CO

OSAGE ORANGE (MACLURA POMIFERA), FOUR TO FIVE INCHES IN DIAMETER

Osage orange is also known as bowwood and as ***bois*** d'arc. The wood yields a yellow dye principle.

OSAGE RIVER, the largest tributary of the Missouri river (*q.v.*) in Missouri, rises as the Marais des Cygnes in the Flint hills near Eskridge, Kan. It becomes the Osage after junction with the Little Osage in Missouri, then flows east through the Ozark highlands to its mouth near Jefferson City. In the Ozarks it has deeply intrenched meanders with a relative relief of 200 to 400 ft., but in Kansas meanders are not intrenched and relief is less. The Osage is 500 mi. long, drains 15,300 sq.mi. and has an average discharge of 9,000 cu.ft. per second near Bagnell dam about 100 mi. above the mouth, with peak flows from March to June. The major tributaries are the Pomme de Terre and Niangua. In Lake of the Ozarks, covering 93 sq.mi. and lying equidistant from St. Louis and Kansas City, it has one of the best known and most scenic recreation areas in Missouri. Nearby are the famous Hahatonka limestone caverns. Bagnell dam, which impounds the lake. was built (1931) to produce electricity for the St. Louis power system. Normal annual production in the late 1950s was 440.000.000 kw.hr. In the 1954 Flood Control act the U.S. congress authorized an Osage basin flood control, water conservation, recreation and power plan involving four reservoirs in Missouri and five in Kansas. (D. S. ST.)

ŌSAKA, Japanese urban prefecture (*fu*) located at the eastern end of the Inland sea. Area: 699 sq.mi., pop. (1960) 5,504,746. Its main part is a delta plain formed by the Yodo and Yamato rivers and almost encircled by low mountain ranges. Prefectural life is dominated by Osaka. Japan's second largest city and one of its most diversified industrial centres. Around it are industrial satellite cities like Sakai. Fuse (*qq.v.*), Kishiwada and Kaizuka and residential satellites like Toyonaka and Suita. Steadily shrinking agricultural areas are cultivated intensively, producing cut flowers, vegetables and fruits. (J. D. EE.)

ŌSAKA, Japan's second largest city, one of its two greatest commercial and industrial centres. and capital of Osaka urban prefecture. It is located on the delta of the Podo river at the head of Osaka bay (eastern Inland sea) only slightly above sea level. It is so intersected by river distributaries and canals that hundreds of bridges are employed to link parts of the city. Osaka occupies one of the longest settled sites of western Japan and for centuries (known as Naniwa) was the main port serving the interior capital cities of Nara and Kyoto. Its growth was checked by the rise of port and trading facilities at Sakai, to the south. However, the powerful general, Toyotomi Hideyoshi, selected Osaka as his headquarters and in 1583 built a powerful castle on an elevated terrace slightly inland from the coast, protected by massive stone walls and broad moats. Destroyed by fire in 1868, the castle was later recreated in reinforced concrete form and towers above the modern city centre. During the feudal (Tokugawa) ern, Osaka became Japan's key commercial city, serving as the collection point for rice, other foodstuffs and raw materials destined for shipment to Edo (modem Tokyo), Kyōto and other large cities. The influence of the rich merchants who handled this business extended throughout Japan. Osaka suffered a momentary setback with the crumbling of the feudal order and the inadequacy of its shallow port to accommodate large ships. Yet, the rapid development of an outport, Kōbe (16 mi. A'.), opening of the national mint (1871), stock exchange, commercial colleges, and continuation of the famous Dojima rice exchange helped Osaka move into modern commercial life. Turning to industry, the city initially became Japan's leading cotton textile producer and after World War I, expanded into heavy industrial products. .Amalgamation of adjacent areas and in-migration caused the population to grow from about 50.000 in 1895 to 3,250.000 in 1940, second only to Tokyo. Badly damaged in World War II, it was slow to recover, and the 1960 census gave a population of 3,011~563. Deterrents to more rapid rehabilitation were the loss of continental Asian markets on which much of Osaka's business depended, powerful central government controls that encouraged industrial location in the competing Tokyo-Yokohama area, and absorption of some of its prewar population by adjacent cities.

Although still a great cotton textile centre, Osaka turns out a variety of other manufactures. Metals (steel), machinery, chemicals, ships, electrical equipment and cement are typical specialties. The city's commercial core is near the castle. while industry has concentrated heavily on waterfront reclaimed land and lowlands along the Yodo river. Osaka is the industrial nucleus of a broader industrial belt that extends westward from the Hyōgo cities of Kōbe, Nishinomiya and Amagasaki. south through Sakai, Kaizuka and Kishiwada. and inland through a host of industrial and residential satellite cities. Similarly, Osaka serves as the financial and commercial capital of western Japan, noted for its large banks. trading firms, department stores and wholesale outlets. It is also the location of Osaka university and prefectural library. Osaka's modern rise has been paralleled by improvements in its port, which is entirely artificial. Dredging permits the entry of 10,000-ton ships to the industrial heart of the city. The city's airport is at Itami, nine miles to the northwest. (J. D. EE.)

OSAWATOMIE, a city of Miami county in eastern Kansas, U.S., is located about 45 mi. S.S.W. of Kansas City on the Marais des Cynges river at the mouth of Potawatomie creek. It is near oil and gas fields in the centre of an agricultural region which produces beef and dairy cattle, corn, wheat, oats and fruit.

Founded in 1854 with support of the Massachusetts Emigrant Aid company, Osawatomie was the site for John Brown's free-state operations in Kansas territory. In retaliation for Brown's slaying of iour prosouthern settlers at Potawatomie creek. the Abolitionist stronghold was invaded on Aug. 30, 1856. by a party of about 250 Missourians. Brown and 30 of his followers were dispersed, and the town was ransacked and burned. 'I'lie 23-ac. John Brown State park located there commemorates this skirmish and Brown's career. Osawatomie, a word which combines the names of the Osage and Potawatomi Indians, was incorporated in 1883. Its population grew to between *4,000* and *5,000* by *1900* and remained fairly steady thereafter. (C. N. GL.)

OSBORN, HENRY FAIRFIELD (1857–1935), *C.S.* paleontologist and for many years president of the American Museum of Natural History. for whose rise to a high level in eshibition. public education and research activities he was largely responsible, was horn at Fairfield. Conn., Xug. *8,* 1857. Before graduating from Princeton in *187;.* he and his friend William Berryman Scott led a fossil collecting expedition to Wyoming. and both determined to take up a career in vertebrate paleontology. Both went abroad for graduate study. and both returned to Princeton. Scott as professor of geology. Oshorn as professor of natural history and anatomy. In 1891 Osborn moved to New York. where he became curator of vertebrate paleontology in the American Museum of Natural History and professor in the newly organized department of zoology at Columbia university. Although he served for a short time as dean of the faculty of pure science. arid retained a research professorship until his death. his connection with the university gradually slackened. and his interests were concentrated on the museum. He became its president in 1908. Despite his engagement in administrative affairs. he continued active work in vertebrate paleontology, and in addition to his own work built this museum department into an outstanding research centre with the world's largest and most important collection of fossil vertebrates. His publications on fossil vertebrates. particularly mammals. were numerous and important. Among his major works were: *From the Greeks to Darwin* (1894); *Evolution of Mammalian Molar Tzetk* (1907); *The Age of Mammals* (1910); *Men oi the Old Stone Age* (1915); *Origin and Evolution of Life* (1917): *Man Rises to Parnassus* (1927); *The Titanotheres of Ancient Wyoming, Dakota and Nebraska* (1929); *Proboscidea,* 2 vol. (1936–1942). Osborn was interested in evolutionary processes. but his ideas on "aristonenesis" and kindred themes are incompatible n-ith modern knowledge of hereditary processes and have met with little acceptance.

Osborn died Nov. 6, 1935.

See obituary by William King Gregory (with portrait) in *Biogr. Mem. Sat. Acad. Sci.,* vol. xix, no. 3, pp. 53–119 (1938).
(A. S. RR.)

OSBORNE, a former royal residence in the Isle of Wight, Eng.. southeast of East Cowes. The name of the manor in early times is quoted as Xusterborne or Oysterborne. In 1845 it was purchased by Queen Victoria. who died there in 1901. King Edward VII presented the property to the nation. A part of the house was transformed into a convalescent home for officers of the navy and army. opened in 1904. In 1903 there was opened on the Osborne estate a Royal Naval college. which in *1921* was closed down: the cadets thenceforward joined Dartinouth college.

OSCAN was one of the Italic dialects (*q.v.*); the name was given by the Romans to that dialect (*lingua Osca*) which they found spoken by the Osci of Campania. Inscriptional and other records (*i.e.,* local and personal names and glosses in ancient authors) manifestly of the same dialect have been found in Canipania, where the dialect was probably not original but imposed upon the Oscans by Samnite invaders in the jth century B.C. Records have also been found in other areas: further south. namely in northern Apulia. Lucania. in the country of the Bruttii (the "toe" of Italy), and even in the northeast angle of Sicily at Messana (the modern Messina), which was captured by the Campanian Mamertines *c.* 289 B.C.; in Samnium proper. including the territory of the Frentani and Hirpini; and finally. farther north, in the country of the Paeligni. Marrucini and Vestini. Thus there are distinguished, geographically, and dialectally, three main groups of Oscan: (1) Central Oscan of Campania and the Samnite tribes. (2) Southern Oscan. and (3) Southern Oscan. These are all closely related to one another as compared with the dialect. of the Volsci and of the Umbrian townships (Iguvium, the modern Gubbio; Tuder. niodern Todi; and one or two others); while Oscan. Volscian and Umbrian. taken together, make one of the two great divisions—the other being Latiri (*q.v.*) with Faliscan—into which the Italic branch of the Indo-European family of languages falls. Since the Samnitic tribes, whose expansion by successive migrations—"sacred springs" as they were called—diffused the Oscan speakers from their home in central Italy, knew their land (in Latin, Samnium) by the name *Safinim,* it has been proposed to describe their dialects as "Safine." a title at once more comprehensive and historically truer than "Oscan." The stock to which the Samnites belonged used commonly a suffix *-no-* (*e.g.,* in *Sabi-ni*) to form their tribal names. as distinguished from the suffixes *-co-* and *-(a)ti-* of an earlier stratum of population (*e.g.,* in *Vols-ci, Tea-te*). In names like *Marru-ci-ni, Ardea-ti-ni,* the superimposed *-no-* suffix hears witness to a conquest or overlordship of the earlier by the later stock.

Until the Roman advance gradually replaced it by Latin—important stapes of this advance are marked not so much by the three Samnite wars as by the destruction of Capua in 211 B.C. and the Social War of 91–89 B.C.—Oscan held its place as a language in recognized official and educated usage side by side with. or instead of. Latin or Greek. The poet Ennius is said tn have spoken all three tongues (Gellius 17,17,1). and if Strabo (j. p. 233 C) may be trusted. the rude farces or puppet-shows introduced from the Oscan town Atella (*fabulae Atellanae, ludi Osci*) were actually performed at Rome in Oscan. The latest Oscan inscriptions, painted on the walls of houses at Pompeii, were written shortly before the eruption of Vesuvius which overwhelmed that city in A.D. 79, and it is probable that the dialect. which has left its mark on modern south Italian dialects. survived in remote country districts as a local patois for some time longer. None of the Oscan inscriptions. on the other hand. is older than the jth century B.C.

Many of the inscriptions are carefully. indeed almost with phonetic accuracy. written in a native alphabet which was itself derived. with certain necessary modifications. from the Etruscan alphabet; but a few belonging to the southern group, and including all those from Sicily. are in the Greek. and some from Lucania and else\\-here in the rustic or Colonial Latin alphabets. Over 250 in nuniher, the majority are quite short: nevertheless, they furnish material; adequate to give us a fairly complete conspectus of the dialect. About two-thirds of the whole come from Campania. and most of those from Capua and Pompeii.

In character they fall mostly into the following classes: (1) official documents—municipal regulations (Bantia). a, treaty (Nola and Abella), inscriptions relating to public works (Pompeii and elsen-here); (2) religious—a1l inventory of statues and altars in a sacred grove at Agnone (Samnium). the interesting group of heraldic *iovilae* (*q.v.*) from Capua, recording or prescribing special ceremonies connected with family cults, numerous simple votive and dedicatory inscriptions: (3) military and election announcements (from Pompeii); (4) private documents—epitaphs. bricks inscribed with names. and (from Campania) a few belonging to the interesting group of curses, inscribed on lead and deposited in tombs: (5) coin legends, including those of the Social War reading *vítelliú, i.e.,* "Italia."

Oscan hss many peculiarities which distinguish it from Latin in sound changes, word forms and vocabulary; in syntax the differences are much less marked. But it also possesses certain features which distinguish it amongst the Italic dialects themselves. Their nature and extent may be indicated roughly by a specimen text (on a sundial found at Pompeii):

mr atiniis nir kvaísstur eítiuvad
múltasíkad kúmbennieís tangi(nud)
aamanaffed

This in Latin would be:

M(a)r(a) Atinius M(a)r(ae) (filius) quaestor pecunia
multaticia conventus scitu
fieri iussit

(Mara Atinius. son of Mara, quaestor, in accordance with a decree of the assembly, had this set up from fine-money.)

See also references under "Oscan" in the Index volume.

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OSCAR I (1799–1859), king of Sweden and Norway, was the son of General Bernadotte, afterward Charles XIV. In 1838 the king began to suspect his heir of plotting with the Liberal party to effect a change of ministry, or even his own abdication. But Oscar avoided an actual rupture. After his accession (March 8th, 1844) it seemed his liberalism was very restricted. He refused any radical reform of the cumbrous, obsolete constitution. But one of his earliest measures was to establish freedom of the press. Most of the legislation during his reign aimed at improving Sweden's economic position. In foreign affairs Oscar I was a friend of the principle of nationality. He supported Denmark against Germany (1848); placed Swedish and Norwegian troops in cantonments in Fünen and North Schleswig (1849–1850): and mediated the truce of Malmö (Aug. 26. 1848). He was one of the guarantors of the integrity of Denmark (London protocol, May 8, 1852). Oscar I left four sons. of whom two, Carl (Charles XV) and Oskar Fredrik (Oscar II), succeeded to his throne. *(See* also NORWAY: *History;* SWEDEN: *History.*)

OSCAR II (1829–1907), king of Sweden and Norway, son of Oscar I, was born at Stockholm on Jan. 21, 1829. In 1857 he married Princess Sophia Wilhelmina, youngest daughter of Duke William of Nassau. He succeeded his brother Charles XV on Sept. 18. 1872, and was crowned in the Norwegian cathedral of Trondheim on July 18. 1873. At his accession he adopted as his motto *Brödrafolkens Väl,* "the welfare of the brother folk." and from the first he realized the essential difficulties in the maintenance of the union between Sweden and Norway. The political events which led up to the final crisis in 1905, by which the thrones were separated, are dealt with in the historical sections under NORWAY and SWEDEN. But it may be said that the peaceful solution eventually adopted could hardly have been attained hut for the tact and patience of the king himself. He declined, indeed, to permit any prince of his house to become king of Norway, but better relations between the two countries were restored before his death, which took place at Stockholm on Dec. 8, 1907. His acute intelligence and his aloofness from the dynastic considerations affecting most European sovereigns gave the king considerable weight as an arbitrator in international questions. At the request of Great Britain. Germany and the United States in 1889 he appointed the chief justice of Samoa, and he was again called in to arbitrate in Samoan affairs in 1899. In 1897 he was empowered to appoint a fifth arbitrator if necessary in the Venezuelan dispute, and he was called in to act as umpire in the Anglo-American arhitration treaty that was quashed by the senate.

Himself a distinguished writer and musical amateur, King Oscar was a generous friend of learning and of education. His works. which included his speeches. translations of Herder's *Cid* and Goethe's *Torquato Tasso,* a play, *Castle Cronberg,* poems and historical works, were collected in 1875–76 (new and enl. ed., 1885–88). His *Memoirs of Charles XII* were translated into English in 1879.

OSCEOLA (c. 1804–1838), a Seminole American Indian, leader in the second Seminole War, was born in Georgia, near the Chattahoochee river. His father was an Englishman named William Powell; his mother a Creek of the Red Stick or Mikasuki division. In 1808 he moved with his mother into northern Florida. When the U.S. comniissioners negotiated with the Seminole chiefs the treaties of 1832–33 for the removal of the Seminoles to Arkansas, Osceola seized the opportunity to lead the opposition of the young narriors. and declared to the U.S. agent, Gen. Wiley Thompson. that any chief who prepared to remove would be killed. Late in 1835 he murdered Charley Emathla (or Emartla), a chief who was preparing to emigrate with his people, and with a few companions shot and killed Gen. Thompson.

In 1836 Generals Edmund P. Gaines (1777–1849), Winfield Scott (1786–1866) and Richard K. Call (1791–1862) waged war against them with little effect?and the year closed with General Thomas Sidney Jesup (1788–1860) in command with 8,000 troops at his disposal. General Jesup drove the enemy from the Withlacoochee country and was pursuing them southward toward the Everglades when several chiefs expressed a readiness to treat for peace. On March 6, 1837, they agreed to cease hostilities, to prepare for emigration to Arkansas, and gave hostages to bind them to their agreement. But on June 2 Osceola came to the camp at the head of about 200 Mikasuki (Miccosukees) and effected the flight of all the Indians there, about 700 including the hostages, to the Everglades. Hostilities were then resumed. but in September, after the capture of several chiefs, Osceola requested an interview. This was granted, and by command of General Jesup he was taken captive and carried to Fort Moultrie, at Charleston, S.C., where he died in January. 1838. The war continued until 1842, but after Osceola's death the Indians did little but attack the unarmed inhabitants.

See J. T. Sprague, *The Origin, Progress and Conclusion of the Florida War* (1848).

OSCHERSLEBEN, a town of Germany in the district of Magdeburg, on the Bode. 19 mi. by rail W.S.W. of the city of Magdeburg, and at the junction of lines to Halberstadt and Jerxheim. Pop. (1959 est.) 19,126. Oschersleben is first mentioned in 803. Among its industrial establishments are sugar refineries, iron foundries. breweries, machine shops and brick works.

OSCILLATOR, in electrical engineering, is a device which generates electrical oscillations. One of the more common applications of such oscillators is the production of high-frequency carrier signals in radio transmission. *See* BROADCASTING: *The Broadcast Transmitter;* RADIO RECEIVER: TRANSISTOR.

OSCILLOGRAPH. An oscillograph is an electromechanical device used for recording such electrical oscillations as alternating-current wave forms. An early practical version, the Duddell bifilar string oscillograph (1893), long served as the model for similar instruments. Basically. it consisted of a pair of series-connected wires running parallel between the pole pieces of a powerful permanent magnet.

Current under study imposed torque on the pair of wires by generating around them a variable magnetic field which interacted with the uniform field from the permanent magnet. Changes in the magnitude and direction of this twisting force on the wires were proportional to variations in the amplitude and direction of the current. These changes were recorded on moving photographic film with a narrow beam of light reflecting from a tiny mirror cemented to the wires. A reliable time base for the record was provided by moving the film at constant speed.

The developed film provided a permanent record of the instantaneous variations in amplitude and direction of the current relative to time. With the film at a reasonable distance, even minute deflections of the mirror were readily discernible.

The rigidly suspended pair of wires and the mirror constituted a natural vibratory system when current flowed, and the system was damped by immersion in an oil bath. Because of the mass of the vibratory system, the instrument was limited to currents of relatively low frequency (approximately 100 cycles per second).

Modern oscillographs and such related instruments as the recording voltmeter. recording current meter and process recorder produce continuous ink records of a variety of cyclic electrical and mechanical phenomena on strips of paper moving at constant speed. Mechanical oscillations (acoustical vibrations, for example) are readily converted to electrical oscillations with suitable transducers (*see* MICROPHONE).

One or more inked pens trace the pattern of change on the moving paper. Usually, each pen is activated by a current-carrying coil, or a moving vane. immersed in a steady magnetic field. As in a galvanometer, the coil carries the current being investigated and moves under the influence of the magnetic fields active in the system. In moving vane instruments. the current to be examined flows through coils mounted on the permanent. magnet and magnetizes the vane. causing it to move in the field.

Modern oscillographic devices function over a greater frequency range than was available with earlier instruments and. depending on their design, can record oscillations ranging from D.C. fluctuations up to those of about 2.000 cycles per second. Ordinarily, it is feasible to record complex wave forms only when their fundamental frequencies are substantially below the 2.000-cycle limit because of possible distortion of higher frequency harmonic components. The natural vibration frequency of the drive mechanism is another limiting factor. The highest frequency to he recorded should be well below the natural vibration frequency of the drive system. To achieve the desired sensitivity, some of these devices are equipped with calibrated electronic amplifiers.

Each drive system and its recording mechanism constitute an element or a channel. Commercial devices are available as single channel and multichannel units. Each channel can function independently. permitting a numher of phenomena to be recorded concurrently. as in the electroencephalograph and in the polygraph used in lie detection.

For additional applications of oscillographic devices and more details regarding the principles by which they operate *see* EPILEPSY: INVESTIGATION. CRIMINAL: *Detection of Deception;* HEART. COMPARATIVE PHYSIOLOGY OF; CATHODE-RAY OSCILLOSCOPE: INSTRUMENTS. ELECTKICAL MEASURING. (J. F. RR.)

OSCILLOSCOPE: *see* CATHODE-RAY OSCILLOSCOPE; OSCILLOGRAPH.

OSEE, PROPHECY OF: see HOSEA: BOOK OF.

OSH, a town of Asiatic Russia. in the Kirghiz S.S.R. in 40° 3j' S..72° 55′ E., 31 mi. S.E. of Andijan railway terminus. at an altitude oi 4,030 ft. Pop. (1959) 65.000. It is on the Xk-bara river. a tributary of the Kara-Su. in a fertile cotton. grain and iruit growing valley leading to the Alai and Pamir. The famous Takht-i-Suleiman (Solomon's Throne) rock, the theme of so many Eastern legends, is near the town and is irequented by pilgrims.

O'SHAUGHNESSY, ARTHUR WILLIAM EDGAR (1844–1880), English poet. was born in London on March 14, 1844, and at 1; became a copyist in the library of the British Museum. Later. he specialized in ichthyology. He published his *Epic of Women* in 1870. *Lays of France*, a free version of the *Lais* of Marie de France. in 1872, and *Music and Moonlight* in 1874. He died on Jan. 30. 1880, his *Songs of u Worker* appearing immediately afterward. In Palgrave's words. he had "a haunting music all his own."

OSHAWA, a manufacturing city and port of entry in Ontario county, Ontario, Can., on the north shore of Lake Ontario: 30 mi. E.N.E. of Toronto. Founded as a settlement on the military Kingston road in 1795 and named Oshawa in 1842 with the establishment of a post office. it was incorporated as a town in 1879 and city in 1924. Pop. (1961) 62.413'. Principal manufactures include automobiles. trucks and auto parts; foundry products, fabricated metals. stampings and machine parts: glass. plastics, textiles and pharmaceuticals; furniture, kitchen equipment. leather and cement products. In the 1960s over 85% of the homes in Oshawa were owner occupied. The city has good public and parochial. schools. a public library, a general hospital, many parks and recreational areas, golf courses and a municipal airport.

(F. G. R.)

O'SHEA, WILLIAM HENRY (1840–1905) and **KATHARINE** (1845–1921), whose connection with the Irish politician: Charles Stewart Parnell (*q.v.*) brought about his downfall. William Henry O'Shea was the only son of a Dublin Catholic solicitor. Henry. Educated at Oscott and at Trinity college. Dublin, he became a cornet of the 18th hussars in 1858, and was retired as captain in 1862. In 186;. he married Katharine. sixth daughter of Rev. Sir John Page Wood. Bart.. of Rivenhall place. Essex. They had one son. Gerard. and two daughters.

O'Shea was elected M.P. for Clare, and supported Parnell ior the leadership of the Irish Nationalist party in 1880. It is not clear when he became aware of the existence of intimate relations between his wife and Parnell. though he subsequently alleged that only his wife's intercession prevented a duel in 1881. O'Shea seems to have been perpetually in financial embarrassment. and forever involved in schemes to get out of it. On four occasions. his intervention in the political activities of the Parnellite party had decisive results on public opinion. In 1882, he claimed credit as unofficial intermediary in negotiating the Kilmainham treaty. Discrepancies revealed publicly in significant documents thereafter led Parnell to distrust him. In 188j. he claimed to have negotiated an agreement between Parnell and Joseph Chamberlain (*q.v.*) for a local government scheme in substitution for Home Rule. Not until 1888 did Chamberlain realize that O'Shea's version. if published, would damage him. After 1885 O'Shea attached himself to Chamberlain and used this contact to secure Parnell's support for his candidature at Galway in 1886. The publicity directed on this occasion to the relations between Parnell and Mrs. O'Shea led her husband to align himself with Chamberlain. and like him he failed to support the Home Rule bill. 'Thereafter O'Shea resigned his seat in the house of commons. Subsequently he gave evidence in favour of the authenticity of Parnell's signature to the forged Pigott letter in the special commission inquiry into Parnellism and crime.

On the death of Mrs. Benjamin Wood. the aunt with whom Mrs. O'Shea resided; her will. by which her considerable property was left to her niece, was contested by O'Shea among others; hut this secured him little financial advantage. The divorce action in which Parnell was named as corespondent was not defended lest any suggestion of collusion might lead the queen's proctor to intervene. thus preventing the subsequent marriage of Mrs. O'Shea with Parnell. The divorce proceedings destroyed Parnell's political career. but also terminated that of O'Shea. who after 1890 retired to Brighton, where he died on April 22. 1905. Mrs. Parnell's reminiscences, published in 1914, included material relating to O'Shea. inserted at the instance of their son: Gerard. 'The composite nature of this publication was not fully recognized until, after Mrs. O'Shea's death in 1921, there appeared the publications of Capt. Henry Harrison. (R. D. Es.)

OSHIMA, a group of three small islands helonging to Japan, lying southward of Kyushu, in 30° 50′ N. and 130° E. Their names, from west to east, are Kuro-shima, Io-Jima and Takeshima. Kuro-shima rises to a height of 2,041 ft., and Io-Jima has an active volcano 2,309 ft. high. These islands are not to be confounded with Oshima. the most northerly island of the Izu-noshichito, or with the northern group of the Luchu Islands.

OSHKOSH, a city of eastern Wisconsin, U.S., is located about 80 mi. N.N.W. of Milwaukee on the west shore of Lake Winnebago at the mouth of the Fox river; the seat of Winnebago county. The French were active in the area from the late 17th century, and from an early date Lake Winnebago and the Fox river formed an important link in one of the main routes from the Great Lakes to the Mississippi.

Although there was sporadic occupation earlier, permanent American settlement did not begin until 1836; the year the Menominee Indians ceded their claims to the area. At first the town was called Athens, but in 1840 it was given the name of Oshkosh in honour of a friendly Menominee chief. It was incorporated as a village in 1846 and as a city in 1853. In 1957 it adopted a council-manager form of government. In its early years lumbering was the main occupation, but other industries moved in later. Manufactures include finished wood products. luggage, machinery, trucks and processed foods. It is the site of Wisconsin State college. Oshkosh, founded in 1871 as State Normal school. For comparative population figures *see* table in WISCONSIN: *Population.* (RE. H.)

OSHOGBO, the capital town since 1951 of the Oshun division of the Western Region of Nigeria, Africa, lies at 1,025 ft. on the Oshun river between forest and savanna. 182 mi. by rail northeast from Lagos. Pop. (1960 est.) 140.997 (African pop.). The town hall and the Central mosque stand at the Oba's market in the centre of the town. There are a government trade centre. eight churches and 42 schools including a grammar school and several teachers' training colleges. The town, which has piped water and electricity, stands at a trunk road junction and has been on the main railway since 1906. The airport, five miles distant, is served weekly by internal airlines. The people are chiefly occupied in trading and farming. Local industries include dyeing and weaving and there is a cotton-ginning plant.

Settlers from Ibokun. headed by the Owa Olaage, founded Ipole, 5 mi. from Oshogbo, but were driven from there by the drying up of the Omu river. Led by Laro. they settled at Ita-Ohuntoto. on the Oshun. from where they were eventually driven by floods. They called their new settlement, at the crossroads, Oshogbo which means "the town that serves as a link to other towns." The Oshun river has much influence on the life of the people and is worshiped at an annual festival in August. Two shrines are connected with this worship, the Ile Oshun. at the Oba's market, in which are stored the idols of this cult, and the Ojubo Oshun, on a bend of the river at the earlier site. which is the centre of the worship. Both are smeared with chalk and camwood. Among the idols is the wooden image of a woman who sold victuals at the crossroads to travelers and whose spirit was associated with the Oshun. The oba holds the title Xtaoja ("he who stretches out his hand and takes the fish") first given to Laro. who fed the fishes and in return received from them a liquid held as efficacious against sterility in women. The position of the town at the edge of the forest protected it from the attacks of northern horsed armies, but the military support given during the 19th century by the more powerful Ibadan resulted in the exaction by that town of a tribute (discontinued in 1951) from the people of Oshogbo. (S. Ad.; M. O. A.)

OSIANDER, ANDREAS (1498–1552). German theologian, a hrilliant, original and erratic Lutheran reformer and ancestor of a long line of eminent theologians and scholars: was born on Dec. 19, 1498, at Gunzenhausen. Brandenburg, the son of a blacksmith. He was educated at Leipzig. Altenburg and the University of Ingolstadt. Ordained priest in 1520, he helped reform the imperial free city of Niirnberg on strictly Lutheran principles. He won Albert von Hohenzollern, grand master of the Teutonic Knights, for the Lutheran movement (1522); helped write the influential Brandenburg-Niirnberg Church Order (1532); drafted the preface to Nicholas Copernicus' *De revolutionibus orbium* (1543) that kept this work off the Index of Prohibited Books until the next century; and compiled the liturgically very conservative Pfalz-Neuburg Church Order (1543). In 1548, when the emperor compelled Nürnberg to accept the Augsburg Interim. Osiander fled. first to Rreslau (Wroclaw), then to Königsberg (Kaliningrad), where, despite his lack of a theological degree, he was appointed professor primarius of the new university's theological faculty (1549) The envy of his colleagues and his own refractory personality combined to produce a violent theological controversy (1550). One Lutheran faculty and synod after the other pronounced against Osiander's depreciation of the "forensic" element in the justification of a sinner and his exaggerated stress on the indwelling of the "essential" righteousness of Christ's Godhead as the principal factor.

Osiander died Oct. 17, 1552, while the controversy was still going on.

The two works in which Osiander set forth the characteristic features of his system most fully are *An filius dei fuerit incarnandus si peccatum non introvisset in mundum, item de imagine dei* (1550) and *Von dem einigen Mittler Jesu Christo und Rechtfertigung des Glaubens* (1551).

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OSIER, the common term under which are included those species, varieties and hybrids of the genus *Salix* used in the manufacture of baskets (*q.v.*). The chief species in cultivation are: *Salix viminalis* (the common osier), *S. triandra, S. amygdalina, S. purpurea* and *S. fragilis,* which botanically are willows. The first named. with about 40 of its varieties, formerly comprised the staple basket-making material in England. It is an abundant cropper. sometimes attaining on low-lying soils a height of 13 ft. Full topped and smooth, it is by reason of its pithy nature mainly cultivated for coarse work. Some harder varieties: known as stone osiers and raised on drier upland soils, are peeled and used for fine work. *S. fragilis,* with about ten varieties, is almost exclusively used by market gardeners for bunching greens, turnips and other produce. In its natural habitat the osier or willow is a dioecious plant reproduced by cross fertilization, but for at least 2,000 years it has been cultivated from cuttings. The stocks have therefore become enfeebled; their cultivation is attended with many disturbing conditions — ground vermin. fungoid and insect pests as well as winter floods and spring frosts.

In eastern North America the name "red osier" has been applied to *Cornus stolonifera,* one of the shrubby dogwoods.

Because of the increased demand for finer work much attention has been given to the cultivation of the more ligneous and tougher species, *S. triandra, S. purpurea* and *S. amygdalina,* with their many varieties and hybrids.

It is incorrectly supposed that osiers or willows will prove remunerative and flourish with little attention on any poor, wet, marshy soil. No crop responds more readily to careful husbandry and skillful cultivation. For the successful raising of the finer sorts of willows good, well-drained, loamy upland soil is desirable, which before planting should be deeply trenched and cleared of weeds.

At any time, from late winter to early spring, the ground may be planted with "sets" (*i.e.,* cuttings) of about 9 to 16 in. in length, taken from clean. well-ripened rods. These are firmly set to within 3 to 6 in. of the top in rows. 16 to 20 in. apart and spaced at intervals of 8 to 12 in. Yearling sets are largely planted, but the practice of the best midland and west of England growers proves the superior productiveness of sets cut from two-yearling rods. Great care should be exercised in planting lest the bark be fractured. loosened or removed from the wood, and if not subject to periodical alluvial floods the ground should be manured yearly. The coarser *S. viminalis* may be raised on lowland soil if not waterlogged or marshy.

The more valuable kinds are known as new kind, black mauls, Spaniards, glibskins, long-bud, long-skin, Lancashire red-bud, French, Italians, Pomeranians and councilors and scores of other local names. A hybrid of *S. viminalis* and *S. triandra,* known as black top. has been found to produce the heaviest crops on the best Leicestershire grounds.

Cutting and binding take place in early winter after the fall of the leaf, the crop being known as green whole stuff. The coarser kinds are sorted, cured (dried in the sun and wind,) and stacked ready for market. These are known as brown rods. The finer kinds, after the more shrubby or ill-grown rods, termed "ragged," have been rejected, are peeled or buffed. Two methods of stripping are chiefly practised: from the heads (sets) and from the pit. By the former method the rods are left on the ground until spring, when a rapid growth of the cambium begins. They are then cut directly from the head and the bark is easily removed by drawing the rods through a bifurcated hand brake of smooth. well-rounded steel, framed in wood. By the "pit" process the green rods are stood upright in shallow pits of water at a depth of about 6 to 9 in. until the sap rises and growth begins, when they are ready for the brake.

The willows are cut at the first indication of the sap rising and "couched" in rotten peelings and soil at a slight angle, the butts being on the ground, which should be strewn with damp straw from a manure heap. The tops are covered lightly with rotted peelings and by periodical application of water, fermentation is induced at the bottom, heat is engendered, the leaves force their way through the covering and peeling may begin. Peeling may be done by hand or by a motor peeler; it lasts from early May to the middle of July.

After stripping, the rods are bleached in the sun and stored for sale as white. If the rods are to be buffed they are immersed in large tanks of boiling water from four to six hours. They are then allowed to cool and mellow, are stripped and carefully dried in sun and air and remain dyed a rich tawny brown or buff colour. Brown rods may also be buffed by sinking them in cold water which is heated to boiling point and maintained at that temperature for the requisite period.

See W. P. Ellmore, *The Cultivation of Osiers and Willows,* 2nd ed. (T. O.; X.)

OSIJEK (Ger. Esseg, Magyar Eszek), town of Croatia, Yugos. Pop. (1961) 71,843, chiefly Croats and Magyars. It is situated on the Drave, which is there crossed by two bridges, below which the river is navigable by small steamers. The upper or old town contains the fortress, while the lower or new town is the commercial centre.

It has several Orthodox and Roman Catholic churches, Franciscan and Capuchin monasteries, a synagogue, *Gymnasium,* school, hospital, chamber of commerce and law courts. Osijek has a thriving trade in grain, fruit, livestock, plum brandy and timber. There are cotton mills, tanneries and a sugar beet factory, while silk weaving, glass blowing and the making of hats and caps are also carried on.

Osijek owes its origin to its fortress, which existed in Roman times under the name of Mursia.

OSIMO, a town and episcopal see (ancient Auximum), Marche region, Italy, province of Ancona, 10 mi. S. of Ancona by rail. Pop. (1957 est.) 23,290 (commune). It is on the top of a hill 870 ft. above sea level and it retains a portion of its ancient town wall (2nd century B.C.). The cathedral has a portal with sculptures of the 13th century, an old crypt and a fine bronze font of the 16th century; the town hall contains a number of statues found on the site of the ancient forum and also a few pictures. Silk spinning and the raising of cocoons are carried on.

OSIPENKO (until 1939, Berdiansk), a port on the Sea of Azov in the Zaporozhe *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R. Pop. (1959) 65,000. It was renamed in honour of a Soviet airwoman, Polina Denisovna Osipenko (1907–39). It was occupied by the Germans during World War I and again in World War II (Oct. 1941 to Sept. 17, 1943). It is a rail terminus and an industrial centre for the manufacture of agricultural machinery and road-building materials; there are also a shoe factory, a vegetable canning plant and flour mills. A seaside health resort, Osipenko is well known for its mud baths on the salt lagoons in the neighbourhood.

OSIRIS, one of the most important Egyptian gods, who composed a trinity with Isis and Horus (*qq.v.*) the child. The name is the Greek form of the Egyptian *us-yri* ("occupier of the throne" —*i.e.,* the king; or, according to H. Bonnet, "a joy to behold").

At first, he was chiefly an agricultural deity in whose cult were combined the killing of the divine man and the belief in the dead god's resurrection. At Abydos, the centre of Osiris worship in Upper Egypt, the ritual concentrated on the fertility of the crops: the seed-corn, modeled with earth or sand in the form of the god, was buried in the ground and watered with Nile water and the plants were hailed as the resurrection of the god. This cult belonged only to Upper Egypt in early times, Lower Egypt being largely marshland and therefore unsuitable for agriculture. But by the time of Herodotus the cult had spread to all parts of Egypt.

Osiris later came to be identified as a god of the dead, and this is his best-known role. Plutarch's *De Iside et Osiride* relates the legend: Osiris, king of Egypt, was murdered by his brother Set (Setekh), his body was enclosed in a wooden chest and thrown into the Nile river. It floated to Byblos on the Syrian coast where it was found by Isis and brought back to Egypt. Set, however, found the chest and tore the body into 14 pieces, which he flung broadcast over the land and of which Isis went in search. When all the pieces were collected she brought Osiris back to life and he remained in the underworld as king and judge of the dead.

Representations of Osiris are rare before the New Kingdom (*c.* 1580–*c.* 1200 B.C.), when he is shown as a mummy with his arms crossed on his breast, one hand holding the crook, the other the flail. He wears the narrow plaited beard characteristic of the king and the gods and on his head is the crown of Upper Egypt in the stylized form of a sheaf of corn. Plutarch, himself an initiate of the Osirian mysteries, gives some idea of the spiritual and mystic beliefs which underlay the materialistic appearance of the cult: mortal eyes cannot see the most pure and truly holy Osiris, for the souls of men are not able to participate in the divine nature whilst they are encompassed about with bodies and passions. . . . . When they are freed from these impediments and remove into purer and unseen regions, 'tis then that this God becomes their Leader and King, upon him they wholly depend, still beholding without satiety, and still ardently longing after that beauty, which is not possible for man to express or think.

As the greater part of modern knowledge of Egyptian religion is derived from tombs and their contents and inscriptions, Osiris' aspect as god of the dead is overemphasized. He was equally important as a living god, as the giver of fertility, especially of the crops.

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OSLER, SIR WILLIAM (1849–1919), British physician, professor of medicine successively at McGill (1874–84), Pennsylvania (1884–89), Johns Hopkins (1889–1904) and Oxford universities (1904–19), was born July 12, 1849, at Bond Head, Canada, and educated at Toronto and at McGill, where he took his M.D. in 1872. He traveled and studied widely in Europe. His religious upbringing and exposure to the classics and humanities led to the development of a style of writing which makes his works among the most readable by any physician, and he excelled as a medical teacher and inspirer of young men. His memory lives and is treasured by medical scholars everywhere.

Osler had "a figure smaller than average, lithe and quick; the penetrating eyes and dark Celtic features whose incisiveness was made gentle by a capacity for 'sunburnt mirth'; the careful observation of the sick person, who saw him as a friend even while being the subject of a most intense scrutiny; the summing up of facts and their evaluation in the light of fruitful and diligent work in ward, autopsy room, and library—and then the synthesis with clarity made luminous by the capacity to tell it in succinct phrase and deft epitome to underscore the lesson driven home. Then the intimate brief friendliness before he moved on. Though it was widely diffused it never became attenuated and each person in the group felt that it was focused on him." (Reprinted by permission of the publisher, Abelard-Schuman Limited from *Osler Aphorisms* by R. B. Bean and W. B. Bean. Copyright 1950.)

Osler had a capacity for friendship, a love of medicine and of man and the power of complete concentration. Hard work he practised and preached. Through his writings is a strain of melancholy, as though some sorrow weighed upon him, but this melancholy never degenerated into pessimism. One outlet he had; he was an inveterate perpetrator of extravagant practical jokes. His fierce pride in the honour of the medical profession at times provoked him into outspoken righteous indignation.

He made many clinical discoveries and did notable work on diseases of the heart and blood. His essays and printed addresses preserve the magic of his magnetism. At McGill is located the Bibliotheca Osleriana, based on his own library, a monument to his devotion to books and medicine. His British heritage flowered at Oxford, where he was curator of the Bodleian library, trustee of Radcliffe and delegate of the Clarendon press. He was created baronet in 1911 and died Dec. 29, 1919.

Among Osler's publications are *The Principles and Practice of Medicine* (1892); *Aequanimitas,* a volume of essays (1904); *An Alabama Student* (1908); *Chorea and Choreiform Affections* (1894); *Angina Pectoris and Allied States* (1897); and *The Diagnosis of Abdominal Tumors* (1901). (W. B. Bn.)

OSLO, the capital and principal port of Norway, lies in a natural basin surrounded by pine-wooded hills on the southern shore at the head of the Oslo fjord, about 80 mi. from the Skagerrak. Pop. (1959 est.) 465,711. In 1957 the city covered an area of 175 sq.mi. of which about 75% was forests and fields and about 5% was fresh water. The neighbouring community of Aker was incorporated in Oslo in 1948.

The original city of Oslo was founded in 1050 by King Harald III. In 1624 King Christian IV founded a new city called, after him, Christiania, close to the site of the old one which had been destroyed by fire. Christiania became the capital of Norway in

1814 and on Jan. 1, 1925 it was renamed Oslo. During the German occupation (April 1940–May 1945) the city suffered relatively little material damage, but its economic development ceased entirely. After World War II it developed rapidly and became the chief industrial and commercial city of Norway. The royal palace (completed in 1848), the residence of the king of Norway, stands at the head of Karl Johan street. Oslo's main thoroughfare. In the same street is the University of Oslo, a group of three buildings erected between 1839 and 1854, the centre one of which contains the university auditorium or *Aula,* with its great murals by Edvard Munch. Opposite the university buildings is the national theatre, traditionally linked with Norway's great dramatists, Henrik Ibsen and Bjornstjerne Bjornson, whose bronze statues flank its entrance. Farther down Karl Johan street is the Storting (parliament) building (1866) and by the market square beyond stands the cathedral, built between 1694 and 1699, restored in 1849–50 and again in 1949–50. The Oslo city hall, centrally placed at the head of the fjord, is a landmark to approaching ships and its characteristic outline is visible for miles around. It was completed in 1950 and has been decorated by Norway's leading painters and sculptors. Akershus castle, one of Norway's great medieval monuments, was built by King Haakon V in 1300. It served as a royal residence from 1319–80, was in course of time rebuilt and is now used for important state occasions. The city has many museums, a special building housing the Viking ships, and another containing Fridtjof Nansen's polar exploration ship "Fram," built for his polar expedition 1893–96. In the Kon-Tiki museum is the raft on which Thor Heyerdahl and five companions drifted across the Pacific ocean in 1947. The Norwegian folk museum has an excellent outdoor collection consisting of 150 wooden buildings portraying Norwegian rural life from the middle ages. Among the buildings is one of Norway's unique stave churches, dating from the 12th century. In the Frogner park are the famous Vigeland sculptures. The state art museum has a large collection of Norwegian works of art.

During the years 1945–55 the city of Oslo expanded rapidly. New residential sections sprang up in former rural districts and much work was done in clearing and redeveloping slum areas. At Ullevaal is the largest municipal hospital in the country. High above the city rises Holmenkollen with its famous ski jump and ski museum. At Blindern there is an extension to the university consisting of a natural science section contained in five buildings, and also modern broadcasting studios and a concert hall. There are fine market places in the city which also possesses 25 public parks and many sports grounds.

Oslo is the centre of a system of roads and railways, linking it with all parts of the country and with the continent through Sweden. The port is kept free of ice during the winter and maintains uninterrupted communications with Europe and countries overseas besides an extensive coastal traffic. Its merchant fleet in 1957 had a gross tonnage of more than 3,000,000 tons. about 40% of the total shipping tonnage of the country. The Fornebu airport. 5 mi. W. of Oslo, maintains regular inland and continental as well as intercontinental services.

The city's principal industries include iron and steel; shipbuilding; tobacco; the manufacture of electric and other machinery; textiles, footwear and clothing; foodstuffs, especially chocolate and margarine, beer and mineral waters; and publishing, printing and bookbinding.

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(S. MN.)

OSMAN ('UṢMĀN), the usual form of the Arabic name 'OTHMAN, as representing the Turkish and Persian pronunciation of the name. It is used, therefore, for (1) the founder of the Osmanli or Ottoman dynasty, Osman I., who took the title of sultan, ruled in Asia Minor, and died in 1326, and (2) the sixteenth sultan Osman II., who reigned 1616–1621. (See TURKEY: *History;* OTHMAN.)

OSMAN (1832–1900), Turkish pasha and mushir (field marshal), was born at Tokat, in Asia Minor, in 1832. Educated at the military academy at Constantinople, he entered the cavalry in 1853, and served under Omar Pasha in the Russian War of 1853–56, in Wallachia and the Crimea. Appointed a captain, in the Imperial Guard, he distinguished himself in the campaigns of the Lebanon in 1860 and of Crete in 1867 to 1869, and was promoted lieut.-colonel. He served under Redif Pasha in suppressing an insurrection in Yemen in 1871, was promoted major-general in 1874, and general of division in 1875. Appointed to command the army corps at Widin in 1876 on the declaration of war by Serbia, he defeated Tchnernaieff at Saitschar and again at Yavor in July, invaded Serbia and captured Alexinatz and Deligrad in October, when the war ended. Osman was promoted to be mushir, and continued his command at Widin.

When the Russians crossed the Danube in July 1877, Osman moved his force to Plevna, and, with the assistance of his engineer, Tewfik Pasha, entrenched himself on the right flank of the Russian line of communication, and gradually made the position a most formidable one. He repulsed the three assaults of the Russians and after being closely invested, held the position until Dec. 9. when, compelled to cut his way out, he mas severely wounded and forced to capitulate. This famous improvised defence delayed the Russians for five months, and entailed their crossing the Balkan range in the depth of winter after the third battle of Plevna. The sultan conferred on Osman the Grand Cross of the Osmanie and the title of "Ghazi" (victorious), and, when he returned from imprisonment in Russia, made him commandant of the Imperial Guard, grand-master of the artillery and marshal of the palace. In Dec. 1878 he became war minister, and held the post, with a small break, until 1885. He died at Constantinople on April 14, 1900.

OSMANLI, the tribal name of the Turks of the Ottoman empire. The Osmanli include a heterogeneous group of peoples, the original conquering Osmanli having mixed very considerably with the conquered peoples, until physically they have ceased to have a definite separate existence.

OSMIUM, a metallic chemical element. silver-gray in colour and one of the six platinum metals (see PLATINUM METALS). The specific gravity of osmium, experimentally determined by X-ray, is 22.56, the same as that of iridium, these two metals being the densest known terrestrial materials. Osmium (symbol Os, atomic number 76, atomic weight 190.2) has the highest melting point (2,700° C.) of any of the platinum metals; fusing and casting of the metal are therefore difficult. Because wires of the metal can be heated to high temperatures, they were used for filaments of early incandescent lamps; however osmium was replaced by tungsten for this purpose. The boiling point of the elerncnt is estimated to be above 5,300° C. Osmium is hard, brittle and difficult to work, even at high temperatures. A hard alloy of osmium and iridium is used commercially for tips of fountain pens and phonograph needles.

Osmium is included in most platinum ores; it occurs with iridium as a major fraction of the native alloy. osmiridium. This component of platinum ores does not dissolve in aqua regia. nor does it alloy with lead in the common methods employed to recover native platinum. Smithson Tennant in England first recovered osmium by repeated alternate acid and alkali treatments of the fractions of platinum ores which did not dissolve in aqua regia. In 1804 he announced its isolation and some of its properties. He named it osmium (from the Greek, "smell") because of the unpleasant odour frequently associated with the element. In modern practice the osmiridium concentrate is heated with zinc to form an alloy which is rapidly soluble in acid.

Once osmium is dissolved, it can he separated easily and cleanly from other heavy metals. It is readily oxidized to the tetroxide, OsO_4, a compound with high volatility (boiling point 131° C.). When an osmium compound is boiled with nitric acid, OsO_4 distills away from other heavy metals and can be collected by condensation. At room temperature OsO_4 forms colourless or pale yellow crystals which melt at 41° C. St possesses an unpleasant odour, somewhat like chlorine, and is extremely poisonous, attacking mucous membranes, the lungs and eyes. Sufficient exposure will cause temporary blindness. Of the platinum metals, osmium is the most rapidly attacked by air. The odour of the oxide can be detected when samples of powdered metal are exposed to air at room temperature, and oxidation becomes rapid at about 200" C. Therefore osmium must be excluded from alloys of the platinum metals which are heated in the air. Ruthenium, the only other element known to exist in the +8 oxidation state, requires a stronger oxidizing agent such as sodium bromate to form RuO_4. The action of aqua regia on pure osmium to form OsO_4 is inconveniently slow; fuming nitric acid is somewhat more satisfactory. In water, osmium tetroxide exhibits weak acidic properties; its aqueous solution is sometimes called osmic acid. It can be extracted from water into organic liquids such as carbon tetrachloride. It is a fairly strong oxidizing agent with limited use in the synthesis of organic compounds, being used in steroid syntheses wherein it oxidizes olefins to glycols. Because it is reduced to the black hydrous dioxide OsO_2 by some biological materials it is sometimes used to stain tissues for microscopic examinations. In addition to the tetroxide a few other compounds can be made with the +8 state such as OsF_8 and $KOsO_3N$.

Well-characterized and stable compounds of osmium contain the element in the +3, +4 and +6 oxidation states in addition to the +8, and there is evidence for compounds with other states. Mild reduction of the tetroxide yields yellow-brown solutions containing negative ions of osmium(VI); *e.g.,* $OsO_4^{=}$ and $OsO_2Cl_4^{=}$. These ions are stable only in basic solutions; in acid they react to yield osmium(IV) and OsO_4. The salt K_2OsO_4 can also be prepared when osmium metal dissolves in a fused mixture of potassium hydroxide and potassium nitrate. Osmium(VI) can be reduced to give compounds of osmium(IV) and osmium (III). In these states coordination complexes are formed in which chloride, water, ammonia or other groups are bonded covalently to the central osmium atom. $K_3(OsCl_6)$ and $K_2(OsCl_6)$ are examples of stable complex-containing compounds. The complexes are kinetically inert in that the groups are replaced slowly. Hydrous oxides of these states are slowly formed from alkaline solutions. All compounds of osmium are easily reduced or decomposed by heating to form the free element as a powder or sponge. (D. S. MN.)

OSMOSIS, in its simplest definition, is the spontaneous passage, or diffusion (*q.v.*), of water or other solvents through a semipermeable membrane (one that blocks the passage of dissolved substances, or solutes). This process was first thoroughly studied in 1877 by the plant physiologist W. Pfeffer. His observations laid the foundation for the important theory of dilute solutions of van't Hoff (see SOLUTIONS). Earlier workers had made less accurate studies-of leaky membranes (*e.g.,* animal bladders) and the passage through them in opposite directions of water and escaping substances, which R. J. H. Dutrochet named endosmose (inward movement) and exosmose (outward movement), respectively. The more general term osmose (now osmosis) was introduced in 1854 by Thomas Graham.

Osmosis is important in many physiological processes in animals and plants: it is involved in the excretion of urine, the interchange of nutrients and wastes between tissue cells and their surroundings, the flow of sap and in many other vital functions. Unidirectional movements into living cells of permeating solutes, closely followed by water, result in volume changes that are frequently used for quantitative measurements of cell permeability. The investigation of more complex osmotic problems, involving special solute effects, electrical forces: anomalous osmosis and bulk flow. has been greatly facilitated by the increasing availability of artificial membranes of known chemical, structural and electrical properties.

In simple osmosis the driving force is the "escaping tendency" of the solvent; when these forces are unequal on the two sides of a semipermeable membrane solvent molecules move in such a way as to establish equilibrium. As an example, consider a 5% sugar solution (in water).contained in a membranous sac that allows free passage of water molecules but not of sugar molecules. The sac, fitted with a cork through which a glass tube extends. is placed in a beaker of water. The following conditions obtain as osmosis proceeds: the water outside the sac moves into the sac at a greater rate than the water inside the sac moves into the beaker, thus causing the water to begin moving slowly up the glass tube; when equilibrium is attained water moves at equal rates into and out of the sac.

In a constant-pressure system in which the escaping tendency of the internal water has been lowered by solutes to a degree below that prevailing externally, equalization involves a greater inward flow of water, with a resulting increase of volume. A mammalian red blood cell behaves in this manner; because of the delicacy of its plasma membrane, and in particular its biconcave form, considerable degrees of shelling are possible with only negligible increases of internal pressure. In a constant-volume system. on the other hand, the entrance of sufficient water for equalization by dilution is impossible; in its place an increase of internal pressure, according to a well-known thermodynamic principle (see THERMODYNAMICS), raises the escaping tendency of the internal water to a state of balance. Plant cells with rigid. though permeable, cellulose cell walls give a close approximation to this condition; the pressures they develop when placed in water may amount to several and sometimes many atmospheres. Most animal cells thus treated show osmotic increases in both volume and pressure, though the latter are usually relatively small.

When a constant-volume system containing a solution of a nondiffusible solute is equilibrated with pure water, the internal pressure so developed is frequently called the osmotic pressure of the solution. The use of this term in connection with osmosis requires some qualification. The observed pressure does not belong to the solution itself and is not the driving force of osmosis, but, on the contrary, a result of osmosis, which it opposes and eventually stops. Furthermore, normal osmosis occurs in a freely expansible system in the virtual absence of pressure changes.

An important problem in mammalian physiology is the manner in which the body prevents the loss of the blood plasma during its passage under pressure through the necessarily leaky capillaries. The explanation given by E H. Starling near the end of the 19th century is that an average state of balance is maintained between outward filtration of a protein-free solution and inward osmosis—the latter being a consequence of the colloid osmotic pressure of the plasma proteins. From a different point of view it might be said that dissolved proteins, to which the capillary walls are almost impermeable, lower the escaping tendency of the plasma water by an amount that statistically. in time and space, just balances the rise due to the capillary blood pressure.

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OSMUNDA, a genus of rather coarse but attractive deep-rooted ferns with 1-3-pinnate or -pinnatifid fronds growing to 5 ft. in large crowns. the spore-bearing segments much contracted and forming panicles. or in *O. claytoniana* some of the segments only are spore-bearing. The cinnamon fern (O. *cinnamomea*), the interrupted fern (*O.* claytoniana) and the royal fern (*O. regalis*) are native to and widespread in North America and Asia. They are excellent ferns for the garden but should be given ample water and good drainage. (J. M. BL.)

OSNABRUCK, a town of Germany which after partition of the nation following World War II was located in the Land (state) of Lower Saxony, Federal Republic of Germany. It lies on the Hase river between the Teutoburg Wald and the Wiehengebirge, 58 mi. N.E. of Dortmund. Pop. (1959) 134.636.

The town still broadly conforms to its medieval plan. Important examples of ecclesiastic architecture are the Catholic cathedral (13th century), the only survivor of Romanesque style in Westphalia, with rococo chancel (1751) and a late Romanesque cloister; the early Gothic St. John's Catholic church. built 1256–91, with an early 16th-century altar and interesting cloisters; the Gothic St. Mary's church (Evangelical), with an early 16th-century Flemish carved altar: and the Gothic St. Katherine's church (Protestant) mid-14th century Hermann Bonnus accepted the Reformation in Osnabrück from St. Mary's church in 1543; since then the town has been predominantly Protestant. The Carolinum grammar school is housed in the south wing of the former Jesuit college, which dates back to a foundation of Charlemagne in 804. There are many town houses in Renaissance, baroque, rococo and classical styles, and one of these in the main square was the birthplace of Justus Moser (*q.v.;* 1720–94). The late Gothic town hall (1487–1512) with its historic peace hall (Friedenssaal) houses the city plate. A small part of the medieval wall-fortifications remains: the rest was leveled in the 19th century to construct a promenade. The town museum is in the old Bucks tower (1250), while the Waterloo gate (1817) commemorates local soldiers killed at Waterloo.

Trading rights were granted in 889. The emperor Frederick I Barbarossa granted civic liberties in 1171. The town, well known for its linen, was once in the Hanseatic league. The Catholic bishopric founded by Charlemagne in 785 was secularized in 1803, but after 1858 the see was re-established. From 1643–48 Osnabriick was the base for the Protestant negotiators at the treaty of Westphalia. which stipulated that the bishopric was to be held alternately by Catholics and Protestants. Ernest Augustus I, the first Protestant bishop, was the father of George I of England, whose brother became the second Protestant bishop. Frederick of York was the bishop when the see was secularized. The castle of the elector bishops (1667–90) has survived.

Osnabruck is a major road and rail junction. It is an industrial centre with iron and steel works; manufactures include machinery, automobile equipment, hardware, celluloid, textiles and paper products. (H. P.-MA.)

OSORNO, a province in southern Chile, extends from the Pacific to the Argentine frontier and is bounded by the provinces of Valdivia on the north and Llanquihue on the south. Area 3.507 sq.mi.; pop. (1960) 143.955. The province, created in 1940 with territory taken from Llanquihue and Valdivia provinces, is divided into two departments for administrative purposes, Osorno and Rio Negro. Osorno province lies in the temperate rain forest zone and is composed of the three longitudinal physiographic regions (coastal mountains, interior valley and Andean cordillera) which characterize much of Chile. Renewed volcanic activity began with the disastrous earthquakes of May–June 1960. The east and west are sparsely settled. The central valley, traversed by the Santiago-Puerto Montt line of the state railways, is a good agricultural and stock-raising region. Beef cattle, dairy products, wheat, potatoes and oats are the most valuable products. The eastern part is noted for its lakes (Puyehue. Rupanco) and mountain scenery (notably Mt. Osorno and Mt. Puntiagudo), lakeside thermal springs, fishing and skiing facilities.

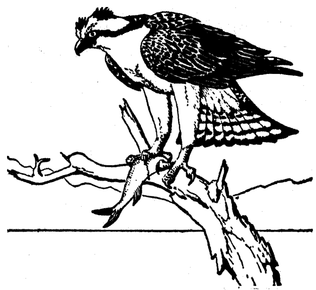
Osorno. pop. (1960) 93,686 (mun.), capital of the province and department of the same name, was founded in 1553 and re-established in 1558. Indians devastated the settlement in 1602; it was repopulated in 1796 by order of Ambrosio O'Higgins. The German influence, strong in all present phases of life, began with colonies established in the 1850s. Most vigorous growth came after 1895, when railway communication was opened to the north. The city of Osorno has the distinction of being the only large urban centre in the province, the fourth largest city in southern Chile, the gateway to southern Chile's famous tourist region and the western terminus of an important international route which leads to the Argentine town of San Carlos de Bariloche. Its industries include grain and lumber milling and dairy and meat processing. Large numbers of live cattle are shipped from the city to central Chile.

Rio Negro (pop. [1960] 14,323 [mun.]) is the second town and administrative centre in the province. (J. T.)

OSPINA PÉREZ, MARIANO (1891–), president of Colombia, 1946–50, was born on Nov. 24, 1891, in Medellín. He studied mining at the University of Antioquia and did graduate work in engineering and economics in the United States and Belgium. The grandson of one president and nephew of another, Ospina entered politics in 1915 as a Conservative and held many elective offices including the presidency (1946–50). Having inherited wealth, he accumulated much more in mining, finance, commerce and agriculture. He held a number of chairs in Colombian universities. At a time of developing interparty conflict, Ospina was elected president but failed to check the growth of violence despite recourse to coalition government. The more moderate upper-class segment of the Conservative party, of which Ospina was a major figure: commonly opposed the majority faction headed by Laureano Gómez, who succeeded him as president; the hostility between the two Conservative leaders presented a serious problem for the National Front government of Colombia. (R. L. GE.)

OSPREY (OSPRAY), a bird of prey of conspicuously marked plumage, the white of its lower parts and head contrasting sharply with the dark brown of the back when it is on the wing. It is the representative of the family Pandionidae, closely related to the *Falconidae.* Its special characters are the presence of a reversible outer toe and spicules on the soles of the feet.

The osprey (Pandion haliaetus) is one of the most cosmopolitan birds of prey. Where, through abundance of food, it is numerous, the nests of the fish-hawk (to use its American name) may be placed on trees to the number of 30 close together. Where food is scarcer and the species accordingly less plentiful, a single pair will occupy an isolated rock, as formerly in Scotland. Few birds lay eggs so rich in colouring; their white or pale ground is spotted, blotched or marbled with almost every shade of purple, orange and red, from the most delicate lilac and buff, through violet, chestnut and crimson, to black. The fierceness with which ospreys defend their eggs and young, in addition to the dangerous situation chosen for the aerie, makes the task of robbing the nests difficult. It no longer breeds in Great Britain.



BY COURTESY OF THE NATIONAL ASSOCIATIO OF AUDUBON SOCIETIES

THE OSPREY (PANDION HALIAETUS) A bird of prey, known in America as the fish-hawk

The term osprey, applied to the nuptial plumes of the egrets in the feather trade, is derived from the French esprit; it has nothing to do with the osprey bird.

OSROENE (OSRHOENE), an ancient kingdom in northwestern Mesopotamia occupying an area between the Euphrates and Tigris rivers and lying across the modern frontier of Turkey and Syria. Its capital was Edessa (*q.v.*), the modern Urfa. The name of the kingdom (which Pliny the elder gives as Orrhoene) appears to be derived from Urha (the Syriac name for Edessa); Urha, in turn, may be derived from that of a certain Osroes or Orhai. who founded the state about 136 B.C. at the time of the disintegration of the Seleucid empire. To judge from his name, this Osroes was of Iranian origin and may have been a Seleucid governor. The next ruler of the kingdom, however, was an Arab, Abdu bar Ma'zur, and from then onward the throne remained almost continuously in Nabataean or Arab control, the commonest royal names being Abgar and Ma'nu.

The kingdom embraced the cities of Melitene (Malatya) in the north, Nisibis (Nisibin) in the east. Zeugma (close to modern Birecik) in the west, Singara (Sinjar) on the southeast and Carrhae (Haran) on the southwest. It thus commanded not only the great strategic highway from west to east which followed the southern edge of the Kurdish plateau from Singara to Zeugma, but also that section of the trade route from Asia Minor to Mesopotamia (the old Persian royal road), which passed probably from Melitene to Carrhae. Osroene was therefore in a strong strategic position during the wars between Rome and Parthia from the 1st century B.C. to the 2nd century A.D. and formed alliances at different times with one or the other. During the Armenian campaigns of Lucullus (69 B.C.), Pompey (66) and Crassus (54–53j it kept generally to the Roman side, though Abgar II (known to the Romans as Ariamnes) was responsible for betraying Crassus to the Parthians in 53. About A.D. 50, Sanatruces, king of Adiabene, the eastern neighbour of Osroene, occupied Nisibis and Edessa, but in A.D. 109 Abgar VII re-established the indigenous dynasty. Trajan deposed him, however, after quelling the Mesopotamian revolt of A.D. 116. and two foreign princes then successively occupied the throne. In 123, however, Ma'nu VII, brother of Abgar VII, succeeded under the protection of Hadrian. Therealter the state maintained a certain measure of autonomy until 216, when Caracalla occupied Edessa and abolished the kingdom.

Under its Arab dynasties, Osroene became increasingly influenced by Aramaic culture and acted as a centre of national reaction against Hellenism. The cultural standing of Osroene was raised by the arrival there in the 3rd century A.D. of Chaldean Christians exiled by the Persian Sassanids. By the 5th century Edessa had become the headquarters of Chaldean Syriac literature and learning. while Nisibis was a centre of the Nestorians. Osroene retained its name until the 7th century. In 608 it was taken by the Sassanid Chosroes II. The east Roman emperor Heraclius recaptured it in 625, but in 638 it fell to the Arabs. *See* also MESOPOTAMIA: *History*; URFA. (WM. C. B.)

OSS, a town of North Brabant province in the Netherlands. is situated 11 mi. E.N.E. of s'Hertogenbosch. Population, mainly Roman Catholic, was 27,520 in 1957.

Civic rights were granted by the duchess of Brabant in 1399. Oss was the centre of the Dutch margarine industry and now specializes in bacon and cooked meats. The manufacture of pharmaceuticals, especially insulin and vitamins, has become important. Other products include electrical equipment, wool, boxes and metalware. (P. M. J. v. S.)

OSSA (mod. Kissovo, *Kissavo*), a mountain (6,489 ft.) in Larissa, S.E. part of Thessaly, Greece; S. of Olympus, from which it is separated by the valley of Tempe, and N. of Pelion which the Giants are said to have piled on it to scale Olympus.

OSSETE LANGUAGE, one of the Iranian languages (*q.v.*) spoken by the Ossetes in the northern Caucasus. There are two primary dialects: (1) eastern called Iron and (2) western called Digor. The majority of Ossetes speak Iron and it is the basis of the literary language now written in the Cyrillic alphabet. Ossetic is the modern descendant of the language of the ancient Alani, a Sarmatian people, and the medieval As. Ossetic loanwords in Hungarian were borrowed in the Alan period when the two peoples were neighbours. Ossetic preserves many archaic features of Old Iranian such as eight cases and verbal prefixes. The phonology of the language has been greatly influenced by the non-Indo-European languages of the Caucasus and the present vocabulary has many loanwords from Russian. There are many folk epics in Ossetic, the most famous are the tales about hero warriors, the Narts. The literary language was established by the national poet Kosta Khetagurov (1859–1906).

See V. Miller, *Grundriss der Iranischen Philologie*, vol. i (for grammar) and Ossetisch-Russisch-Deutsches *Wörterbuch,* 3 vol. (1927); *V. I.* Abaev, *Osetinskii Yazyk i Folklor* (1949). (R. N. F.)

OSSETIAN AUTONOMOUS AREAS, two administrative units of Russia. (1) The South Ossetian A.S.S.R. created in 1922 is linked administratively with the Georgian S.S.R. Area 1,506 sq.mi. Pop. (1959) 96.807. (2) The North Ossetian A.S.S R. created in 1924 is also linked administratively with the Georgian S.S.R. Area 3.089 sq.mi. Pop. (1959) 50,581.

The Ossetes are descended from the Alans, the strongest and most numerous of the Sarmatian tribes, and their language belongs to the Iranic group of the Aryan tongues. The earliest reference to the Alans is A.D. 35 when, according to Josephus, they occupied the Kuban valley; later they occupied the Don and Dnieper regions, where they joined forces with Germanic tribes in attacks on the Romans. Legend gives the Emperor Maximin a Gothic father and an Alan mother. The Hun invasion swept them from the steppe, but they took refuge in the Caucasus and were probably settled in their present territory in the 5th and 6th centuries. They have been described by some writers as long headed, blue eyed and fair haired, but recent Russian investigators describe them as rather broad headed, with swarthy complexions, dark eyes and hair, and straight noses, their stature being above the average. In the Caucasus they held the grassy passes leading from the sources of the Terek and the Ardon to those of the Rion and the Kura, by which alone horsemen and troops can cross the range in summer, and in the height of their prosperity their flocks whitened the steppe and their vintages were famous. The rude walls and towers of their fortified farms and villages still remain on high and defensible ridges in the mountain fastnesses. Later they formed villages with two storied stone houses, the lower for the cattle and the upper for human habitation, with flat wooden roofs and balconies.

Queen Thamar of Georgia introduced Christianity among them in the 12th century, but later the Kabardians drove them from many of their pastures and Turkish tribes supplanted them in the lower valleys and introduced the Islamic faith within their borders. The Ossetes, however, even in their decline, still held the upper passes, the keys of the Caucasus. The Russian hold on the region began when a small fortress was established at Vladikavkaz in 1784 and the Ossetes were conquered in 1802. Later the famous Georgian military road through the Dariel gorge of the Terek, constructed 1811 to 1864, brought the Ossetes more definitely under Russian rule.

Most of the territory of the Ossetes consists of the mountain region of the Caucasus. with snow clad peaks. *e.g.*, the Uilpata (15.243 ft.). Numerous streams. which ultimately join the Terek, are of great value as a source of hydroelectric energy. The chief pass is the Mamison. Vladikavkaz is the administrative centre for the North Ossetes, but forms a separate administrative division of the Georgian S.S.R. Stalinir (formerly Tskinvali). (pop. [1959] 22.000). is the administrative centre of the South Ossetes. The chief range apart from the Central Caucasus. is the Bokovoi Ridge, exceeding a height of 10,000 feet. The average altitude of South Ossetia is 10.000 feet. (*See* CAUCASUS.)

Forest and shrub are general in the region, oak and hardbeam being the prevailing varieties in the north, where timber is exported through Alagir. The forests extend to the upper limit of the limestone gorges, but the crystalline schists are bare of vegetation. Coniferous forests extend above the oak, hardbeam, ash. maple and lime, and alpine meadows with a rich variety of blossoms are found above the tree limit. On the plateau in the north maize gives good harvests; winter wheat, potatoes. fruit, sunflower seed, tobacco and vegetables are also cultivated. Coal. naphtha, iron, manganese. graphite. asbestos, lead, wolfram and arsenic exist. South Ossetia is essentially a grazing region, with sheep and goats in the east and cattle in the west. It is thinly peopled in comparison with the north, and its population was further diminished by the disastrous war conditions following the 1917 revolution, when many natives left their homes and went northward. Conditions in this region recovered slowly. Peasant industries include the making of metal goods, fur caps and leather goods.

There are two main Ossetian dialects, the Iron and thd Digor; the South Ossetians call themselves Tualte and speak a dialect related to the Iron group. (R. M. F.; X.)

OSSETIAN LANGUAGE: see OSSETE LANGUAGE.

OSSIETZKY, CARL VON (1889–1938), German journalist and pacifist, winner of the Nobel peace prize for 1935, was born at Hamburg on Oct. 3, 1889. He was the son of a former German army officer who was a member of a germanized branch of the Polish Roman Catholic family of Osiecki.

In 1912 he joined the German Peace society (Deutsche Friedensgesellschaft) but was conscripted into the army and served throughout World War I. In 1920, in Berlin, he became secretary of the D.F.G. Convinced that "nothing was more devastating for peace and democracy than the omnipotence of the generals," he helped to found the Nie Wieder Krieg organization in 1922. He was associate editor of the daily newspaper Berliner *Volkszeitung* and a contributor to *Weltbühne,* a left-wing political weekly. He became editor of *Weltbühne* in 1927 and in a series of articles unmasked the *Reichswehr* leaders' secret preparations for rearmament. Accused of treason, he was sentenced in Nov. 1931 by the Leipzig supreme court to 18 months' imprisonment. but was amnestied in Dec. 1932. On Hitler's accession to power Ossietzky refused to flee abroad and resumed publication of *Weltbühne.* At the end of Feb. 1933 he was arrested and sent to the Papenburg concentration camp from which. suffering from tuberculosis. he was transferred in May 1936 to a prison hospital in Berlin and a few months later to a public hospital where, however, he remained in custody until his death on May 4. 1938. On Nov. 24, 1936. he had been awarded by the Norwegian *storting* the Nobel peace prize for 1935. Hitler's reply to this was a decree of Jan. 30. 1937, forbidding Germans to accept any Nobel prize in the future.

See A. Williams-Ellis (ed.), *What Was His Crime? the Case of Carl von Ossietzky* (1937).

OSSINING, a village of Westchester county, N.Y., U.S., is located on the steeply ascending east bank of the Hudson river, about 17 mi N. of the Bronx (New York city) between Tappan Zee and Haverstraw bay and opposite Hook Mountain State park. Surrounded by attractive wooded countryside, it is the home of the Maryknoll (Roman Catholic) missions, and the site of Sing Sing (state) prison founded in 1824 with the idea of using convict labour to work nearby marble quarries. The village derives its name from the home of the Sin Sinck Indians, a branch of the Mohican tribe, and its name means "stone upon stone." The village site was within a large tract granted in 1680 by Charles II to Frederick Phillipse, who finally acquired actual title to this section by purchase from the Sin Sincks in 1685. Phillipsburgh manor, as this area was known, was confiscated by New York state in 1779 because of the Tory sympathies of its last lord. It was then broken up and sold in 1785. mainly to patriot tenant farmers. The two hamlets, Sparta and Hunter's Landing, developed and were incorporated as the village of Sing Sing in 1813. To avoid too close identification with the prison, the village name was changed to Ossining in 1901. Manufactures include hearing aids. office furniture, wire, drugs, maps, precision instruments and wallpaper. For comparative population figures *see* table in NEW YORK: *Population*. (XI. D. HH.)

OSSORY (OSRAIGHE), an ancient kingdom of Ireland whose capital was Kilkenny and whose kings maintained their position until 1110. The diocese of Ossory includes Kilkenny and parts of Leix and Offaly. The Church of Ireland diocese was united with those of Ferns and Leighlin in 1832.

OSTADE, VAN, the name of two Dutch painters whose father had moved to Haarlem early in the 17th century from the village of Ostade near Eindhoven. The artists were the eldest and youngest sons of a large family.

ADRIAEN VAN OSTADE (1610–1685) was baptized Dec. 10, 1610, in Haarlem, where he lived his entire life. He is traditionally supposed to have been a pupil of Frans Hals, and it is possible that both he and his Flemish contemporary Adriaen Brouwer (*q.v.*) were in Hals's studio about 1627, though some sources suggest Salomon van Ruysdael as his master. In 1662 he was president of the painters' guild in Haarlem.

His works won him much popularity during his lifetime and he became a fairly wealthy man. Although Ostade and Brouwer may for a time have been pupils of Hals, the latter's style was not a major influence on either of them, and there is a much closer resemblance between the paintings of the two younger men than between their pictures and those of any older master. Both delighted in scenes of low peasant life, tavern brawls, etc., usually in dimly lit interiors with a single source of light illuminating the principal group. Both treated these themes with a broad and vigorous technique and in a subdued range of colours that at times borders on monochrome, and both used a considerable element of caricature to underline the coarseness of their peasant types. There is little doubt that Brouwer's artistic personality was the stronger and that he was the most important influence in shaping Ostade's style. Ostade's colour schemes in the early period are largely confined to a range of neutral bluish-grays and browns, sometimes enlivened by a single note of more positive colour. Later, from the 1640s onward, he gradually adopted a brighter palette, and his subjects, though still mostly from peasant life, tend to become less violent and grotesque. In the works of his maturity are found more outdoor subjects, such as figures by a cottage door or peasants making merry outside an inn. Although the great majority of his works are genre pieces, he experimented also with religious subjects, portraits and landscapes. He worked in water colour as well as oil. was a spirited draftsman with the pen and produced a number of etchings. He was a prolific artist, painting usually on panel and invariably on a small scale, and is well represented in the principal collections of Europe and America. His most important pupils or followers were his brother Isack, Cornelis Bega. Cornelis Dusart and Jan de Groot.

ISACK VAN OSTADE (1621–49) was born in Haarlem. where, as far as is known, he spent the whole of his short life. He was at first a pupil of his brother Adriaen, whose manner he followed so closely that some of his early genre pieces have been confused with the elder Ostade's work. However, he was too accomplished and individual an artist to remain an imitator of his brother, and soon branched out into a style that was more ambitious both in scale and in complexity of composition. The works of his most distinguished period include a small number of winter landscapes, with sleighers and skaters on the ice, which can be ranked among the finest of all Dutch paintings in this genre, but his most characteristic subjects are those that depict parties of travelers with carts and horses resting outside an inn, in a vein reminiscent of some similar compositions by Salomon van Ruysdael. They show an excellent grasp of design in the disposition of the different groups, together with great vivacity in the treatment of individual figures. His rendering of misty or smoke-laden atmosphere is equally masterly. His work is well represented in the National gallery. London, and the Wallace collection has a fine painting of "A Market Place." Perhaps the most celebrated of the winter scenes is that in the Louvre, Paris.

He was buried on Oct. 16, 1649.

Since he died at such an early age. Isack van Ostade can have had few if any pupils, yet his influence on the succeeding generation of Haarlem painters was by no means negligible. Philips Wouwerman (*q.v.*), in particular, seems to have owed much to him, carrying on his characteristic subject matter of travelers, horses and wayside inns and apparently deriving his favourite motif of the gray horse directly from Ostade's example.

See C. Hofstede de Groot, *Catalogue of Dutch Painters,* vol. iii (1910). (R. E. W. J.)

OSTAIJEN, PAUL VAN (1896–1928), the most important personality of the Flemish expressionist movement. was born in Antwerp, Feb. 22, 1896. While a clerk in the municipal service (1914–18), he began to contribute to newspapers and periodicals. His first volume of verse, *Music-Hall* (1916), introduced modern city life as a subject for poetry. His second, *Het Sienjaal* (1918), showed the influence of the war and of German expressionism and affirmed a pathetic belief in humanity. It inspired the humanitarian expressionist movement in Flanders, later developed by Wies Moens, Marnix Gijsen, Karel van den Oever, Achilles Mussche and others. Compromised as a political activist, Van Ostaijen went into exile in Berlin (Nov. 1918–21). The political and artistic climate there and the hardships he endured made him a nihilist: he changed over to dadaism as a writer of poetry in rhythmic typography (*Bezette Stad,* 1921) and of grotesque prose. But he soon came to consider dadaism an antidote and developed a poetic system of his own, an "organic expressionism," aiming at a "pure poetry" that gave up personal and humanitarian confessions. Words were freed from their traditional syntactic relationships and images replaced by associations. These concepts, which bordered on the experiments with the absolute word of the German *avant-garde* review, *Der Sturm,* especially of August Stramm, were embodied in "Het eerste boek van Schmoll" (part of *Gedichten,* 1928), containing his best and most original poems, evocative fragments of exceptional sensibility and haunting musicality.

His essays on art and literature and his pithy but biased criticism are also important (*Krities proza,* 2 vol., 1929–31). His creative prose (*e.g., Vogelvrij,* 1927; *De bende van de stronk,* 1932; *Diergaarde voor kinderen van nu,* 1932) consists mainly of grotesque sketches showing keen cerebral imagination and concerned less with telling a story than with capturing whimsical associations. By its lucidity, stubborn analysis of a theme and underlying restlessness, this prose sometimes recalls Kafka, of whom Van Ostaijen was the first foreign translator, publishing five of Kafka's short prose pieces in Flemish in 1925.

After his return to Flanders, Van Ostaijen worked in the book trade and then became an art dealer in Brussels (1925–26). He died at Miavoye-Anthée near Namur, March 18, 1928.

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OSTEND (Flemish *Oostende*), West Flanders, Belg. Pop. (1955 est.) 53,323. It is the most fashionable seaside resort and the third port of the kingdom. In the middle ages it was strongly fortified and underwent several sieges, notably in 1601–04, when it surrendered only by order of the states to Spinola. The creation in 1722 of the Compagnie de Commerce des Indes seemed to assure a hopeful future to the port of Ostend. But the success obtained caused the envy of neighbouring nations, who forced Emperor Charles VI to revoke the grant made. Under Joseph II Ostend enjoyed another period of commercial prosperity. In the 20th century a new town was created. The digue or parade, constructed of solid granite, extends along the shore in a southerly direction from the long jetty which protects the entrance to the port. The modern docks accommodate ships of large tonnage. Apart from these docks Ostend has a very considerable passenger and provision traffic with England and is the headquarters of the Belgian fishing fleet. Ostend supplies sea fish and is renowned for its oyster and lobster beds. It has a school of navigation and a fishery training school. There is a daily service from Ostend to Tilbury carrying food produce for England. Ostend was occupied by the Germans during World War I and was at first, until it was rendered untenable by aerial bombardments, a base for destroyers and submarines. In May 1918 the entrance channel to the harbour and the canal to Ghent and Bruges were blocked by the sinking of the "Vindictive." After the war parts of the "Vindictive," "Intrepid" and "Thetis" were made into a memorial on the digue. The city was occupied by the Germans again in World War II.

OSTEND COMPANY. The treaties of Utrecht and of Rnstatt (1713–14) at the end of the War of the Spanish Succession transferred the Spanish Netherlands to the house of Austria but maintained Dutch control over the Scheldt and so over the commerce of Antwerp as under the peace of Westphalia (1648). In Ostend, however, the Flemings had a port on the open sea, and from 1715 onward attempts were being made, both by the Ostenders themselves and by foreign adventurers, to exploit its geographical advantages for trading in emulation of the Dutch and English East India companies. These private enterprises led to protests and to the seizure of interloping ships by the Dutch and English companies. But meanwhile the imperial government, prompted to some extent by the schemes of the English adventurer John Colebrooke, was considering a major undertaking on the same lines; and in Dec. 1722 the emperor Charles VI granted a charter for 30 years to a company that was to be based on Ostend to trade to the East and West Indies and Africa (in return for the charter the imperial treasury was to enjoy 3%–6% of the profits). The company founded two settlements in India, the more important of which was Bankibazar on the Hooghly, and trade proved at first highly profitable, particularly as it was able to benefit from extensive smuggling into England. The protests of the English and Dutch companies, whose shares slumped before this competition, were reinforced by those of their governments, who, particularly when Spain gave its support to the venture (1725), were alarmed at its political as well as commercial implications.

Public opinion was aroused, and the United Kingdom parliament declared participation by a British subject in the Ostend company to be a criminal offense. In consequence of this alarm the fate of the new company loomed large in the diplomacy of the great powers from 1725 to 1731. On this, as well as on other more vital issues, Great Britain, France, the United Provinces and, at first, Prussia allied themselves against the emperor and Spain, later joined by Russia and by Prussia (who abandoned its former allies). In 1727, however, the emperor's desire for intrrnational recognition of the pragmatic sanction ensuring the succession of his daughter Maria Theresa led him to agree to suspend the company for seven years; and in 1731, under the treaty of Vienna, the company was dissolved in return for the recognition of the pragmatic sanction. The suspension of its charter did not immediately end the cornpany's activities. Attempts by the Danish company to attract its members were checked by the vigorous representations of Great Britain, the United I'rovinces and France, but at Bankibazar the servants of the defunct company raised the emperor's flag and continued to carry on their trade until in 1744 the settlement fell to a siege by the *faujdar* of Hooghly.

(L. S. So.)

OSTEND MANIFESTO, a secret dispatch of Oct. 18, 1854, frorn James Buchanan, John Y. Mason and Pierre Soulé (U.S. ministers respectively to Great Britain, France and Spain) to Secretary of State William L. Marcy recommending that the United States acquire Cuba from Spain. Cnder instructions from Marcy, who acted in accord with the views of Pres. Franklin Pierce, the three ministers met, supposedly in secrecy, first in Ostend, Belg., and then in Xix-la-Chapelle (Aachen), Prussia, to formulate plans for the acquisition of Cuba. Their joint report, primarily the work of Soulé, restated old arguments as to why Spain should sell Cuba and why the United States should buy it. The dispatch compared the alleged "africanization" of Cuba to a fire in a neighbour's house that justified tearing down the structure if there were not other means of preventing the flames from destroying one's own house. Under the circumstances, the report said, if Spain would not sell Cuba, "then, by every law, human and divine, we shall be justified in wresting it from Spain if we possess the power." Since the dispatch was not a public declaration, it was not in any sense a true manifesto. News of the ministers' meetings and of the flamboyant language of the report leaked out, stimulated an unsavoury publicity that shocked Europeans and Americans and led Marcy to reject the proposals.

The Ostend manifesto symbolized aggressive expansionism and marked the high point of U.S. efforts to acquire Cuba in the 1850s.

(A. DE C.)

OSTEOARTHRITIS: *see* ARTHRITIS.

OSTEOLOGY, in anatomy, the study of the structure, gross and minute, of the bones and the skeleton. *See* BONE; CONNECTIVE AND SUPPORTING TISSUES; SKELETON, VERTEBRATE; etc.

OSTEOPATHY is a form of healing first promulgated by Andrew T. Still (*q.v.*), who developed the doctrine that all diseases are due to abnormalities in or near joints and that the treatment ior every disease is the correction of these abnormalities without the use of drugs, which he considered poisons. He developed the concept of what later came to be called the "osteopathic lesion"—a localized area of disease process which may occur in a bone, muscle, joint, ligament or other tissue. These lesions, he believed, may be produced by injury, strain, infection, reflexly from disease elsewhere, or simply by nervous influences. As a result, local stiffness develops, movement of the affected part becomes impaired and the flow of blood to the surrounding tissues slows down, causing acidosis and irritating neighbouring nerves, which in turn affects distant organs supplied by the nerves and produces disease in those organs (*e.g.,* appendicitis) by reducing their blood supply. A further consequence of these lesions, or subluxations as they are called when referring to joints, is an interference with the ability of the body to produce its own antitoxins and antibodies to fight infections. The correction of all of these disturbances, according to Still, is primarily manipulation.

By the mid-20th century osteopathic philosophy had undergone considerable change. It holds that the body is a unit that possesses the inherent ability to overcome most curable diseases. It recognizes that physical, chemical and nutritional factors influence the state of health and that drugs and surgery are necessary in the treatment of many diseases. However, its concept of the lesion still persists. Spinal joint subluxations (the original "osteopathic lesion") have been shown on a stereoscopic X-ray examination: they are nonsurgical and in themselves nonfatal. They are manifested by single or multiple areas of pain, tenderness, muscle spasm and localized limitation of motion in and about joints, principally those of the spine. They are regarded as a symptom complex and not as a disease per se, although still considered capable of frequently causing disturbances in distant organs. When there is no recognized disease elsewhere. manipulation alone may be used with the expectation that in a large percentage of cases immediate permanent. protracted or temporary relief may be obtained. When relief is not obtained. rest, physical support, mechanical traction, heat, diathermy, exercises and pain-relieving and muscle-relaxing drugs are used according to indications in the individual case. The importance of avoiding overtreatment and employment of manipulation in the absence of indications for its use is stressed. When the symptom complex occurs in conjunction with recognized disease elsewhere, manipulation may or may not be employed. When it is, it is used as an adjunct to and not as a substitute for accepted methods of treatment. It is no longer considered definitely curative in all disease states.

Teaching, Licensing and Organizations.— Still first proclaimed his doctrine on June 22. 1874, and the American School of Osteopathy was established in 1892 at Kirksville. Mo.; by 1958 there were six colleges of osteopathy in the United States. In 195j a committee of the American Medical association. on invitation. visited five of the colleges. The committee found that their curriculums were more or less identical in content with those of recognized medical schools, with the exception that the concept of the osteopathic lesion and the technique of manipulative therapy were still being taught. However, the emphasis given the latter was not great and in some schools was actually very little. The colleges had departments of medicine, surgery. obstetrics, etc.. as do medical schools. The length of the course was four years and the degree given on graduation was D.O. (doctor of osteopathy). Admission requirements were comparable with those of medical schools. The colleges owned and operated their own hospitals. which they used for their clinical teaching. the income from the hospital providing a considerable proportion of the college budget.

The American Osteopathic association was organized in 1897 with headquarters in Chicago. Ill. It publishes a monthly journal. There are also regional. state and local societies, British and Canadian associations, the Osteopathic Women's National association and several specialist societies. In most states osteopaths themselves control their examinations for licence to practice; in some states this is the responsibility of the state board of health, on many of which osteopaths sit as members.

In Great Britain there are two teaching centres, the London College of Osteopathy, where only medical graduates are taught, and the British School of Osteopathy. which does not limit its students to medical graduates. The length of the course at the former is 1j months and at the latter four to five years. Both these teaching schools place special emphasis on the teaching of osteopathic subjects. The London college is under the direction of the British Osteopathic association (itself recognized as a divisional unit of the American Osteopathic association, though the London college is not recognized by the American association), while the latter is associated with the Osteopathic Association of Great Britain. There is also the General Council and Register of Osteopaths, which has a function similar to that of the Medical Register, though its list of bona fide osteopaths is incomplete.

Of the European countries France had the largest number of osteopaths at the end of the 1950s; most of them were trained at the London College of Osteopathy. There are osteopaths scattered here and there in other countries. In the British commonwealth. South Africa, India. Australia. New Zealand and the West Indies all have a few practising osteopaths.

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(J. M. K.; X.)

OSTERMAN, ANDREI IVANOVICH, Count (1686–1747), Russian statesman, born at Bochum. Westphalia, mas a student at Jena but fled to Holland after a duel and became secretary to Vice-Adm. Cornelis Cruys, who took him to Russia in 1704. Having acquired a good knowledge of Russian, Osterman was in 1708 appointed interpreter at the Russian foreign office and in 1710 was given the rank of secretary.

In 1711 he assisted vice-chancellor Petr Pavlovich Shafirov in the peace negotiations with the Turks after Peter's disaster on the Pruth. At the Åland peace congress in 1718 Osterman represented Russia together with Gen. J. D. Bruce. but in fact he played the leading part even before 1719, when he went to Sweden in an attempt to persuade the Swedes to accept the Russian conditions. For the successful conclusion of the peace treaty at Nystad in 1721, Osterman was created baron. Two years later he signed a favourable treaty with Persia and was given the post of vice-president of the reorganized foreign office. Although Osterman was also consulted on internal problems, as in the case of the reorganization of the foreign office in 1720, foreign affairs remained his special sphere under Peter. Under Catherine I (1725–27) Osterman became vice-chancellor. member of the supreme secret council. postmaster general and president of a special commission for commerce: which posts gave him not only complete control over foreign affairs but also occasion to introduce financial and economic measures. He was also governor to the future tsar Peter II, retaining this post even after the latter's accession in 1727. Osterman's shrewd behaviour in 1730 during the abortive attempt to curtail the powers of the empress Anne secured his further career; he was created count and was from 1731 on a member of the new cabinet of ministers. In 1740, after Anne's death. Osterman was given the post of admiral-general and, in addition to foreign affairs, took over naval matters (which had preoccupied him earlier). Toward the end of Anna Leopoldovna's regency (1741) some people considered him as being the actual ruler. This steady ascendancy during the period of favourites was due to his great knowledge and experience and to the skill with which he adapted himself to changes and paved his way with intrigues. However, his foreign policy was consistently based on the alliance with Austria. The two costly wars that ensued, the War of the Polish Succession (1733–35) and the war against Turkey (1735–39). raised Russia's prestige; but because of the political situation the Belgrade treaty (1739) brought only moderate gains. Moreover, intent on avoiding warfare on two fronts, Osterman had restored to I'ersia the conquests made by Peter. Anglo-Russian relations improved as a result of the commercial treaty concluded in 1734, but Osterman's firm adherence to the Pragmatic Sanction brought Russia into conflict with Austria's enemy, France, and this proved fatal for him personally. The French ambassador J. J. Trotti, marquis de La Chetardie, was behind the coup d'état of 1741 in favour of Elizabeth, whom Osterman had consistently neglected. Osterman was tried and condemned on charges of interfering with the imperial succession. reprieved on the scaffold and banished to Siberia (1742), where he died five years later.

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OSTERODE, a town in the Land of Lower Saxony, at the south foot of the Harz mountains. 34 mi. N.W. of Nordhausen by rail. Pop. (1959 est.) 15,832. The church of St. Aegidius was founded in 724 and rebuilt after a fire in 1578. The dukes of Brunswick-Grubenhagen made Osterode their residence from 1361 to 1452. There are manufactures of woolen goods. cigars, casks and leather, and iron foundries, tanneries, dyeworks and gypsum quarries. In recent years Osterode has become celebrated as a health resort.

OSTIA, an ancient town and harbour of Latium, Italy. at the mouth of the river Tiber. on its left bank. It lies 14 mi. S.W. from Rome by the Via Ostiensis, a road of very ancient origin followed by the modern road which preserves some traces of the old pavement and remains of several ancient bridges, until the construction of a new motor road to Ostia Mare. It was said to he the first colony ever founded by Rome—according to the Romans th mselves, by Ancus Martius—and took its name from its position at the mouth (*ostium*) of the river. Excavations have. however, brought to light nothing earlier than the 4th century B.C., the date of a small rectangular fort, measuring 200 by 125 yd., built of hewn blocks of volcanic stone, which may have been in Virgil's mind when he wrote his description of the fortified camp which Aeneas founded at the Tiber mouth. It was out of this fort that the city developed the establishment of the salt-marshes (*salinae—see* SALARIA, VIA) which only ceased to exist in 1875. We learn much as to its cults, magistrates and trade guilds (for the last see J. P. Waltzing, Les Corporations *professionelles* [Brussels and Liège]) from the large number of inscriptions found. The city was divided into five regions. Vulcan was the most important deity worshipped at Ostia, and the priesthood of Vulcan was held sometimes by Roman senators. The Dioscuri, too, as patrons of mariners, were held in honour. Later we find the worship of Isis and of Cybele, the latter being especially flourishing, with large corporations of *dendrophori* (priests who carried branches of trees in procession) and can*ephori* (basket-carriers); the worship of. Mithras, too, had a large number of followers. There was a temple of Serapis at Portus. At Portus a considerable number of Jewish inscriptions in Greek have come to light. In the 4th century Ostia began to be abandoned while the importance of Portus increased.

Until Trajan formed the port of Centumcellae (Civitavecchia) Ostia was the best harbour along the low sandy coast of central Italy between Monte Argentario and Monte Circeo. It is mentioned in the history of the year 354 B.C. as a trading port, and became important as a naval harbour during the Punic Wars. Its commerce increased with the growth of Rome, and this, and the decay of agriculture in Italy, which obliged the capital to rely almost entirely on imported corn (which was, from 26; B.C. onwards: under the charge of a special quaestor stationed at Ostia), rendered the possession of Ostia the key to the situation on more than one occasion (87 B.C., A.D. 409 and 537). Ostia, however, was by no means an ideal harbour; the mouth of the Tiber is exposed to the south-west wind, which often did damage in the harbour itself: in **A.D.** 62 no less than 200 ships with their cargoes were sunk, and there was an important guild of divers (urinatoresj at Ostia. The difficulties of the harbour were increased by the continued silting up, produced by the enormous amount of solid material brought down by the river. Even in Strabo's time the harbour of Ostia had become dangerous.

Caesar had projected remedial measures, but it was only under Claudius that-the problem was approached. He constructed a large new harbour on the right bank. 2½ mi. N. of Ostia. with an area of 170 ac. enclosed by two curving moles, with an artificial island, supporting a lofty lighthouse, in the centre of the space between them. This was connected with the Tiber by an artificial channel, and by this work Claudius, according to his inscriptions of **AD**. 46, freed the city of Rome from the danger of inundation. The harbour was named by Nero Portus Augusti.

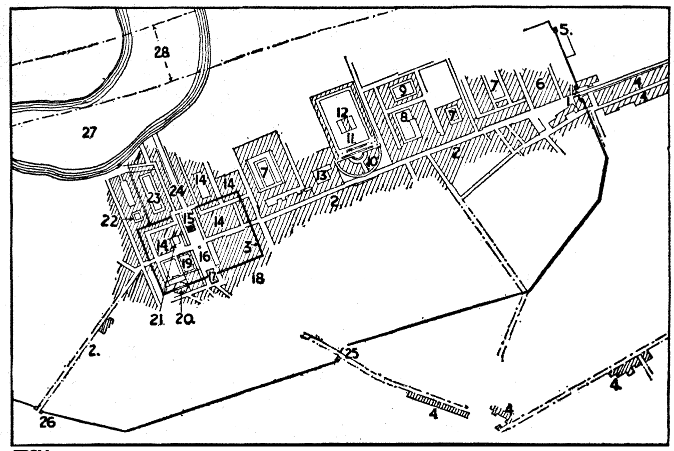
Trajan found himself obliged in **AD**. 103, owing to the silting up of the Claudian harbour and the increase of trade, to construct another port further inland—a hexagonal basin enclosing an area of 97 ac., with enormous warehouses and docks attached, communicating with the harbour of Claudius and with the Tiber by means of the channel already constructed by Claudius, which was prolonged so as also to give direct access to the sea This became blocked in the middle ages, but was reopened by Paul V. in 1612, forming the right arm of the Tiber, by which navigation is carried on at the present day, and is known as the Fossa Trajana. The island between the two arms Procopius calls Insula Sacra (it is still named Isola Sacra).

Ostia thus lost a considerable amount of its trade, but its importance still continued to be great. The 2nd and 3rd centuries, indeed, are the high-water mark of its prosperity: and it still possessed a mint in the 4th century A.D. The first bishop of Ostia of whom we have knowledge dates from **A.D.** 313, and the first bishop of Portus from about the same time. Both sees exist; the former is held by the dean of the Coilege of Cardinals.

During the Gothic wars, trade was confined to Portus and the ravages of pirates led to the gradual abandonment of Ostia. Gregory IV. conitructed in 830 a fortified enceinte, called Gregoriopolis, in the eastern portion of the ancient city, and the Saracens were signally defeated here under Leo IV. (847–856). The battle is represented in Giulio Romano's fresco from Raphael's design in the Stanza dell' Incendio in the Vatican.

In the middle ages Ostia became a quarry for the cathedral of Orvieto, etc., some of its marbles being conveyed by the Pisans as far as Sardinia. Later it regained something of its importance owing to the silting up of the right arm of the Tiber. In 1483–1486 Giuliano della Rovere (nephew of Pope Sixtus IV., and afterwards himself Pope Julius II.) caused the castle to be erected by Baccio Pontelli. a little to the east of the ancient city. It is built of brick and is one of the finest specimens of Renaissance fortification, and exemplifies especially the transition from the old girdle wall to the system of bastions: it still has round corner towers, not polygonal bastions. An agricultural colony, founded after 1875, and consisting mainly of cultivators from the neighbourhood of Ravenna, has produced a great change for the better in the condition of the place. The modern village is part of the commune of Rome. The marshes have been drained, and a pumping station erected near Castel Fusano. An electric railway has been constructed from Rome to Ostia and thence to the sea-bathing resort of Ostia Mare.

Excavations on the site of Ostia were only begun towards the close of the 18th century, and no systematic work was done until 1854, when under Pius IX. a considerable amount was done (the objects are now in the Lateran museum). The Italian Government laid bare many of the more important buildings in 1880–89: and resumed work in 1907. Owing to the fact that the site is largely covered with sand and to the absence of any later alterations, the preservation of the buildings excavated is very good, and Ostia is, with the exception of Pompeii, the best example in Italy of a town of the Roman period, while its houses, the massive concrete walls of which were faced with brick and reticulate work (both as a rule left unplastered on the outside) rose to a height of three or four storeys and had balconies and numerous windows. They were frequently planned like modern apartment houses, and show us what the ancient Roman *insula* or block was. On the east the site is approached by the ancient road from Rome, flanked by tombs. It entered the enceinte of the 1st century B.C. (see plan) by a gate still preserved. This wall enclosed an irregular area far larger than that of the 4th century fort, extending down to the ancient coast line and the continuation of the road forms the main street of the town A considerable part of it had porticoes on each side. On the right (N.) are some small well-preserved thermae, and the barracks of the firemen (*vigiles*), a special cohort of whom was stationed here. On one side of the central courtyard of the latter building



FROM ADAPTATION AFTER GISMONDI IN "THE QUARTERLY REVIEW" (JOHN MURRAY)

OSTIA

1, 25, 26. Gates. 2. Decumanus. 3. Walls of original *castrum*. 4. Tombs. 5. City wall tower. 6, 7, 22, 23. Storehouses. 8, 18. Thermae. 9. Barracks of *vigiles*. 10. Theatre. 11. "Piazzale delle Corporazioni." 12, 13, 17, 20 (?) Temples. 14. Private Houses. 15. Capitolium. 16. Forum. 19. Basilica. 21. Curia. 24. Cardo. 27. Present course of Tiber. 28. Course of Tiber prior to flood, 1557 is a chapel with inscribed pedestals for imperial statues (2nd and 3rd century A.D.) and a well-preserved black and white mosaic representing a sacrifice.

To the south-west is the theatre, an area 265 ft. square surrounded by colonnades, in which were placed the offices of the various collegia or guilds of boatmen. raftmen and others, which had a special importance at Ostia; the names of the guilds may still be read in inscriptions in the mosaic pavements of the chambers. In the centre of the area are the substructions of a temple,

AUTHENTICATED NEWS

RUINS OF ROMAN COLONY AT OSTIA, ITALY

and on the south-east side are the remains of the theatre, built in the early imperial period, restored by Septimius Severus in 196–197 and again in the 4th or 5th century. To the south-uest of the theatre are the remains of four small temples, one dedicated to Venus, and a well-preserved hlithraeum, with mosaics representing the seven planets, etc. To the south-west again is the conspicuous brick cella of a lofty temple, on arched substructures, hitherto supposed to be that of Vulcan, but more probably the Capitolium or temple of Jupiter, Juno and Minerva, with a threshhold block of *africano* (Euboean) marble over 1; ft long; from it a street over 20 ft wide leads north-west to the river. It is flanked on each side by well-preserved warehouses, another 'group of which, surrounding a large court, lies to the south-west. Further still are the well-preserved Horrea Epaphroditiana et Epagathiana, a large private warehouse. Hence an ancient road, leading between warehouses (into which the Tiber is encroaching), in one room of which a number of well-preserved large jars may be seen embedded in the floor, runs close to the river to a large private house with thermae, in which fine mosaics were found: it (groundlessly) bears the name of "imperial palace." Farther to the south-west are remains of other warehouses, and (possibly) of the docks—long narrow chambers, which may have served to contain ships. The mediaeval Torre Bocacciana marked approximately the mouth of the river in Roman times.

The south-eastern portion of the city has been excavated only partially. Opposite the Capitolium is the Forum, with remains of a temple of Rome and Augustus, a basilica (much destroyed by mediaeval plunderers), the curia, etc. To the south-west of this are the remains of the temple of Cybele, with a portico. This lay close to the commencement of the Via Severiana (see SEVERIANA, VIA), and the line of tombs which flanked it soon begins. Farther south-east, a line of sand dunes, covering the ruins of ancient villas, marks the coast line of the Roman period.

See G. Calza, Ostia (trans by R Weeden Cooke, 1926). (T.A)

OSTRACISM, a political device instituted as a constitutional safeguard for the Athenian democracy. Its effect was to remove from Athens for a period of ten years any person who threatened the harmony and tranquillity of the body politic. In the sixth prytany (see PRYTANEUM AND PRYTANIS) of each year the representatives of the Boulē asked the Ecclesia whether it was for the welfare of the state that ostracism should take place. If the answer was in the affirmative, a day was fixed for the voting in the eighth prytany. No names were mentioned, but two or three names at the most could have been under consideration. The people met, not as usual in the Pnyx, but in the Agora, in the presence of the archons, and recorded their votes by placing in urns small fragments of pottery (ostmka) on which the; wrote the name of the person whom they wished to banish. Ostracism did not take effect unless ten thousand votes in all were recorded. The ostracised person was compelled to leave Athens for ten years, but he was not regarded as a traitor or criminal. When he returned, he resumed possession of his property and his civic status was unimpaired. The adverse vote simply implied that his power was so great as to be injurious to the state. Ostracism must therefore be carefully distinguished from exile in the Roman sense, which involved loss of property and status, and was for an indefinite period (*i.e.,* generally for life). At the same time it was strictly unjust to the victim, and a heavy punishment to a cultured citizen for whom Athens contained all that made life worth living. Its political importance really was that it transferred the protection of the constitution from the Areopagus to the Ecclesia. It was later replaced by the *Graphē Paranomōn.*

The object was primarily to get rid of the Peisistratid faction without perpetual recourse to armed resistance. Aristotle's Constitution of Athens (22) gives a list of ostracized persons, the first of whom was a certain Hipparchus of the Peisistratid family (488 B.C.). This, however, may conceivably be simply the list of those recalled from ostracism at the time of Xerxes' invasion, all of whom must have been ostracized less than ten years before 481 (*i.e.,* since hlarathon). With the end of the Persian Wars, the original object of ostracism was removed, but it continued in use for forty years and was revived in 417 B.C. It then became a mere party weapon, and the farcical result of its use in 417 in the case of Hyperbolus led to its abolition. Such a device inevitably lent itself to abuse (see Aristotle, Pol. 38, 1284 b. 22).

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OSTRACODA, a subclass of the class Crustacea (*q.v.*) comprising minute clamlike forms found in fresh water and in the sea as floaters, swimmers or bottom dwellers; a few may be parasitic; several live only in water held by the leaves of air plants (epiphytes) or in moist debris in holes in trees. Of their food habits little is known. Many are omnivorous, some carnivorous and others feed on aquatic plants and diatoms. ,411 are important as food for larger organisms including fish; some fossil forms are used in age determination. Ostracods are distinguished by having the body and limbs completely enclosed in a hinged double shell (bivalve). They are remarkable for having a smaller number of appendages than any other crustacean, there being not more than four pairs and sometimes only two pairs of limbs behind the mouth parts (mandibles). The antennules and antennae are used for swimming or creeping. The mandibles have a large fleshy palp, often forked (biramous) and sometimes leglike. The remaining limbs are varied in form: some of them are leglike and used in locomotion. The breeding habits of the ostracods present several interesting features. Development of eggs without fertilization (parthenogenesis: *q.v.*) is common, at least among the fresh-water species. in many of which males are rarely seen; in some species males are not yet known. A colony of a species of *Cypris* has been kept in an aquarium for more than 30 years and during the whole of that time no males have made their appearance. the colony reproducing exclusively by parthenogenesis. In some ostracods the threadlike spermatozoa are not only relatively but absolutely larger than those of any other animals In one species which, when adult, is no more than $\frac{1}{32}$ in in length the spermatozoa are about $\frac{1}{4}$ in long

Most species live on or near the bottom, creeping among weeds or burrowing in mud but some marine species are floaters (plank-

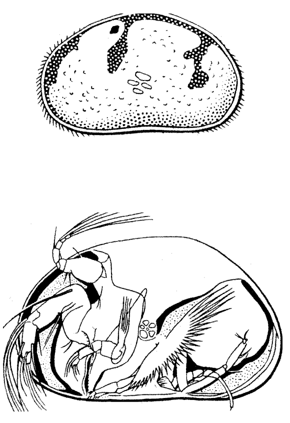
OSTRACODS

1. *Halocypris cornuta* (Müller), anterior view. Length 3.2-3.5 mm. Atlantic ocean. Order Myodocopa, family Halocypridae (after Müller)
2. *Cypria dentifera* (Sharpe), lateral view. Length 0.69 mm. Found in fresh-water ponds of the eastern United States. Order Podocopa, family Cypridae (after Sharpe)
3. *Halocypris cornuta* (Müller), lateral view
4. *Cythere lobiancoi* (Müller), female, dorsal view. Length 0.48 mm. Mediterranean sea. Order Podocopa, family Cytheridae (after Müller)
5. *Cypridina castanea* (Brady), male, lateral view. Length 4-6 mm. Atlantic and Indian oaeans. Order Myodocopa, family Cypridinidae (after Müller)
6. *Cythere diffusa* (Müller), female, dorsal view. Length 0.49-0.52 mm. Mediterranean sea. Order Podocopa, family Cytheridae (after Müller)
7. *Cythereis ornata* (Müller), male, lateral view. Length 0.98 mm. Mediterranean sea. Order Podocopa, family Cytheridae (after Müller)
8. *Gigantocypris agassizii* (Müller), female, anterior view. Length 23.0 mm. Pacific and Atlantic oceans. Order Myodocopa, family Cypridinidae (after Müller)
9. *Conchoecia atlantica* (Lubbock), female, lateral view. Length 3.3-4.8 mm. Atlantic, Pacific and Indian oceans. Order Myodocopq family Halocypridae (after Müller)
10. *Gigantocypris agassizii* (Müller). Lateral view (after Müller)

tonic) One of the latter. *Gigantocypris*, is the largest member of the group reaching a length of 9 in ; most species however, are rnuth smaller and some do not exceed 02 in in length

Ostrncods are classified by paleozoologists solely on fossil shell characters, zoologists working on living forms classify them mostly on the basis of soft parts Four orders comprise the subclass Myodocopa Cladocopa Platycopa and Podocopa The first three are exclusively marine To the Podocopa belong the vast majority of living genera including all the known fresh-water forms The order is characterized by an unbranched (uniramose) second antenna and a styliform or vestigial tail fork (caudal furca). The Myodocopa have an anterior notch in the valves of the body covering (carapace) a biramose second antenna, a heart and four pairs of postoral limbs. Both orders have a median eye in the nauplius stage, later adding a pair of compound eyes. The Cladocopa and Platycopa differ from the Myodocopa in the absence of the anterior notch and the eyes: the Cladocopa have two pairs of postoral appendages, the Platycopa three pairs. Classification of the fossil families is still unsettled: however, the "straight-backed" forms have been placed in an additional order Paleocopa. (W. T. C.; I. G. S.)

A



FROM (A) SARS CRUSTACEA OF NORWAY (B) THE "ZOOLOGICAL JOURNAL"

FRESH-WATER OSTRACOD (CYPRIDOPSIS VIDUA) ENLARGED

(A) External appearance; (B) appendages after removal of left valve shell; left, antennule and antenna; centre, mouth parts and behind them to the right, two leglike appendages

OSTRACODERM, a small extinct fishlike Paleozoic vertebrate. members of which belonged to several orders particularly abundant in late Silurian and early Devonian formations of Europe and North America (period from about 350.000.000 to 300.000 years ago). Jaws were not developed and paired appendages were often absent. These are primitive characteristics which show that they were allied to the living *Cyclostomata* (*see* CYCLOSTOME) —hagfish and lampreys—with which they are often grouped to form the vertebrate class Agnatha. Ostracoderms carried bony armour and internal bony areas iossifications) are sometimes present as well.

There are three major orders: Osteostraci, Anaspida and Heterostraci. In the Osteostraci (Cephalaspid-like form) such as *Cephalaspis,* the head and gill region were covered by a broad crescent-shaped shield of bone. Dorsally there were paired orbits, a median eye and, anterior to this (as in lampreys), a median opening leading to the nasal organ and hypophysis. Areas of small checkered or tessellated plates, to which large nerves led, are thought to represent electric organs or pressure-sense organs. The "head" region is ossified internally; delicate dissection and sectioning has revealed cavities for brain, nerves and blood vessels of a pattern broadly comparable to that of lampreys. The underside of the head region was covered by a series of small plates. with about ten round gill openings at either margin. The mouth was small. Internally there was a large branchial or gill chamber; the animal appears to have been a filter feeder after the fashion of lower chordates. In many osteostracans there mere paired paddle-shaped structures behind the shield in the position of pectoral fins.

The Anaspida include small spindle-shaped (or fusiform) fishes with a narrower and deeper form than that of osteostracans. There is no expanded head shield and this region is covered by a series of small oat-shaped scales. No internal structures are known but the pattern of openings for sense organs and gills is similar to that of the Osteostraci.

In the Heterostraci (Pteraspid-like form) the anterior part of the long slender body was enclosed in a set of large plates which fused to a variable degree. In contrast with the other two orders of the group the small paired eyes were laterally placed. There was no dorsal nostril opening; the nares may have been paired and placed at the corners of the mouth opening. The mouth was a transverse ventral slit, bounded posteriorly by small movable plates, suggesting a mud-grubbing mode of feeding. No internal structures have been preserved, but impressions inside the plates indicate the presence of large gill chambers. There was a single external gill opening on either side. Possibly related to the Heterostraci are *Thelodus* and other genera in which no plates or large scales were present, but, rather, the whole body was covered with minute scales.

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OSTRICH (*Struthio camelus*), the largest living bird; the male may be nearly 8 ft. high, and weigh 300 lb. The ostrich, together n·ith other flightless birds is sometimes placed in a special group, Ratitae, members of which are characterized by the absence of a keel on the breastbone. The cock bears the fluffy black and white curly plumes formerly prized in the millinery trade. The smaller female has a duller. brownish wlumane. Ostriches are unique in possessing only two toes (all other birds have three or four). thus distinguishing it from the ostrichlike rhea of South America and the emu and the cassowary of the Australian region.

The ostrich inhabits sandy plains and open country in Africa. being more abundant in the eastern than the western portion of that continent. Formerly abundant in Arabia as well, it has not been sighted there since 1941.

Ostriches travel in small troops of five or six; usually one bird is a cock and the rest hens. At other times a troop will form mixed herds with zebras and various antelopes. The bird has keen eyesight; when resting or hiding, it may sit and stretch its lanky neck along the ground, peering intently at some far-off threat. At a distance only the ostrich's bulky body is visible; hence the belief that the bird hides its head in the sand. When danger is imminent, however, the ostrich warily moves off, the male all the while producing a loud hissing sound, somewhat like a muffled roar.

W. SUSCHITZKY

OSTRICH (STRUTHIO CAMELUS), **NATIVE TO AFRICA**

Extremely fleet of foot, the ostrich can stride across a flat plain at speeds up to 40 m.p.h. (Because of this ability, some captives have been trained for racing, whether harnessed to light, two-wheeled carts, or saddled for riding.) When brought to bay, it often uses its strong legs to deliver vicious kicks.

The hen may lay up to 15 buffy-white, rough-surfaced eggs. each weighing about three pounds—thc largest egg of any living bird. Several hens combine to lay their eggs in one nest, and on these the cock sits by night while the females relieve one another by day (this is more to guard the eggs from beasts of prey than to incubate them, the heat of the sun sufficing for that). Yellowish and black-striped young, hatching in about six weeks, are covered with a bristly down. The parents display great solicitude for their agile little chicks. They forage together for anything fit to eat—small animals as well as fruit and other plant parts.

The great value of ostrich feathers, combined with the growing scarcity of the birds themselves, led to the establishment of ostrich farms, where the birds are kept and deprived of their plumes at regular intervals. Ostrich farming was carried on in Cape Province (in south Africa), Egypt, Algeria, the French Riviera, the southern U.S. and elsewhere, but the commercial raising of the birds has dwindled away in France and America.

All ostriches belong to a single species, which has six races including the now extinct Arabian one. The best known are

Strritkio camelus camelus of north Africa, ranging from the Atlas mountains to the Sudan; *S.c. malybdophanes* of Somaliland and northern Kenya; *S.c. Massaicus* of eastern equatorial Africa; and *S.c. australis* of south Africa. The southern race is now quite local. finding its optimum numbers in the Kalahari desert of Bechuanaland and in adjacent portions of South-West Africa. Southern Rhodesia, northern Transvaal and Mozambique. In Rio de Oro. on the northwest coast of Africa, is a small and little-known race *S.c. spatzi*. *See* also references under '.Ostrich" in the Index volume. (Ht. Fn.)

OSTROGOTHS or East Goths, one of the two main branches into which the Goths were divided, the other being the Visigoths, or West Goths. *See* Goths; *see* also references under "Ostrogoths" in the Index volume.

OSTROVSKY, ALEXANDER NIKOLAEVICH (1823–1886), Russian dramatic author, was born on April 12, 1823. in Moscow, where his father was an official of the senate. He studied law in the university of that city, which he quitted without having submitted to the final examination. He was then employed as a clerk in the office of the "Court of Conscience," and subsequently in that of the Commercial Court at Moscow. Among his early comedies are *Byednaya Nivesta* ("The Poor Bride"), *Byednost ne Porok* ("Poverty not a Vice"), and *Ne v'svoi sani ne sadis* (literally "Don't put yourself in another's sledge"). Of this last Nicholas I said. "it was not a play, but a lesson." The Moscow merchants are strikingly portrayed in *Grozá* (1860, Eng. trans. *The Storm*, by C. Garnett. 1898) the most famous of all his plays, and *Svoyi lyudi sotchtyomsya* ("Between near relatives no accounts are needed") (1850) which was originally called "The Bankrupt." *The Bankrupt* was prohibited for ten years. until the accession of Alexander II. and Ostrovsky was dismissed from the government service and placed under the supervision of the police. The Liberal tendencies of the new reign. however, soon brought relief; Ostrovsky was one of several well-known literary men who were sent into the provinces to report on the condition of the people. Ostrovsky's field of inquiry lay along the upper Volga. This mission inspired several historical dramas, such as *Kuzma Zakharich Minin Soukhorouk*, *Vassilisa Melentieva* and others. Four of his *Plays* have been translated into English by G. R. Noyes (1917). Ostrovsky enjoyed the patronage of Alexander III. and received a pension of 3.000 roubles a year. With the help of Moscow capitalists he established in that city a model theatre and school of dramatic art, of which he became the first director. He also founded the Society of Russian Dramatic Art and Opera Composers. He died on June 24, 1886.

OSTWALD, WILHELM (1853–1932), German chemist. winner of the Nobel prize for chemistry in 1909; may be regarded as one of the pioneers of modern physical chemistry.

He was born at Riga. Latvia. Sept. 2, 1853, and educated at the University of Dorpat (Estonia). In 1881 he became professor in Riga, and six years later was appointed professor of physical chemistry in the University of Leipzig. where he was later director of the Physico-chemical institute. In 1906 he resigned his university appointment and subsequently lived in retirement in Saxony. With J. H. van't Hoff (*q.v.*) in 1887 he founded the important *Zeitschrift fur physikalische Chemie*. His own contributions to physical chemistry were mainly in the fields of electrochemistry and solutions. Ostwald died near Leipzig, April 4, 1932.

On the technical side he is remembered chiefly for his discovery in 1900 of a method of oxidizing ammonia to form oxides of nitrogen. a mixture of air and ammonia being passed over a platinum catalyst. By means of this process and by later developments in connection n·ith it. Germany was able to continue the manufacture of explosives during World War I after the Allied blockade had been eniorced; the method came to he used in various countries. under the name of the Ostwald-Brauer process, for the manufacture of nitric acid from ammonia.

His published works include *Lehrbuch der allgemeinen Chemie* (2 vol., 1885–88; 3rd ed.. 1910–11), *Grundlinien der anorganischen Chemie* (1900; jth ed.. 1922) and *Die wissenschaftlichen Grundlagen der analytischen Chemie* (1894; 7th ed., 1920), which have been translated into English. His autobiography, *Lebenslinien, eine Selbstbiographie* (3 vol.), appeared in 1926–27. His interests were not confined to chemistry. as evidenced by *Vorlesungen über Naturphilosophie* (1903; 3rd ed.. 1905), his studies of colour theory, monism, the technique of painting, etc. His studies of the lives of scientists are notable for their insight into the factors that make for great men (*see* his *Grosse Manner*, 1909).

See F. G. Donnan, "Ostwald Memorial Lecture," J. *Chem. Soc.*, 136:316 (1933). (*R.* E. O.)

OSTWALD, WOLFGANG (1883–1943), German chemist and specialist in colloid chemistry, was born at Riga. Latvia. on May 27, 1883. He was educated at Leipzig, majoring in zoology. In 1904 he was assistant to Jacques Loeb at the University of California, Berkeley. He returned to Leipzig, and became interested in colloid chemistry. The whole of his academic career was spent at Leipzig, where he eventually held the proiessorship of colloid chemistry in the famous institute built and directed by his father. Wilhelm Ostwald (*q.v.*). From 1907 to his death he edited the *Kolloid Zeitschrift* and the *Kolloidchemische Beihefte*. He died at Dresden on Nov. 22, 1943.

See R. Oesper, *J. Chem. Educ.*, vol. xxii, p. 263 (1945). (R. E. O.)

OSTYAK (Khant), a western Siberian people belonging to the Ugrian branch of the Uralic language family. The language of the Khant is most closely related to that of their neighbours. the Vogul (Mansi), and somewhat more distantly to the Hungarians (Magyars). (*See* Ural-Altaic Languages.)

The Khant territory lies between the Ural mountains and the Ob river; it is a cold. flat country of marsh and bog within the Siberian Taiga. When the Ostyaks settled their present habitat is not precisely known but it was probably in the middle of the first millennium A.D. They and their congeners. the Vogul (Mansi), moved there from the south Ural steppe region, and have a continuous occupancy of their present territory of about 1,500 years. Their traditions in the 1960s still recall that distant time when they were steppe horse breeders.

There is some confusion over the name Ostyak, which has been indiscriminately applied to the Khant or Ob Ostyaks, the Ket or Yenisey Ostyaks and the Sel'kup or Samoyed Ostyaks. Some of the Mansi have also been referred to as Ostyaks. Therefore a more precise terminology has been adopted, reserving the name Ostyak to the Khant.

The Khant and the Mansi have a common habitat, common traditions, economy and organization. Together they are known as the Ob Ugrians. Their principal source of subsistence is hunting and fishing. They hunt in their traditional culture with bow and arrow and by trapping for hare, reindeer, lynx and bear. They fish with nets: weirs. seines and traps. Limited reindeer domestication has come only in recent centuries. Other forms of animal breeding are poorly developed and agriculture is a minor source of food. Their dwellings reflect available natural resources; in winter they use log cabins. which yield to birch-bark tents in summer. Travel over water is by dugout, and over snow by skis.

These Ob Ugrian peoples were divided into tribal units, each with a distinctive locality (territorial grouping). The tribal units. in turn. were divided into clans, each with its proper name. sign and internal organization. The most striking kinship feature is their dual organization; the territorial units were divided into pairs. These dual organizations were exogamic, and later the clans became the exogamic units. The prevailing principle in the tracing of descent lines, kinship and the establishment of marriage rules was patrilineality of kinship in the male line. They worshiped family, clan and territorial spirits. Their ritual also included an ancestor cult and an animistic cult of animals and fish.

These two peoples lived in the 1960s in the Khanty-Mansi national district of the U.S.S.R. The Khant numbered 19.000 (Soviet census of 1959). This was a decline of 15% from their number in 1926 (22.300). The Mansi numbered 6.000 (1959), a slight increase over 1926 when they numbered 5,800.

See S. A. Tokarev, *Etnografiya Narodov SSSR* (1958); M. A. Czaplicka, *Aboriginal Siberia* (1914). (L. K.)

ŌSUMI-GUNTŌ, a group of islands, lying south of the Ōsumi peninsula of Ryushu. in Kagoshima prefecture. southern Japan. They consist of the two larger islands of Tanega-shima and Yaku-shima and several smaller islands. Tanega-shima is famous because in 15.13 the Portuguese landed there and introduced the first guns to Japan. (R. B. H.)

OSUNA, a town of southern Spain, in the province of Seville; 57 mi. E.S.E. by rail of Seville. Pop. (1950) 23,350 (mun.). Osuna is built on a hill, overlooking the fertile plain watered by the Salado, a subtributary of the Guadalquivir. Osuna, the Urso of Hirtius, famous in the 1st century B.C. for its long resistance to the troops of Caesar and its fidelity to the Pompeians, was subsequently called by the Romans Orsona and Gemina Urbanorum, the last name being due, it is said, to the presence of two urban legions here. Osuna was taken from the Moors in 1239, and given by Alphonso X to the knights oi Calatrava in 1264. Don Pedro Giron appropriated it to himself in 1445. One of his descendants. Don Pedro Tellez, was the first holder of the title duke of Osuna, conferred on him by Philip II in 1562. The University of Osuna, founded in 1549, was suppressed in 1820. The industries are agriculture and the making of esparto mats, pottery, bricks. oil, soap, cloth. linen and hats.

OSWALD (d. 992), archbishop of York, was a nephew of Oda, archbishop of Canterbury. Desiring to become a monk, he went with Oda's approval to the monastery of Fleury on the Loire—at that time the great centre of reviving Benedictinism. In 959 he returned to England at the request of Oda. who, however, died before his arrival. He now went to York to his kinsman the archbishop Oskytel, who took him with him on a pilgrimage to Rome. Soon after his return he was appointed bishop of Worcester at the recommendation of Dunstan, his predecessor (961). As bishop he carried through an elaborate reorganization of the estates of the see. He took a prominent part in the revival of monastic discipline on Benedictine lines of which Aethelwold, bishop of Winchester, was the most ardent leader. By the gradual substitution of monks for clerks he transformed his cathedral church of Worcester into a monastery of the reformed Benedictine pattern. Among other religious houses he founded that of Ramsey in conjunction with Aethelwine, ealdorman of East Anglia. In 972 he was translated to the archbishopric of York, with which he continued to hold the see of Worcester. He died on Feb. 29, 992.

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OSWALD (*c.* 605–641). king of Northumbria. was one of the sons of Aethelfrith and was expelled from Xorthumbria on the accession of Edwin. though he himself was a son of Edwin's sister Acha. He appears to have spent some of hi; cxilc in Iona. where he was instructed in the principles of Christianity. In 633 he defeated and slew the British king Ceadwalla near a stream called Denisesburn. now known as the Rowley Water. Northumberland. By this he avenged his brother Eanfrith. who had succeeded Edwin in Bernicia, and became king of Northumbria. Oswald reunited Deira and Bernicia, and soon raised his kingdom to a position equal to that which it had occupied in the time of Edwin, with whom he is classed by Bede as one of the seven overlords of all the southern English peoples. His close alliance with the Celtic church is the characteristic feature of his reign. In 635 he sent to the elders of the Scots for a bishop. On the arrival of Aidan in answer to this request he assigned to him the island of Lindisfarne as his see, near the royal city of Bamborough. He also completed the minster of St. Peter at York which had been begun by Paulinus under Edwin. Bede declares that Oswald ruled over "all the peoples and provinces of Britain, which includes four languages, those of the Britons, Picts, Scots and Angles." His relationship to Edwin may have helped him to consolidate Deira and Bernicia. Early in his reign he was sponsor to the West Saxon king Cynegils, whose daughter he married. In 641 he was defeated and slain at a place called Maserfeld probably Oswestry in Shropshire, by Penda of Mercia.

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OSWEGO, a city and lake port of north-central New York, U.S., is located about 35 mi. N.W. of Syracuse. on Lake Ontario, at the mouth of the Oswego river; the seat of Oswego county. The site, known as Osh-we-geh, an Iroquois term meaning "pouring-out, place." was visited about 1616 by Samuel de Champlain and was later a station for Jesuit missionaries and *coureurs de bois.* A British trading post. founded there in 1722 and fortified in 1727, was the western terminus of the water route connecting the Mohawk and Hudson rivers with Lake Ontario. Oswego played a role in the French and British colonial wars, its two forts, Ontario and Oswego (1755–56), being captured and destroyed by General Montcalm in 1756. Ft. Ontario was restored by the British in 1759 and ceded to the U.S. in 1796. In 1814 it was again brietly in British hands; it was rebuilt by the U.S. in 1939, abandoned in 1899 and reconstructed again in 1905. It is the oldest fort in the U.S. that is still garrisoned. Permanent settlement began with the 1796 cession to the U.S., and in 1817 the first steamboat on Lake Ontario put in at Oswego. With the opening of the Oswego canal in 1828, Oswego became the Lake Ontario port of the Erie canal; it was incorporated as a village that same year and became a city in 1848. Through the canal. salt, manufactured goods and immigrants poured westward, and Canadian lumber entered the United States. Railroad transportation, however, practically killed the port, and about 1880 Oswego turned to manufacturing. Manufactures include boilers, cornstarch. malt. textiles, matches, paper and paper products, machinery and candy.

In 1917 following completion of the New York State Barge canal system. the port revived and in the second half of the 20th century handled principally Canadian cement and wood pulp, Pennsylvánia coal and western grains. With the opening of the St. Lawrence seaway in 1959, Oswego, most easterly port on the Great Lakes; became a world port. It is the hydro- and steam-electric power centre of central New York and has unlimited water supplies for industrial and other uses.

The State University College of Education, founded by the city as a normal school in 1861. was taken over by the state in 1867 and after 1945 was a unit of the State University of New York. For comparative population figures *see* table in NEW YORK: *Population.* (M. E. MA.)

OSWEGO TEA (*Monarda didyma*), a North American plant of the mint family (Labiatae), called also American beebalm. native to moist soil from Quebec to Michigan and southward to North Carolina and Georgia. It is a stout perennial, two to three feet high. with opposite, lance-shaped. sharply toothed leaves, and showy scarlet flowers, about 2 in. long. borne in dense bracted heads terminating the branches. The Oswego tea. so named because of former medicinal use. is one of the most handsome flowering plants native to eastern North America.

OSWESTRY, a market town and municipal borough in the Oswestry parliamentary division of Shropshire, Eng., 1S mi. N.W. of Shrewsbury by road and near the Welsh border. Pop. (1961) 11,193. Area 3.1 sq.mi. Situated on a slope which rises gently from the Shropshire plain toward a spur of the Berwyn mountains, Oswestry lies largely between Offa's and Wat's dykes—at one time famous boundary lines. Its name (formerly Maserfeld) is thought to derive from Oswald. king oi Northumbria, who died there in battle against Penda. the ruler of Mercia. The heavily fortified encampment of "Old Oswestry," about a mile from the town, suggests early border warfare. On an eminence known as Castle bank are the ruins of the ancient castle built by Madog. prince of Powys, whose widow married Alan. lord of Clun in Shropshire. The title of baron of Oswestry is still held by the Fitzalans, earls of Arundel. The town was twice burned by Welsh invaders in the middle ages. In the 15th and 16th centuries a weekly market was held for the sale of woollen goods manufactured in Wales. but Shrewsbury drapers ruined the trade by refusing to buy cloth there. In 1559 Oswestry suffered from the plague arid the market was moved to a site marked by the Croeswyllan stone (the Cross of Weeping). The borough was incorporated in 1617. In 1642 the castle was garrisoned for Charles I but fell to the parliamentary forces in 1644. The church of St. Oswald, originally conventual, is Early English and Decorated, hut has been much restored. In it is a memorial to Elihu Yale, the benefactor in 1718 of the U.S. university that hears his name. The grammar school, founded in 1407, was moved in 1776 to bigger buildings, hut the original house, near the church, still stands. Llwyd mansion is a half-timbered house in Cross street. Oswestry's industries include agriculture: with a big cattle market; railway works and running sheds; plastics. clothing and printing. It is the birthplace of the poet Wilfred Owen (1893–1918).

OSWIECIM (AUSCHWITZ), the county town of the Cracow *wojewodztwo* ("province") of southern Poland, lies 51 km. (32 mi.) W. of Cracow. Pop. (1960 est.) 31,000. Area 29.2 sq.km. (11.3 sq.mi.j.

Oswiecim came into being at the confluence of the Vistula and Sola rivers in the marshy valley of the same name. It was formerly a fortress in the province of Cracow and was incorporated in Silesia at the end of the 12th century. It obtained the status of a town in the 13th century and from 1306 was the capital of a principality, made subject to Bohemia in 1307. It was returned to Poland in 1457. Seized by Austria at the first partition of Poland in 1772, it was restored to Poland in 1918. During World War II, the Germans established near Oswiecim a concentration camp called Auschwitz-Birkenau (Oswiecim-Brzezinka), covering about 30 sq.km. 115 sq.mi.). It consisted of three main camps, and there were 39 supplementary camps throughout Silesia. The first prisoners arrived on July 14. 1940. and the camp was evacuated and closed on Jan. 27, 1945. About 40.000 registered prisoners passed through the Oswiecim camp. hut the number of persons murdered is estimated at 4,000,000, mainly Poles and Jews.

The camp was situated in an uninhabited area. from which the populations of the nearby villages were evacuated. The entire complex of buildings in Brzezinka, used for mass gassing of prisoners and the cremation of their remains, was camouflaged and later converted or destroyed before the camp was evacuated.

In 1016 the Oswiecim State museum was founded on the site of the camp, and it has become a place of pilgrimage from Poland and abroad. A chemical factory. erected by prisoners in the Dwory camp 4 km. (2.4 mi.) from Oswiecim, has been rebuilt after its complete destruction and is now one of the largest and most up-to-date factories in Poland. Oswiecim is a centre of communications, where five railway lines meet.

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OTARU, a commercial town on Otaru bay, Hokkaido. Japan. Pop. (1960) 198.511. It is the most important seaport next to Hakodate and the largest industrial and commercial city on the west coast of the island. The word Otaru is a corruption of the Ainu word *Otarunai,* meaning "sandy beach." The development of Otaru as a modern town was undertaken by the Japanese government around 1875. Provided with a good natural harbour. the town developed rapidly. After the loss of Sakhalin Island to the U.S.S.R. at the end of World War II, Otaru's prosperity suffered some decline. (R. B. H.)

OTFRID (OTFRIED) (fl. 9th century), monk of Weissenburg (Wissembourg) in Alsace and the first German poet whose name is known. He was trained in the monastery school of Fulda under Rabanus Maurus, who directed it from 802 to 824. Otfried's fame rests on his *Evangelienbuch* (*c.* 870), a poem of 7.416 lines. which is extant in three good contemporary manuscripts. It is an exceptionally valuable document not merely linguistically as the most extensive work in the South Rhine Franconian dialect of Old High German but also theologically as an introduction to early Christian thought in Germany. In German literary history it is also a milestone since it is the first poem to use rhyme and not alliteration. adopting the stylistic device of the Latin hymn rather than following the tradition of Germanic verse. The *Evangelienbuch* deals with the life of Christ. presenting the narrative in small chapters and interposing short passages of interpretation or commentary. Although Otfried wrote his epic to counteract the influence of popular heathen songs, it seems likely that his poem was meant not to be sung but rather to provide passages for daily study. He made concessions to the pagan Germanic outlook in his presentation of Christ and hoped to show that his native Franconian dialect was as suitable as the classical languages for poetic writing. His efforts to achieve rhyme made his poem somewhat laboured, however.

See editions of *Otfried* by J. Kelle, 3 vol. (1856–81), O. Erdmnnn *(1882;* 2nd ed. *by* E. Schroder, 1934) and P. Piper, 2nd ed. (1882–84) (W. W. Cs.)

OTHMAN (*c.* 574–656), in full 'OTHMAN IBN 'AFFAN. the third of the Mohammedan caliphs. a kinsman and son-in-law of Mohammed and cousin of Abu Sofian, whose son Mu'awiya became the first of the Omayyad dynasty. He was elected caliph in succession to Omar in 644, but due to his age and increasing weakness and his preference of the Koraish for all responsible positions irrespective of their capacity. disorders broke out in Egypt and Iraq, which led to his assassination by Mohammed, son of Abu Bekr. He was succeeded by 'Ali. See CALIPHATE.

OTHO, MARCUS SALVIUS (32–69), Roman emperor, mas born on April 28, A.D. 32. He appears first as one of the wildest of Nero's court. In 58 he refused to divorce his wife Poppaea Sahina at Nero's bidding, and was thereupon sent to be governor of Lusitania. In 68 Galba, governor of the neighbouring province of Tarraconensis, rebelled against Nero: Otho accompanied him to Rome. hoping to succeed him. But in Jan. 69 Galba adopted Piso as his successor. Otho at once organized a revolt of the praetorian guard, and on Jan. 1j had himself proclaimed emperor, murdered Galba and Piso. and was accepted by the senate. He owed his success partly to the guards' dislike of Galba's disciplinary measures. partly to the power of the memory of Nero, which he further enlisted by restoring his statues and the officials of his household. and proposing to complete his palace, the Golden House. Before Galba's death, however, the army in Germany had declared for Vitellius. Otho failed to prevent the Vitellians entering Italy, but his advance guard successfully held the line of the Po against Alienus Caecina and was subsequently joined by substantial forces from Illyricum. Otho himself left Rome on March 14. When he reached the armies a council of war ensued. he himself wishing to force a decisive battle. others advising him to await further troops from the Danube. Otho prevailed. and while he himself retired south of the Po to Brixellum, his main force left its camp at Bedriacum (Calvatone) and was decisively defeated outside Cremona by the combined armies of Caecina and Fabius Valens. Otho refused to renew the struggle and committed suicide in his tent on the morning of April 15, 69, and was buried at Brixellum.

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OTIS, ELISHA GRAVES (1811–1861), inventor of the safety elevator (lift), was born at Halifax, Vt., on Aug. 3, 1811. He worked as a builder in Troy. N.Y.. in 1834, and later. while employed as a master mechanic in a bedstead factory in Albany. N.Y., invented several labour-saving machines. As a result he was sent to Yonkers, N.Y., in 1852 to build a new factory. There he designed and installed the first elevator equipped with an automatic safety device to prevent it from falling. The next year he set up a small elevator shop and sold his first freight machine on Sept. 20, 1853. Orders were few until May 1853 when. at the Crystal palace in New York city, he demonstrated his elevator by riding the platform high in the air and ordering the rope cut. In 1857 he installed the first safe elevator for passenger service in a store in New York city. After he died in Yonkers on April 8, 1861. his sons Charles and Norton carried on the business. (D. SN.)

OTIS, JAMES (1725–1783), U.S. patriot, was born at West

Barnstable, Mass., on Feb. 5, 1725. He was the eldest son of James Otis (1702–1778), fourth in descent from John Otis (1581–1657), a native of Barnstaple, Devon, and one of the first settlers (in 1635) of Hingham, Mass. The elder James Otis was elected to the provincial general court in 1758, was its speaker in 1760–1762, and was chief justice of the court of common pleas from 1764 until 1776; he was a prominent patriot in the colony of Massachusetts. 'The ion graduated at Harvard in 1743; and after studying law in the office of Jeremiah Gridley (1702–1767), a well-known lawyer with Whig sympathies. rose to great distinction at the bar, practising first at 1'1:-mouth and after 1750 at Boston. In 1760 he published *Rudiments of Latin Prosody,* a hook of authority in its time. Soon after the accession of George III to the throne of England in 1760, the British government decided upon a rigid enforcement of the navigation acts, which had long been disregarded by the colonists and had been almost wholly evaded during the French and Indian War. 'The writs of assistance issued in I; jj were about to expire, and it was decided to issue new ones, which would empower customhouse officers to search any house for smuggled goods, though neither the house nor the goods had to be specifically mentioned in the writs. Much opposition was aroused in Massachusetts, the legality of the writs was questioned, nnd the superior court consented to hear argument. Otis held the office of advocate-general at the time. and it was his duty to appear on behalf of the government. He refused. resigned hi.; office, arid appeared for the people against the issue of the writs.

The case was argued in the old town house of Boston in Feb. 1761, and the chief speech was made by Otis. His plea was fervid in its eloquence and fearless in its assertion of the rights of the colonists. Going beyond the question at issue. he dealt with the more fundamental question of the relation between the English in America and the home government, and argued that even if authorised by act of parliament such writs were null and void. The young orator was elected in May of the same year a representative from Boston to the Massachusetts general court. To that position he was re-elected nearly every year of the remaining active years of his liie. serving there with his father. In 1766 he was chosen speaker of the house of representatives, but the choice was negatived.

In Sept. 1762 the younger Otis published *A Vindication of the Conduct of the House of Representatives of thi' Province of Massachusetts Bay,* in defense of the action of that body in sending to the governor a message (drafted by Otis) rebuking him for asking the assembly to pay ior ships he had (with authorization of the council and not of the representatives) sent to protect New England fisheries against French privateers: according to this message "it would be of little consequence to the people whether they were subject to George or Louis, the king of Great Britain or the French king. if both were as arbitrary as both would be if both could levy taxes without parliament." He also wrote various state papers addressed to the colonies to enlist them in the common cause, or sent to the government in England to uphold the rights or set forth the grievances of the colonists. His influence at home in controlling and directing the movement of events which led to the War of Independence was universally felt and acknowledged; and abroad no American was so frequently quoted. denounced or applauded in parliament and the English press before 1769 as the recognized head and chief of the rebellious spirit of the New England colonists. In 1765 Massachusetts sent him as one of its representatives to the Stamp Act congress at New York city. and there he was a conspicuous figure, serving on the committee which prepared the address sent to the British house of commons.

From 1769 almost continually until his death. Otis was harmlessly insane, though he had occasional lucid intervals, serving as a volunteer in the battle of Bunker Hill in 1775 and arguing a case in 1778. He was killed by lightning (it is said that he had often expressed a wish that he might die in this way) at Andover, Mass., on May 23, 1783.

Otis' political writings esercised an enormous influence. his pamphlets being among the most effective presentations of the arguments of the colonists against the arbitrary measures of the British ministry. His niore important pamphlets were *A Vindication of the Conduct of the House of Representatives of the Province of Massachusetts Bay* (1762); *The Rights of the British Colonies Asserted and Proved* (1764); *A Vindication of the British Colonies against the Aspersions of the Halifax Gentleman in his Letter to a Rhode Island Friend*—a letter known at the time as the "Halifax Libel" (1765); and *Considerations on Behalf of the Colonists in a Letter to a Noble Lord* (1765).

The best biography is that by William Tudor (Boston, 1823); there is a shorter one by Francis Bowen (Boston, 1847). The best account of Otis' characteristics and influence as a writer may be found in M. C. Tyler's *Literary History of the American Revolution* (1897). Consult the notes on the Writs of Assistance by Horace Gray, Jr., in Quincy's *Massachusetts Rrporfs, 1701–1772* (Boston, 1865). *See* also Francis Wilson Sprague, *Birthplace of the Patriot James Otis* (1917).

OTLEY, an urban district in the Ripon parliamentary division of the West Riding of Yorkshire, Eng., 10 mi. N.W. oi Leeds by road. The population in 1961 was 11.930. Area 4.6 sq.mi. It stands on the Wharfe at the foot of the precipitous Chevin. Southwest of Otley the Guiseley gap affords a route, only 4 mi. long. between the Aire and the Wharfe which is traversed by roads and railways and brings much of the Aire valley within range of Otley market.;. In 937 Xethelstan granted the manor of Otley to the archbishop of Work. The town and the church were laid waste in 1069.

Otley became an important local centre of the woollen cloth industry. which was introduced late in the 11th century. An annual fair was granted in 1222 and a weekly market in 1248.

The growth of cereals. which was important until the 18th century, was abandoned in favour of pastoral industries for the supply of meat to the dense population on the Yorkshire coal field. The prosperity of Otley depends not on its importance as an agricultural centre but on its industries, chief among which are the manufacture of printing machinery, papermaking and worsted spinning and weaving.

OTRANTO, seaport and archiepiscopal see. Puglia region. Italy. in province of Lecce, 29½ mi. S.E.from the city of Lecce by rail, 49 ft. above sea-level. Pop. (1957 est.) 3.995 (commune). It is on the E. coast of the peninsula of ancient Calabria (*q.v.*). The castle was erected by Alfonso of Aragon; the cathedral. consecrated in 1088, has a rose window and side portal of 1481. The interior, a basilica with nave and two aisles. contains a mosaic pavement of 1165. It has a crypt supported by 42 marble columns. The church of S. Pietro has Byzantine frescoes.

Otranto occupies the site of the ancient Hydrus or Hydruntum, a town of Greek origin. In Roman times it was less important than Brundisium as a point of embarkation for the East. It was taken by Robert Guiscard in 1068. In 1480 it was utterly destroyed by the Turkish fleet, and has never since recovered its importance. About 30 mi. S.E. lies the promontory of S. Maria di Leuca. (so called since ancient times from its white cliffs). the southeast extremity of Italy, the ancient Promontorium Iapygium or Sallentinum. The district between this promontory and Otranto is thickly populated, and very fertile. It was a supply base in World Wars I and II. The straits are about 40 mi. wide; cables leave here for Valona and Corfu.

ŌTSU, the capital of Shiga prefecture in South Honshu, central Japan. Pop. (1960) 113.547. It is located on the shore of Biwa-ko. the largest lake in Japan. and was a castle town established by Toyotomi Hideyoshi in the 16th century. Situated at the junction of ancient highways, including the Tokaido (Tokyo-Osaka.) route. Ōtsu has been a gateway to Kyoto and a centre of transportation. There are many places of historical interest and scenic beauty in the vicinity. *See* also SHICA. (R. B. H.)

OTTAKAR I. (d. 1230), king of Bohemia, was a younger son of King Vladislav II. (d. 1174) and a member of the Premyslide family, hence he is often referred to as Premysl Ottakar I. Recognized as ruler of Bohemia. by the emperor Henry VI. in 1192, he was, however, soon overthrown, but in 1196 forced his brother, King Vladislav III., to abandon Bohemia to him and to content himself with Moravia. Ottakar first sought the support of the German king Philip, duke of Swabia, but then went over to his rival Otto of Brunswick. Philip thereupon invaded Bohemia, and Ottakar changed sides once more. Later still, he supported the young king, Frederick II. He united Moravia with Bohemia in 1222, and when he died in 1230 he left to his son, Wenceslaus I., a kingdom united and comparatively peaceable.

OTTAKAR II., or PREMYSL OTTAKAR II. (c. 1230–1278), king of Bohemia, was son of King Wenceslaus I.; his maternal grandfather was the German king, Philip, duke of Swabia. In his father's lifetime he ruled Moravia, and in 1251 secured his election as duke of Austria, where he strengthened his position by marrying (Feb. 11, 1252) Margaret (d. 1267), sister of Duke Frederick II., the last of the Babenbergs and widow of the German king, Henry VII. In Sept. 1253 he succeeded his father in Bohemia, and in 1254 concluded peace with Bela IV. of Hungary, who had claimed Styria, advancing the Austrian frontier to the present line. In 1259 he expelled the Hungarians from the rest of Styria, then divorced his wife, married a granddaughter of Bela IV. and secured his investiture (by letter) with Austria and Styria from the German king, Richard Cornwallis.

In 1269 Ottakar II. inherited Carinthia and part of Carniola; and having made good his claim, contested by the Hungarians, in battle, he was the most powerful prince in Germany when an election for the German throne took place in 1273. The electors, however, fearing his power, chose Rudolph of Habsburg, who in 1276 placed Ottakar under the ban, besieged Vienna, and compelled Ottakar to renounce all his possessions except Bohemia and Moravia. (*See* AUSTRIA, EMPIRE OF.) Ottakar was killed at Dürnkrut on the March, Aug. 26, 1275, in an attempt to recover his lands. Clever, strong and handsome, he is the subject of a tragedy by F. Grillparzer, *König Ottokars Glück und Ende*.

See O. Lorenz, *Geschichte, Konig Ottokars*, ii *(1866)*; F. Palacky, *Geschichte von Böhmen*, vol. i *(1844)*.

OTTAVA RIMA, a stanza of eight iambic lines, containing three rhymes, invariably arranged as follows: *a b a b a b c c*. It is an Italian invention of the 14th century. Giovanni Boccaccio employed it for the *Teseide* (1340) and for the *Filostrato* (about seven years later). These epics gave to ottava rima its classic character. In the succeeding century it was employed by Politian and by Mattèo Boiardo for his famous *Orlando Innamorato* (1486). It was Luigi Pulci, however, in the *Morgante Maggiore* (1482), who invented the peculiar mock-heroic or, rather, half-serious half-burlesque style with which ottava rima has been most commonly identified. The measure, now recognized as the normal one for all Italian epic poetry, was wielded with extraordinary charm and variety by Berni, Ariosto and Tasso. The most striking monument in ottava rima in English is *Don Juan* (1819–24). Byron also used the measure in *The Vision of Judgment* (1822). Shelley had become attracted by it and in 1820 translated the *Hymns* of Homer into ottava rima. Writers from the Iberian peninsulas largely used the form; *e.g.*, Juan Boscán Almogaver, Luiz de Camões in *Os Lusiadas* (1572) and Lope de Vega.

(E. G.; X.)

OTTAWA, the national capital of Canada, a city of Carleton county, province of Ontario, is on the south bank of the Ottawa river, 101 mi. W. of Montreal and 217 mi. N.E. of Toronto. Pop. (1961) 268,206; greater Ottawa (1961) 320,750, which also includes the city of Hull (*q.v.*), the town of Eastview and various other suburbs.

Physical Setting.--Ottawa has an attractive physical setting. It is located near the confluence of three rivers, the Ottawa from the northwest, Gatineau from the north and Rideau from the south. The swirling waters of the Ottawa at Chaudière falls and the tumbling, misty waters of the Rideau at Rideau falls contribute to the scenic beauty of the site. Above the Chaudiere falls, the Ottawa river is broken by the Deschênes rapids and beyond these it expands into Lake Deschênes. Considerable hydroelectric power is developed on the Ottawa and Gatineau rivers in the vicinity of Ottawa.

The city is built on a cluster of hills, 60 to 1.55 ft. above the river along the high southern bank and commanding a fine, panoramic view in places. The surrounding lowland, particularly the broad valley of the Ottawa, is a prosperous agricultural area. The heavily wooded Laurentian hills to the north are broken by the picturesque Gatineau valley. Fast-running rivers, a lowland of early lumbering and agricultural potential and a forested upland underlie both the beauty and the development of Ottawa and its environs.

History. — The single most important fact about Ottawa is its role as the national capital of Canada. In 1858 it was selected by Queen Victoria as the capital of the united province of Canada, its rival claimants being Montreal, Quebec, Toronto and Kingston. The British North America act of 1867 made Ottawa the national capital. Prior to its selection as capital Ottawa was a small lumbering community on the northern frontier of settlement; since its selection it has developed into a city of international importance, with about 50 foreign countries maintaining representatives in it.

Samuel de Champlain reached and described the future site of Ottawa in 1613. For almost 200 years the Ottawa river was important only as a thoroughfare to the interior. Explorers and fur traders became familiar with the Chaudière portage while traveling by canoe via the Ottawa, Mattawa, Lake Nipissing and French river route to Georgian bay and the country to the west. Following U.S. independence and the arrival of United Empire Loyalists in Upper Canada, the Ottawa area became a place of opportunity for settlement. Early in the 19th century the strategic importance of a transportation route between Montreal and Kingston, sufficiently remote from the U.S. border to afford military protection, brought about the development of the Rideau canal system linking the Ottawa river with Lake Ontario. These events and developments assured Ottawa of a future.

The first settler in the area was Philemon Wright of Woburn, Mass. In 1800, accompanied by 25 men and their families, he established a permanent settlement on the north bank of the Ottawa river at the site of the present city of Hull. Land was cleared for agriculture but within a few years lumbering became the most important industry in the Ottawa valley. Square timbers cut from the magnificent stands of white pine were rafted down the Ottawa and St. Lawrence rivers to Quebec, beginning in 1807 and continuing during the heyday of lumbering in the 19th century.

Settlement was slow to begin on the south bank of the Ottawa river. Finally, about 1820, one Nicholas Sparks moved across the river and cleared a farm in what is now the heart of the capital city. The real impetus to settlement came later, in 1827, shortly after Col. John By and his royal engineers were sent from England to build a canal from a point below the Chaudiere falls to Kingston on Lake Ontario. The canal was completed in 1833 at a cost of almost $4,000,000. It was never called upon to fulfill its primary object of enabling gunboats and military supplies to reach the lakes from Montreal without being exposed to attack along the St. Lawrence frontier; it did, however, create a thriving community at the Ottawa end, which came to be known as Bytown. In 1854 the population of Bytown was estimated at 10,000. In that year it was incorporated as a city, the name being changed to Ottawa, the English form of the name of the band of Indians who inhabited the area at the time of the first white contacts. The flourishing lumber industry began at that time to bring rapid economic development. In addition, capital status gave the city an important role in the political development of the nation and assured civic growth.

Buildings. — The crowning architectural feature of the city is the splendid group of Gothic buildings on the summit of Parliament hill. The three blocks are on the sides of a great quadrangle, the fourth side being historic Wellington street, along which a number of government buildings are located. The cornerstone of the main building on Parliament hill was laid by the prince of Wales in 1860. With the exception of the library, it was destroyed by fire in 1916 and was later rebuilt. It contains the house of commons and the senate chambers. In the 300-ft. tower is a remarkably beautiful war memorial chamber, and above it is hung a carillon of 53 bells. Other national institutions with impressive buildings scattered throughout the city are the public archives, royal mint, National Research council, Central post office, Dominion observatory, the Dominion bureau of statistics and the National Art gallery. Other noteworthy buildings include the new city hall, the University of Ottawa, St. Patrick's college, Carleton university, the Roman Catholic and Church of England cathedrals and Rideau hall, the governor-general's residence. The War memorial on Confederation square is a striking monument. City charities include a large civic hospital and nurses' home, a general

NATIONAL FILM BOARD OF CANADA

CENTRE BLOCK OF THE PARLIAMENT BUILDINGS ON PARLIAMENT HILL, OTTAWA. THE PEACE TOWER IS AT CENTRE. WITH THE COMMONS WING AT LEFT AND THE SENATE WING AT RIGHT. THE SPIRE OF THE LIBRARY OF PARLIAMENT IS IN THE BACKGROUND

hospital supported by the Roman Catholics and three special hospitals devoted to contagious diseases.

National Capital Plan.—Efforts toward the systematic development and beautification of Ottawa as a national capital began as early as 1899, when the Ottawa Improvement commission was organized. The Federal District commission was formed in 1927 to promote such an objective and some miles of urban scenic drives and parks were developed. Following World War II the government initiated a program for the development of the national capital district, comprising 900 sq.mi. of territory and about 30 municipalities on both sides of the Ottawa river. The Federal District commission, renamed the National Capital commission in 1958, assumed responsibility for the work.

The principle of a green belt surrounding the city was adopted, the necessary land being purchased by the commission from private owners. Many miles of parkway have been built in Ottawa and in Gatineau park, a 75,000 ac.-area in the Laurentians to the north of the city. The commission plan provided for the removal of railway lines from the heart of the city and the building of arterial roadways to ease the flow of traffic. Congestion in the central part of the city was being reduced by the erection of new governmental buildings in outlying parts of the city.

Industries.—Ottawa is not a city of impressive industrial development; selectivity has been and is being exercised in the types of industry encouraged to locate in the national capital. Greater Ottawa, including Hull, has a number of industries reflecting the availability of cheap hydroelectric power and the vast timber resources of the Ottawa and Gatineau river valleys. In addition to lumber, pulp and paper, and cement, manufactures include stoves, refrigerators, washing machines, camping equipment and furniture.

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OTTAWA, a city of north-central Illinois, U.S., is located about 85 mi. S.W. of Chicago on the Illinois river at the mouth of the Fox river; the seat of La Salle county. First visited by French explorers and missionaries in the 17th century, the town was laid our in 1830. At first called Carbonia, from rich coal deposits nearby, Ottawa, renamed for the Indian tribe, was incorporated as a town in 1837 and as a city in 1853. Ottawa became an important river port for shipping grain, grown in the surrounding rich agricultural region, to Chicago. Local deposits of St. Peter sandstone made it important in the silica sand and glass-making industries. Manufactures include glass products, fire brick, tile, pottery, sewer pipe, farm machinery, asphalt, playground equipment and roofing materials. On Aug. 21, 1858, Ottawa was the scene of the first of the Lincoln-Douglas debates. For comparative population figures *see* table in ILLINOIS: *Population*. (M. Ws.)

OTTAWA RIVER, chief tributary of the St. Lawrence (*q.v.*), is a wide, swift river rising in wild bush country of western Quebec and forming the boundary between the provinces of Quebec and Ontario for most of its 696 mi. Its total drainage basin is 55,560 sq.mi. Through a series of lakes it flows westward to Lake Timiskaming, then southeastnard the rest of its course to join the St. Lawrence at the island of Montreal. The principal tributaries on the left bank are the Rouge (115 mi.), North Nation (60), Lièvre (205), Gatineau (240), Coulonge (135), Dumoine (80); and on the right bank, the South Nation (90), Mississippi (105), Madawaska (130) and Petawawa (95). The only navigable one is the Rideau, which with its canal system connects the Ottawa with Lake Ontario. Above Lake Timiskaming are four major dams for storage reservoirs, having a drainage area of 28,900 sq.mi. Below Timiskaming are large power developments at La Cave, Des Joachims, Bryson, Chenaux, Chats and Chaudière, generating more than 1,000,000 h.p. Above Pembroke is Chalk River, the Canadian government's establishment for atomic research.

The Ottawa is bordered by wooded hills through most of its course, its upper reaches being barely settled. Below Pembroke is considerable farming country, several towns and two cities, Ottawa, Ont., capital of Canada, and Hull, Que., a lumber centre. The main industry of the lower valley has always been lumbering. Logs cut from surrounding forests are floated down the river or its tributaries to mills where they are processed into wood products, chiefly pulp and paper.

The Ottawa was first explored by Samuel de Champlain in 1613. Thereafter it became a favourite route of explorers and fur traders to the Great Lakes. Travelers in canoes and bateaux followed the river from Montreal, portaging at rapids and falls, to Mattawa, then westward through Lake Nipissing to Georgian bay. In 1825 first canals were cut on lower Ottawa at Ste. Anne's, Carillon and Grenville, later being deepened to accommodate eight-foot draft at low water, making the river navigable as far as Chaudière falls at Ottawa. During the 19th century there was much traffic in lumber barges and steamboats. With the coming of railways and highways it disappeared, and since early in the 20th-century traffic has been mainly in pleasure craft. (E. D. L.)

OTTER, any of several species of semiaquatic mammals of the subfamily Lutrinae of the weasel family (Mustelidae). The common otters widespread throughout the world belong to the genus *Lutra*. They have the same general proportions as a weasel—the lithe, slender body, long neck, small ears and short legs. The head is flattened, and the base of the tail is almost as thick as the body. A large male measures 4 ft. over-all, stands 10 in. high and weighs 20 lb.; the female is smaller. The pelage consists of a dense, fine underfur of dark gray-brown, overlaid with a heavy coat of long, straight, glistening dark brown guard hairs; the muzzle and throat are grayish. Few other animals produce a fur so highly valued by man and so durable; the darker furs of northern animals are the most prized.

Otters are among the most nearly aquatic of all the mustelids. They swim easily with webbed feet, and can travel underwater for a quarter of a mile without surfacing for air. They prefer to travel by water but (their short legs notwithstanding) can travel on land faster than a man can run. They travel extensively and methodically. Their food consists of all manner of small aquatic animals, including fish, which they catch expertly, sometimes by teamwork; they also prey on other small mammals, and a few otters can decimate a muskrat colony in several days. The sense of smell is acute; of sight, good; of hearing. mediocre.

Otters live in and around lakes and streanrs. especially in timbered areas. The den may be a burrow dug in a bank by some other animal, a muskrat or beaver lodge or even a hollow log. There the one to five young are born in midspring after a gestation of 61–63 days. The young. whose eyes open in about five weeks, are cared for by the mother until the next litter is due—about a year. The males may have several mates in one season.

Unlike almost all other wild mammals, otters are playful almost frivolous. as adults. A favourite sport is sliding down a steep hank of mud or snow and plunging into water or a snowdrift. This is repeated until the slide is smooth and polished. Adults. even old ones, throw stones in the water. dive in after them and catch them as they sink, seemingly purely for pleasure. They are intelligent, friendly and inquisitive and, when obtained young. can be trained readily.


W. SUSCHITZKY
EURASIAN OTTER (LUTRA LUTRA)

The common otters include the river otter (*L. canadensis*). of North America; the southern river otter (*L. annectens*), of Central and South America: the Eurasian otter (L. *lutra*), of northern Africa north to the arctic and nest to Burma and southern China; and *L. cinerea,* of the East Indies. Other otters, of related genera, include the Brazilian giant otter. or saro (*Pteronura* species), the Asiatic dwarf otter (*Amblonyx* species) and the African small-clawed otter (*Aonyx* species). The larger, rare and very valuable sea otter (*Enhydra lutris*) is entir ly aquatic and lives in the northern Pacific ocean. *See* also CARNIVORE; FUR. (K. R. KN.)

OTTERY ST. MARY, a market town and urban district in the Honiton parliamentary division of Devon, Eng.. 12 mi. E.N.E. of Exeter by road. Pop. (1961) 4,121. Area 15.6 sq.mi. It stands on the river Otter at the foot of the Blackdown hills. and is notable for some fine Elizabethan building, such as Cadhay house and Knightstone manor. S. T. Coleridge, the poet, was born at the rectory. The splendid church of St. Mary was consecrated in 1259 and rebuilt by Bishop John Grandisson, who made it into a collegiate church, in 1338–42. An annual carnival (Nov. 5) preserves the ancient custom of the "Rolling of the Barrels." The town has a large agricultural trade.

OTTO I (912–973), THE GREAT. Roman emperor, eldest son of King Henry I the Fowler by his second wife Matilda, was born on Nov. 23, 912. Little is known of his early years, but he probably shared in some of his father's campaigns. In 929 he married Edith, daughter of Edward the Elder, king of the English, and sister of the reigning King Aethelstan. In 936 Otto was chosen German king and crowned by Hildebert, archbishop of Mainz. Otto soon showed his intention of breaking with the policy of his father, who bad been content with a nominal superiority over the duchies; in 937 he punished Eberhard, duke of Franconia, for an alleged infringement of the royal authority; and in 938 deposed Eberhard, duke of Bavaria. Trouble soon arose in Saxony, probably from his refusal to give certain lands to his half-brother, Thankmar, who, although the king's senior, had been passed over in the succession as illegitimate. Thankmar, aided by an influential Saxon noble named Wichmann, and by Eberhard of Franconia, seized the fortress of Eresburg and took Otto's brother Henry prisoner; but soon afterwards he was defeated by the king and killed whilst taking sanctuary. The other conspirators were pardoned, but in 939 a fresh revolt broke out under the leadership of Henry, and Giselbert, duke of Lorraine. Otto gained a victory near Xanten, which was followed by the surrender of the fortresses held by his brother's adherents in Saxony, but the rebels, joined by Eberhard of Franconia and Archbishop Frederick of Mainz, continued the struggle, and Giselbert of Lorraine transferred his allegiance to Louis IV., king of France. Otto's precarious position was saved by a victory near Andernach when Eberhard was killed, and Giselbert drowned in the subsequent flight. Henry took refuge with Louis of France, but was soon restored to favour and entrusted with the duchy of Lorraine, where, however, he was unable to restore orcler. Otto therefore crossed the Rhine and deprived his brother of authority. Henry then became involved in a plot to murder the king, which was discovered in time, and the good offices of his mother secured him a pardon at Christmas 941.

The deaths of Giselbert of Lorraine and of Ebcrhord of Franconia, quickly followed by those of two other dukes, enabled Otto to unite the stern-duchies more closely with the royal house. In 944 Lorraine was given to Conrad, surnamed the Red, who in 947 married the king's daughter Liutgard; Franconia was retained by Otto in his own hands; Henry married a daughter of Arnulf, duke of Bavaria, and received that duchy in 947; and Swabia came in 949 to the king's son Ludolf. who had married Ida, a daughter of the late duke, Hermann. During these years the tribes living between the Elbe and the Oder were made tributary, bishoprics were founded in this district, and in 950 the king himself marched against the Bohemians and reduced them to dependence. Strife between Otto and Louis IV. of France had arisen when the French king sought to obtain authority over Lorraine and aided the German rebels in 939; hut after the German king had undertaken an expedition into France, peace was made in 942. Afterwards, when Louis became a prisoner in the hands of his powerful vassal Hugh the Great, duke of France. Otto attacked the duke, who. like the king, was his brother-in-law, captured Reims, and negotiated a peace between the two princes; and in subsequent struggles between them his authority was several times invoked.

In 945 Berengar I.. margrave of Ivrea, left the court of Otto and returned to Italy, where he soon obtained a mastery over the country. After the death in 950 of Lothair, king of Italy, Berengar sought the hand of his widow Adelaide for his son Adalbert; and Henry of Bavaria and Ludolf of Swahia had already been meddling independently of each other in the affairs of northern Italy. In response to an appeal from Adelaide, Otto crossed the Alps in 951. He assumed the title of king of the Lombards, and having been a widower since 946. married Adelaide anti negotiated with Pope Agapetus II. about his reception in Rome. The influence of Alberic, prince and senator of the Romans, prevented the pope returning a favourahle answer to the king's request. But when Otto returned to Germany in 952 he was followed by Berengar, who did homage for Italy at Augsburg. The chief advisers of Otto at this time were his wife and his brother Henry. Henry's influence seems to have been resented by Ludolf, who in 946 had been formally designated as his father's successor. When Adelaide bore a son, and a report gained currency that Otto intended to make this child his heir, Ludolf rose in revolt and was joined by Conrad of Lorraine and Frederick of Mainz. Otto fell into the power of the rebels at Mainz and was compelled to agree to demands made by them, which, however, he promptly revoked on his return to Saxony. Ludolf and Conrad were declared deposed, and in 953 war broke out in Lorraine and Swabia, and afterwards in Saxony and Bavaria. Otto was finally victorious and with the capture of Regensburg in 955 the rising ended. Conrad and Ludolf retained their estates, but their duchies were not restored to them. Meanwhile the Magyars had renewed their ravages and were attacking Augsburg. Otto marched against them, and in a battle fought on the Lechfeld Aug. 10, 955, the king's troops gained a victory which freed Germany from these invaders; while in the same year Otto defeated the Slavs ravaging the Saxon frontier.

About this time the king seems to have perceived the necessity of ruling in closer union with the church. Lands and privileges were granted to prelates, additional bishoprics were founded, and some years later Magdeburg was made the seat of an archbishop. In 960 Otto was invited to come to Italy by Pope John XII., who was hard pressed by Berengar, and he began to make preparations for the journey. As Ludolf had died in 957 and Otto, his only son by Adelaide, had been chosen king at Worms, the government was entrusted to Bruno of Cologne, and Archbishop William of Mainz, a natural son of the king. Reaching Pavia at Christmas 961, the king promised to defend and respect the church. He then proceeded to Rorne, where he was crowned emperor on Feb. 2, 962. After the ceremony he confirmed the rights and privileges which had been conferreti on the papacy, while tht: Romans promised obedience, and Pope John took an oath of fidelity to the emperor. But as he did not long observe his oath he was deposed at a synod held in St. Peter's, after Otto had compelled the Romans to swear they would elect no pope without the imperial consent; and. a nominee of the emperor, who took the name of Leo VIII., was chosen in his stead. A pestilence drove Otto to Germany in 96j, and finding the Romans again in arms on his return in 966, he allowed his soldiers to sack the city, and severely punished the leaders of the rebellion. His next move was against the Greeks and Saracens of southern Italy, hut seeking to attain his objects by negotiation, sent Liudprand, bishop of Cremona, to the eastern emperor Nicephorus II. to arrange for a marriage treaty between the two empires. Nicephorus refused to admit the validity of Otto's title. and the bishop was roughly repulsed; but the succeeding emperor, John Zimisces, was more reasonahle, antl Theophano, daughter of the emperor Romanus II., was married to the younger Otto in 972. The same year witnessed the restoration of peace in Italy and the return of the emperor to Germany, whcre he received the homage of the rulers of Poland, Bohemia and Denmark; but he died suddenly at Memleben on May 7, 973.

The empire was less universal under Otto, its restorer, than Charlemagne, but what it lacked in splendour it gained in stability. His object was not to make the state religious but the church political, and the clergy must. first be officials of the king, and secondly members of an ecclesiastical order. He shared the piety and superstition of the age, and did much for the spread of Christianity. Although himself a stranger to letters he welcomed scholars to his court and eagerly seconded the efforts of his brother Bruno to encourage learning; ancl while he neither feared nor shirked battle, he was always ready to secure his ends by peace.

Bibliography.—*See* Widukinrl, *Res gestae Saxonicae;* Liudprand of Cremona, *Historia Ottonis;* Flodoard of Rheims, *Annales;* Hrotsvit of Gandersheim, *Carmen de gestis Oildonis—all* in the *Monumenta Germaniae historica. Scriptores,* Bände iii. *and* iv. (Hanover and Berlin, 1826 fol.): *Die Urkunden des Kaisers Ottos I.,* 'edited by *Th.* von Sickel in the *Monumenta Germaniae historica. Diplomata* (Hanover, 1879); W. von Gicsebrecht, *Geschichte der deutschen Kaiserzeit* (Leipzig, 1881); R. Köpke and E. Dümmler, *Jahrbücher des deutschen Reichs unter Otto I.* (Leipzig, 1876); Th. von Sickel, *Das Privilegium Otto I. fur die römische Kirche* (Innsbruck, 1883); H. von Sybel, *Die deutsche Nation und dns Kaiserreich* (Düsseldorf, 1862); O. von Wydenbrugk, *Die deutsche Nation und dus Kaiserreich* (Munich, 1862); J. Ficker, *Das deutsche Kaiserreich in seinen universalen und nationalen Beziehungen* (Innsbruck, 1861); and *Deutsches Königthum und Kaiserthum* (Innsbruck, 1862); G. Maurenbrecher, "Die Kaiserpolitik Otto I." in the *Historisrhe Zeitschrift* (Munich, 1859); G. Waitz, *Deutsche Verfassungsgeschichte* (Kiel, 1844); J. Ficker, *Forschungen zur Reichs- und Rechtsgeschichte Italiens* (Innsbruck, 1868–74); F. Fischer, *Über Ottos I. Zug in die Lombardei vom Jahre 951* (Eisenberg, 1891); and K. Kotler, *Die Ungarnschlacht auf dem Lechfelde* (Augsburg 1884).

OTTO II. (955–983), Roman emperor, was the son of the emperor Otto the Great, by his second wife Adelaide. He was chosen German king at Worms in 961 and on Dec. 25, 967, was crowned joint emperor at Rome by Pope John XIII. On April 14, 972, he married Theophano, daughter of the eastern emperor Romanus II., and after sharing in various campaigns in Italy, returned to Germany and became sole emperor on the death of his father in May 973. After suppressing a rising in Lorraine, difficulties arose in southern Germany, probably owing to Otto's refusal to grant the duchy of Swnbia tc Henry II., the Quarrelsome, duke of Bavaria. The first conspiracy was easily suppressed, and in 974 an attempt on the part of Harold III., king of the Danes, to throw off the German yoke was also successfully resisted; but an expedition against the Bohemians led by the king in person in 975 was a partial failure owing to the outbreak of further trouble in Bavaria. In 976 Otto deposed Duke Henry, restored order for the second time in Lorraine, and made another expedition into Bohemia in 977, when King Boleslaus II. promised to return to his earlier allegiance. Having crushed an attempt made by Henry to regain Bavaria, Otto was suddenly attacked by Lothair, king of France. who held Aix in his possession for a iew days; but when the emperor retaliated by invading France he met with little resistance. He was, however, compelled by sickness among his troops to raise the siege of Paris, ancl on the return journey tht: rearguard of his army was destroyed and the baggage seized by the French. An expedition against the Poles was followed by peace with France, when Lothair renounced Lorraine.

The emperor then prepared for a journey to Italy. In Rome, where he restored Pope Benedict VII., hc held a splendid court, attended by princes antl nobles from all parts of western Europe. He was next required to punish inroads of the Saracens on the Italian mainland, and in September 981 he marched into Apulia, where he met at. first with considerable success; but an alliance between the Arabs and the Eastern Empire, whose hostility had been provoked by the invasion of Apulia, resulted in a severe defeat for Otto's troops near Stilo in July 982. Without revealing his identity. the emperor escaped on a Greek vessel to Rossano. At a diet held at Verona, largely attended by German rind Italian princes, a fresh campaign was arranged against the Saracens. Proceeding to Rome, Otto secured the election of Peter of Pavia as Pope John XIV. Just as the news reached him of a general rising of the tribes on the eastern frontier of Germany, he died in his palace in Rome on Dec. 7, 983.

See *Die Urkunden des Kaisers Otto II.*, ed. Th. von Sickel, in the *Monumenta Germaniae historica. Diplomata* (Hanover, 1879); L. von Ranke, *Weltgeschichte,* Part vii. (Leipzig, 1886); W. von Giesebrecht, *Geschichte der deutschen Kaiserzeit* (Leipzig, 1881–90); and *Jahrbücher des deutschen Reichs unter Kaiser Otto II.* (1837–40); *H.* Detmer, *Otto II. bis zum Tode seines Vaters* (Leipzig, 1878); J. Moltmann, *Theophano die Gemahlin Ottos II. in ihrer Bedeutung für die Politik Ottos I. und Ottos II.* (Göttingen, 1878); antl A. Matthaei, *Die Händel Ottos II. mit Lothar von Frankreich* (Halle, 1882).

OTTO III. (980–1002), Roman emperor. son of the emperor Otto II. antl Theophano, daughter of the eastern emperor Romanus II., was born in July 980, chosen as his father's successor at Verona in June gd,; and crowned German king at Aix-la-Chapelle on Dec. 25. Otto II. had died a few days before this ceremony, hut the news did not reach Germany until after the coronation. Early in gS4 the king was seized by Henry II., the Quarrelsome, the deposed duke of Bavaria. who claimed the regency as a member of the reigning house, and probably entertained the idea of obtaining the kingly dignity himself. A strong opposition was quickly aroused. and when Theophano and Adelaide, widow of the emperor Otto the Great, appeared in Germany, Henry was compelled to hand over the young king to his mother. Otto's abilities were carefully cultivated by Bernward, afterwards bishop of Hildesheim, and by Gerbert of Aurillac, archbishop of Reims, and he was called "the wonder of the world." The government of Germany during his minority was in the hands of Theophano, and after her death in June 991 passed to a council in which the chief influence was exercised by Adelaide and Willigis, archbishop of Mainz.

Having accompanied his troops in expeditions against the Bohemians and the Wends. Otto was declared of age in 995. In 996 he crossed the Alps and was recognized as king of the Lombards at Pavia. Before he reached Rome. Pope John XV., who had invited him to Italy, had died, whereupon he raised his own cousin Bruno, son of Otto duke of Carinthia, to the papal chair as Pope Gregory V., and by this pontiff Otto was crowned emperor on May 21, 996. On his return to Germany, the emperor learned that Gregory had been driven from Rome, which was again in the power of John Crescentius, patrician of the Romans, and that a new pope, John XVI., had been elected. Leaving his aunt, Matilda, abbess of Quedlinburg, as regent of Germany, Otto, in Feb. 998, led Gregory back to Rome, took the castle of St. Angelo by storm and put Crescentius to death. A visit to southern Italy, where many of the princes did homage to the emperor, was cut short by the death of the pope, to whose chair Otto then appointed his former tutor Gerbert, who took the name of Sylvester II.

In the palace which he built on the Aventine, Otto sought to surround himself with the splendour and ceremonial of the older emperors of Rome, and dreamed of making Rome once more the centre of a universal empire. Many names and customs were introduced into his court from that of Constantinople; he proposed to restore the Roman senate and consulate, revived the office of patrician, called himself "consul of the Roman senate and people" and issued a seal with the inscription, "restoration of the Roman empire.!' Passing from pride to humility he added "servant of the apostle," and "servant of Jesus Christ" to the imperial title, spent a fortnight in prayer in the grotto of St. Clement and did penance in various Italian monasteries.

Leaving Italy in the summer preceding the year 1000, when it was popularly believed that the end of the world was to come, Otto made a pilgrimage to the tomb of his old friend Xdalbert, bishop of Prague. at Gnesen, and raised the city to the dignity of an archbishopric. He then went to Xix, and opened the tomb of Charlemagne, where, according to a legendary tale, he found the body of the great emperor sitting upright upon a throne, wearing the crown and holding the sceptre.

On his return to Rome, trouble arose between Otto and the citizens, and for three days the emperor was besieged in his palace. After a temporary peace, he fled to the monastery of Classe near Ravenna. Troops were collected, but whilst conducting ? campaign against the Romans, Otto died at Paterno near Viterbo on Jan. 23, 1002, and was buried at Xix-la-Chapelle.

See Thangmar, *Vita Bernwardi episcopi Hildesheimensis* in the *Monumenta Germaniae historica. Scriptores*, Band iv. (Hanover, and Berlin, 1826 fol.); *Lettres de Gerbert*, ed. J. Havct (1889); *Die Urkunden Kaisers Ottos III.*, ed. Th. von Sickel in the *Monumenta Germaniae historica. Diplomata* (Hanover, 1879); R. Wilmans, *Jahrbücher des deutschen Reichs unter Kaiser Otto III.* (1837–40); P. Kehr, *Die Urkunden Otto III.* (Innsbruck, 1890).

OTTO IV. (*c.* 1182–1218), Roman emperor, second son of Henry the Lion, duke of Saxony, and Matilda, daughter of Henry II., king of England. was most probably born at Argenton in central France. His father died when he was still young. and he was educated at the court of his uncle Richard I., king of England: under whose leadership he gained valuable experience in war, being appointed duke of Aquitaine, count of Poitou and earl of Yorkshire. When the emperor Henry VI. died in September 1197, some of the princes under the leadership of Adolph, archbishop of Cologne, were anxious to find a rival to Philip, duke of Swabia, who had been elected German king. After some delay their choice fell upon Otto, who was chosen king at Cologne on June 9, 1198. Hostilities broke out at once, and Otto, after a series of defeats, was driven to Brunswick. Preparations were made to drive him from here, when he was saved by the murder of Philip in June 1208. Many of the supporters of Philip now made overtures to Otto, and an attempt to set up Henry I., duke of Brabant, having failed, Otto submitted to a fresh election and was chosen German king at Frankfort on Nov. 11, 1208, in the presence of a large gathering of princes. A general reconciliation followed, which was assisted by the betrothal of Otto to Philip's eldest daughter Beatrix, but as she was only ten years old, the marriage was deferred until July 22, 1212. The pope, who had previously recognized the victorious Philip, hastened to return to the side of Otto; large concessions were made to the church.

In August 1209 the king set out for Italy. Meeting with no opposition, he was received at Viterbo by Innocent, but refused the papal demand that he should concede to the church all the territories which, previous to 1197, had been in dispute between the Empire and the Papacy, consenting, however, not to claim supremacy over Sicily. He was crowned emperor at Rome on Oct. 4, 1209, a ceremony which was followed by fighting between the Romans and the German soldiers. The pope then requested the emperor to leave Roman territory; but he remained near Rome for some days, demanding satisfaction for the losses suffered by his troops. The breach with Innocent soon widened, and in violation of the treaty made with the pope Otto attempted to recover for the Empire all the property which Innocent had annexed to the Church, and rewarded his supporters with large estates in the disputed territories.

Having occupied Tuscany he marched into Apulia, part of the kingdom of Frederick of Hohenstaufen, afterwards the emperor Frederick II., and on Nov. 18, 1210, was excommunicated by the pope. Regardless of this sentence Otto completed the conquest of southern Italy, but the efforts of Innocent had succeeded in arousing considerable opposition in Germany, where the rebels were also supported by Philip Augustus, king of France. A number of princes assembled at Nuremberg declared Otto deposed, and invited Frederick to fill the vacant throne. Returning to Germany in March 1212, Otto made some headway against his enemies until the arrival of Frederick towards the close of the year. The death of his wife in August 1212 had weakened his hold on the southern duchies, and he was soon confined to the district of the lower Rhine, although supported by money from his uncle King John of England. The final blow to his fortunes came n-hen he was decisively defeated by the French at Bouvines in July 1214. He escaped with difficulty from the fight and took refuge in Cologne. His former supporters hastened to recognize Frederick; and in 1216 he left Cologne for Brunswick, which he had received in 1202 by arrangement with his elder brother Henry. The conquest of Hamburg by the Danes, and the death of John of England, were further blows to his cause. On May 19, 1218, he died at the Harzburg after being loosed from the ban by a Cistercian monk, and was buried in the church of St. Blasius at Brunswick. He left no children.

See *Regesta imperii* V., ed. J. Ficker (Innsbruck, 1881); L. von Ranke, *Weltgeschichte*, Part viii. (Leipzig, 1887–88); W. von Giesebrecht, *Geschichte der deutschen Kaiserzeit*, Band v. (Leipzig, 1888); O. Abel, *Kaiser Otto IV. und König Friedrich II.* (1856); E. Winkelmann, *Philipp von Schwaben und Otto IV. von Braunschweig* (Leipzig, 1873–78); G. Langerfeldt. *Kaiser Otto der Vierte* (Hanover, 1872); R. Schwemer, *Innocenz III. und die deutsche Kirche während des Thronstreites* (Strassburg, 1882); and A. Luchaire, *Innocent III., la papauté et l'empire* (1906); and *Innocent III., la question d'Orient* (1906).

OTTO, king of Greece (1815–1867), second son of Louis I., king of Bavaria, and his wife Teresa of Saxe-Altenburg, was born at Salzburg on June 1, 1815, and was educated at Munich. In 1832 he was chosen by the conference of London to occupy the newly-erected throne of Greece, and on Feb. 6, 1833, he landed at Nauplia, then the capital of independent Greece. Otto, who was not yet eighteen, was accompanied by a council of regency composed of Bavarians under the presidency of Count Josef Ludwig von Armansperg (1787–1853). In 1835 Otto came of age, but, on the advice of his father and under pressure of Great Britain and of the house of Rothschild, who all believed that a capable finance minister was the supreme need of Greece, he retained Armansperg as chancellor of state. The Greeks were more heavily taxed than under Turkish rule; they had exchanged government by the sword, which they understood, for government by official regulations, which they hated; they had escaped from the sovereignty of the Mussulman to fall under that of a devout Catholic, to them a heretic. Otto was well intentioned, honest and inspired with a genuine affection for his adopted country; but it needed more than mere amiable qualities to reconcile the Greeks to his rule.

In 1836 Otto married Princess Amalie of Oldenburg, who made herself unpopular by interfering in the government. Meanwhile Armansperg had been dismissed by the king, but a Greek minister was not put in his place, and the granting of a constitution was postponed. The attempts of Otto to conciliate Greek sentiment by efforts to enlarge the frontiers of his kingdom, *e.g.*, by the suggested acquisition of Crete in 1841. only succeeded in embroiling him with the powers. His power rested wholly on Bavarian bayonets; and when. in 1843, the last of the German troops were withdrawn, he was forced by the outbreak of a revolutionary movement in Athens to grant a constitution and to appoint a ministry of native Greeks.

For the British blockade of the Peiraeus and Greek intervention in the Crimean War *see* GREECE: *Modern History*. Otto's position in Greece became untenable. In 1861 a student named Drusios attempted to murder the queen, and was hailed by the populace as a modern Harmodius. In Oct. 1862 the troops in Acarnania under Gen. Theodore Srivas declared for the king's deposition; those in Athens followed suit; a provisional government was set up and summoned a national convention. The king and queen, who were at sea, took refuge on a British warship, and returned to Bavaria where, on July 26, 1867, Otto died.

See E. A. Thouvenel, *La Grèce du roi Othon* (1890); G. L. von Maurer, *Das griechische Volk*, etc. (18.36); C. W. P. Mendelssohn-Bartholdy, "Die Verwaltung König Ottos von Griechenland und sein Sturz" (in *Preuss. Jahrbücher*, iv. 3653; K. T. v. Heiqel, *Ludwig I., König von Baiern*, pp. 149 ff. (1872); H. H. Parish. *The Diplomatic History of the Monarchy of Greece From the Year 1830* (1538).

OTTO, NIKOLAUS AUGUST (1832–1891), German engineer, who introduced a gas engine which marked an important stage in the development of internal-combustion engines. was born at Holzhausen on June 10, 1832, and died in Cologne on Jan. 26, 1891. Otto realized that there mas a need for an improved gas engine as a prime mover for small workshops. since steain engines and their equipment were too large for this purpose. He and his partner E. Langen made an improved free-piston engine which they exhibited in Paris in 1867. Alphonse Beau de Rochas had patented the first description of the four-stroke cycle for gas engines in France in 1862; it had one working stroke for every four strokes of the piston. He did not build an engine and the cycle was not employed successfully until 15 years later. Then its advantages were emphasized by Otto and Langen when they incorporated it in their silent gas engine. which was patented in 1877. This proved a smooth-running reliable engine of considerable efficiency which did much to relieve the toil of craftsmen in small workshops. *See* also INTERNAL-COMBUSTION ENGINE.

See A. Langen, *Nicolaus August Otto der Schopfer des Verbrennungsmotors* (1949). (C. St. C. B. D.)

OTTO, RUDOLF (1869–1937), German theologian and philosopher. was born Sept. 25. 1869, at Peine, a small town in Hanover. Nurtured in the Lutheran faith. Otto was attracted during his student days at Erlangen and Gottingen to the theology of Albrecht Ritschl and the romanticism of Friedrich Schleiermacher (*qq.v.*). While professor of theology at Gottingen some years later (1907–14), his major concern gradually shifted to the history and psychology of religion (*Religionswissenschaft*). At Göttingen he became a leading spokesman of the neo-Friesian school that flourished there for a time. and his *Kantish-Friessche Religionsphilosophie* (1909: Eng. trans.. *The Philosophy of Religion*, 1931). an important publication of this movement, provides the fullest statement of his own philosophy of religion based upon the post-Kantian idealism of Jakob Friedrich Fries (*q.v.*). After three years on the theological faculty at Breslau (1914–17), Otto became professor of systematic theology at the University of Marburg, where he remained until his death on March 6. 1937.

Visits to north Africa. India and Japan in 1911–12 turned Otto's attention to the more primitive expressions of religion and also gave him an enduring appreciation of the great oriental faiths. Tumerous studies of the religious thought of India gained him a place among the influential and sympathetic European interpreters of Hinduism. Among the more important of these studies are *West-Östliche Mystik* (1926; Eng. trans.. *Mysticism East and West*, 1932) and *Die Gnadenreligion Indiens und das Christentum* (1930; Eng. trans., *India's Religion of Grace and Christianity*, 1930). Otto's last work. completed just prior to his death. was a series of German translations and commentaries upon the Bhagavad Gita and the Katha Upanishad.

The immediate and strong impact of his major work. *Das Heilige* (1917; Eng. trans.. *The Idea of the Holy*, 1923), established Otto as a leading figure in German theological circles and at once brought him to the attention of religious thinkers throughout the world. Its discerning psychological analysis of religious experience and creative synthesis of the major tendencies in modern German theology mark *The Idea of the Holy* as one of the significant religious books of the first half of the 20th century. Otto portrays in convincing fashion a depth in human experience and an awareness of the otherness of God that liberal Protestantism had largely lost sight of. Within 12 years of its publication translations appeared in English, Swedish, Spanish, Italian. Dutch. French and Japanese. During those years Otto wrote a number of influential theological and historical essays developing further its central ideas. These essays later appeared in two independent volumes. *Das Gefühl des Überweltlichen* and *Sünde und Urschuld* (1932; Eng. trans. in part in *Religious Essays*, 1931).

Otto made important practical contributions also to the devotional life of the Lutheran Church and to its missionary enterprises. In a chapel near Marburg he worked throughout his life in experimental fashion to develop a vital worship service reflecting his conviction that at the heart of religion there lies a sense of profound mystery and "creature-feeling." In 1923 he published a volume on public worship built around this concept of religion. and for years he collaborated in the preparation of devotional materials for use in church service. schools and private worship.

Throughout Otto's work as a whole. whether theological or devotional. historical or philosophical, one unifying principle is always apparent—a constant emphasis upon the autonomy of religion. In the distinctly religious moment of human experience he identifies three major components: a unique quality of feeling. the numinous: an autonomous category of interpretation and valuation. the sacred: and an independent intuitive insight. expressed in myth or ideogram. These Otto takes to be separate but essential aspects of an a priori religious category of meaning and value. Since the 1930s. in almost every significant study of the nature of religion the issues he raised are debated.

See Robert F. Davidson, *Rudolf Otto's Interpretation of Religion* (1947). (R. F. D.)

OTTO OF FREISING (1114?–1158), German bishop and chronicler, was the fifth son of Leopold III., margrave of Austria, by his wife Agnes, daughter of the emperor Henry IV. By her first husband. Frederick I. of Hohenstaufen, duke of Swabia, Agnes was the mother of the German king Conrad III., and grandmother of the emperor Frederick I.; and Otto was thus related to the most powerful families in Germany. He studied in Paris, and became abbot of the Cistercian monastery of Morimond in Burgundy about 1136, soon afterwards being elected bishop of Freising. In 1147 he took part in the disastrous crusade of Conrad III., returning to Bavaria in 1148 or 1149. He enjoyed the favour of Conrad's successor, Frederick I.; was probably instrumental in settling the dispute over the duchy of Bavaria in 1156; was present at the famous diet at Besançon in 11j7, and died at Morimond on Sept. 22, 1158.

Otto wrote a *Chronicon*, sometimes called *De duabus civitatibus*, an historical and philosophical work in eight books, which follows to some extent Augustine and Orosius. It goes down to 1146, and from this date until 1209 has been continued by Otto, abbot of St. Blasius (d. 1223). Of the *Gesta Frideiici imperatoris* the first two books were written by Otto, and the remaining two probably by his pupil Ragewin, .or Rahewin. First printed by John Cuspinian at Strasbourg in 151j, Otto's writings are now issued in the *Monumenta Germaniae historica*, Band xx. (Hanover, 1865); German trans. by H. Kohl (Leipzig, 1881–86). The *Gesta Friderici* has been published separately with introduction by G. Waitz.

See J. Hashagen, *Otto von Freising als Geschichtsphilosoph und Kirchenpolitiker* (Leipzig, 1900); J. Schmidlin, *Die geschichtsphilosophische und kirchenpolitische Weltanschauung Otto von Freising* (Freiburg i./B., 1906); A. Hofmeister, "Studien über 0. v. Freising" in *Gesellschaft jiir ältere deutsche Geschichtskunde* (Hanover, 1911); A. Potthast, *Bibliotheca historica* (1896).

OTTO OF NORDHEIM (d. 1083), duke of Bavaria: belonged to the rich and influential Saxon family of the counts of Nordheim. and received the duchy of Bavaria from Agnes. widow of the emperor Henry III., in 1061. In 1062 he assisted Anno, archbishop of Cologne, to seize the German king, Henry IV.; led a successful expedition into Hungary in 1063; and took a prominent part in the government during the king's minority. In 1064 he went to Italy to settle a papal schism, secured the banishment from court of Adalbert, archbishop of Bremen, and crossed the Alps in the royal interests on two other occasions. In 1070 Otto was accused of being privy to a plot to murder the king, and was required to submit to the ordeal of battle with his accuser. The duke asked for a saie-conduct to and from the place of meeting, and when this was refused he declined to appear, and was consequently deprived of Bavaria, while his Saxon estates were plundered. He obtained no support in Bavaria; but raised an army among the Saxons and carried on a campaign of plunder against Henry until 1071, when he submitted; in the following year he received back his private estates. When the Saxon revolt broke out in 1073 Otto is represented by Bruno, the author of *De hello Saxonico,* as delivering an inspiring speech to the assembled Saxons at Wormsleben, after which he took command of the insurgents. By the peace of Gerstungen in 1074 Bavaria was restored to him; he shared in the Saxon rising of 1075, after which he was again pardoned and made administrator of Saxony. After the excommunication of Henry IV in 1076 Otto attempted to mediate between Henry and the Saxons, but when these efforts failed he again placed himself at their head. He assented to the election of Rudolph, count of Rheinfelden, as German king, when his restoration to Bavaria was assured, and by his skill and bravery inflicted defeats on Henry's forces at Mellrichstadt. Flarchheim and Hohenmolsen. He remained in arms against the king until his death on Jan. 11, 1083. By his wife Richenza, widow of Hermann, count of Werla, he left six children.

OTTOMAN EMPIRE, the empire founded by Osman (1288–1320), which lasted six centuries and a half, and fell before the democratic movement inaugurated at Angora in 1919 by Mustafa Remal Pasha. *See* MUSTAFA KEMAL ATATÜRK; TURKEY.

OTTRELITE (from Ottrez, Belg., the original locality), in mineralogy, is the manganese-bearing member of a group of closely related hydrous iron aluminum silicate minerals in which the iron is often in part replaced by magnesium or manganese. On account of its petrographic importance the term ottrelite is often used as the group name for this series, though the name clintonite is also in use. They are gray, green or black micaceous minerals, but in distinction from the "elastic" micas and "flexible" chlorites they are often referred to as the brittle micas on account of the brittleness of their laminae. The chief members of the group are chloritoid ($H_2 Fe Al_2 SiO_7$), sismondine ($H_2[Fe,Mg]Al_2SiO_7$), in which the magnesia rises to 7%, and ottrelite! the manganiferous variety ($H_2[FeMn]Al_2SiO_7$) in which the MnO content may rise to 8%.

Like the micas and chlorites the ottrelites possess monoclinic symmetry and a perfect cleavage parallel to the flat surface of the plates. Their superior hardness (H = 6.5 j readily distinguishes them from both these groups of minerals. Multiple twinning on the mica law is exceedingly common, and a zonal structure (often of hourglass type) is often apparent. The ottrelite group of minerals is confined to metamorphic rocks—particularly those developed in regional metamorphism—in slates, phyllites and schists. Noteworthy occurrences of this mineral are in the slates of the Ardennes, of Tintagel (Cornwall) and in the Mesozoic and Permian schists of the Swiss and Italian Alps.

The minerals margarite. xanthophyllite and kossmatite show some relations with the ottrelite group of minerals. They are distinguished by an inferior hardness and contain calcium as an essential constituent. Margarite ($H_2CaAl_4Si_2O_{12}$) occurs in white pearly scales associated with corundum and is a common mineral of emery deposits. Xanthophyllite occurs in talc-chlorite schists at Slatoust. in the Urals, and in altered limestone at Riverside, Calif., while kossmatite is a lime-rich mineral (H = 2.5) occurring in the dolomite marbles of west Macedonia. (C. E. T.; X.)

OTTUMWA, a city of southeastern Iowa. U.S.. on the Des Moines river. is located about 75 mi. E.S.E. of Des hloines: the seat of Wapello county. Indian title to this region was removed in 1842. and settlers began arriving the following year. Called Louisville when it hccame the county seat in 1844, it was renamed Ottumwa, an Indian word meaning "rippling waters.!' in 1845. Many of the early settlers came from the Ohio valley and included a considerable number of southerners. By 1900 these had been augmented by several thousand Swedes. Germans and British. Incorporated as a town in 1851 and as a city in 1857. Ottumwa adopted a council-manager form of government in 1953. The city is a trade centre ior the surrounding agricultural, livestock and coal-mining region. Industries include meat packing and the production of machinery, dairy products, livestock feed. furniture. brick and tile. Local agriculture is of the corn-belt type. but with emphasis upon grazing. For comparative population figures *see* table in IOWA: *Population.* (A. G. Bo.)

OTWAY, THOMAS (1652–1685), English dramatist, was born at Trotton, near Midhurst, Sussex, on March 3. 1652. His father. Humphrey Otway, was at that time curate of Trotton, but Otway's childhood was spent at Woolbeding. a parish 3 mi. distant, of which his father had become rector. He was educated at Winchester college, and in 1669 entered Christ Church, Oxford, as a commoner, but left the university without a degree in the autumn of 1672. In 1675 Thomas Betterton produced at Dorset Garden theatre Otway's first drama, *Alcihiades,* which was printed in the same year. It is a poor tragedy saved from absolute failure by the actors. He made a great advance on this first work in *Don Carlos, Prince of Spain* (licensed June 15, 1676; an undated edition probably belongs to the same year). In it the two characters familiar throughout his plays make their appearance. Don Carlos is the impetuous, unstable youth, who seems to be drawn from Otway himself, while the queen's part is the gentle pathetic character repeated in his more celebrated heroines. Monimia and Belvidera. In 1677 Betterton produced two adaptations from the French by Otway, *Titus and Berenice* (from Racine's *Bérénice*), and the *Cheats of Scapin* (from Molière's *Fourheries de Scapin).* These were printed together, with a dedication to Lord Rochester. In 1678 he produced an original comedy, *Friendship in Fashion,* popular at the moment, though it was hissed off the stage for its gross indecency when it was revived at Drury Lane in 1749.

Meanwhile he had conceived an overwhelming passion for Mrs. Barry, who filled many of the leading parts in his plays. Six of his letters to her survive. the last of them referring to a broken appointment in the Mall. In 1678, driven to despair by her. Otway obtained a commission through Charles, earl of Plymouth, a natural son of Charles II, in a regiment serving in the Netherlands. The English troops were disbanded in 1679, but were left to find their way home as best they could. They were also paid with depreciated paper, and Otway arrived in London late in the year, ragged and dirty. a circumstance utilized by Rochester in his "Sessions of the Poets," which contains a scurrilous attack on his former protégé.

Early in the next year (Feb. 1680) was produced at Dorset Garden the first of Otway's two tragic masterpieces, *The Orphan, or The Unhappy Marriage,* Mrs. Barry playing the part of Monimia. Written in blank verse, which shows a study of Shakespeare. its success was due to the tragic pathos, of which Otway was a master, in the characters of Castalio and Monimia. *The History and Fall of Caius Marius,* produced in the same year, and printed in 1692. is a curious grafting of Shakespeare's *Romeo and Juliet* on the story of Marius as related in Plutarch's *Lives.* In 1680 Otway also published *The Poet's Complaint of His Muse, or A Satyr Aguinst Libells,* in which he retaliated on his literary enemies. An indifferent comedy. *The Soldier's Fortune* (1681), was followed in Feb. 1682 by *Venice Preserved, or A Plot Discover'd.* The story is founded on the *Histoire de la conjuration des Espagnols contre la Venise en 1618,* by the Abbé de Saint-Rial, but Otway modified the story considerably. The character of Belvidera is his own, and the leading part in the conspiracy, taken by Bedamor, the Spanish ambassador, is given in the play to the historically insignificant Pierre and Jaffier. The piece has a political meaning, enforced in the prologue. The Popish Plot was in Otway's mind, and Anthony, 1st earl of Shaftesbury, is caricatured in Antonio. The play won instant success. It was translated into almost every modern European language. and even Dryden said of it: "Nature is there, which is the greatest beauty."

The Orphan and *Venice Preserved* remained stock pieces on the stage until the 19th century, and the leading actresses of the period played Monimia and Belvidera. One or two prefaces, another weak comedy. *The Atheist* (1684), and two posthumous pieces. a poem, *Windsor Castle* (168j). a panegyric of Charles II and a *History of the Triumvirates* (1686), translated from the French. complete the list of Otway's works. He apparently ceased to struggle against his poverty and misfortunes. The generally accepted story regarding the manner of his death was first given in Theophilus Cibber's *Lives of the Poets. He* is said to have emerged from his retreat at the Bull on Tower Hill to beg for bread. A passerby: learning who he was. gave him a guinea. with which Otway hastened to a baker's shop. He began too hastily to satisfy his ravenous hunger. and choked with the first mouthful. Whether this account of his death he true or not, it is certain that he died in the utmost poverty, and was buried on April 16, 1685, in the churchyard of St. Clement Danes, A tragedy entitled *Heroick Friendship* was printed in 1686 as Otway's work, but the ascription is unlikely.

The Works of Mr. Thomas Otway With Some Account of His Life and Writings, published in 1712, was followed by other editions (1757, 1768, 1812). The standard edition is that by T. Thornton (1813). A selection of his plays was edited for the Mermaid series (1891 and 1903) by Roden Noel.

See E. Schumacher, *Thomas Otway* (1924).

OUACHITA MOUNTAINS, a lens-shaped rugged hill land extending approximately 225 mi. east-\yest from Little Rock. Ark., to Atoka, Okla. The north-south extent is approximately 50–60 mi. from the Arkansas river valley to the northern margin of the coastal plain. The hilly area is essentially coincident with the visible portion of underlying strata much faulted and closely folded to form an anticlinorium. or arch. Ridges trend generally east-west and are approximately the same height. 'The highest elevation (more than 2,800 ft.) is on Rich mountain. near the Oklahoma-Arkansas boundary. Oak-pine forests cloak the hills and cultivation is restricted to favoured valley bottoms.

(A. H. Dr.)

OUACHITA RIVER rises in the Ouachita mountains of west central Arkansas. U.S., and flows east, then south and southeast for about 60; mi. to its junction with the Red river in Louisiana The lower 57 mi. of the Ouachita is known as the Black river. Most of the 25,000-sq.mi. drainage basin lies in the Upper Coastal Plain of Arkansas and Louisiana and the Mississippi Alluvial valley. Chief tributaries of the Ouachita are the Little Missouri. Saline. Bayou Bartholomew, Boeuf and Tensas rivers. Discharge at Monroe, La., ranges from 300 to 100,000 cu.ft. a second.

The Ouachita has been used for navigation since the late 18th century. Six locks and dams built prior to 1924 provide $6\frac{1}{2}$-ft. depth for 351 mi. from the mouth of the Black river to Camden, Ark. Shallower depths are found upstream to Xrkadelphia. Ark., generally considered to be the head of navigation. In 1950 a nine-foot channel was authorized to Camden. Logs, pulpwood and chemicals are the chief cargo below Camden.

Three dams on the upper Ouachita within the Ouachita mountains provide power for a private power company and recreational facilities, and alleviate flood damage downstream. Lakes Catherine and Hamilton. formed by Remmel and Carpenter dams, cover 11,-000 ac. n-hile Lake Ouachita, formed by Blakely Mountain dam in 1955. covers over 75 sq.mi. The Narrows dam, forming Lake Greeson. is a multipurpose dam on the Little Missouri tributary. Chief cities on the Ouachita are Arkadelphia and Camden, Ark., and Monroe, La. (M. W. M.)

OUBLIETTE, a French architectural term used in two senses, of a dungeon in a prison or castle which could only be reached by a trap door from another dungeon, and of a concealed opening or passage leading from a dungeon to the moat or river, into which bodies of prisoners might be dropped. Many so-called oubliettes in medieval castles were in reality the cesspools or receptacles of the castle latrines.

OUDENARDE, a town of Belgium in the province of East Flanders. 1S mi. S. of Ghent. Pop. (1955 est.) 6,637. Known for the victory by Marlborough and Eugene over the French under Vendôme in 1708, Oudenarde has other features of interest. The town hall, which took ten years to build (1525–35), has after that of Louvain the most elaborately decorated façade in Belgium. It was designed by H. van Peede and G. de Ronde. and is in tertiary Gothic style. The belfry tower of five stories with three terraces, surmounted by a golden figure, is a striking feature. The council chamber contains a fine oak door and Gothic chimney-piece. both c. 1530. There are also two interesting old churches, St Walburga, partly of the 12th and partly of the 14th century. and Our Lady, dating from the 13th century. 'fhe former contains several pictures by Craeyer and other Flemish masters.

The Battle of Oudenarde (June 30–July 11, 1708) was fought on the ground northwest and north of the town, which was then regularly fortified and was garrisoned by a force of the allies. For an account of the strategic situation which led up to the battle, *see* SPANISH SUCCESSION, WAR OF THE. The French army under the duke of Burgundy and Marshal Vendôme. after an abortive attempt to invest Oudenarde. took up a defensive position north of the town when Marlborough and Eugene. after a forced march, arrived with the main allied army. The advanced guard of the allies under General (Lord) Cadogan promptly crossed the Scheldt. annihilated an outlying body of French troops, and established itself on the ground it had won, in front of the French centre. But the allied main army took a long time to defile over the Scheldt and could form up (on the left of Cadogan's detachment') only slowly and by degrees. Observing this. Burgundy resolved to throw forward his right toward Oudenarde to engage and hold the main body of the allies before their line of battle could be formed. This effected, it was hoped that the remainder of the French army could isolate and destroy Cadogan's detachment: which was already closely engaged with the French centre. But he miscalculated both the endurance of Cadogan's men (among whom the Prussians were conspicuous for their tenacity) and the rapidity with which in Marlborough's and Eugene's hands the wearied troops of the allies could be made to move. Marlborough. n-ho personally directed the operations on his left wing, not only formed his line of battle successfully, hut also began seriously to press the forces that had been sent to check his deployment. Before long. while the hostile left wing still remained inactive. the unfortunate troops of the French centre and right were gradually hemmed in by the whole force of the allies. The decisive blow was delivered by the Dutch marshal. Overkirk, who was sent by Marlborough with a large force (the last reserve of the allies) to make a wide turning movement round the extreme right of the French, and at the proper time attacked them in rear. A belated attempt of the French left to intervene was checked by the British cavalry, and the pressure on the centre and right. which were now practically surrounded, continued even after nightfall. A few scattered units managed to escape. and the left wing retreated unmolested, but at the cost of about 3,000 casualties the allies inflicted a loss of 6,000 killed and wounded and 9,000 prisoners on the enemy. who were, moreover. so shaken that they never recovered their confidence to the end of the campaign. The battle of Oudenarde was not the greatest of Marlborough's victories. but it affords almost the best illustration of his military character. Contrary to all the rules of n-ar then in vogue. he fought a piecemeal and unpremeditated battle. with his hack to a river, and with wearied troops, and succeeded.

OUDINÉ, EUGÈNE ANDRÉ (1810–1887), French sculptor and medalist oiten considered the "father of the modern medal," was born in Paris in 1810. He devoted himself from the beginning to the medalist's branch of sculpture. although he also excelled in monumental sculpture and portrait busts. He gained the grand prize for medal engraving in 1831 and in the same year exhibited his "Wounded Gladiator." Subsequently he was official designer to the inland revenue and to the mint. His most famous medals are those struck in commemoration of the annexation of Savoy by France and of the peace of Villafranca, between Austria and France, in 1Sjg. Others are "The Apotheosis of Napoleon I," "The Universal Exposition." "The Establishment of the Republic" and "Napoleon's Tomb at the Invalides." Oudiné died in 1887.

OUDINOT, CHARLES NICOLAS (1767–1847), duke of Reggio. marshal of France. was born at Bar-le-duc, on April 25, 1767. He served in the regiment of Médoc from 1784 to 1787, retiring with the rank of sergeant. On the outbreak of war in 1792 he became lieutenant colonel in the volunteers of the Meuse, being transferred to the regular army aiter his defense of the fort of Bitsch (1792). He was promoted general of brigade in June 1794, after the battle of Kaiserslautern. He served on the German frontier under Hoche. Pichegru arid Moreau, and in the Swiss campaign of 1799 with Masséna. He was made inspector general of infantry, and in the war of 1805 he commanded the famous "grenadiers Oudinot," with which he seized the Vienna bridges, and gave the decisive blow at Austerlitz. In 1808 he was made governor of Erfurt and count of the empire, and in 1809 after Wagram, he was promoted marshal. He was made duke of Reggio, and received a large money grant in April 1810. Oudinot governed Holland from 1810 to 1812, and commanded the II corps of the *Grande Armée* in the Russian campaign. For his defeat at Grossbeeren *see* NAPOLEONIC CAMPAIGNS. Oudinot again held important commands at Leipzig and in the 1814 campaign. He was made a peer under Louis XVIII, and did not join Napoleon in 1815. He commanded a corps, and was for a time governor of Madrid.

OUDRY, JEAN BAPTISTE (1686–1755), French portrait and animal painter, was born in Paris on March 17, 1686. His father was a painter and art dealer and Oudry lived among unpretentious artists. His real master was Nicolas de Largillière, with whom Oudry was on intimate terms and through whom he made useful connections. He started as a portrait painter and became a member of the Royal Academy in 1719. King Louis XV commissioned him to paint the dogs of his pack and he became official painter of the royal hunts. In 1734 he became head of the Beauvais tapestry factory, which he re-established by bringing in new artists such as François Boucher and Charles Joseph Natoire. Oudry made 267 drawings for an edition of the *Fables* of La Fontaine (1755) and illustrated *Don Quixote* and *Le Roman comique.* His lively studies of nature are surprising for his time. Among his clients were Tsar Peter the Great, who wanted to take him to Russia, the queen of Sweden and the prince of Mecklenburg-Schwerin. Works by this most popular animal painter are to be found in the Louvre, Paris, the palace of Compiègne, the Wallace collection, London, and the Metropolitan museum, New York city.

Oudry died in Beauvais on April 30, 1755.

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OUGHTRED, WILLIAM (1574?–1660), was one of the most influential students of mathematics in England in the first half of the 17th century. His early training was at Eton and at Kings college, Cambridge, where he served as a fellow for some years. In 1604 he left the university to be vicar of Shalford and subsequently rector of Albury, both in Surrey. Although his years in the ministry included the period of the Commonwealth when more than 8,000 clerics were deprived of their charges, Oughtred was permitted to continue in his parish. John Aubrey is responsible for the tale that Oughtred died of joy on hearing of the return of Charles II. Augustus de Morgan commented, "It should be added by way of excuse that he was then 86 years old."

During his residence in Albury, Oughtred had a succession of students coming to him for the instruction in mathematics which the universities did not then afford.

His most important published work was the *Clavis mathematicae* (1631) which included a description of Hindu-Arabic notation and decimal fractions and a considerable section on algebra. Oughtred experimented with many different algebraic symbols and he seems to have been responsible for the use of :: in writing a proportion, $\sim$ to denote the value of the difference between two numbers and $\times$ for multiplication. Oughtred adapted Napier's logarithms to a scale, inventing a circular slide rule about 1632 and a rectilinear rule by 1633. The priority of these inventions was contested by one of his former students, Richard Delamain, but evidence points to the conclusion that the two men worked independently. Oughtred's *Trigonometry* (1657) treated plane and spherical trigonometry and among the symbols in this work were the familiar *sin, tan* and *sec.*

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OUIDA, the pen name—derived from a childish attempt to pronounce "Louisa"—of Maria Louise [de la] Ramée (1839–1908), English novelist, born at Bury St. Edmunds, where her birth was registered on Jan. 7, 1839. Her father Louis Ramée was French and her mother Susan Sutton, English. In 1860 her first story, afterward republished as *Held in Bondage* (1863), appeared in the *New Monthly* under the title of *Granville de Vigne;* this was followed in quick succession by *Strathmore* (1865), *Chandos* (1866) and *Under Two Flags* (1867). The list of Ouida's subsequent works is a long one; but it is sufficient to say that, together with *Moths* (1880), those already named are not only the most characteristic, but also the best. In a less dramatic genre, her *Bimbi: Stories for Children* (1882) may also be mentioned; but it was by her more flamboyant stories, such as *Under Two Flags* and *Moths,* that her popular success was achieved. She died at Viareggio, Jan. 25, 1908.

OULU, a seaport and industrial town of Finland on the Gulf of Bothnia in 65° N., 25° 29' E., linked by rail to Helsinki. Pop. (1950) 37,910. It is the chief town of a forested department of the same name. The accommodation in the harbour depends on the wind. Exports are timber, tar, leather, flour and wood products; imports colonial produce, coals, iron, hides and salt.

OUNCE (SNOW LEOPARD), *Panthera uncia,* a middle-sized true leopard of the cat family, Felidae, sometimes placed in the genus *Felis* or *Uncia.* "Ounce" was originally applied to the lynx (*q.v.*), later to any medium-sized cat, and now generally is restricted to the animal better known as the irbis. The ounce inhabits the highlands from the Himalayas north to the Altai, and has been reported from eastern Siberia. This cat stands about two feet high and measures about six and one-half feet in length: about three feet of this being tail. The fur is long, dense and soft; of a buffy gray colour, it is marked with ill-defined dark rosettes. The feet are large and well furred as befits a cat living in a cold, snowy climate. It lives among the rocks and preys on wild sheep and goats, large rodents and birds. It is a fairly uncommon animal and, although the furs are prized, few reach the market. (K. R. KN.)

OUNCE: *see* WEIGHTS AND MEASURES.

OUNDLE, a market town and urban district in the Peterborough parliamentary division of Northamptonshire, Eng., 28 mi. N.E. of Northampton by road. Pop. (1951) 2,224. Area 3.5 sq.mi. The manor belonged to the abbot of Peterborough and after the Dissolution it was granted to John, earl of Bedford. The church of St. Peter has early English, decorated and perpendicular work and a crocketed spire which is a landmark for miles. Built of local gray limestone, Oundle is a small residential and educational town. There is a yearly horse and cattle fair and twice yearly a pleasure fair. Oundle school was founded in 1556 under the will of Sir William Laxton, lord mayor of London, and in 1930 was granted a royal charter. The school, with Laxton grammar school (founded in 1876), are descendants of the grammar school founded by the Guild of Our Lady of Oundle about 1507.

OURO PRETO (Portuguese for "Black Gold"), a city of the state of Minas Gerais, Brazil, 336 mi. by rail N. by W. of Rio de Janeiro and about 300 mi. W. of Vitória, Espirito Santo; on the eastern slope of the Serra do Espinhaço and within the drainage basin of the Rio Doce. The city is built upon the lower slope of the Serra do Ouro Preto, a spur of the Espinhaco, deeply cut by ravines and divided into a number of irregular hills. Narrow, crooked streets are built upon the hills and groups of houses form each a separate nucleus. From a mining settlement the city grew as the inequalities of the site permitted. The climate is subtropical and humid, though the elevation (3,700–3,800 ft.) gives a temperate climate in winter. The days are usually hot and the nights cold.

The city dates from 1701, when a gold-mining settlement was established by Antonio Dias of Taubauté. The circumstance that the gold turned black on exposure to air gave the name of Ouro Preto to the mountain spur and the settlement. Within a decade of its founding the settlement had become the centre of the greatest gold rush in the Americas up to that date. When it was raised by royal decree to the status of a city, with the name of Vila Rica, in 1711, it 'retained many of the characteristics associated with boom towns—prices were high, there was much gambling, tempers were easily aroused. The inhabitants had already fought in a civil war for control of the mining region. In 1720, Vila Kica became the capital of the newly created captaincy of Minas Gerais. Five years later a smelting house and mint were opened as part of an effort by the Portuguese crown to reap a greater share of the wealth.

Near the end of the century residents of the city participated actively in the abortive *Inconfidência* movement to free Brazil from Portugal. In 1823, following the winning of independence, Ouro Preto was made the capital of the province of Minas Gerais, a distinction it held until 1897 when because of transportation difficulties in reaching Ouro Preto the state administration was transferred to the new city of Belo Horizonte.

Long before it lost the capital, Ouro Preto had entered upon a period of decay. Its population, which surpassed 60.000 by 1760 had dwindled to less than 10,000 by 1900 and to 8.751 in 1950. Although it has a respected school of mines, a few factories and some agriculture, Ouro Preto lives largely in the past. In 1933 it was decreed a national monument and the surrounding region a national park. The objective of the federal government was to preserve or restore the city's elaborate public buildings, churches and private homes. These buildings, dating for the most part from the late 18th century, make the city a veritable open-air museum. The old colonial governor's palace houses the National School of Mines (founded 1876) and a museum that contains an outstanding collection of minerals native to Brazil. The massive colonial penitentiary contains the Museum of the *Inconfidência,* dedicated to the history of gold mining and culture in Minas Gerais. The colonial theatre, restored in 1861–62, is the oldest in Brazil.

The city has many baroque churches. Church architecture and religious sculpture attained their highest perfection in the city and perhaps in all Brazil under the skillful hands of Antonio Francisco Lisbôa, better known as O Aleijadinho ("The Little Cripple"). who is generally conceded to be the outstanding sculptor to practise his art in Latin America. The church of St. Francis of Assisi is probably his masterpiece. Much of the ornateness of the churches of Ouro Preto is said to have resulted from white and Negro lay brotherhoods competing with one another during the colonial period. In the 20th century Ouro Preto has provided a gold mine of subjects for artists from many parts of the world. (J. J. J.)

OUSE, the name of several English rivers, an ancient word derived from a root word, meaning water, found in Sanskrit.

(1) The Great Ouse rises in Northampton, in the hills between Banbury and Brackley, and falls about 500 ft. in 156 mi. to its mouth in the Wash (North sea). It flows east past Brackley and Buckingham and then turns northeast to Stony Stratford, receiving the Tove and the Ouzel at Newport Pagnell. It then follows a sinuous course past Olney to Sharnbrook, where it turns abruptly south to Bedford, then to flow northeast past St. Neot's to Godmanchester and Huntingdon, when the river trends easterly to St. Ives. Hitherto the Ouse has watered an open valley, but below St. Ives the river debouches suddenly upon the Fens; its fall from this point to the mouth, a distance of jj mi. by the old course, is little more than 20 feet. From Earith to Denver the waters of the Ouse flow almost wholly in two straight artificial channels called the Bedford rivers, the old course being called the Old West river. This is joined by the Cam 4 mi. above Ely. North of this point the river receives the Lark, the Little Ouse, or Brandon river, and the Wissey. Below Denver sluice, 16 mi. from the mouth, the Ouse is tidal. It flows past King's Lynn, and enters the Wash near the southeast corner. The river is locked up to Bedford, a distance of 74½ mi. by the direct course.

(2) A river of Yorkshire. Its headstream, the Swale, rising on the eastern flank of the Pennines was formerly tributary to the Tees. It now turns southward across the Vale of York at Danby Wiske, where its old course is blocked by a morainic ridge left at the close of the Ice Age. After its junction with the Ure near Boroughbridge, the joint stream is known as the Ouse as far as its entry into the Humber. On its way it passes York, Selby and Goole, and receives the Nidd, Wharfe, Aire and Don, from the Pennines on its right bank and the Derwent on its left. Like the Swale and Ure, all the Pennine tributaries are consequent streams. The canal system of the Aire and Calder is the most important inland waterway in England.

(3) A river of Sussex, rising in the Forest Ridges between Horsham and Cuckfield, and draining part of the Weald Like other streams there, it breaches the South Downs, where its passage was guarded by Lewes castle, and reaches the English channel at Newhaven after a course of 30 mi. (T. Her.)

OUSELEY, SIR FREDERICK ARTHUR GORE (1825–1889), English musician, was born on Aug. 12, in London. Educated at Christ Church, Oxford, he took orders in 1849 and became a curate in London. In 1855 he was appointed professor of music at Oxford, and was made precentor of Hereford cathedral. In 1856 he became vicar of St. Michael's, Tenbury, and warden of St Michael's college His works include two oratorios, a great number of services and anthems. chamber music, songs and organ preludes and fugues, and theoretical works on counterpoint. He died at Hereford on April 6, 1889.

OUTLAWRY, the process of putting a person out of the protection of the law; a punishment for contemptuously refusing to appear nhen called in court, or evading justice by disappearing. It was of very early existence in England, and was the punishment of those nho could not pay the *were* or blood-money to the relatives of the deceased. By the Saxon law, an outlaw lost his *libera lex* and had no protection from the frank-pledge in the decennary in which he was sworn. He was, too, a *frendlesman,* because he forfeited his friends; for if any of them rendered him any assistance, they became liable to the same punishment An outlaw was *civiliter mortuus.*

He could not sue in any court, nor had he any legal rights which could be enforced, but he was personally liable upon all causes of action. It was finally abolished in civil proceedings in 1879, while in criminal proceedings it has practically become obsolete, being unnecessary through the general adoption of extradition treaties.

In Scotland outlawry or fugitation may on the motion of the crown be pronounced by the supreme criminal court when the panel has absconded and fails to appear to plead to the indictment on the day of trial.

OUTLAWRY OF WAR: see War.

OUTRAM, SIR JAMES (1803–1863), English general, and one of the heroes of the Indian Mutiny, was born on Jan 29, 1803. In 1818 he went to the Marischal college, Aberdeen; and in 1819 an Indian cadetship was given him. In 1825 he was sent to Khandesh, where he trained a light infantry corps, formed of the wild robber Bhils, employing them with great success in checking outrages and plunder. In the first Afghan War in 1838 he nas extra aide-de-camp on the staff of Sir John Keane He opposed the policy of his superior, Sir Charles Napier, which led to the annexation of Sind. When mar broke out he defended the residency at Hyderabad against 8,000 Baluchis

On his return from a short visit to England in 1843, he was appointed to a command in the Mahratta country, and in 1847 he nas transferred from Satara to Baroda, nhere he incurred the resentment of the Bombay government by his exposure of corruption. In 1854 he was appointed resident at Lucknow, in which capacity two years later he carried out the annexation of Oudh. Appointed in 1857 to command an expedition against Persia, he defeated his enemy at Khushab.

From Persia he was summoned in June to India, with the brief explanation—"We want all our best men here." Immediately on his arrival in Calcutta he was appointed to command the two divisions of the Bengal army occupying the country from Calcutta to Cawnpore. Already the mutiny had assumed such proportions as to compel Havelock to fall back on Cawnpore. On arriving at Cawnpore with reinforcements, Outram, waiving his rank, tendered his services to Havelock as a volunteer.

Resuming supreme command after the relief of Lucknow, he held the town till the arrival of Sir Colin Campbell. after which he conducted the evacuation of the residency so as completely to deceive the enemy. In the second capture of Lucknow, on the commander in chief's return, Outram was entrusted with the attack on the side of the Gumti, and afterward, having recrossed the river, he advanced "through the Chattar Manzil to take the residency." After the capture of Lucknow he was gazetted lieutenant general. In February *1858* he received the special thanks of both houses of parliament, and in the same year the dignity of baronet with an annuity of £1.000 He returned to England in *1860* and died on March *11. 1863.*

OVARIOTOMY or OÖPHORECTOMY, the operation for removal of one or both ovaries or of an ovarian tumour *(see* REPRODUCTION; REPRODUCTIVE SYSTEM). In *1701*, Houston of Carluke, Lanarkshire, did a successful partial extirpation; John and William Hunter *(1780)* indicated the practicability of the operation. In 1809 Ephraim M'Dowell of Kentucky, inspired by John Bell, his teacher in Edinburgh, performed ovariotomy, and continued to operate with success. The procedure was placed on a firm basis by Spencer Wells, the English surgeon, who performed his first operation in 1858.

Improved methods were rapidly introduced, and eventually, by the introduction of antiseptic, and later aseptic surgical methods, this operation, formerly regarded as one of the most grave, came to be attended with a lower mortality than many others of a major character. (F. L. A.)

OVENBIRD, the name given to birds of the genus *Furnarius* of the American family of wood hewers *(Dendrocolaptidae)*, on account of the structure of the nest. They are small thrushlike birds confined to South America.

The name ovenbird is commonly given in the U.S. to the golden crowned water thrush (*Seiurus aurocapillus*), one of the wood warblers. uhich builds an oven-shaped nest on the ground.

See C. Darwin, *Voyage of the Beagle* (1845); *W. H.* Hudson, *A Naturalist in La Plata* (1892).

OVERBECK, JOHANN FRIEDRICH *(1789–1869)*, German painter, the reviver of "Christian art" in the early 19th century, was born at Liibeck on July *3, 1789.* In *1806* he entered the Academy of Vienna. Disappointed in the pseudo-classicistic methods of teaching, Overbeck. with his friend Franz Pforr and some other young painters. founded in *1809* the "Lucas Brotherhood," aspiring to the renewal of arts by virtue of Christian faith. For inspiration, they turned to the old German (Diirer) and to the *quattrocento* masters of Italy (Perugino, early Raphael).

In 1810. the "Lucas Brethren" went to live in Rome, and, in *1813,* Overbeck joined the Roman Catholic Church. The group, which now included Peter von Cornelius (*q.v.*), Schnorr von Carolsfeld, Philipp Veit and Wilhelm von Schadow-Godenhaus, became known as the "Nazarenes." Their painting was characterized by nobility of conception. precision of outline and clear, bright colours, emphasizing symbolic qualities. Overbeck, with his lofty ideals. was the natural leader of the party.

In 1816 the Prussian consul. J. L. S. Bartholdy, commissioned them to decorate his villa in Rome with frescoes on the story of Joseph and his brethren. This led to another commission from Prince Massimo to paint the interior of his pavilion (1817–29). In *1829* Overbeck executed "The Rose-Miracle of St. Francis" for the chapel called the Portiuncula. at Assisi. As he advanced in pears. Overbeck's painting became pallid and stereotyped. Wet these late works influenced European devotional art until the beginning of the 20th century, whereas his notable early pictures and imposing drawings were not rediscovered until the early 20th century. There are relations with the Pre-Raphaelites, too, the connecting link being William Dyce (*q.v.*).

Overbeck died in Rome on Nov. 12, 1869. His principal paintings are: "Christ's Entry Into Jerusalem" (1809–24; destroyed in Lübeck, *1942);* "Adoration of the Magi" (1811–13; Hamburg); "Germania und Italia" *(1811–28*; Munich); "Family Portrait" *(1820:* Liibeck); and "Vittoria Caldoni" (*1821;* Munich).

See M. Howitt, *Friedrich Overbeck* (1886); *C.* G. Heise, *Overbeck und sein Kreis* (1928). (G. LE.)

OVERBURY, SIR THOMAS (*1581–1613*), English poet and essayist, the victim of a famous intrigue at the court of James I. was born in *1581* at Compton Scorpion, Warwickshire, and baptized on June *18,* 1581. In *1595* he became a gentleman commoner of Queen's college, Oxford. He entered the Middle Temple, London. in *1598.*

While in Edinburgh in *1601,* he met Robert Carr, then a page to the earl of Dunbar. Overbury became a servant of Sir Robert Cecil, traveled taice to the Low Countries, later writing *Observations in His Travailes Upon the State of the XVII Provinces (1626).* Returning from his first visit in *1606.* he found that Carr had attracted the attention of James I, and was becoming the king's favourite. He became Carr's secretary and closest adviser. and was knighted in 1608 and appointed a servitor in ordinary to the king. As Carr rose, Overbury's influence grew and it was said that "Overbury governed Carr and Carr governed the King."

Early in *1611* Carr, now earl of Rochester, became enamoured of Frances Howard. countess of Essex. The affair, supported by Frances' relatives, the earls of Northampton and Suffolk, who saw a marriage between Frances and Rochester as a means to enhance their position at court, at first received Overbury's encouragement. When he realized that Lady Essex would reduce his influence over Rochester, and make him the tool of one court faction instead of the arbiter between factions, Overbury bluntly expressed his opinion of Lady Essex to Rochester, who repeated it to her. At the same time Overbury circulated manuscript copies of a poem called *A Wife*, which was a picture of the virtues a young man should demand of a woman, and which was interpreted as an indirect attack on Lady Essex.

"A man of unbounded and impudent spirit," in the words of Francis Bacon, Overbury had incurred the displeasure of James I and his queen, and it was not difficult for the Howards to contrive his imprisonment. Overbury was offered a post abroad and, on refusing it, was thrown into the Tower in April *1613.* charged with disrespect to the king. Suffolk and Northampton, now abetted by Rochester, were content to see Overbury imprisoned while they secured the divorce of Lady Essex from her husband. She, however, was resolved that Overbury "should return no more to this stage." She bribed the jailer, aided by a Mrs. Turner, the widow of a physician. and by an apothecary called Franklin, to poison Overbury. His constitution long withstood the timid doses they gave him, but he eventually succumbed and died in the Tower on Sept. 15, *1613.*

In December Rochester, now earl of Somerset, married Lady Essex. More than a year passed before suspicion was aroused, and when it was, the king showed disinclination to bring the offenders to justice. In the trial which followed. the plot was discovered. The accomplices were hanged; the countess of Somerset pleaded guilty but was spared, and Somerset himself was disgraced.

Naturally, Overbury's fame as a writer was enhanced by so much posthumous publicity. His A *Wife,* entered on the Stationers' Register in Dec. *1613* and published early in *1614,* ran through several editions within a year. To the second edition were added *21 Characters,* increased in following editions until, by *1622.* they numbered *82*. Only a few were by Overbury, the remainder being by others, including Webster. Dekker and Donne. Their portraits of Jacobean "types," drawn with wit and satire, give a vivid picture of contemporary society, and are important in the development of the essay.

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OVERHEAD CHARGES. Overhead charges. or on-costs, are an important factor in cost accounts. Prime cost represents outlays directly incurred for a particular purpose, and thus capable of being charged directly thereto. In addition, there are a number of indirect expenses which can only be dealt with by spreading them as equitably as may be over the total output.

Generally speaking, overhead charges consist of such items as rent, rates, taxes, salaries, depreciation. interest, discounts, bad debts, etc., from which may be deducted corresponding credits. But in order to arrive at costs that are comparable with those of similar undertakings, various adjustments become necessary. Thus, where business premises are owned, the rental value should be included. although not actually expended. When time is of importance, interest on outlays should be included, even although no interest may actually have been paid away. Per contra: interest on borrowed moneys (including debentures) is not properly a factor in costs at all; and interest received on investments, although undoubtedly a profit. does not tend to reduce operative costs and should therefore he excluded.

Many authorities also consider that bad debts have nothing to do with the costs. Depreciation of equipment is generally a very important factor but the modern tendency is to charge a machine rate of so much per hour as part of the direct costs, such rate being designed to cover depreciation, repairs and interest on capital; when this is done, no charge in respect of depreciation falls to be included as overhead.

Formerly, it was thought to be sufficiently accurate to add a given percentage to prime cost as a loading to cover overhead. It is now recognized that no satisfactory results can be achieved in this way. A uniform percentage of loading for overhead would result in the aggregate amount actually charged against output varying directly with the prime cost, and thus the amount so charged would almost certainly be appreciably more or appreciably less than the true figure, according to whether the output was above or below the average. Further, such a system of allocation assumes that the fair loading for overhead varies directly with the prime cost. whereas the employment of expensive materials does not necessarily increase the overhead burden, and in many cases economies in labour costs can only be achieved by increasing the overhead burden; *e.g.*, when machine work is substituted for hand work.

Most production is complex. and consists of a series of successive processes or operations. each involving its own overhead charges. The modern practice is accordingly in the direction of analyzing overhead into departments. and distributing the burden of the departmental overhead over the output of the department, usually pro rata according to the time occupied. In this way some approach to substantial accuracy may be reached. but no cut and dried formula will meet all cases.

Sometimes costs are appreciably increased by "spoils"—the curtailment of salable output as a result of defective materials, machinery, workmanship or supervision. The only satisfactory way to deal with losses arising from spoils is to charge them as part of the overhead burden of the department causing the spoil. If and when this is done the loss is thrown upon the right shoulders. and the effect commonly is to reduce very materially the loss arising from spoils by compelling managers to inquire more carefully into causes and possible remedies. (L. R. D.)

OVERSEA INVESTMENTS: *see* CAPITAL. EXPORT OF.

OVERTURE (Fr. *ouverture,* opening), in music. a detachable instrumental introduction to a dramatic or choral composition. The notion of an overture had no existence until the 17th century. The *toccata* at the beginning of Monteverdi's *Orfeo* is a barbaric flourish of every procurable instrument, alternating with a melodious section entitled *ritornello;* and. in so far as this constitutes the first instrumental movement prefixed to an opera, it may be called an overture. As an art-form the overture began to exist in the works of J. B. Lully. His favourite, but not his only, form constitutes the typical French overture that became classical in the works of Bach and Handel. This French overture consists of a slow introduction in a marked "dotted rhythm" (*i.e.,* exaggerated iambic, if the first chord is disregarded), followed by a lively movement in fugato style. The slow introduction was always repeated, and sometimes the quick movement concluded by returning to the slow tempo and material, and was also repeated (*see* Bach's French Overture in the *Klavierübung*).

The operatic French overture was frequently followed by a series of dance tunes before the curtain rose. It thus naturally became used as the prelude to a suite (*q.v.*); and the term was then applied to the whole suite.

Bach was able to adapt the French overture to choruses, and even to the treatment of chorales. Thus the overture—movements of his fourth orchestral suite became the first chorus of the church cantata *Unser Mund sei voll Lachens;* the choruses of the cantatas *Preise Jerusalem den Herrn* and *Höchst erwünschtes Freudenfest* are in overture form; and, in the first of the two cantatas entitled *Nun komm, der Heiden Heiland,* Bach has adapted the overture form to the treatment of a chorale.

Gluck could find no use for the French overture. In the epoch-making preface to *Alceste* he laid down the rule that the overture should he the musical argument of the drama. And the perfunctory overture to *Orfeo* is the only exception to the rule that in his great operas the orchestral introduction is actually interrupted by the rise of the curtain. In *Iphigénie en Tauride* it is merely the calm before the storm.

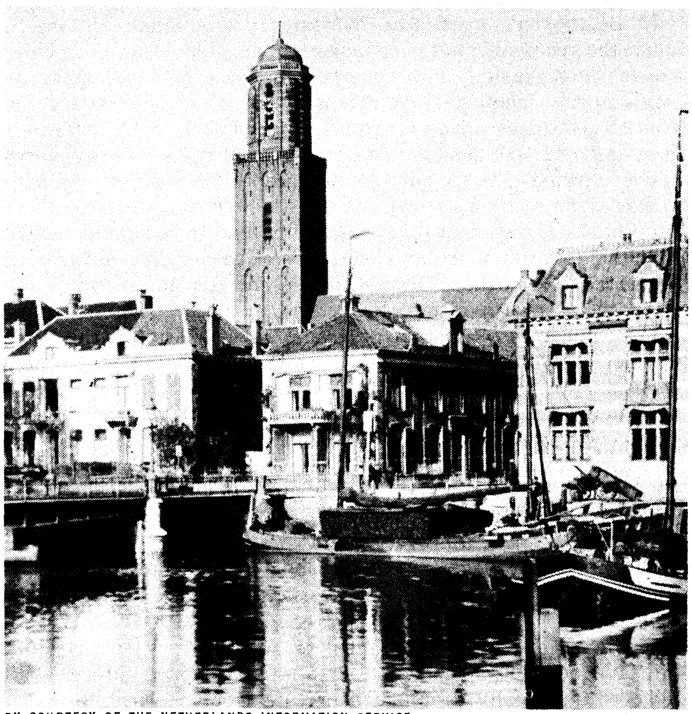
The abolition of the French overture did not, however, lead at first to any widespread adoption of Gluck's loose-knit Italian texture. The next form of overture was that of a three-movement symphony (*q.v.*) in sonata style. In Mozart's early opera *La Finta giardiniera* the curtain rises upon what should have been the third movement; and in all later works the overture is distinguished from symphonic music in style as well as form. It is a single quick movement (with or without a slow introduction,) in sonata form, loose in texture. without repeats. and frequently without a development section. Sometimes. in place of development. there is a melodious episode in slow time; as in Mozart's overtures to *Die Entführung* and to the fragment *Lo Sposo deluso,* in both of which cases the curtain rises at a point which throws a dramatic light upon this feature. Mozart at first intended a similar episode in the overture to *Figaro,* but struck it out as soon as he had begun it.

In Beethoven's hands the overture became more and more unlike the symphony. but it no longer remained an inferior species; and the final version of the overture to *Leonora* is the most gigantic single orchestral movement ever based on the sonata style. Weber's overtures work out prominent themes in his operas in a loose but effective sonata form, and are effective concert-pieces besides serving Gluck's purposes admirably. On the overture to Mendelssohn's *Elijah, see* MENDELSSOHN-BARTHOLDY, JAKOB LUDWIG FELIX. Overtures to plays naturally tend to become detached from their surroundings; and hence arises the concert overture, led by Beethoven's mighty *Coriolan,* and second only to the symphony as an orchestral art-form. Its derivation implies that it is programme music (*q.v.*), but the programme need not impair the form, whether the form be Berlioz's or Brahms's. and the programme particular or generalized. Among overtures with a generalized programme Mendelssohn's *Hebrides* overture is a perfect masterpiece: and so is Brahms's *Tragic* overture, one of the greatest orchestral movements since Beethoven. Brahms's *Academic Festival Overture* is a glorious working out of German student songs.

In modern opera the overture, *Prelude, Vorspiel,* or whatever else it may be called, is often nothing more definite than that portion of the music which takes place before the curtain rises. *Tannhäuser* is the last important opera in which the overture retains vestiges of a self-contained sonata form. Fifty years before Wagner's wonderful *Vorspiel* to *Lohengrin,* Mehul had achieved an equally complete departure from classical forms in his interesting overtures to *Ariodant* and *Uthal,* in the latter of which a voice is heard on the stage before the rise of the curtain. Even the most self-contained of Wagner's later preludes lose by transference to the concert-room. The glorious *Vorspiel* to *Die Meistersinger* is nobler when its long *crescendo* leads to the rise of the curtain and the engaging of all the listener's sense of sight and language, than when it can merely lead to a final tonic chord. Wagner himself added a page to finish the *Vorspiel* to *Tristan,* and by the richness and subtlety of that page he reveals how unready for independent existence the original *Vorspiel* was. He also finished the *Parsifal Vorspiel* for concert use by the addition of a few extra bars, which will always sound perfunctory. The four dramas of the *Ring* begin with introductions designed to prepare the hearer immediately for the rise of the curtain; and these works can no more be said to have overtures than Verdi's *Falstaff* and Strauss's *Salome, Electru* and *Die Frau ohne Schatten,* in which the curtain rises at the first note of the music. (D. F. T.)

OVERYSSEL (OVERIJSSEL), a Netherlands province. bounded south and southwest by Gelderland, west by the Zuider Zee, north by Friesland and Drente. and east by Germany. Pop. of the province (1957 est.) 748,337. shoming about 57% increase during the 20th century; area, 1,257 sq.mi. It is a varied glaciated delta-land consisting of a sandy flat relieved by hillocks, and covered vith waste stretches of heath broken by patches of wood and high fen; but the coastal strip north of Zwartsluis consists largely of low-lying fertile pasturelands with cattle rearing and associated buiter and cheese manufactures, while along the shores mats and brushes are made.

The river system is determined by two main glacial ridges. of which the eastern, which separates the Dinkel and Regge, extends from Enschede northnard into the German enclave; the larger one runs parallel with it and. commencing at Lochem (Gelderland), extends into south Drente. In the south it separates the Yssel and Regge; its summit height (Lemeler hill. 262 ft.) is near where it is breached by the Vecht. This river crosses the province from east to west joining a part of the Yssel near Zwolle to form the Zwarte Water. which communicates uith the Zuider Zee by the Zwolsche Diep; the main Yssel enters the Zuider Zee separately below Kampen. The streams are flanked by small-estate fertile grasslands from which agriculture and cattle rearing have gradually spread over the sand grounds; much of the area, however, is still waste though forest culture is practised locally, especially in the east. and pigs are bred. Peat digging and fen reclamation have long been practised and much high fen north of the Vecht in the neighbourhood of Dedemsvaart has been reclaimed though the main reclamation took place along and near the eastern ridge.



BY COURTESY OF THE NETHERLANDS INFORMATION SERVICE

VIEW OF ZWOLLE. CAPITAL OF OVERYSSEL PROVINCE. IN THE BACKGROUND IS THE STEEPLE OF THE CHURCH OF OUR LADY

Overyssel has become a highly industrialized province. Textile manufacturing is particularly important, especially in the Twente district. Cotton-spinning, together with bleaching works, came into some prominence in the 19th century in the southeast district of Twente. The inhabitants for long had practised weaving as a home craft but capitalist Baptist refugees who arrived in the 17th and 18th centuries organized it into an industry. Deventer has iron foundries and carpet factories but is more famed for its honey cakes. The capital of the province is Zwolle, pop. (1957 est.) 54,-087 (mun.), though Enschede (118,671 [mun.]) is the largest town. Deventer, Hengelo and Almelo each exceed 20,000 population and all four are situated in the south. Deventer is an old but busy little river port with a 16th-century weighhouse of unusual design. Kampen. on the Yssel with its harbour long since silted up, has lost much of its importance of Hanseatic days but its 14th-century churches and gateways are interesting. Its Stadhuis (16th and 18th centuries) is probably the finest town hall in the Netherlands. It shares a fishing trade with Vollenhove and Blokzijl, all on the Zuider Zee. Tucked away in the extreme north near the Drente border is the delightful little settlement of Giethoorn, literally a water village, each house possessing its own quay, draw-bridge and punt. The railway system of the province is supplemented by streetcar lines and the roads are good but the waterways still carry much traffic.

OVID (in Latin, PUBLIUS OVIDIUS NASO) (43 B.C.–A.D. 18), Roman poet, who can be regarded either as the last of the Augustan poets or as the first poet of the Silver Age of Latin literature and whose work has had immense influence both for its imaginative interpretation of the classical world and as an example of supreme technical accomplishment, was born at Sulmo (modern Sulmona), in the country of the Paeligni, on March 20, 43 B.C., of an old middle-class family. The main events of his life are described in a famous autobiographical poem (*Tristia,* iv, 10). While still a boy he was sent to Rome to be educated, being intended by his father for the public service. He studied rhetoric under the best masters of the day and was thought to have the makings of a good orator, but in spite of his father's admonitions he neglected his studies for the verse making which came so naturally to him. After completing his education with travels in Greece, Asia Minor and Sicily, he held some minor official posts, but he finally abandoned his career to devote himself to poetry.

His first work, the *Amores* ("Loves"), had an immediate vogue and was followed, in rapid succession, by the *Heroides* ("Heroines"), the *Medicamina faciei* ("Cosmetics"), the *Ars amatoria* ("Art of Love") and the *Remedia amoris* ("Remedies of Love"), all reflecting the brilliant, sophisticated, pleasure-seeking society in which he moved. The common theme of these early poems is love and amorous intrigue, but it is unlikely that they mirror Ovid's own life very closely. Of his three marriages the first two were short lived, but his third wife, of whom he speaks with respect and affection, remained constant to him until his death. (His one daughter was probably by his second wife.) At Rome he enjoyed the friendship and encouragement of M. Valerius Messalla, patron of a circle which included Tibullus, whom Ovid knew only for a short time before his untimely death; his other friends included Horace, Propertius and the grammarian Hyginus. Virgil, as he said, he had only seen. Having won an assured position among the poets of the day he turned to more ambitious projects, the *Metamorphoses* ("Transfigurations") and the *Fasti* ("Calendar"). The former of these was nearly complete, the latter half finished, when his life was shattered by a sudden and crushing blow. In A.D. 8 the emperor Augustus banished him to Tomis (or Tomi; near the modern Constanta) on the Black sea. The reasons for his exile will never be fully known: Ovid himself specifies two, his *Ars amatoria* and an offense which he does not describe beyond insisting that it was an indiscretion *(error),* not a crime (*scelus*). Of the many explanations which have been offered of this mysterious *error,* the most probable is that he had somehow become an accomplice in the adultery of Augustus' granddaughter, the younger Julia, who was also banished at the same time. In 2 B.C. her mother, the elder Julia, had similarly been banished for immorality, and the *Ars amatoria* had appeared while the scandal was still fresh in the public mind. These coincidences, together with the tone of Ovid's reference to his offense, suggest that he had acted in some way damaging both to Augustus' program of moral reform and to the honour of the imperial family. Since his punishment, which was the milder form of banishment called relegation, did not entail confiscation of property or loss of citizenship, his wife, who was well connected, remained in Rome to protect his interests and to intercede for him. Exile at Tomis, a half-Greek, half-barbarian port on the extreme confines of the Roman empire, was for a man of Ovid's temperament and habits perhaps the cruelest punishment that could be devised. He never ceased to hope, if not for pardon, at least for mitigation of sentence, keeping up in the *Tristiu* ("Sorrows") and *Epistulae ex Ponto* ("Letters From the Black Sea") a ceaseless stream of pathetic pleas, chiefly through his wife and friends, to the emperor; but neither Augustus nor his successor Tiberius relented, and Ovid was even becoming reconciled to his fate nhen dedth released him

WORKS

Ovid's extant poems. all written in elegiac couplets except the *Metamorphoses*, fall into three groups.

Early Works. — The chronology of the early works is obscure. The first edition of the *Amores,* in five books, was issued when Ovid was still very young; the edition that has survived. in three books, dates from a later revision. The *Amores* invite comparison with the poems of Tibullus and Propertius. but the resemblance is only superficial. Their keynote is not passion, but the witty and rhetorical exploitation of erotic commonplace: they chronicle, not a real relationship between Ovid and Corinna (who, unlike the Delia of Tibullus. or the Cynthia of Propertius, cannot be identified with a real woman and probably never existed). but all the phases of a typical affair with a demimondaine.

In the *Heroides* Ovid was developing an idea already used by Propertius (iv, 3) into something like a new literary genre. The first 15 of these letters from legendary ladies such as Penelope, Dido and Ariadne to absent husbands or lovers appeared between the two editions of the *Amores.* Their epistolary form hardly disguises the fact that they are really dramatic monologues, in which the influence of Ovid's rhetorical education, particularly the exercise called *ethopoeia* (character drawing), can be clearly seen. Unlike most ancient writers Ovid liked women as a sex; and though no doubt many of his shrewd touches reflect his reading rather than an intimate knowledge of "feminine psychology," the note of sympathy and understanding is unmistakable. But not all his skill can disguise the inherent monotony of subject and treatment, and there are many *longueurs* and lapses of taste. The six later epistles, the authenticity of which has been unjustly suspected, are on a different and more successful plan: they form three pairs. the lover addressing and being answered by the lady. The correspondence of Paris and Helen is one of antiquity's minor masterpieces.

In turning, as he next did, to didactic poetry, Ovid mas following a popular fashion: his first attempt, the *Medicamina faciei,* of which only 100 lines survive. was typical of many such witty exercises. This frivolous but harmless poem was followed (1 B.C.) by the notorious *Ass amatoria,* a manual of seduction and intrigue for the man about town. The seducer's prey. in this work, is ostensibly the courtesan (which in Rome meant the freedwoman, the nearest equivalent to the Greek *hetaera*), and Ovid explicitly disclaims the intention of teaching adultery; but all his teaching could in fact be applied to the corruption of married women. Such a work constituted a direct challenge, no less effective for being flippant, to Augustus' cherished moral reforms, and it is part of Ovid's essential naïveté that he either could not or would not see the gravity of his offense in publishing it. The first two books, addressed to men. were the original extent of the work; a third, in response to popular demand, was added for women. For most modern readers, including Lord Macaulay, this is Ovid's masterpiece. a brilliant medley of social and personal satire, \-ignettes of Roman life and manners and charming mythological digressions. The veneer of didacticism is light but unmistakable, with deliberate echoes of Lucretius and of Virgil's *Georgica,* the traditional role of the poet as teacher being cleverly perverted in Venus' service. In the *Amores* he had presented love as a game to be played for enjoyment only; in the *Ars* he codified and illustrated the rules. In the social sense the *Ars* is an immoral poem, and the candid reader must recognize the justice if not the wisdom of Augustus' condemnation of it; but it is not pornographic. and it may be doubted whether many have been the worse for reading it. It was followed by a mock recantation. the *Remedia amoris,* also a burlesque of an established genre. Though amusing, this contains clear indications of flagging inspiration, and Ovid now turned to new types of poetry in which he could indulge to the full his supreme narrative and descriptive gifts.

Metamorphoses and Pasti. — The poems of the second group of Ovid's works nere being nritten concurrently from *c.* A.D. 1 onward. The *Metamorphoses* represented for Ovid himself. as its concluding lines show, the masterpiece from which he hoped for immortality. Ostensibly it is a collection of stories depicting the transformations so frequent in classical legend, told in approximately chronological order from the creation of the world to the poet's own day; in fact his theme gave him an excuse to tell almost any story that took his fancy. The idea and its execution were Alexandrian, but Ovid's use of his Greek sources was free, and in the various devices and digressions that he employed for connecting and "framing" the stories he displayed a variety and ingenuity that outdid his models. The result is a long poem in 15 books of hexameters. with a total of nearly 12,000 lines; and the wonder is that it can be read through with so much pleasure and so little fatigue. Moreover, by his genius for narrative and vivid description, Ovid gave to scores of legends. some of them little known before, what was to be for many generations of poets and painters their definite form. No single work of literature has done more to transmit the riches of the Greek imagination to posterity. Though the poem is brought down to Augustus, the Roman legends in it are comparatively few.

The treatment of Roman legends mas mostly reserved by Ovid for his *Fnsti.* This work was originally planned to comprise 12 books, one for each month, but only the first 6, covering January–June. were finished at the time of Ovid's banishment. It recounts the Roman festivals as they occur and relates the myths appropriate to each; again an opportunity for storytelling. Ovid's chief Greek model was Callimachus' *Aetia,* but here again, as in the *Heroides,* he was following a lead given by Propertius (iv). As a medium for narrative the elegiac couplet in Ovid's hands rivals the hexameter. and as a collection of stories the *Fasti* ranks second only to the *Metamorphoses.* It was intended. however. a something more — as a national, specifically Roman poem. a part in fact of the Augustan literary program. From the inevitable comparison with Virgil it emerges badly, especially in its perfunctory patriotism and gross adulation of the imperial family. The *Fasti* constitutes a unique source of information about Roman religion but must be used with extreme caution.

Poems of Exile. — The *Tristia* and the *Epistulae ex Ponto* were written and sent to Rome at the rate of about a book a year from A.D. 9 onward; they consist of letters to the emperor and to Ovid's wife and friends. describing his miseries and pleading for their alleviation. Book ii of the *Tristia,* a characteristic defense of the *Ars amatoria,* addressed to Augustus, is of particular interest to the literary historian, but its mixture of casuistry and something very near impudence can scarcely have helped its author. A few of the other poems stand apart because of their subjects (for example: *Tiistia* i, 3, a moving description of Ovid's last night in Rome; and iv, 10. the autobiographyj. but most of both the *Tristia* and of the *Epistulae ex Ponto* exhibit a uniform tone of depression and self-pity. Ovid has been condemned for his lack of fortitude. but only the most self-righteous can fail to be moved as. remembering what he had been, they read of the terrible winters of Tomis, of barbarian incursions across the frozen Danube and of the aging poet taking his turn at sentry duty; or of his lack of books and of civilized company and of his wistful imaginings of life in Rome.

During his exile Ovid partially revised the *Fasfi;* otherwise the only work of this time that has survived is the *Ibis.* This is a long curse directed at an unnamed enemy whom. following Callimachus in his attack on Apollonius, he called Ibis after the Egyptian bird (supposed to have filthy habits). Its amalgam of rhetorical abuse and curious learning is typically Alexandrian. and it may have been no more than a literary exercise. If Ibis was a real enemy, this poem was Ovid's only lapse from the high standard of fairness and benignity (*candor*) on which he prided himself.

Lost and Spurious Works. — The loss of Ovid's tragedy *Medea,* written at Rome. is particularly to be deplored; it was praised by Quintilian and Tacitus. Of the extant works sometimes attributed to Ovid, the best case can perhaps be made out for the *Nux* ("Nut-tree"), a pleasing little poem. The fragment of the *Halieutica* ("Sea-fishing") which has survived is certainly not his; nor, it is generally agreed, are the *Consolnfio ad Liviam* and the

Elegia in Maecenatem.

THE MAN AND THE POET

When the battle of Actium was fought in 31 B.C., Ovid was still a child. Older men, like Horace and Virgil, who had endured the anarchy and bloodshed of the declining Roman republic, were deeply thankful for the regime of Augustus, in whom they saw the saviour of civilization. Their beliefs and aspirations held little interest for the younger generation, for whom the peace and security of their environment formed merely the background to the private pursuit of pleasure. Ovid's early training encouraged his romantic and escapist bent. Rhetoric, still the staple of higher education though increasingly divorced from reality, had degenerated in the hands of many of its exponents into an elaborate game with words and ideas; and in Ovid can be seen the beginnings of the long domination of rhetoric over poetry. Latin elegiac poets regularly turned away from public life and responsibility, but Ovid was better fitted by temperament even than Tibullus and Propertius for escape to the poet's world of fantasy. His imagination was stirred not so much by his own experience (though the *Amores* and the *Ars amatoria* show him as an acute and witty observer of the contemporary scene) as by the riches of Greek legend.

From his boyhood Ovid venerated and cultivated the society of poets; few poets have read more poetry than he or remembered and reproduced more of what they read. In his exile poetry was his only solace. As its subject matter stimulated his imagination, so its technique fascinated his intellect. His astonishing dexterity is the response to the difficulty of adapting the intractable Latin tongue to dactylic Greek metres. The Roman elegiac couplet was already governed by stricter rules than its Greek model, and Ovid further refined these rules. He is the most Alexandrian of the Roman poets. His aims can be summed up in the one word point: point conveyed by smoothness, fluency and balance. To achieve this he shaped the already artificial poetic diction elaborated by his predecessors into an instrument which within its inherent limitations is nearly perfect. Its elegance masks its extreme artificiality, and the casual reader overlooks the quiet ruthlessness of Ovid's linguistic innovations, particularly in vocabulary. His hexameters in the *Metamorphoses* are a superb vehicle for rapid narrative and description.

To this technical facility was added an unrivaled power of invention which enabled Ovid to exploit ideas and situations to the utmost. This fertility, that "plenty of subjects and words" which was the goal of ancient rhetorical education, was not without dangers. The elder Seneca, who provides a valuable portrait of the young Ovid in his *Controversiae* (ii, 2, 8), remarks elsewhere (ix, j, 17) that he could not let well alone; and the reader of the *Heroides* and *Metamorphoses* is alternately enchanted and repelled by his baroque exuberance. His undoubted rhetorical gifts have caused him to be dubbed insincere and even heartless, and he seems indeed to have lacked the capacity for strong emotion or religious feeling; but the *Heroides* and the poems of exile show that he was not without sensibility. When he offends it is through his refusal (which Seneca tells us was deliberate) to control his genius: his wit leads him into outright frivolity, and the whole is forgotten in the pleasure of developing its parts. Classical perfection had no appeal for him; he was accustomed to say that a mole improved a beautiful face. Judged however by his gift for fantasy Ovid is one of the great poets of the world. The *Metamorphoses,* formless as it is, shows him at his most characteristic. For him and for his readers the scenes of his poetry were full of the associations of history and legend, and he had a keen eye for natural beauty. His idealized landscapes are peopled, not by the gods, demigods and mortals of classical Greek mythology, but by what might almost be called fairy substitutes, creatures of the poet's fancy invested with some of their attributes. Ovid had few illusions about the historic past and did not share the fashionable nostalgia for a golden age; his escape was into the timeless and miraculous world of romance, and into his depiction of this unreal world he infused all the beauty and gaiety of which the world of the senses is capable. His talent is not of that highest order which can pierce the outward semblance of men and things and receive intimations of a deeper reality; but what he could do, few if any poets have ever done better.

INFLUENCE

The immense popularity that Ovid enjoyed during his lifetime continued after his death, being little affected by the action of Augustus, who banned his works from the public libraries. Virtually no Latin poet was thereafter immune from his influence. The elegiac couplet, in particular, remained substantially what he had made it.

From about 1100 onward Ovid's fame, which during late antiquity and the early middle ages had been to some extent eclipsed. began to rival and even at times to surpass Virgil's. The 12th and 13th centuries have with some justice been called "the age of Ovid." Surprisingly, he was esteemed in this period not only as entertaining but also as instructive: he was a "golden author" whose works, not even excluding the *Remedia amoris,* that "remedy worse than the disease," were read in schools. Not even he had been able to ignore the fundamentally moral orientation of ancient literature; his poetry is full of epigrammatic maxims and sententious utterances which, lifted from their contexts, make a respectable appearance in the excerpts in which medieval readers often studied their classics. He also provided a rich material for a favoured exercise of the age, allegorical interpretation—a treatment which not even the *Ars amatoria* escaped. His popularity was part, however, of a general secularization and awakening to the beauties of profane literature: he was the poet of the wandering scholars who were one of the scandals of the age as he was of the vernacular poets. the troubadours and minnesingers; and when the concept of romantic love, in its new chivalrous or "courtly" guise, was developed in France, it was Ovid's influence that dominated the book in which its philosophy was expounded, the *Roman de la rose.* His fame at this time was such that he was even translated into Greek by the monk Maximus Planudes, when interest in Latin literature had for centuries been dormant in the Byzantine empire. (Planudes' prose versions of the *Heroides* and *Metamorphoses* are still extant.) Ovid continued, then, to be one of the familiar poets of the middle ages, Dante and Chaucer, for instance, being much indebted to him; but some of the ways in which he influenced medieval literature and thought would undoubtedly have astonished him. Like Virgil, he survived in the memory of his native countryside as saint and wizard.

With the culmination of the Renaissance, Ovid may be said to have come into his own. While the middle ages had honoured him where he least deserved it, that is, for his morality, the humanists of the 15th century, striving to recreate ancient modes of thought and feeling, honoured him for his poetry (though it must also be remembered that Greek literature and thought were for many accessible only through the medium of Latin, so that the *Metamorphoses* was indispensable if only as a mythological handbook). His vivid and striking descriptions, the gaiety and free play of his fancy, the elegance and brilliance of his language, even his superficial hedonism, all combined to recommend him to the new spirit that was abroad. Printed editions of his works followed each other in an unending stream from 1471 onward. He continued to be read in schools. and when the composition of Latin verses was established as an integral part of the standard literary education, it was his verse, above all, that was imitated. A knowledge of his works was taken for granted in an educated man. In the 1jth, 16th and 17th centuries it would be difficult to name a poet or painter of note who was not in some degree indebted to him. Of scores of names it suffices to mention Shakespeare and Milton in England.

The subsequent decline in Ovid's popularity is not wholly attributable to the decrease in the importance of the classics which followed the romantic movement at the end of the 18th century and the rise of scientific education in the 19th. As classical studies took their place as a discipline beside other disciplines, ancient authors came to be esteemed as they were original, informative or improving rather than for their power to delight and entertain. In the 20th century. however, reaction against Victorian rigidity brought signs that Ovid might be attaining in the opinion of contemporary critics the place to which, in Seneca's words his "cultivated, seemly and pleasing genius" entitles him.

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OVIEDO, a maritime province of northern Spain, bounded on the north by the Bay of Biscay, east by Santander, south by León and west by Lugo. Pop. (1950) 895,804; area, 4,207 sq.mi. In popular speech Oviedo is often called by its ancient name of Asturias (*q.v.*). Oviedo is rich in forests, coal, streams and waterfalls, greatly contributing to its modern industrial development. The horses of Oviedo rank among the best in Spain. Wild deer, boars and bears were formerly common among the mountains; the sea coasts, as well as the streams, abound with fish, including salmon and lampreys. Oviedo possesses valuable coal measures, which are worked at Langreo (mun. 54,676), Mieres (mun. 58,768), Siero (mun. 32,750) and elsewhere. The copper mines near Avilés (mun. 21,340) and Cangas de Onis (mun. 11,307) have lost their importance, but lead, magnesia, arsenic, cobalt, lapis lazuli, alum, antimony, jet, marble and rock crystal are found in various parts of the province, while amber and coral are gathered along the coast. There are manufactures of fine textiles, coarse cloth and ribbons in Salas (mun. 14,838), Piloña (mun. 16,243) and Avilés; of paper in Pianton; of porcelain and glass in Gijón (86,523), Avilés and Pola de Siero; of arms in Oviedo and Trubia; while iron foundries are numerous. An important highway is the 16th-century *Camino real,* or royal road, leading from Gijón to León and Madrid, which cost so much that the emperor Charles V inquired if it were paved with silver.

OVIEDO, an episcopal city and capital of the Spanish province of Oviedo; 16 mi. S. of the Bay of Biscay, on the Nalon river. Pop. (1950) 71,598. Oviedo is built on a hill rising from a broad and picturesque valley, which is bounded on the northwest by the Sierra de Naranco. Oviedo, founded in the reign of Fruela (762), became the fixed residence of the kings of the Asturias in the time of Alphonso II, and continued to be so until about 924, when the advancing reconquest of Spain from the Moors led them to remove their capital to León. The university was founded by Philip III in 1604. The Gothic cathedral, founded in 1388, occupies the site of a chapel founded in the 8th century, of which only the Camara Santa remains. The Camara Santa (dating from 802) contains the famous *arca* of Oviedo, an 11th-century Byzantine chest of cedar, overlaid with silver reliefs of Biblical scenes. In it are two crosses from the 8th and 9th centuries. Oviedo is an agricultural centre; other industries are marble quarrying, the manufacture of arms, fabrics, iron goods, leather and matches.

OVOLO: *see* Molding.

OVULE, the organ or structure in plants which after fertilization develops into a seed. *See* Flower.

OWEN, JOHN (1563 or 1564–1622), Welsh epigrammatist whose mastery of the Latin epigram caused him to be called "the British Martial," was born at Llanarmon, Carnarvonshire, probably in 1563 or 1564. He was educated at Winchester, and at New college, Oxford, where he was elected fellow in 1584. In 1591 he became a schoolmaster at Trelleck, near Monmouth, and later taught at Warwick free grammar school. He died in London in 1622.

Owen's first collection of epigrams was published in 1606—*Epigrammatum . . . Liber Tres.* A second volume followed in 1607 and two more in 1612, bringing the number of books up to ten (three volumes contained three books each, and one consisted of a single book). They achieved immediate popularity. Owen was highly praised by his contemporaries, both in England and abroad, for his readability, nimble wit, linguistic dexterity, and the skill with which he turned his verses. His epigrams are pointed rather than poetic: full of anagrams and near puns, they were appreciated particularly by a public brought up on Latin versification and accustomed to its use as a professional language. He incorporated many familiar Latin tags in his own work, sometimes with a skillful turn which added the shock of unexpectedness to the reader's pleasure in recognition. His works were frequently reprinted during the 17th and 18th centuries, both in England and abroad, and were translated into English, French, German and Spanish. The first English translation was by John Vicars (1619).

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OWEN, JOHN (1616–1683), English Nonconformist pastor, was born at Stadham in Oxfordshire in 1616, and educated at Queen's college, Oxford. He was chaplain and tutor in the families, first of Sir Robert Dormer, and later of Lord Lovelace, but lost his place by siding with parliament in the Great Rebellion. He then lived in Charterhouse yard, in London, and on April 29, 1646, preached, before the Long Parliament, a sermon which showed his tendency toward the tolerant Independent or Congregational system of church government. He now became pastor at Coggeshall in Essex. He was chosen to preach to parliament on the day after the execution of Charles. Cromwell took him in 1649 as his chaplain to Ireland, where he regulated the affairs of Trinity college, and in 1650 to Scotland, making him chancellor of Oxford (1651), dean of Christ-church (1651–52) and vice-chancellor in 1652.

When Richard Cromwell succeeded his father, Owen lost his vice-chancellorship, and joined the Wallingford House party, throwing his influence on the side of a simple republic as against a protectorate. In March 1660 the Presbyterian party being uppermost, he was deprived of his deanery and returned to Stadham. Driven to London by the Conventicle and Five Mile acts he gathered a congregation there; at the revival of the Conventicle acts in 1670 he drew up a protest to the house of lords. After the Declaration of Indulgence (1672) he frequently preached in congregations of Independents and Presbyterians, and was in favour with Charles II and James II. He died at Ealing on Aug. 24, 1683.

OWEN, SIR RICHARD (1804–1892), British biologist, a pioneer in vertebrate paleontology, was born at Lancaster on July 20, 1804. In 1820 he was apprenticed to a local surgeon and apothecary, and in 1824 he proceeded as a medical student to Edinburgh university. After completing his medical course at St. Bartholomew's hospital, London, he began a professional career; but, being induced by the eminent surgeon John Abernethy to accept the position of assistant to William Clift, conservator of the museum of the Royal College of Surgeons, he devoted himself to the more congenial work of scientific research. In 1831 Owen attended Georges Cuvier's lectures in Paris. He prepared a series of catalogues of the Hunterian collection in the Royal College of Surgeons, and, in the course of this work, acquired the knowledge of comparative anatomy which facilitated his researches on the remains of extinct animals. In 1836 he was appointed first Hunterian professor in the college; in 1849 he succeeded Clift as conservator and in 1856 became superintendent of the natural history departments of the British museum. He then devoted his energies to a scheme for a national museum of natural history, which eventually resulted in the removal of the natural history collections of the British museum to a new building at South Kensington, London. He retained office until the completion of this work in 1884, when he was created knight commander of the Bath, and thenceforward lived in retirement at Sheen lodge, in Richmond park, until his death on Dec. 18, 1892.

Owen's first notable publication, the *Memoir on the Pearly Nautilus* (1832), was soon recognized as a classic. Thereafter, for more than 50 years, he continued to make important contributions to comparative anatomy, devoting special attention to the remains of extinct groups, and published his work on *Odontography* (1840–45). His chief memoirs on British specimens were reprinted in his *History of British Fossil Reptiles,* 4 vol. (1849–84). He also wrote much on extinct birds. Sir Thomas Mitchell's discovery of fossil bones in New South Wales provided material for Owen's long series of papers on extinct mammals of Australia, which were eventually reprinted in book form in 1877. His industriousness placed him in the forefront of anatomists, but it is to be regretted that his work was not free from gross errors of observation and interpretation. His views on evolution were equivocal.

Besides those mentioned, Owen wrote: *A History of British Fossil Mammals and Birds* (1846) ; *The Archetype and Homologies of the Vertebrate Skeleton* (1848); *Comparative Anatomy and Physiology of Vertebrates,* 3 vol. (1866–68); *Monograph of the Fossil Mammalia of the Mesozoic Formations* (1871); *Antiquity of Man as Deduced From the Discovery of a Human Skeleton* (1884); and *Catalogue of the Fossil Reptilia of South Africa* (1876).

See R. S. Owen, *The Life of Richard Owen* (1894). (G. DE B.)

OWEN, ROBERT (1771–1858), British reformer and socialist, was born at Newtown, Montgomeryshire, on May 14, 1771, where he received his school education, which terminated at the age of nine. When only 19 he became manager of a large cotton mill in Manchester. Soon he had made it one of the best establishments of the kind in Great Britain. In this factory Owen used the first American sea-island cotton ever imported into the country, and made improvements in the quality of the cotton spun. On becoming manager and partner in the Chorlton Twist company at Manchester, Owen induced his partners to purchase the New Lanark mills. Encouraged by his great success in Manchester, he had already formed the intention of conducting New Lanark on higher principles than the current commercial ones.

Connected with the mills were about 2,000 people, 500 of whom were young children from the poorhouses and charities of Edinburgh and Glasgow. The children especially had been well treated by the former proprietor, but the general condition of the people was unsatisfactory. Crime and vice bred by demoralizing conditions were common; education and sanitation were alike neglected; and housing conditions were intolerable. Owen greatly improved their houses, and mainly by his personal influence trained them to habits of order, cleanliness and thrift. He opened a store, where the people could buy goods of the soundest quality at little more than cost price; and the sale of liquor was placed under the strictest supervision. His greatest success, however, was in the education of the young, to which he devoted special attention. The first infant school in Great Britain was started with Owen's approval and support at the New Lanark mills.

In all these plans Owen obtained success. Though at first regarded with suspicion as a stranger, he soon won the confidence of his people. The mills continued to be a commercial success, but some of Owen's schemes involved considerable expense, which was displeasing to his partners. Tired at last of the restrictions imposed on him by men who wished to conduct the business on the ordinary lines, Owen formed a new firm. the members of which, content with 5% of return for their capital, were ready to give freer scope to his philanthropy (1813). In this firm Jeremy Bentham and the well-known Quaker William Allen were partners. In the same year Owen published *A New View of Society, or Essays on the Principle of the Formation of the Human Character,* in which he expounded the principles on which his system of educational philanthropy was based. From an early age he had lost all belief in the prevailing forms of religion and had thought out a creed for himself, which he considered an entirely new and original discovery.

The chief points in Owen's philosophy were that man's character is formed by circumstances over which he had no control and that he is not a proper subject either of praise or blame. These convictions led Owen to the conclusion that the great secret in the right formation of man's character is to place him under the proper influences from his earliest years. The irresponsibility of man and of the effect of early influences are the keynote of Owen's whole system of education and social amelioration.

For the next few years Owen's work in New Lanark had a national and even European significance. New Lanark itself became a much frequented place of pilgrimage for social reformers, statesmen and royal personages. According to the unanimous testimony of all who visited it, the results achieved by Owen were singularly good. The children brought up on his system were graceful. genial and unconstrained; health, plenty and contentment prevailed; and the business was a commercial success. In 1815 Owen started, apparently single-handed, an agitation for factory reform, with little effect. His work as a practical reformer gave way in 1817 to the ideas—still vital—which made him the forerunner of socialism and co-operation. Owen pointed out that the competition of human labour with machinery was a permanent cause of distress, and that the only effective remedy was the united action of men and the subordination of machinery. His proposals for the treatment of pauperism were based on these principles. He recommended that communities of about 1,200 persons each be settled on quantities of land from 1,000 to 1,500 ac., all living in one large building in the form of a square, with public kitchen and messrooms. Each family should have its own private apartments, and the entire care of the children till the age of three, after which they should be brought up by the community, their parents having access to them at meals and all other proper times. These communities might be established by individuals, by parishes, by counties or by the state; in every case there should be supervision by duly qualified persons. Work and the enjoyment of its results should be in common. The size of his community was no doubt suggested by his village of New Lanark; and he soon advocated such a scheme for the reorganization of society in general. In its fully developed form it was as follows. He desired that communities of from 500 to 3,000, mainly agricultural but possessing the best machinery, and being, as far as possible, self-contained, "should increase in number, unions of them federatively united shall be formed in circles of tens, hundreds and thousands," till they should embrace the whole world in a common interest.

His plans for the cure of pauperism were received at first with considerable favour. But at a large meeting in London, Owen declared his hostility to the received forms of religion. After this act of defiance his theories became suspect to the ruling classes, though he did not lose all support from them. To carry out his plan of self-contained communities in 1825 he bought 30,000 ac. of land in Indiana in the United States from the Rappite religious community, and renamed it New Harmony (*q.v.*). For a time the community life was well ordered and contented under Owen's practical guidance, but differences about the form of government and religion soon appeared, and all the numerous attempts at reconstruction failed to compose them, though there is a consensus of testimony to the admirable spirit which prevailed amid all the dissensions. The community was wound up in 1828, and Owen lost £40,000—four-fifths of his fortune. The other chief Owenite community experiments were at Queenwood, Hants (1839–45), in which Owen took part for three years, and Orbiston near Glasgow (1825–28) and Ralahine in Ireland (1831–33), with neither of which he was directly concerned.

In his Report to the County of Lanark (a body of landowners) in 1820, Owen declared definitely that not reforms but a transformation of the social order was required. The appeal of such a doctrine to the workers is obvious. From 1820 his proposals for communities attracted the younger workers. brought up under the factory system; and between 1820 and 1830 numerous societies were formed and papers started to advocate his views. The growth of labour unionism and the emergence of a working-class point of view caused Owen's doctrines to be accepted as the expression of the workers' aspirations. When he returned to England in 1829 he found himself regarded as their leader. In the unions Owenism stimulated the formation of self-governing workshops, and their need for a market led to the formation of the Equitable Labour exchange in 1832, applying the principle that labour is the source of all wealth. The unprecedented growth of labour unions made it seem possible that the separate industries and eventually all industry might be organized by these bodies. Owen and his followers carried out an ardent propaganda all over the country. with the result that the new National Operative Builders union turned itself into a guild to carry on the building industry. and the Grand National Consolidated Trades union was formed (1833–34). The enthusiasm and the numbers joining were remarkable, but the determined opposition of the employers and the severe repression by the government and law courts ended the movement in a few months. It was two generations before socialism, first popularly discussed at this time, again influenced unionism. Throughout these years Owen's community ideas maintained a hold; ultimately they provided the basis for the world-wide Consumers' Co-operative movement which sprang from the Rochdale Pioneers Co-operative society founded in 1822. *(See* Co-OPERATIVES.)After 1834 Owen devoted himself to preaching his educational, moral, rationalist and marriage reform ideas. At the age of 82, he became a spiritualist. He died on Nov. 17, 1858, at Newtown.

Of Owen's numerous works in exposition of his system, the most important are the *New View of Society;* the *Report* communicated to the Committee on the Poor Law; *The Report to the County of Lanark;* the *Book of the Sew Moral World;* and *Revolution in the Mind and Practice of the Human Race.*

Robert Owen's four sons all became U.S. citizens. The eldest. Robert Dale Owen (1801–1877), sat in congress (1844–47), and drafted the bill founding the Smithsonian, institution. In the Indiana house of representatives, 1836–39 and 1851–52, and constitutional convention, 1850, he was instrumental in securing a married woman's property law. a common free school system, and more freedom in divorce. From 1853 to 1858 he was United States ambassador to Naples. He was a strong believer in spiritualism. *See* SOCIALISM: *Owenism; see* also references under "Owen. Robert" in the Index volume.

BIBLIOGRAPHY.—*Life of Robert Owen Written by Himself* (1857), and *Threading My Way, Twenty-Seven Pears of Autobiography* (1874). There are also lives of Owen *by* F. Podmore (1906) and G. D. H. Cole (with bibliography) (1925). *See* also Leonard Woolf, *Co-operation and the Future of Industry* (1919). (X.; D. F. DD.)

OWEN, WILFRED (1893–1918), British poet, whose angry pity at the cruelty and waste of mar received tragic confirmation in his own death in action, was born at Oswestry, Shropshire, March 18. 1893, and educated at the Birkenhead institute. A delicate. dreamy boy, he did not go to a university, although he matriculated at London in 1910; after an illness in 1913, he lived in France. He had already begun to write and. while working as a tutor near Bordeaux. was preparing a book of "Minor Poems—in Minor keys—by a Minor" which was never published, however. These early poems are consciously modeled on Keats: often ambitious, they show keen enjoyment of poetry as a craft.

In 1915, Owen enlisted in the Artist's Rifles. His experience of trench warfare brought him to rapid maturity: the poems written after Jan, 1917 are full of anger at its brutality and an elegiac pity for "those who die as cattle," as well as of rare descriptive power. In June 1917 he was invalided home and while in a hospital near Edinburgh met Siegfried Sassoon, who shared his feelings about the war and who became interested in his work. Reading Sassoon's poems, and discussing his own work with him, revolutionized Owen's style and his conception of poetry. Despite plans to find him a staff job, he returned to France in Aug. 1918 as a company commander. He was awarded the military cross in October, and was killed a week before Armistice day, on Nov. 4, 1918,

Published posthumously by Sassoon, his single volume of *Poems* contains the most poignant English poetry of the war. W. B. Yeats, in his introduction to the *Oxford Book of Modern Verse,* criticized war poets like Owen for identifying themselves too much with the unhappiness of their men. To many this identification seemed a source of true poetic strength rather than weakness. The fragmentary preface to the poems contains a maxim much meditated by the poets of the 1930s: "All a poet can do to-day is to warn. That is why the true poets must be truthful." Apart from their moving content, Owen's poems are of great interest as technical experiments in assonance.

See *Poems* (1920), enlarged edition (1931). (S. H. SR.)

OWENSBORO, a city of northwestern Kentucky, U.S., 29 mi. S.E. of Evansville, Ind., on the Ohio river, is the seat of Daviess county. It is an important market for tobacco, corn, wheat. dairy products and livestock. Owensboro is also the centre of a gas and oil field. Manufactures include electrical tubes and lamps, chemicals, steel, whisky, furniture, cigars, toys and building materials.

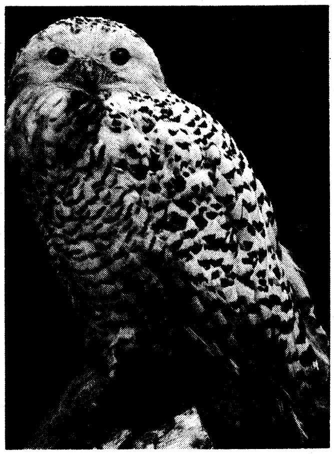
In 1815. it was officially named Rossborough after David Ross, a local landowner. The site of the town had been known to Ohio boatmen as Yellow Banks, because of the colour of riverside clay deposits. even before the erection of the first cabin in 1799. It was incorporated as a town and renamed Owensborough in 1817 after Col. Abraham Owen (1769–1811), an Indian fighter killed at the battle of Tippecanoe. The name was later changed to Owensboro. It received a city charter in 1866; a council-manager form of government came into effect in 1954. During the American Civil War. Owensboro was the scene of several minor skirmishes in 1862 and the victim of a Confederate guerrilla raid in 1864. Owensboro is the seat of Brescia college (Roman Catholic, 1925) and Kentucky Wesleyan college (Methodist, 18581. For comparative population figures *see* table in KENTUCKY : *Population.* (J. C. CR.)

OWL, the common name for usually nocturnal birds of prey which form the order Strigiformes. Although they bear some likeness to hawks and eagles (order Falconiformes). and were once placed with them in the same order, they are not closely related. Owls. unlike other birds of prey. have virtually noiseless flight; the butterflylike flapping of wings is muffled by downy-fringed plumage. These seemingly neckless birds vary in length from five inches in one of the pygmy owls (*Glaudidium cobanense*) to more than two feet in the great horned owls *(bztbo* species). On each side of the base of the beak are several rows of small, curved, stiff-shafted feathers, which form a ruff to support the long feathers of the disc or space around the eyes. The ear openings, hidden by bristlelike hairs, are large. with well-developed and often asymmetrical folds of skin! so that the right and left ears may be differently shaped. Some species have hornlike tufts near the ears. Many species of owl show two phases of coloration —one in which the brown tends toward red, the other in which it tends toward gray. The outer toes of all owls are reversible. Unlike most birds. owls incubate from the laying of the first egg.

Owls are grouped in two families, Tytonidae, the barn owls or "monkey-faced" owls, so called from their heart-shaped facial discs and the absence of ear tufts. and Strigidae, the typical owls, many of which have conspicuous ear tufts. The Tytonidae comprises 11 species found all over the world except in the polar regions, New Zealand, the Hawaiian Islands and some of the Malay archipelago. The Strigidae includes 123 species and is similarly world-wide in its range. except for a few oceanic islands and the south polar areas. One species, the snowy owl (*Nyctea scandiaca*), inhabits the northern circumpolar belt as far as northern Scandinavia, northern U.S.S.R., northern Alaska, Ellesmereland and northern Greenland, and wanders south during severe winters when food becomes scarce in the snow-covered lands.

Representative of the family Tytonidae is the tawny owl (Tyto *aluca*), found throughout Europe and in Asia Minor, Palestine and along the Barbary coast of Africa. A woodland bird, it feeds largely on rats. mice, voles and shrews. Allied species are found in America, northern Europe and Asia.

The eagle owl. Bubo bubo. ranges over most of Europe and Asia north of the Himalayas. The allied great-horned owl, B. virginianus extends over all North and South America from the northern limit of trees in the arctic to the Straits of Magellan, but is absent in the West Indies. They are sombre-coloured birds and among the largest species. Equally large is the snowy owl, a circumpolar species nith white plumage flecked with brown. In winter it migrates southward. The long- and short-eared owls (*Asio otus* and A. *flammeus*) are common to the northern parts of Europe and America. The short-eared owl, often seen abroad in the daytime, prefers open country. The long-eared owl is a woodland bird. Both possess erectile tufts on the side of the head. The burrowing owl, Speotyto *cunicularia,* of America lives in excavations, frequently sharing those of the prairie dog and viscacha. The bird of the Greek goddess Xthena is Athene *noctua,* the little owl of Europe, which was introduced into Great Britain, where it spread rapidly. *A. brama* replaces it in India. 'The American screech owl (Otus asio), in its numerous varieties, is found practically throughout North America except at the far north. It varies much in colour and size. It can be distinguished at night by its peculiar whistles, snarls and hisses.



W SUSCHITZKY

SNOWY OWL (NYCTEA SCANDIACA), OF ARCTIC REGIONS

Owls, as might be expected of nocturnal hunters, have very large eyes, which gather more light in dim nocturnal illumination. enabling these predators to see better in the dark. The orbs are directed forward giving owls binocular vision: they are thus able to perceive the whereabouts of their prey in a three-dimensional manner. Their eyes absorb light to such an extent that most owls are quite uncomfortable in broad daylight. They become dazzled by bright light. Despite this fact there are some owls that are diurnal. The snowy owl sees very little darkness during the arctic summer when there is daylight for most of the 24-hour-day.

A few tropical African and Asian owls are fish eaters, such as *Scotopelia* and *Ketupa,* but most of these birds live on small mammals and small birds which they kill after the manner of hawks. Thev usuallv tear the larger prey to pieces and then swallow the parts, fur, feathers and bones included. Smaller prey is often gulped down whole. A little later, after the prey has been digested, the bones, fur and feathers are coughed up in small pellets. Examination of these owl pellets has produced knowledge as to the feeding habits of the several species of owl. These data have shown clearly that owls are very beneficial to the agriculture of their areas, for while they consume large numbers of destructive or harmful rodents, they destroy relatively few beneficial insect or weed-seed-eating birds.

JOHN MARKHAM

TAWNY OWL (TYTO ALUCA), OF OLD WORLD WOODS

Because of their nocturnal habits and their ominous hooting sounds, owls early became associated in the mind of man with the occult and the otherworldly. They became symbolic of intelligence because it was thought they presaged events. One species, the barn owl of Europe (Tyto *alba*), was looked upon as a bird of ill omen, and subsequently became a symbol of disgrace. In the middle ages the common little owl of Europe was used as a symbol of the "darkness" that was prevalent before the coming of Christ; by further extension it was used to symbolize the nonbelievers who preferred to dwell in this "darkness."

See also BIRD. (HT. FN.)

OX, strictly speaking, the Saxon name for the males of domesticated cattle (Bos *taurus*), but in a zoological sense employed so as to include not only the extinct wild ox of Europe but likewise bovine animals of every description; that is to say, true oxen, bison and buffaloes. The characteristics of the subfamily Bovinae. or typical section of the family Bovidae, are given in the article BOVIDAE; for the systematic position of that family see RUMINANT. For the typical oxen, as represented by the existing domesticated breeds, see CATTLE.

OXALIC ACID, the simplest dibasic organic acid, and one of the strongest organic acids. Industrially, it is widely used as a laundry sour. where, in addition to neutralizing alkalinity, it is unusually effective in removing rust and ink stains since it forms a complex ferrioxalate ion with iron. Oxalic acid together with a small amount of added corrosion inhibitor is the chief constituent of the many automobile radiator scale removers. These two uses consume a large part of the oxalic acid of commerce. It is also employed as an electrolyte in the anodic oxidation of aluminum, as a bleaching agent for straw. cork and rosin. as a wash for anthracite coal which has been too long in storage and as a precipitant for rare earths. It is often used where an acid in solid. water-soluble. nonhygroscopic form is desired. as in printing of cloth, photography. etc. The sodium salt is used in pyrotechnics, as an antiflash agent in artillery ammunition and in chrome tanning to increase the amount of chromium taken up by the hide. The iron salt is used in the manufacture of blueprint paper, the tin and antimony1 salts in printing and dyeing. The laboratory applications of oxalic acid are discussed below.

The formula of oxalic acid is $(COOH)_2$, or, in its usual form of crystalline hydrate $(COOH)_2.2H_2O$. Its occurrence in wood sorrel (Oxalis *acetosella,* hence the name) and in sour dock (*Rumex* acetosa) in the form of its potassium salt was known at the beginning of the 17th century. Karl W. Scheele in 1776 prepared the acid by oxidizing sugar with nitric acid and showed this acid to be identical with the one derived from sorrel. The existence of oxalates in nature is widespread in both plant and animal kingdoms.

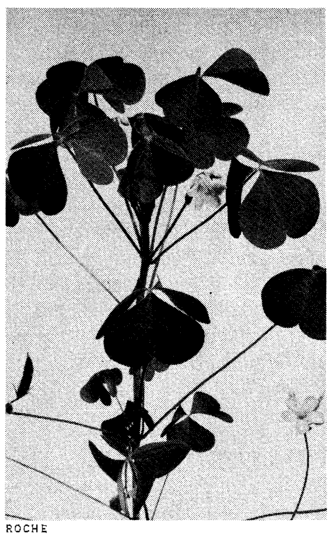
There are four industrial methods for the manufacture of oxalic acid: (1) Synthetic sodium formate is heated to 360° C. in the presence of an alkali catalyst to yield hydrogen and sodium oxalate, from which oxalic acid is obtained. (2) Carbohydrates, such as sugar, starch or cellulose, are oxidized with concentrated nitric acid in the presence of a vanadium catalyst to give oxalic acid. The oxides of nitrogen are recovered and reoxidized. (3) Wood waste, such as sawdust, is treated with fused sodium hydroxide to give sodium oxalate. This process became obsolete at the end of the 19th century, but in 1942 a procedure for carrying out this reaction continuously, thereby lowering the cost, was described. (4) Fermentation of sugar solutions by molds was later developed.

Oxalic acid crystallizes from water as a dihydrate in monoclinic prisms melting at 101.5° C. Heated at 100° C. it readily loses its water of crystallization. The anhydrous acid begins to sublime below 100° C. and sublimes rapidly above 125° C. The anhydrous acid may be recrystallized from glacial acetic acid and melts at 189.5° C. It has been used as a condensing agent. When heated more strongly, oxalic acid decomposes into carbon dioxide, carbon monoxide and water. The decomposition to carbon dioxide and formic acid is an intermediate stage in this reaction. Dehydrating agents such as sulfuric acid accelerate the thermal decomposition of oxalic acid. Oxalic acid heated with glycerin at 100° C. gives formic acid and carbon dioxide. At higher temperatures allyl alcohol is formed. Electrolytic reduction of oxalic acid at lead or mercury cathodes yields glycollic acid. At low temperatures glyoxylic acid may be obtained as an intermediate stage. Permanganates in acid solution oxidize oxalic acid to carbon dioxide and water. The reaction is autocatalytic. It is of great importance in analytical chemistry. In the presence of uranyl salts, oxalic acid undergoes photochemical decomposition. This reaction has found application in actinometry. Oxalic acid may be characterized by the following spot test: a fragment, melted with a little diphenylamine in a micro test tube, is heated over a free flame. The melt is then dissolved in a drop of alcohol. Formation of aniline blue shows the presence of an oxalate. Deutero-oxalic acid and its deuterate have been prepared and studied.

Oxalic acid is poisonous. The antidotes for oxalic acid poisoning are milk of lime, chalk, whiting or even wall plaster, followed by evacuation brought about by an enema or castor oil. Only the salts of the alkali metals are soluble in water. Besides the ordinary acid and neutral salts, a series of salts called tetraoxalates is known. these being salts containing one molecule of acid salt, in combination with one molecule of acid; one of the most common is "salt of sorrel." $KHC_2O_4.H_2C_2O_4.2H_2O$. The oxalates are readily decomposed when heated, leaving a residue of carbonate: or oxide of the metal. The silver salt decomposes with explosive violence. leaving a residue of the metal.

Ethyl oxalate $(CO.OC_2H_5)_2$, prepared by boiling anhydrous oxalic acid with absolute alcohol, is a colourless liquid which boils at 186° C. Methyl oxalate $(CO.OCH_3)_2$, which is prepared in a similar manner, is a solid melting at 54° C. It is used in the preparation of pure methyl alcohol. Oxalyl chloride. a liquid boiling at 64° C. (melting point −12° C.). has been obtained by the action of phosphorus pentachloride on anhydrous oxalic acid. Oxamic acid, $HO_2C.CONH_2$, is obtained by heating acid ammonium oxalate or by boiling oxamide with ammonia; it is among the products produced when amino acids are oxidized with potassium permanganate. It is a crystalline powder difficultly soluble in water and melting at 210° C. (with decomposition). Its ethyl ester, known as oxamethane, crystallizes in rhombic plates which melt at 114°–115° C. Oxamide $(CONH_2)_2$, is best prepared by the action of ammonia on the esters of oxalic acid. It is also obtained by the action of hydrogen peroxide on hydrocyanic acid, or of manganese dioxide and sulphuric acid on potassium cyanide. It is a white crystalline powder which is almost insoluble in cold water. When heated with phosphorus pentoxide it yields cyanogen. It is readily hydrolyzed by hot solutions of the caustic alkalies. Substituted oxamides are produced by the action of primary amines on ethyl oxalate.

OXALIS, a large genus of small herbaceous plants, comprising. with a few small allied genera, the family Oxalidaceae. The name is derived from the Greek *oxalis* ("acid"). the plants being highly acid to the taste. The genus contains about 800 species, chiefly south African and tropical and South American. It is represented in eastern North America and Great Britain by the wood sorrel *(O. acetosella)*, a small, stemless plant with radical, trefoillike leaves growing from a creeping, scaly rootstock, and the flowers borne singly on an axillary stalk; the flowers are regular with five sepals, five obovate, white, purple-veined, free petals, ten stamens and a central five-lobed, five-celled ovary with five free styles. The fruit is a capsule, splitting by valves; the seeds have a fleshy coat, which curls back elastically, ejecting the true seed. The leaves, as in the other species of the genus, show a "sleep movement," becoming pendulous at night. Besides the wood sorrel, about 20 other species occur in North America, among which are the yellow wood sorrel (*O. stricta*), of the eastern United States and Canada, with yellow flowers; the violet mood sorrel (*O. violacea*), of the eastern United States, with rose-purple flowers; the redwood wood sorrel (*O. oregana*), of the coast redwood belt from California to Oregon with pink to white flowers and *O. cernua*, known as Bermuda buttercups, with showy yellow flowers, native to south Africa and naturalized in Florida and the Bermudas. *Oxalis crenata,* the oca of South America. is a tuberous-rooted half-hardy perennial. native of Peru. Its tubers are comparatively small. and somewhat acid; but if they be exposed in the sun from six to ten days they become sweet and floury. *Oxalis deppei,* a bulbous perennial of Mexico. has scaly bulbs, from which are produced fleshy, tapering, white, semitransparent, edible roots, about four inches in length and three to four inches in diameter.



ROCHE

CREEPING OXALIS (O. CORNICULATA)

Various species are in cultivation as basket plants for window gardens, border plants and hothouse ornamentals.

OXENSTJERNA, COUNT AXEL GUSTAFSSON (1583–1654), chancellor of Sweden, was born at Fono, and was educated with his brothers at the universities of Rostock, Jena and Wittenberg. On returning home in 1603 he was appointed *kammerjunker* to King Charles IX. In 1606 he was entrusted with his first diplomatic mission, to Mecklenburg, was appointed a senator during his absence, and henceforth became one of the king's most trusted servants. In 1610 he was sent to Copenhagen to prevent a war with Denmark. This unsuccessful embassy marks the beginning of Oxenstjerna's long diplomatic struggle with Sweden's traditional rival in the north. Oxenstjerna was appointed a member of Gustavus Adolphus's council of regency. High aristocrat as he was, he would at first willingly have limited the royal power. An oligarchy guiding a limited monarchy was his ideal government, but the genius of the young king was not to be fettered.. On Jan. 6, 1612, he was appointed chancellor. His controlling, organizing hand was speedily felt in every branch of the administration. For his services as first Swedish plenipotentiary at the Peace of Knäred, 1613, he was richly rewarded.

During the frequent absences of Gustavus in Livonia and Finland (1614–1616) Oxenstjerna acted as his vice-regent. During the king's Russian and Polish wars he supplied the armies and the fleets with everything necessary. In 1622 he accompanied Gustavus to Livonia and was appointed governor general and commandant of Riga. He was entrusted with the negotiations which led to the truce with Poland in 1623. and succeeded in averting a rupture with Denmark in 1624. On Oct. 7, 1626, he was appointed governor general of the newly acquired Prussian province. In 1629 he concluded the truce of Altmark with Poland. In 1628 he had arranged with Denmark a joint occupation of Stralsund. After the battle of Breitenfeld (Sept. 7, 1631) he was summoned to assist the king with his counsels and co-operation in Germany. During the king's absence in Franconia and Bavaria in 1632 he was appointed *legatus* in the Rhine lands, with plenipotentiary authority over all the German generals and princes in the Swedish service. After the death of the king at Liitzen Oxenstjerna inspired the despairing Protestants both in Germany and Sweden with fresh hopes. He reorganized the government both at home and abroad. He united the estates of the four upper circles into a fresh league against the common foe (1634), in spite of the envious and foolish opposition of Saxony. By the patent of Jan. 12, 1633, he had already been appointed legate plenipotentiary of Sweden in Germany with absolute control over all the territory already won by the Swedish arms. No Swedish subject, either before or after, ever held such far-reaching authority. Gustavus would not only have aggrandized Sweden, he would have transformed the German empire.

Oxenstjerna wisely abandoned these vaulting ambitions. All his efforts were directed toward procuring for the Swedish crown adequate compensation for its sacrifices. Simple to austerity in his own tastes! he nevertheless recognized the political necessity of impressing his allies and confederates by an almost regal show of dignity; and at the abortive congress of Frankfort-on-blain (March 1634), held for the purpose of uniting all the German Protestants, Oxenstjerna appeared in a carriage drawn by six horses, with German princes attending him on foot. But from first to last his policy suffered from the slenderness of Sweden's material resources, a cardinal defect which all his craft and tact could not altogether conceal from the vigilance of her enemies. The success of his system postulated an uninterrupted series of triumphs, whereas a single reverse was likely to be fatal to it. Thus the frightful disaster of Nordlingen (Sept. 6th, 1634; see SWEDEN: History) compelled him to solicit direct assistance from France. But he refused at the conference of Compiègne (1635) to bind his hands in the future for the sake of some slight present relief. In 1636, however, he concluded a fresh subsidy-treaty with France at Wismar.

The same year he returned to Sweden and took his seat in the Regency. For the next nine years his voice, especially as regarded foreign affairs, was omnipotent in the council of state. He drew up beforehand the plan of the Danish War of 1643–1645, so brilliantly executed by Lennart Torstensson, and saw Denmark crippled by the Peace of Bromsebro (1645). His later years were embittered by the jealousy of the young Queen Christina, who thwarted the old statesman in every direction. He always attributed the exiguity of Sweden's gains by the Peace of Osnabruck to Christina's undue interference. Oxenstjerna was opposed at first to the abdication of Christina, because he feared mischief to Sweden from her appointed successor, Charles Gustavus. The extraordinary consideration shown to him by the new king ultimately, however, reconciled him to the change. He died at Stockholm on Aug. 28. 1654

OXENSTJERNA, COUNT BENGT or BENEDICT GABRIEL (1623–1702) was the son of Axel Oxenstjerna's half-brother, Gabriel Bengtsson (1586–1656). After a careful education he began his diplomatic career at the great peace congress of Osnabruck. During his stay in Germany he made the acquaintance of the count palatine, Charles Gustavus, afterward Charles X, whose confidence he completely won. Two years after the king's accession (1654), Oxenstjerna was sent to represent Sweden at the Kreistag of Lower Saxony. In 1655 he accompanied Charles to Poland and was made governor of the conquered provinces of Kulm, Kujavia, Masovia and Great Poland. The firmness and humanity which he displayed in this new capacity induced the German portion of them, notably the city of Thorn, to side with the Swedes against the Poles.

During Charles's absence in Denmark (1657), Oxenstjerna, in the most desperate circumstances, tenaciously defended Thorn for ten months; the terms of capitulation were made the basis of the subsequent peace negotiations at Oliva. During the domination of Magnus de la Gardie he played but a subordinate part in affairs. From 1662 to 1666 he was governor general of Livonia. In 1674 he was sent to Vienna to try to prevent the threatened outbreak of war between France and the empire, and he was one of the Swedish envoys to the congress of Nijmwegen (1676). From 1680 to 1697 he conducted the foreign relations of Sweden.

His leading political principles were friendship with the maritime powers (Great Britain and Holland) and the emperor, and a close anti-Danish alliance with the house of Holstein. Charles XI appointed Oxenstjerna one of the regents during the minority of Charles XII.

The martial proclivities of the new king filled the prudent old chancellor with alarm and anxiety. He advised Charles in vain to accept the terms of peace offered by the first anti-Swedish coalition.

Oxenstjerna has been described as "a shrewd and subtle little man, of gentle disposition, but remarkable for his firmness and tenacity of character." (R. N. B.; X.)

OXEYE DAISY: see DAISY.

OXFORD, EARLS OF, an English title held successively by the families of Vere and Harley. The three most important earls of the Vere line are noticed separately below. The Veres held the earldom from 1142 until March 1703, when it became extinct on the death of Aubrey de Vere, the 20th earl. In 1711 the English statesman Robert Harley was created earl of Oxford (*q.v.*); but the title became extinct in this family on the death of the 6th earl in 1853. It was revived in favour of H. H. Asquith who became earl of Oxford and Asquith (*q.v.*).

OXFORD, EDWARD DE VERE, 17TH EARL OF, in the Vere line (1550–1604), won a considerable reputation as a lyric poet and dramatist, though most of his work was probably anonymous. He was born on April 12, 1550, at Castle Hedingham, Essex, and studied at Queens' and St. John's colleges, Cambridge. Succeeding to the earldom as a minor in 1562, he lived for eight years as a royal ward under the care of William Cecil (later Lord Burghley). In Dec. 1571 he married Burghley's daughter. Ann Cecil. He visited the Netherlands in 1574 and France and Italy in 1575–76. On his return he became estranged from his wife and Burghley until 1582. In 1579 he quarreled with Sir Philip Sidney, who challenged him and fell into disgrace for refusing to apologize as Queen Elizabeth I commanded. In 1581 Oxford himself fell into disgrace, but was restored to favour in 1583. By then his financial position had become very straitened. perhaps chiefly through his lack of financial sense. His younger children were provided for by Burghley. with whom he remained friendly even after Ann's death (June 1588) and his own remarriage in 1591 or 1592. In 1586 the queen granted him an annuity of £1,000, which he enjoyed for the remainder of his life. He died at Newington, Middlesex, on June 24, 1604.

He was never appointed to any important office or command, though he was named on the commissions for the trials of Mary, queen of Scots (1586), the earl of Arundel (1589) and the earls of Essex and Southampton (1601); and was said to have been made a privy councilor by James I. It has therefore been suggested that the annuity may have been granted for his services in maintaining the company of actors which he had taken over from the earl of Warwick in 1580; and that the obscurity of his later life is to be explained by his immersion in literary pursuits. He was indeed a notable patron of writers. He employed John Lyly, the author of *Euphues,* as his secretary for many years. Along with Francis Bacon, Christopher Marlowe, the jth earl of Rutland. the 6th earl of Derby and others. Oxford has been seen as the putative author of Shakespeare's works (see SHAKESPEARE, WILLIAM).

His poems were collected from various Elizabethan anthologies by A. B. Grosart, vol. iv of Fuller Worthies Library (Edinburgh, 1876). *See* also B. *M*. Ward, *The 17th Earl of Oxford* (London, 1928); J. T. Looney, *Shakespeare Identified in Edward de Vere* (London, 1920). (R. B. WM.)

OXFORD, JOHN DE VERE, 13TH EARL OF (1443–1513), was second son of John, the 12th earl, a prominent Lancastrian, who, with his eldest son Aubrey de Vere, was executed in February 1462. John de Vere the younger was himself attainted, but two years later was restored as 13th earl. But his loyalty was suspected, and for a short time in 1468 he was in the Tower. He sided with Warwick, the king-maker, in 1469, accompanied him in his exile next year, and assisted in the Lancastrian restoration of 1470–1471. As constable he tried John Tiptoft, earl of Worcester, who had condemned his father nine years before. At the battle of Barnet, Oxford was victorious in command of the Lancastrian right, but was ultimately defeated and escaped to France. In 1473 he organized a Lancastrian expedition, which, after an attempted landing in Essex, seized St. Michael's Mount in Cornwall. After a four months' siege Oxford was forced to surrender in Feb. 1474. He was sent to Hammes near Calais, whence, ten years later, in Aug. 1484, he escaped and joined Henry Tudor in Brittany. He fought for Henry at Bosworth, and was rewarded by restoration to his title, estates and hereditary office of Lord Chamberlain. At Stoke on June 16, 1486, he led the van of the royal army. In 1492 he commanded the expedition to Flanders, and in 1497 was foremost in the defeat of the Cornish rebels on Blackheath. Oxford was high steward at the trial of the earl of Warwick, and one of the commissioners for the trial of Sir James Tyrell and others in May 1502. He died March 10, 1513.

See *The Paston Letters,* ed. *J.* Gairdner; *Chronicles* of *London,* ed *C. L.* Kingsford (1905); Sir James Ramsay, *Lancaster and York,* and *The Political History of England,* vols. iv and v. (1906).

OXFORD, ROBERT DE VERE, 9th Earl of (1362–1392), English courtier, was the oniy son of Thomas de Vere, 8th earl of Oxford, and Maud de Ufford, a descendant of King Henry III. He became 9th earl of Oxford in 1371, and married Philippa (d.

1412), daughter of his guardian Ingelram de Couci, earl of Bedford. a son-in-lam of Edward III. Already hereditary great chamberlain of England, Oxford was made under Richard 11. a member of the privy council and a Knight of the Garter; while castles and lands were bestowed upon him, and he was constantly in the company of the young king. In 1385 Richard sent him to govern Ireland, but although preparations were made for his journey he did not leave England. The king's partiality for Oxford was one of the causes of the dissatisfaction of the barons. Oxford also made powerful enemies by divorcing his wife, Philippa, and by marrying a Bohemian lady.

The king, however, indifferent to the gathering storm; created Vere duke of Ireland in Oct. 1386, and gave him still more powers in that country. Richard was deprived of his authority for a short time. and Vere was ordered in vain to proceed to Ireland. He was then accused by the king's uncle Thomas of Woodstock, duke of Gloucester. and his supporters in 138;; and rushing into the north of England he gathered an army to defend his royal master and himself. At Radcot bridge in Oxfordshire, however. his men fled before Gloucester's troops and Oxford himself escaped in disguise to the Netherlands. In the parliament of 1388 he was found guilty of treason and condemned to death, but as he remained abroad the sentence was never carried out. With another exile, Michael de la Pole. duke of Suffolk. he lived in Paris until after the treaty between England and France in 1389, when he took refuge at Louvain. He was killed by a boar whilst hunting, and left no children.

See T. Walsingham, *Historia Anglicana,* edited by H. T. Riley (London, 1863–64); J. Froissart, *Chroniques,* edited by S. Luce and G. Raynaud (Paris. 1869–97); H. Wallon, *Richard II.* (Paris, 1864); and W. Stubbs, *Constitutional History,* vol. ii. (Oxford, 1896).

OXFORD (properly OXFORD AND MORTIMER). **ROBERT HARLEY,** 1ST EARL OF, (1661–1724), English statesman, eldest son of Sir Edward Harley (1624–1700), a Herefordshire landowner. who opposed legislation against nonconformists in the parliaments of Charles II. Bred in the atmosphere of political and religious opposition to the established order, Harley eventually changed his political connections. but never abandoned his early Presbyterian piety. In 1683 he and his father occupied Worcester in the interest of William III. Harley was made sheriff of Herefordshire in 1689, entered parliament for Tregony, 1689–90, and sat for New Radnor, 1690–1711.

Harley owed much of his electoral influence to political and marriage connections with the Foley family, founded by a celebrated Worcestershire ironmaster. and deeply rooted in the counties of Stafford, Hereford and Worcester. In parliament he combined with Paul Foley to maintain the "country" traditions of the Harleys, directing his group of 10 to 20 members in attacks on the weight and misapplication of taxes, the influence of placemen (*i.e.,* those holding office under the crown) in parliament, the suspension of habeas corpus, the ruin of trade, and demanding that privy councillors must sign any advice given to the king and so make it possible that they could be impeached successfully. By 1693 Harley and his father were recognized as leaders of the new country party. and in 1694 he introduced the Triennial bill.

Unable to stem this combined opposition of Whigs and Tories, the Danby ministry (see LEEDS, THOMAS OSBORNE, *1st earl of*) was gradually supplanted by the Whig Junto (a small group of powerful Whigs who directed policy), but the Foley-Harley group, despite its former Whig connections, was not now amenable to court measures and in 1695, supported by a solid Worcestershire and Herefordshire vote, carried Foley's election as speaker against the government candidate. In 1696 their influence was again underlined when Harley and Foley headed the ballot for the powerful commission of accounts, and it was Harley who by family background was fitted to establish links with the Tories. Until the fall of the Junto in 1698 Harley continued in constant opposition; with Foley he promoted the Land Bank act in 1696 and, after the peace of Ryswick (1697), carried reductions in the army in 1697 and 1695.

Much remains obscure about the years 1698 to 1702 which saw Harley converted from a country to a court politician. But his manoeuvres were not without consistency, for to him as to his later colleague Bolingbroke (*q.v.*) the Revolution seemed final. To defend this settlement he sought to wean the country Tories from their high-flying leaders. and also to thwart what he regarded as the king's campaign against the ancient constitution. His great victory in this struggle came in 1700 with the passing of the Forfeitures bill. In the summer of 1700 the government was compelled to seek support from Harley's opposition, and in 1701 he was elected speaker as a ministerial candidate. The deaths of Foley (1699) and Sir Edward Harley (1700) further weakened his ties with the opposition. Nevertheless the constitutional clauses of the Act of Settlement (1701) which he helped to carry embodied the doctrines he had always proclaimed.

From 1702 the policies of Anne proved decisive for Harley and his political following. The central knot of Anne's government till 1708 consisted of Marlborough and Sidney Godolphin (*q.v.*), court politicians both. and Harley, a leader of the country party and master of parliamentary procedure and still determined to keep royal government free from the party managers whether Whig or high church. On these three the conduct of the War of the Spanish Succession (*q.v.*) in the field: in finance and in the lobby, largely depended, and of the three. Harley became the favourite with Anne, herself resolved to avoid the shackles of party. The high Tories expected to come into their own in the new reign but had to accept the triumvirate of nonparty men in influential places; finding that the three usually settled important business together, that the main war effort was to be on the continent, and that centre politics triumphed in the government even against the project of an Occasional Conformity bill. they resigned, and met disaster in opposing the ministry at the election of 1705. Harley meanwhile had become northern secretary of state (1704) and turned the influence of the Whig duke of Newcastle and the propaganda of Daniel Defoe (*q.v.*) to electoral profit.

Soon after the election, however,, friction developed between Harley and Godolphin. The latter had been an especial butt of Tory propaganda. and now looked for protection from the Whig Junto; moreover. since the court party was in a minority. he argued that support must come from one of the party corps. that is. in the circumstances, from the Whig Junto. Knowing that the queen supported his traditional policy. Harley replied that the known determination of the queen to remain above party would rally sufficient support for the government from court and independent country members. for the party corps were also minority groups. Godolphin and Marlborough had now come to distrust both Harley's intrigues in the house. and his success in displacing the duchess of Marlborough in Anne's affections by his cousin, Abigail Masham, and, defeated on a war issue by Tory votes, they insisted on the resignation of Harley and his friends in Feb. 1708. Harley, already widely distrusted as an intriguer. was now thrust into an alliance with the Tories, evidenced by his willingness to support William Bromley for the speakership. His policy now was to rely on the queen's favour, and to exploit her detestation of the new ministers forced on her, the animosities of the ministers among themselves and their blunders in domestic and foreign affairs.

In 1710 Anne restored Harley to office as chancellor of the exchequer at the head of another coalition. Although he secured a great majority at the general election his new ministry was more radically Tory than Harley wished. He now reached the peak of his career, and after surviving a murderous assault by the Marquis de Guiscard, a French spy who had been arrested and was being interrogated at a privy council meeting, was raised to the peerage and made lord treasurer and knight of the garter in 1711. By funding the most pressing portion of the national debt in the South Sea company stock (1711), and by securing a reasonable peace at Utrecht (1713), Oxford dealt with two crucial issues. but was now threatened by the intrigues of his protégé and colleague, Bolingbroke. Avid for power, Bolingbroke, like Godolphin earlier, could argue the need for an alliance with a party, and the Schism act (1714), abolishing the dissenting academies in one of which Oxford himself had been educated, was his pledge to the Tory high-fliers. The struggle between them became the more desperate! for both had been discountenanced by George, the Hanoverian heir to the throne, for making peace at Utrecht; both engaged in treasonable correspondence with the pretender, with whom the relations of both were shattered by his refusal to change or dissemble his religion, finally announced in March 1714. Oxford, now preoccupied with nepotism. was in physical and mental decline. but Anne stubbornly kept him in office till July 27, 1714, five days before her death.

Permanently exiled from power by the Hanoverian succession. Oxford was imprisoned in 1715; an impeachment, among the managers of which was his Herefordshire enemy Lord Coningsby, collapsed in 1717 because of differences between the two houses and within the Whig party itself, but Oxford played no further part of importance in parliamentary politics or Jacobite conspiracy.

Oxford formed a great library and collection of manuscripts. both of which were enlarged by the second earl. In 1753 the manuscripts were bought by the nation to form the Harleian collection in the British Museum.

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(W. R. Wd.)

OXFORD, the county town of Oxfordshire. Eng., a municipal and parliamentary borough, cathedral city, and seat of an ancient university, on the Thames river, is 55 mi. W.N.W. of London by road. Pop. (1951) 98,684. Area 13.2 sq.mi. The Thames is navigable past Oxford and there is a canal to the Avon valley and Birmingham.

The site of Oxford is a low gravel terrace between the upper Thames and its tributary, the Cherwell, which meet in wide water meadows within a gap in a line of oolitic plateaus represented by Headington hill on the east and the twin crests of Cumnor Hurst and Wytham on the west. There was stray prehistoric and Roman habitation on the gravel patches on which Oxford later grew up. and the Roman road from Dorchester to Alchester and the Watling street crossed Headington hill. Some pagan Saxon burials have been found at Summertown and Osney, but Oxford as a town did not exist until the 9th century. There is evidence of various kinds. both documentary and archaeological, concerning late Saxon Oxford. which by the time of the Domesday survey was one of the principal towns in the country and had already been styled *civitas* on its 10th-century coins.

The present street system, which was largely in existence by the 13th century, centres on Carfax (Lat. *quadrifurcus*, French *carrefour*, meaning four forks, or crossroads). Eastward of it the High street crosses the Cherwell by Magdalen bridge, and offers alternative routes to London via Headington or Littlemore; southward St. Aldate's. formerly Fish street, crosses the Thames (Isis) at Folly bridge, for Abingdon and Newbury; northward, by Cornmarket, are the roads to Banbury and Woodstock; westward from Queen street, Castle street leads round the south side of the Norman castle to Quaking bridge, over the mediaeval mill stream toward Osney, while New road (1772), north of the castle, leads direct to the railway station and Botley road for the upper Thames, and southwest England.

Oxford first appears in history when Edward the Elder, in A.D. 912 "held Lundenbyrg (London) and Oxnaford and all the lands that were pertaining thereto." From the 10th century Oxford and the parallel *burgh* at Wallingford became the trading centres of the upper Thames, district. though there were important earlier ecclesiastical foundations at Xbingdon and Dorchester, the latter the seat of a bishopric as early as 635. Abingdon abbey was, indeed. important enough in pre-Conquest times for its abbot to exact tolls on river traffic to and from Oxford. The town was several times attacked by the Danes during the 10th and 11th centuries and "councils" or "national assemblies" were held there by Canute and Harold I (1036 and 1065).

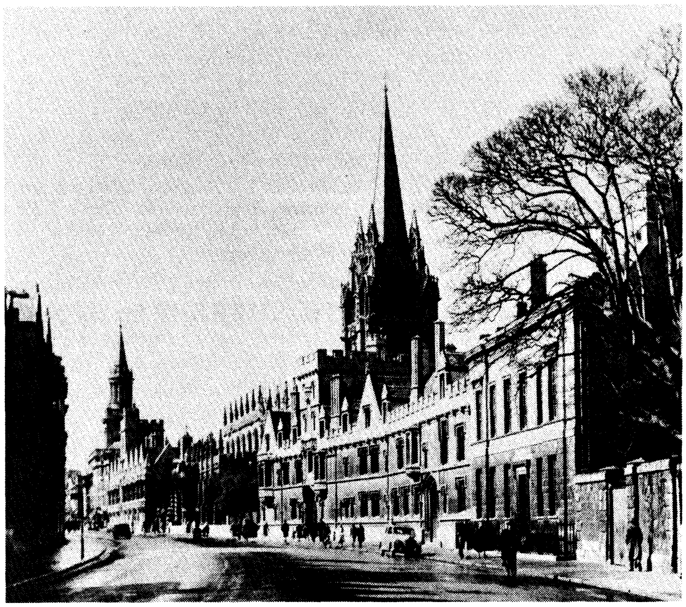
The Norman governor. Robert d'Oyly, built a castle at the west end of the town, destroying some houses in the process (as recent excavations have proved). Within its precincts he founded the collegiate church of St. George. His work is now represented by the Mound on which there was originally a wooden tower, later replaced by a stone shell keep: a stone wall-tower and the crypt of St. George's chapel are now incorporated in the prison.

Other early buildings are St. Michael-at-the-north-gate church, which still retains its Saxon tower, and the churches of St. Frideswide (now Christ Church cathedral) and St. Peter-in-the-east, where good Norman building construction can be seen. Robert d'Oyly's son Robert founded the once-splendid Osney abbey, beyond the castle. Outside the city. north of Gloucester green, Henry I built his Beaumont palace overlooking Osney and Port meadow. and under his rule, according to a dubious legend, Theobald of Etampes already, about 1120, was teaching "60 to 100 clerks." As residence of Empress Queen Maud. Oxford suffered siege by Stephen. Until the later 12th century it appears to have been enclosed only by earthen and wooden defenses. The existing mediaeval walls, with their half-round projecting towers, of which fine portions can be seen in New college and on the north side of Christ Church meadow, are largely a work of the 13th century but constantly repaired in later times. While domestic business was conducted between the Cornmarket and the High within the walls, the wool fair and strangers' market outside the north gate had, about 1200. a church of St. Giles. Beyond it lay a hospital. and east of it other establishments mainly for strangers, the Scots college of John de Balliol. Durham college (afterward Trinity), a Cistercian house of St. Bernard's (afterward St. John's college); and, when Beaumont palace was granted by Edward II to the Carmelites. the Benedictines occupied the site they had left. building the older "cottages" of Gloucester hall. later to become Worcester college. Other Cistercians built Rewley abbey beyond Hythe bridge; Dominican and Franciscan houses in the poorer southwest quarter leave their names in Blackfriar street. Preacher's bridge and Friars wharf; and the Austin canons of St. Frideswide added the Latin chapel to their church. On the site of Magdalen college there was the hospital of St. John the Baptist, and farther east the leper hospital of St. Bartholomew.

In the area occupied by the Bodleian library and the Radcliffe camera. "School street" traversed a kind of "Latin quarter" frequented by wandering scholars, whose *universitas* or guild came into history with the visit of Giraldus Cambrensis in 1185. and the mention of a chancellor in 1214. *(See* Oxford University.) On the south frontage of this resort of scholars. St. Mary's church was used for faculty meetings. degree ceremonies and university sermons (though lectures were given in hired halls); its bell tower and spire, congregation house and library were built between 1280 and 1320; a new nave and aisles were rebuilt by the university in about 1490; and the Renaissance porch marks Archbishop William Laud's reconstitution of the university, and long dated "in *parviso*" the certificates of satisfactory "responsions" of novices to the "masters of the schools" who controlled their admittance. For the history of this university and the several fortunes of its colleges, *see* below.

The 13th century was the great age of mediaeval Oxford. Several parliaments were held there, notably the "Mad Parliament" of 1258, with its Provisions of Oxford. But the growth and privileges of the university restricted the normal development of the mediaeval borough, with its trade and craft guilds; and in any case, Oxford was in a state of economic decline from the 13th to the 16th century. The liberties of the university, in relation with the city, were defined by charter in 1248, and revised in favour of the "chancellor, masters and scholars," after the town-and-gown riots of St. Scholastica's day, 1355, and other occasions; from the 14th century the university was even allowed to incorporate certain kinds of tradesmen, exempting them from civic jurisdiction. These unusual but once necessary provisions were only revoked or became obsolete with the modern transformation of the university students, a censorship of public entertainments, and direct representation on the city council.

The Renaissance and the Reformation affected Oxford mainly



BY COURTESY OF BRITISH TRAVEL ASSOCIATION PHOTO

HIGH STREET. THE MAIN THOROUGHFARE. OXFORD. IN THE CENTRE RISES THE SPIRE OF ST. MARY'S, THE "UNIVERSITY CHURCH"

through academic controversies. the foundation of a fresh series of colleges, and the creation by Henry VIII of a bishopric. with St. Frideswide's church as its cathedral, and a chapter. the dean and canons of Christ Church. economized out of Wolsey's "Cardinal college." But in the Great Rebellion, Oxford's strategical importance made it the royalist headquarters. The king retired hither after defeats at Edgehill. Newbury and Naseby; Prince Rupert made hence his raids in 1643. Not till May 1644 was the king forced by the concerted advances of the earl of Essex and Sir William Waller to evacuate this fortress and after the battle of Cropredy Bridge he re-occupied it. Only in May 1646, when all other strongholds were lost and Charles himseli had escaped in disguise, was Oxford besieged by Lord Fairfax and surrendered on June 24. Temporary fortifications were built at this time well outside the mediaeval walls. and traces of these may still be seen in the King's Mound area. Though the university was mainly royalist. the citizens had been secretly parliamentarian; on both sides were losses, and party feelings were disastrous; and though Oliver Cromwell himself was chancellor (1651–57), his successor, Gilbert Sheldon, had much work to restore efficiency; his monument is the Sheldonian theatre, for the business and ceremonies of the reconciled masters; the Clarendon building (now the administrative headquarters of the university), and the Old Ashmolean museum. Christ Church library and Peckwater quadrangle, large additions to New college, All Souls and Magdalen, and the total rebuilding of Queen's college, are academic counterpart to a general rebuilding of mediaeval and Tudor Oxford in the next century. Though Charles II held a parliament here in 1681, the restored Stuarts temporarily alienated university loyalty, but in the 18th century the university became Jacobite, and the city Hanoverian. This feud, however, was reconciled at the visit of George III in 1785, and Oxford passed out of national politics.

The city grew slowly. In 1801 at the first census, there were only 12.000 inhabitants and by 1851 the population was 27,000. Soon after, in 1858. dons were first allowed to marry though they had to live within $1\frac{1}{2}$ mi. from Carfax. (This limit was later in part abolished and in part extended to 43 mi.). Industry nearly reached the city in 1865 when the Great Western railway proposed building a carriage and wagon works at Oxford. Violent opposition from the university prevented this. Nevertheless by 1901 the population had reached nearly 50,000. The presence in Oxford of good schools and the amenities of social life attracted a considerable immigrant population not connected with the university or any local industry. But the city still covered a comparatively small area in a wholly rural neighbourhood. The 20th century has seen a great change. The popuiation in 1951 was 98,684 and the villages of Headington, Marston, Wolvercote and Littlemore had all become dormitory suburbs. What was the village of Comley is now a great industrial excrescence, in which in 1955 about 15,000 persons were employed. Wytham alone, which forms part of an agricultural and woodland estate of 2,500 ac., within 1 mi. of Carfax, acquired by the university since World War II to be preserved forever as an agricultural estate, has escaped urban development. Illustrative of the rapid urbanization during the 20th century is the average number of vehicles which daily cross Magdalen bridge, estimated in 1954 at over 41,000. Practically all this traffic traverses the High street which divides into two nearly equal portions the area about 900 yd. wide at its widest point and 893 yd. long between Magdalen bridge and Carfax. This area contains nearly all the architecturally and historically important university and college buildings.

The buildings in that area are in themselves a compendium of the history of architecture in England. though among the university and college buildings there are only two surviving specimens of an earlier style than Perpendicular — the chapel and part of Mob quad at Merton and the Old Congregation house which is really part of the church of St. Mary the Virgin. The oldest building in Oxford which is still in use is the tower of St. Michael's at the North gate. This tower was originally part of the military defenses of the North gate. The rest of the church. which was of later date than the tower, was largely destroyed by what was almost certainly an incendiary fire in 1954, but the tower which dates from Saxon times was uninjured. Some traces of work contemporary with St. Michael's remain in the Lady chapel in the cathedral. From that time on, building has been continuous. The development of style may be traced in single buildings. In the cathedral, the east end was begun about 1150 in the massive Norman style, the 14th-century Lady chapel is in the Early English style and the 14th-century Latin chapel in the Decorated. Each successive generation of masons has built according to its own ideas, and the resulting variety is a large part of the charm of Oxford. Changes of style (such as the use of buttresses to ensure the stability of roofs which allowed the windows of the Divinity school, built in about 1480, to occupy almost the whole of the wall space) were in the earliest days mainly a reflection of more accurate knowledge of the mechanics of building and of improved tools: and they were in consequence gradual. Nevertheless the Gothic style was used continuously down to the late 17th century. In that century, with the introduction of the Palladian style as a conscious imitation of Italian architecture, and much more markedly in the 20th century, changes have been more revolutionary. The most recent architects have therefore rightly aimed. more than their predecessors did, at making their buildings harmonize with their neighbours. Consequently, the most modern buildings — the New Bodleian built in 1940, and Nuffield college which was designed in 1939 but not begun until 1949, and several of the new laboratories — have not departed from traditional styles enough to be rated as typical examples of modern English architecture: moreover, the influence of the layman probably affects the design of buildings more in a university than it does elsewhere. Unhappily, one of the periods of great building activity in Oxford was the middle of the 19th century, so that Oxford got more than its fair share of Victorian Gothic. The University museum in Parks road which was built in 1860 and Keble college just opposite, built in 1870, are the major buildings in this style. They were, nevertheless, the products of architects of taste and skill and are, at worst, noble buildings in a bad style. But the villas built along the Banbury and Woodstock roads for the early married dons, being mostly designed by inferior architects, are inferior buildings in that style. Their ugliness is redeemed in spring and summer by a profusion of trees and flowering shrubs. The growth of residential Oxford started just too late to catch the pleasant domestic architecture of the Regency.

Those buildings erected before the middle of the 14th century which survive are almost all churches. or parts of churches which, like the cathedral, are embodied in college buildings. The first college chapel to be built was Merton, the choir of which at the end of the 13th century replaced the original parish church of

St. John's, the transepts being begun later and finished about 1424; the projected nave was never built. A T-shaped plan was also adopted in other college chapels, which consist of a choir and an ante-chapel in the form of a diminutive nave.

The first college quadrangle to be built was the front quadrangle of New college, which mas completed in about 1386 though the top story was not added until the 17th century. No doubt the intention was to protect the scholars from being disturbed by noises other than those of their own making, and to seclude them from the population of the city. The general arrangement otherwise folloned the pattern of domestic architecture with rooms on each side of a central staircase. At Magdalen, cloisters connected the staircases with one another and with the hall and chapel. Similar cloisters were planned but never built at Christ Church. But this pattern was not generally followed except partially at Queen's and Worcester. Lincoln and All Souls followed New college in the same century and adopted a similar plan mhich thus became the pattern for all the colleges in Oxford. except Worcester, which took over the monastic "mansiones" of the earlier Gloucester college, the more conventional college staircases which now face them, being added in the 18th century. The quadrangular pattern, however, was not followed in the back quadrangle of All Souls or the front one at Queen's or at Nuffield college. St. Antony's, founded in 1948, acquired an Anglican nunnery. In 1878 Lady Margaret hall, the first of the women's colleges, mas founded. to be followed the next year by Somerville hall (later Somerville college). By 1956 there were five colleges for women in Oxford.

For information about the colleges and the university *see* OXFORD UNIVERSITY. (D. \.,

OXFORD, a university town of Butler county in southwestern Ohio, C.S.. is about 30 mi. N.N.W. of Cincinnati, near the Indiana border. It is the seat of Miami university, a state-supported institution of higher learning. chartered in 1809 and opened in 1824. Oxford College for Women (1830) was consolidated with Miami in 1928. Western College for Women, a private, nonsectarian institution founded in 1853. is also there. The town was laid out in 1810 and chartered in 1830. For comparative population figures see table in OHIO: Population.

OXFORD, PROVISIONS OF, the articles constituting a preliminary scheme of reform enacted by a parliament which met at Oxford on June 11, 1258. The term was also used by contemporaries to indicate the whole baronial program including the administrative reforms known otherwise as the Provisions of Westminster of 1259. King Henry III had promised on May 2 that the state of his realm should he rectified and reformed by 24 counsellors who were to meet at Oxford for this purpose five weeks later. Twelve of these counsellors were chosen by the king. and 12 by the earls and barons. When the parliament met the 24 drew up a provisional scheme of reform, later known as the Provisions of Oxford. By this it was arranged that a council of 15, chosen by four of the 24, should be appointed to advise the king in all matters. The new council was to meet three times a year in parliaments to which 12 commissioners were to be summoned to discuss the affairs of the realm on behalf of the whole community. Another body of 24 was appointed to consider granting an aid. Desiring to limit the power of the king and his household officers, the barons determined to revive the justiciarship, in abeyance since 1234. But they did not want over-powerful great officials. It was therefore decided that one or two justiciars should be appointed for one year who should be paid. but should be accountable at the end of the year. The chancellor and treasurer similarly had to account; the sheriffs, too, were appointed for one year only. Inquiries into abuses were begun and further reforms were to be reported on by Christmas. The king declared his adhesion to the Provisions on Oct. 18.

Disputes broke out in the baronial party. Simon de Montfort, earl of Leicester, supported by Edward. the king's son. demanded the logical extension of the reforms in local government to include the baronial franchises. The earl of Gloucester opposed this. Forced by Edward, a second series of provisions, known as the Provisions of Westminster, was issued in Oct. 1259. The quarrels among the barons encouraged Henry to break free. On April 13, 1261. a papal bull absolved him from his oath to observe the Provisions. After three years on the verge of civil war, both parties agreed to refer the question to the arbitration of Louis I S of France, who formally annulled them on Jan. 23. 1264. hut expressly declared that his decision was not to invalidate the privileges, liberties and laudable customs of the realm of England, which had existed before the time of the provisions.

See E. F. Jacob, *Studies in the Period oj Baronial Reform and Rebellion* (Oxford, 1925); R. F. Treharne, *The Baronial Plan of Reform, 1258–63* (Manchester, 1932); N. Denholm-Young, "Documents of the Barons' Wars" in *Collected Papers* (Oxford. 1946).

(N. D.-Y.: X.)

OXFORD AND ASQUITH, HERBERT HENRY ASQUITH, 1ST EARL OF (1852–1928), who as prime minister headed the first coalition ministry in World War I, was born, at Morley, Yorkshire, on Sept. 12, 1852. His origins were Liberal, Nonconformist and middle class in character. Joseph Dixon Asquith, his father, owned a cloth manufacturing business in Morley, and his mother was the daughter of William Willans, a Huddersfield merchant. His father died while he and his brother (who afterward became a master at Clifton) and his sister were children. and the two boys were left in the care of an uncle in London, where they went to the City of London school. then under the able headmastership of Dr. Edmin Abbott. Upon him Asquith made a deep impression, and to him Asquith later in life was accustomed to express a great debt of gratitude. He won a Balliol scholarship, and at Oxford he took a Craven university scholarship and firsts in "Mods" and "Greats" and became president of the Union and a fellow of his college.

Early Career. — Adopting the bar as a profession, he first attracted public notice by his defense of R. B. Cunninghame Graham and John Burns for their part in the riot in Trafalgar square (Nov. 1887), but it was his deadly cross-examination of the manager of the *Times* before the Parnell commission in 1889, when he acted as junior to Sir Charles Russell, that established his legal reputation. In the next year he took silk, but the law was only a steppingstone to the political career that from boyhood he had always had in view. He had entered parliament as member for East Fife in 1856, and on the formation of the Gladstone government in 1892 he was appointed home secretary. He had just previously sustained a heavy domestic blow by the death of his wife, Helen. the daughter of a Manchester surgeon, whom he had married in 1877. In office Asquith's great parliamentary gifts were at once apparent. and his administration of the home office was made memorable by the appointment of the first women inspectors, improvements in the administration of the Factory acts, the introduction of the Employers' Liability bill. which mas rejected by the Lords, and the introduction of a Factory bill which became law. In 1893 he was bitterly and most unjustly attacked in connection with the shooting of two miners by soldiers who were called in to deal with a strike at the Featherstone colliery. He did not summon the soldiers and appointed a commission immediately to inquire into the affair, but for years his platform appearances were always greeted with cries of "Featherstone."

In 1894 Asquith married a second time, his bride being the brilliant Margaret ("Margot") Tennant, one of the daughters of the wealthy ironmaster. Sir Charles Tennant. She was a prominent member of the most exclusive society circle, and the marriage very definitely changed the current of Asquith's social life and in some measure affected his political relationships. The period was one of great disruption within the Liberal party. The feud between the Lord Rosebery and the Sir William Harcourt groups was at its height, and after the fall of the Liberal government in 1895, the conflict with the Boer republics divided the party into two hostile camps, the Liberal Imperialists, led by Lord Rosebery, and the pro-Boers, led by Henry Campbell-Bannerman. Asquith. who had returned to the bar, associated himself with the Rosebery group, which endorsed the Chamberlain policy. In this he was influenced, no doubt, by his confidence in Sir Alfred Milner, who had been his friend from his Balliol days, and who had become the instrument of British policy in South Africa. When the Boer controversy culminated in war. it seemed that the quarrel between the Rosebery and Camphell-Bannerman factions must result in permanent separation, and the formation of the Liberal league, of which Lord Rosebery was president and Asquith vice-president, apparently put reconciliation out of the question.

From this catastrophe the Liberal party was saved by the raising of the tariff reform issue. On this subject Lord Rosebery spoke with an equivocal voice, but Asquith at once became the most formidable protagonist of free trade. The discussion of the subject became largely a duel between him and Joseph Chamberlain, and the series of speeches he delivered throughout the country was among the most conspicuous triumphs of his career. It restored him to the full confidence of the party, and when Campbell-Bannerman formed his government at the end of 1905 Asquith's appointment as chancellor of the exchequer was a matter of course. The moderation of his temper and the entirely public-spirited motives that always inspired him contributed to the return of harmony within the party. and his achievements as chancellor established his claim to the succession to the premiership. His record at the treasury. culminating in his final budget. which inaugurated old age pensions, gave him a place among the most illustrious chancellors in history.

Prime Minister.—On the resignation of Campbell-Bannerman through illness in 1908, Xsquith became prime minister. with David Lloyd George as chancellor of the exchequer. No prime minister since Pitt had been called upon to face such grave issues as those which confronted Asquith at the beginning and developed as his long term of office—the longest of any prime minister since Lord Liverpool—advanced. A new mood of revolt filled the labour world with unrest and menace, the long struggle for the enfranchisement of women had passed out of the academic phase into a phase of unprecedented and almost fantastic violence. the sky over Europe was visibly darkening with the naval activity of Germany and over and above all two capital issues reached a crisis—the issue of the house of lords and the issue of Ireland. It was the former of these two questions that first tested the stuff of which the new prime minister was made. The budget of 1909, which dealt with the taxation of land, was rejected by the house of lords. Asquith appealed to the country against its rejection in Jan. 1910, and his government was reinstated, though only with the support of Labour and the Irish members. He addressed himself forthwith to the question of the abolition of the veto of the house of lords. and during the summer made efforts to reach a pacific solution of the question by compromise. But the conference with the opposition leaders broke down, and in the following December he appealed once more to the country and was once more returned—this time with a majority of 126 over the opposition.

Passing of the Parliament Act.—The opening of the session of 1911 may be taken as the crowning moment in Asquith's public career. The decisive mandate which the country had given in December dictated the issue that immediately occupied the new parliament. A bill abolishing the veto of the house of lords was introduced into the house of commons and passed all its stages by the beginning of the summer. But the battle had still to be won in the lords and the opposition were entrenched in overwhelming power there. Ever since the emergence of the issue it had been evident that the attainment of Asquith's goal depended on whether he could in the last resort invoke the authority of the crown to dilute the house of lords with sufficient new peers to change its complexion. The question was answered on July 20. The Parliament bill! then in the house of lords undergoing its second reading, was so amended as to deprive it of any utility for the purpose for which it was framed. Asquith therefore addressed to A.·J. Balfour, the leader of the opposition, a letter stating that the government had decided that if the bill in its essential form could be passed in no other way, the crown would be advised to create a sufficient number of peers to ensure its passage, and that the crown had signified its willingness to accept such advice.

The publication of this letter aroused an unprecedented storm, and on July 24, on rising in the house of commons to make a statement. Asquith was greeted with a demonstration without parallel in living memory. For the best part of an hour he stood speechless before the roar of anger that issued from the opposition benches and at last resumed his seat without having uttered a continuous sentence. What became known as "the pothouse brawl" inaugurated the last stage of the struggle. The government was accused of "dragging in the king." and the opposition organized an uncompromising resistance in the belief that they would not dare to carry their threat into execution. But on Aug. 10. when the final debate was taking place in the house of lords, Lord Morley confirmed the government's previous intimation of his majesty's intention. Up to this point the "die-hards" seemed to he assured of a majority. but in the division they were defeated and the bill was passed. On Aug. 18 the Parliament act received the royal assent.

Home Rule.—From this victory Asquith proceeded to his next great task, with the ground sensibly cleared for action. Gladstone's successive Home Rule adventures had broken on the rock of the lords' veto; that rock no longer obstructed the channel. But before the Irish issue was fully launched another controversy absorbed the prime minister's activities. Discontent had long been growing in the mining industry, and at the end of Feb. 1912 the miners' union declared a strike. Vast dislocation followed. From the outset the government endeavoured to bring the conflicting parties to agreement, and Asquith took personal charge of the negotiations. After a month the government introduced the Miners' Minimum Wage bill. which. by providing a halfway solution, forced the hands of both sides and brought the immediate struggle to an end, although the issue incidentally raised—that of the reorganization and control of the coal industry—was to perplex parliament and the country for many years to come.

Meanwhile, the Home Rule bill had been introduced and passed through the house of commons, while the Parliament act provided adequately against the resistance of the house of lords. That house fought the delaying action, which was all the opposition now had in its power. by rejecting the bill in two successive sessions. After its next passage through the commons it would have overridden opposition and automatically become law. By this time, however. the opposition to the measure had taken an extra-parliamentary shape. The Ulster covenant had been promulgated in the previous September and talk of open rebellion, should the Home Rule bill be passed. was already current. In June arms had been discovered both at Belfast and Dublin. As the year wore on the outlook became still more serious. and a speech by A. Bonar Lam. the leader of the Conservative party. at Blenheim. seemed to give encouragement to the idea of resistance by force. On Sept. 2j the Ulster Unionist council appointed a provisional government and prominent Conservatives openly preached armed resistance; Sir Edward Carson, the leader of the Ulster Unionists, left no doubt that in the last resort Ulster would fight.

With the close of the session of 1913 there came a brief lull, and during the recess conversations with the opposition leaders were opened by Asquith, who throughout preserved an attitude of patience andforbearance. It will always be matter for controversy whether, when the policy of violent resistance had been adopted, he was justified in ignoring so direct a challenge to constitutional government. His natural disposition was to allow the utmost scope for the play of discussion and the influence of the time element; but it is an open secret that he would have taken up the challenge but for the persuasions of John Redtnond. leader of the Irish Nationalists. who believed that prosecution of the Ulster leaders would prejudice the prospects of friendly relations with Ulster when Home Rule was actually on the statute book. In any case, the conversations of the autumn were futile, and on March 9. 1914, the government announced the provisions of their amending bill, their last word of compromise. The chief provision was that any county in the north of Ireland was to be allowed to vote itself out of the operation of Home Rule for five years.

The offer was rejected by the opposition and events rushed forward to an apparently unavoidable catastrophe. On the night of April 24–25, 55,000 rifles were landed at Larne from a German port for the use of the Ulster army. On the other side of the border the nationalists were beginning to enroll a volunteer army and to make counterpreparations. Meanwhile, a more sinister menace appeared. In the debate on the vote of censure on the government on March 19, Bonar Law, speaking on the Home Rule issue, had used the ominous phrase "soldiers are citizens like the rest of us." There had been much talk of disaffection in the army in regard to the coercion of Ulster. and on March 20 it took shape in the Curragh incident (*see* IRELAND, REPUBLIC OF; IRELAND, NORTHERN), which led to the resignation of Col. J. E. B. Seely (afterward Lord Mottistone), the secretary for war. For a moment it seemed that the loyalty of the army was imperiled and the situation looked desperate. But the announcement by Asquith the next day that he would assume the secretaryship for war created a profound impression in parliament and stopped for the time being. at all events. what had seemed like a revolt in the army. Following the mutilation of the amending bill by the house of lords and Sir Edward Carson's challenge to the government to "give us a clean cut or come and fight us," the king, on Asquith's advice, summoned a conference at Buckingham palace on July 20 to see if some agreement was still not possible. It broke down four days later and the last hope of avoiding violence seemed gone.

World War I.—What Asquith would have done to avert a civil war while maintaining the authority of the constitution was not to be revealed. for on the day that the Buckingham palace conference broke up Austria sent its ultimatum, and within ten days the British army was embarking, not for Ulster, but for Flanders. In the feverish struggle within the cabinet that preceded the entry of Great Britain into World War I, Asquith's position was never in doubt. He had throughout been a party to the ambiguous military understandings and conversations which had been in progress with France since before the fall of the Balfour government in 1905, and when the war came he did not waver in his conviction that both the duty and the interest of the country lay in throwing the country's whole weight into the scales against what he considered to be the calculated design of the Central Powers to establish a military despotism over Europe.

The invasion of Belgium by Germany saved his government from disruption. and he addressed himself, free from domestic disquietudes. to the heaviest task ever imposed on a British prime minister. For the moment even the Irish trouble subsided, all political differences were shelved and Xsquith became the voice of a united nation. The speeches he delivered in the early days of the war have taken their place beside the classic orations of Pitt during the Napoleonic wars. and his constancy of mind and freedom from all personal ambition played a dominating part during the next two years in laying the foundations of the ultimate victory. It was not to be expected that in the presence of so vast a convulsion discontents would not develop. They became more urgent as the true character of the struggle emerged. Xsquith had made no change in the political constitution of his cabinet at the outbreak of war, although he had taken the leaders of the opposition into his confidence and private counsels, but by the spring of 1916 it became clear that this informal relation would have to yield to a formal coalition.

In February Bonar Law and Lord Lansdowne intimated that they could accept no responsibility for the way in which the war was being conducted, and in the popular press a powerful and ceaseless agitation arose, directed mainly against Asquith. Sir Edward Grey and Lord Haldane, and inspired by the inevitable shortage of munitions which the progress of the war had revealed. Coincidentally, a violent disagreement as to the employment of the navy in the Gallipoli adventure had arisen between Winston Churchill, the first lord of the admiralty, and Lord Fisher, the first sea lord, and on May 26 Xsquith reformed his cabinet on a coalition basis. bringing in the leaders of the opposition and excluding Haldane. To meet the growing need for munitions, a special ministry of munitions was set up with Lloyd George at its head.

This first coalition ministry was never popular nor at ease within itself. The Unionists felt that too many of the key positions were still held by Liberals; the Liberals deeply resented the exclusion oi Haldane for his alleged pro-German views and the inclusion of the "rebel" Carson. A growing distrust of Asquith's leadership was reflected in, and in part created by, the popular press, especially the papers owned by Lord Northcliffe. Lloyd George received all the credit for the growing supply of munitions, even when they resulted from schemes set afoot earlier. The events of the war were untoward. The offensives in France—Loos in 1915 and the Somme in 1916—failed to break the German line. The battle of Jutland, May 31, 1916, left the British navy in full command of the sea, but the heavier British losses in an unfinished battle disappointed a nation reared on stories of the battles of the Nile and Trafalgar. The swift defeat of the Rumanian armies in the autumn of 1916 was another disappointment. The public grew ever more inclined to believe that Asquith was dilatory and that his watchword was "wait and see." In inner circles gron-ing concern was felt about cabinet organization and management. Even members most friendly and respectful to Asquith, such as Austen Chamberlain. Lord Robert Cecil and others, began to doubt whether he was the most suitable head of a wartime government.

The crisis came in the first week of Dec. 1916. On the death of Lord Kitchener in 1916 Lloyd George had become secretary for war. In consultation with Bonar Law, the Unionist leader. he resolved to offer his resignation in order to bring about a reconstruction of the ministry which would give the direction of the war to a small committee or war cabinet on which Asquith would not sit, whether he did or did not remain the official head of the government. The news broke in the press in a manner hostile to Asquith, including a letter in the *Times,* thought at the time. although as it later appeared. wrongly, to have been informed and inspired by Lloyd George. Asquith rejected Lloyd George's proposals and Lloyd George then resigned with other members. Asquith then had to inform the king that he could no longer carry on the government. Bonar Law as the official leader of the Conservative party was asked to form an administration, and when he had failed there was a conference at Buckingham palace, after which Lloyd George successfully formed the second coalition ministry. All attempts to find a compromise which would include Asquith in dignified position, but without the conduct of the war, broke down on his refusal to take part in a government in which he would have office without responsibility.

In Opposition.— For the remainder of the war Asquith acted as formal leader of the opposition, speaking rarely but maintaining his claim to be leader of the Liberal party. In May 1918 he ventured to voice the general anxiety about the undermanning of the western front and moved for an inquiry by a select committee. Lloyd George treated this as a question of confidence and Asquith was supported by only 106 Liberal members. This debate, known as the Maurice debate after Gen. Frederick Maurice whose indiscretion had raised the question of the western front. was treated by the government as a declaration of war. When at the end of 1918 the long parliament of Dec. 1910 was dissolved. Xsquith and his supporters were treated as enemies and the Conservative candidates opposing them received a letter of support from both Lloyd George and Bonar Law. which was called derisively the "coupon." Asquith and all but 33 of his followers lost their seats. He returned to the house in 1920 by winning a remarkable victory in a by-election at Paisley. which seat he held through two elections till a Labour candidate defeated him in 1924. During this period he acted in opposition with dignity and restraint. criticizing the government's Irish policy and. with much moderation, the conditions of the peace of Versailles. When the issue of protection was raised in the election of 1923, he joined forces with Lloyd George and in the new parliament took the decision to defeat Stanley Baldwin's government and place Ramsay MacDonald in office as the first Labour prime minister. On his defeat in 1924 he accepted an earldom.

Last Years.— Other honours were conferred on him. He became a member of the judicial committee of the privy council, a knight of the Garter and a fellow of the Royal society. After he entered the house of lords he rarely intervened in public discussion. But at the outbreak of the general strike in 1926. he urged the paramount duty of concentrating on the struggle against the "coercion of a new dictatorship," though he blamed the government for not taking steps during the preceding nine months to make constructive proposals for the coal industry. Some recrimination followed. and there was a split in the Liberal party (*q.v.*). He still retained the leadership of the Liberal party, to which Lloyd George had now returned. But on the outbreak of the general strike in 1926 a sharp difference appeared in the attitude of Lord Oxford and Lloyd George toward the event. and the latter declined to consult his colleagues. Lord Oxford thereupon formally intimated that he could have no political relations with him. and as the result of the consequent breach Oxford retired from any active part in the afiairs of the party which he had led for 18 years. In his retirement he devoted himself to writing a book of reminiscences and reflections. under the title of *Fifty Years of Pārliament*, and in the autumn of 192; he also published a volume of his speeches. Thereafter his health gave way and he died on Feb. 1 j. 1928. at his home at Sutton Courtenay. Berkshire. being buried. according to his wish. in the churchyard of the parish church there. By his first marriage Asquith had four sons and one daughter Violet. who married Sir Maurice Bonham-Carter and became president of the Women's Liberal Federation (1923–25) and a well-known speaker and radio broadcaster. Raymond Asquith. his brilliant eldest son. was killed in action in 1916. By his second marriage he left a son Anthony, who became a well-known film director. and a daughter Elizabeth. who married Prince Bibesco. He was succeeded in the earldom by his grandson Julian. only son of Raymond Asquith.

Character and **Achievement.**—Few statesmen have been more free than Asquith from the meaner vices of public life. If he was ambitious it was a legitimate ambition. without which the state would lack great servants. His magnanimity sometimes seemed to border on weakness. A proud and somewhat shy man. he lacked the qualities to make himself a demagogue. He was loyal to his colleagues almost to a fault, for a political leader must prune as well as plough, and if his lofty indifference to the scurrilous attacks made on him during the war was splendid, it was also a deficiency in him as a party leader that he appeared not to care, perhaps even not fully to know. how strongly the current had set in against him. He shared with the younger Pitt the view that the greatest quality of statesmanship was patience and was never betrayed into violent speech. He would never force a situation while there was hope that a reasonable solution could be found. This served him well until he confronted situations in which there was little of reason or moderation at work.

A general judgment of his career may be as follows: Up to 1912 his public career showed a superb perfection of speech and conduct which was an extension of his earlier academic triumphs. With the rise of Ulster militancy he was placed in a cruel dilemma and no one can say whether he should have struck or held his hand. But he seemed to have apprehended less clearly than others the nature of the passions involved. and his rationality inclined him to an optimism that was in fact unreasonable. The opening of the war again showed him at his best, but his conduct of it has been severely criticized for lack of swiftness and prevision and for a too obstinate resistance to the adoption of the smaller cabinet, now recognized after the experience of two wars to be necessary. In general the more orthodox minds sympathize with Asquith's ideas about the conduct of the war if not with his methods. Supporters of Earl Jellicoe and Earl Haig tend to like Asquith; supporters of Earl Beatty and General Henry Wilson are admirers of Lloyd George. Nor can we be sure that he served his party best by his conduct on resignation: complete retirement from politics for a time, or service under Lloyd George, as Balfour had served under him, might have avoided the terrible schism. His mind moved in the orbit of a calm philosophy of government which made him both efficient and self-sufficient. In some matters it served well, but as the 20th century in its course revealed more and more the terrible passions and violence of mankind this philosophy became less relevant. He will be remembered as one of the most illustrious of British prime ministers. not the most profound in thought or most forward in action, but the most perfect of parliamentarians, clear! calm, wise, patient, dignified and sane.

Bibliography.—Asquith's own writings included *The Genesis of the War* (London, 1923). *Fifty Years of Parliament,* 2 vol. (London, 1926) and *Memories and Reflections, 1852–1927,* 2 vol. (London, 1928); his speeches were collected in *Occasional Addresses, 1893–1916* (London, 1918) and *Speeches* (London, 1927). The official life. by J. A. Spender and Cyril Asquith, appeared in 2 vol. (London. 1932). *See* also *The Autobiography* of *Margot Asquith,* 2 vol. (London, 1920–22) and memoirs of contemporary statesmen. (A. G. Ga.; R. B. McC.)

OXFORD AND ASQUITH, Margot, Countess of (1864–1945), the sixth daughter of Sir Charles Tennant. 1st Bart.. married, in 1894, as his second wife. H. H. Asquith, later the Earl of Oxford and Asquith (*q.v.*). Before her marriage she was well known as a member of the coterie known as the "Souls," and maintained her reputation as one of the wittiest and most brilliant women in London society. In 1922 she published *The Autobiography* of *Margot Asquith* (2 vol.), which reflected the natural frankness of her character. It is a valuable chronicle of the time. She died in London on July 28. 1945.

Her other works include *Places and Persons* (1925), *Lay Sermons* (1927) and a novel *Octavia* (1928).

OXFORDSHIRE (abbreviated Oxon.), a southern midland county of England. bounded north by Northamptonshire and Warwickshire. west by Gloucestershire. south by Berkshire and east by Buckinghamshire. The boundaries since 1911 enclose an area of 748.7 sq.mi. The population of the geographical county was 275,-808 in 1951. The 14 Oxfordshire hundreds include five of the Chiltern hundreds, the jurisdiction over which belonged to the manor of Benson and, in 1199, to Robert de Harecourt.

Physical Features. — The county lies across the central portion of the Jurassic and Cretaceous outcrops. The strike of the strata is in each case from northeast to southwest. for Tertiary movements have tilted them gently down to the southeast so that the transition from the northwest of the county. beginning roughly from a line joining Banbury to Burford. to the southeast is from older to newer rocks passing in succession from the Lower Jurassic Lias over the Lower, Middle and Upper Oolite to the Lower Greensand. Gault. Upper Greensand and finally to the Upper Cretaceous of the Vale of the White Horse. the Berkshire downs and the Chilterns. In the northwest. the marlstone of the Middle Lias and the limestones of the Oolitic series are permeable and relatively resistant. and the marlstones and the Inferior Oolite rocks being specially hard, stand out as a sharp edge. continuing the line of the Cotswolds at a lower level (average 500 ft.) but rising to 705 ft. in Edge Hill in the northeast of the county. In the southeast, the chalk is also permeable and resistant: and the hard chalk-with-flints crowning the Chilterns also presents a sharp edge to the northwest.

Between these two upland regions the intermediate geological series forms a broad vale (about 10 mi, widej of alternating clays and calcareous, sandy beds. The Upper Greensand forms a low feature at the foot of the chalk hills; this is succeeded by the Gault. with width of outcrop varying from 4 mi, to $1\frac{1}{2}$ mi. between Dorchester and Sydenham. The Lower Greensand appears from beneath the Gault at Culham and Nuneham Courtenay and in outliers north of Cuddesdon; Portland Limestone. Portland Sands and Purbeck Beds lie between it and the Kimmeridge Clays, which outcrop between Sandford and Waterperry. Coral Rag is traceable from Sandford to Wheatley and beyond this comes a broad outcrop of Oxford Clay followed by the Cornbrash (a brownish rubbly limestone). This outcrops at Norton Bridge. Woodstock and Shipton, forms a broad plateau between Middleton Stoney and Bicester. and also occurs as inliers at Islip, Charlton, Merton and Black Horse Hill.

The county lies almost wholly in the basin of the upper Thames, in which the significant drainage is that of the Cherwell-Thames. The drainage pattern as a whole consist3 of numerous consequent streams from the scarplands (Evenlode. Windrush. etc.) which have been captured and diverted into the Cherwell-Thames by powerful subsequent streams (Ock, Upper Thames. Ray, Thame), working along lines of weakness in the strike of the rocks. obsequent streams flowing down the scarp edge often being a further result of the capturing. The Cherwell occupies a broad sag between Edge Hill and the Northampton uplands. It flows south-southeast, joins the Thames coming from the west at Oxford, after which the combined stream contipues the southeast direction. passing by the Goring gap through the chalk between Wallingford and

Reading. That the gap originated northwest of its present position is argued from the fact that the level of the river bed at this point is 100 ft. while that of the hills on either side is 700–800 ft. It is an old. but rejuvenated drainage system. which, working upon calcareous rocks. has given rise to a characteristic topography. There is little glacial drift except in the northeast of the county. Gravel deposits, both plateau (North Leigh. Combe. Tiddington. etc.) and flood plain (Bampton. Oxford, Dorchester, etc.). are very important; tracts of clay-with-flints. brickearth and gravel, as well as outliers of the London Clay (Nettlebed. Caversham, etc.) occur on the dip slope of the chalk.

History.— The gravels and sands near the Chilterns and gravels near Wolvercote have yielded Lower Palaeolithic flint tools. Some Mesolithic flints have been found. There is ample evidence for the settlement of Neolithic farmers, *e.g.*, at Dorchester, Abingdon, Eynsham and other places; the Beaker people have left many traces especially between the Evenlode and the Windrush. The Rollright stone circle (probably built by the Beaker people) on the Oolite scarp needs special mention. Settlement on the dip slope of the Chilterns was debarred by forests, as also in the forested northeastern portion of the county. but the Icknield way, generally on the Greensand, and the Ridgeway, on the Chalk above. followed the scarp face to the Thames crossing. The Bronze Age period was a trading time for the area. Iron Age invaders had begun to arrive by the early 3rd century B.C. There are plentiful Iron Age finds in the valleys of the Oxford heights and, especially. near the Thames crossing at Dorchester. During the Roman period the area was thickly populated and roads were made linking Alchester and Dorchester in the Cherwell-Thames with Watling street and Towcester (Northants) to the north and Silchester (Hants) to the south. Alchester was also connected by Akeman street with Verulamium (Herts) to the east and Cirencester (Glos) to the west. The Saxon settlements are noticeably on valley sites. occupied in pre-Roman times. and these have continued as nucleated settlements to the present day; isolated farms are mainly on plateau or vale from which forest was cleared comparatively late. In the 6th century the West Saxons under Cuthwulf took Benson and Eynsham. (See the Anglo-Saxon Chronicle for 571.)

In the 7th century the Mercians held all the northern border of the Thames, and during the 8th century this district fell to Wessex after the battle of Burford, and to Mercia after a battle at Benson, when it was included in the diocese of Lincoln. The bishopric at Dorchester, given to Birinus (the apostle of Wessex) in 634. seems to have come to an end on the establishment of the see of Winchester. Before the Mercian conquest in 777 Oxfordshire was in the diocese of Sherborne. In 873 the jurisdiction of Dorchester reached to the Humber, and when the Danes were converted it extended over Leicestershire and Lincolnshire, Oxfordshire forming about an eighth of the diocese. In 1092 the seat was transferred to Lincoln. In 1542 a bishopric of Osney and Thame was established, taking its title from Oxford. the last abbot of Osney being appointed to it. In 1546 the existing bishopric of Oxford was established.

The Danes overran the county during the 10th and 11th centuries. At Oxford Harold allowed Tostig to be outlawed and Morkere to be chosen earl in his place. thus preparing the way for his own downfall and for the Norman conquest. The bishops of Winchester and Lincoln and many religious houses (*e.g.*, Abingdon, Osney and Godstow) held much land in the county. Robert D'Oyly, heir of Wigod of Wallingford, built a castle at Oxford, of which town he was governor. The importance of Oxford (*q.v.* for history) was already well established; the shire moot there is mentioned in Canute's Oxford laws, and it was the seat of the county court from the first. the castle being the county jail. The dissolution of the monasteries, though it affected the county greatly, caused no general disturbance.

When King Charles I won the battle of Edgehill (Oct. 23, 1642), Oxford at once became the stronghold of the royalist cause. More than once. notably at Chalgrove Field (June 18, 1643), Prince Rupert's cavalry struck hard and successfully. In the campaign of Newbury skirmishes took place as the parliamentary troops under Essex passed through north Oxfordshire on their way to the relief of Gloucester, and at the close of the campaign the fortresses of the county offered the defeated royalists a refuge which Essex was powerless to disturb. In the following campaign Charles abandoned the idea of an envelopment and decided to use Oxfordshire as the stronghold from which to strike in all directions. Material wants made it impossible for Charles to maintain permanently his central position, and eventually Essex headed for tlie southwest. leaving Sir William Waller to face the king alone. The battle of Cropredy Bridge followed (Jan. 29), and the victorious king turned south to pursue and capture Essex at Lostwithiel in Cornwall. In the operations of 1644 Oxfordshire again served as a refuge and base (Newbury and Donnington).

On the appearance of Oliver Cromwell and the New Model army a fresh interest arose. Leaving Windsor (April 20, 1645), the future Protector carried out a daring cavalry raid. He caught the royalists unaware at Islip, pursued the fugitives to Bletchington and forced the governor to surrender. He swept round Oxford, fought again at Bampton. and rejoined Fairfax. in Berkshire. A few days later Charles again marched northward. while Fairfax was ordered to besiege Oxford. Charles was compelled to turn back to relieve the city, and the consequent delay led to the campaign and disaster of Naseby. Yet even after Naseby Oxfordshire still retained its importance. but in 1646 the Roundheads closed in from all sides and Stow-on-the-Wold witnessed the final battle of the war. On May 9 Banbury surrendered. on June 24 Oxford capitulated, and three days later Wallingford, the last place to give in, followed its example.

By the middle of the 17th century the great Cotswold wool industry was dying out, though it persisted at Burford until the 19th century. The forests also were diminishing as a result of the Civil War and of enclosures. but there are still extensive n-oods where once were the forests of Shotover, Bernwood. Woodstock and Wychwood. The building of canals and turnpike roads in the 18th century altered the status of many towns which, by the mid-19th century had been further changed by the setting-up of new industries.

Architecture.— The limestone of the Oolite series has provided beautiful material for both ecclesiastical and domestic architecture. The castles, of which there are few, qere probably built for temporary defense in the civil strife of Stephen's reign. Considerable portions of the Norman Oxford castle survive, and slighter remains of the castle at Bampton, the seat of Aylmer de Valence in 1313.

Among remains of former mansions Greys court near Henley on Thames (13th century), Minster Lovell, on the Windrush above Witney, and Rycote, between Thame and Oxford, may be noted. Minster Lovell was the seat of Francis. Lord Lovel. the son of a Lancastrian who incurred the hatred of that party by serving Richard III; he afterward aided Lambert Simnel and mysteriously disappeared after the battle of Stoke. Rycote is of fine Elizabethan brick, and in the chapel attached to the manor there is remarkable Jacobean woodwork, the entire fittings being of this period. Here Elizabeth I resided both before and after her accession. Broughton castle near Banbury (14th century). Shirburn castle (mainly 1 jth-century Perpendicular) and Stanton Harcourt (1450, with a gatehouse of 1540, a vast kitchen and Pope's tower) are ancient mansions still inhabited. Mapledurham, on the Thames above Reading, is a fine Tudor mansion of brick; and Walter Eaton on the Cherwell is a singularly perfect Jacobean house of stone. Rousham house (17th century) has a landscape garden by William Kent. Blenheim palace, near the little town of Woodstock. was designed by Sir John Vanbrugh and is the seat of the dukes of Marlborough.

A large number of monastic foundations arose in the neighbourhood of the university; Augustinian at Bicester. Caversham. Cold Norton, Dorchester, Osney and Wroxton; Cistercian at Bruern and Thame; Benedictine at Cogges, Eynsham, Milton; Mathurin at Nuffield; Gilbertine at Clattercote; Templar at Sandford-on-Thames. Gosford possessed one of the only two preceptories of female Templars in England. Of all these, excepting the abbey church at Dorchester, remains are scanty. The boundary walls still stand oi Godstow nunnery on the Thames, the retreat and burial place or' Rosamund Clifford. or "Fair Rosamond," the object of Henry II's famous courtship.

In ecclesiastical architecture Oxfordshire. apart from Oxford it-elf. is remarkably rich. but nearly all the churches are of mixed dates. Iffley. Adderbury and Minster Lovell are types of a single style. Iffley. 1 mi. south of Oxford. is one of the finest examples of pure Romanesque in England. with a highly ornate west front. Adderbury, 4 mi. south of Banbury, is a great cruciform Decorated church with a massive central tower and spire. Minster Lovell. also cruciform. is pure Perpendicular; its central tower is supported on four detached piers.

Oxford cathedral dates from the 12th century. There are splendid central spires to the great churches at Witney. Bampton, Shipton-under-Wychwood and Bradwell and a fine spire at Bloxham which is one of the largest and most heautiiul churches in the county. Burford and Langford have particularly fine large early Norman churches. At South Leigh. Beckley and Swinbrook are remarkable mediaeval mural paintings, while at Caversiield there is what is probably the oldest church hell in England—cast before 1219. About 5 mi. north of Oxford there are Kidlington (Decorated). with a beautiful needle-like Perpendicular spire. and Islip, the birthplace of Edward the Confessor. En-elme church (Perpendicular) is remarkable for the tomb of Alice. duchess of Suffolk (147j). gorgeous nith tracer? and gilded canopy. and that of Sir Thomas Chaucer (1434). with enamelled coats of arms. Here William de la Pole. duke of Suffolk, founded in 1436 the picturesque hospital and free school still standing.

Agriculture, Industries and **Communications.**—A large proportion of the county (about 80% in the mid 1950s) is under cultivation. The Cornbrash is especially good for grain growing. In 1955, 119.542 ac. were covered with grain crops. Stock are raised on the clay lowlands. and dairying ('Shorthorns. Friesians. Channel Island and Ayrshire con-s) is carried on. Sheep (Oxford Downs. Hampshire Downs and crossbred) are still reared, although intensive ploughing reduced numbers during World War II. In 1868 there were over 400.000 sheep; in 195j. 115.005. Potatoes. little grown before 1939, covered 10.286 ac. in 1946 but only 3,065 ac. in 195j.

Ironstone is obtained from the Middle Lias around Banbury; limestone (from the Great Oolite) is still quarried in small quantities at Bladon. but the preparation of stone slates for which part of the county was noted. has now ceased. Clay is dug and there are cement works at Chinnor and Shipton. The National Trust owned 572 ac. in 195j and protected 464 ac.

The largest centre of industry is at Cowley, Oxford (Nuffield industries and pressed steel). There are also considerable engineering and aluminum works at Banbury. Blankets are made at Witney and tweeds at Chipping Norton. There are paper mills at Shiplake. Sandford, Wolvercote and Eynsham, using pure stream water.

The making of leather gloves has been established in Woodstock. Charlbury and Didcot since the 16th century. Banbury has long been celebrated for a currant cake; Oxford makes marmalade and nearly 1,000 people are employed by the Oxford Cniversity press.

Oxford is a road centre not only for the county but also for the midlands; it was not so in prehistoric or Roman times, though many of the roads are ancient routes on the plateau or following the strike of the rocks. The main railways are markedly transverse. linking London with the industrial northwest. One main line from London passes through the gap to Oxford where it divides. one line going to Banbury and another to the Severn valley, Worcester and Birmingham.

Population and Administration.— The area of the administrative county. excluding the county borough of Oxford. is 735.6 sq.mi. with a population (1951) of 177,124. Wartime evacuees between Sept. 1939 and Feb. 1941 raised the population by 214. The municipal boroughs are Banbury (pop., 19j1. 18.916). Chipping Norton (3,878), Henley on Thames (7,982). Oxford (98,-684), a cathedral city and the county town. and Woodstock (1,715). There are three urban and six rural districts, The county is in the Oxford circuit and assizes are held at Oxford. It has one court of quarter sessions and is divided into 11 petty sessional divisions. The borough of Banbury and the city of Oxford have separate courts of quarter sessions and commissions of the peace. and the borough of Henley on Thames has a separate commission of the peace. There are 232 civil parishes. The ancient county (which in 1289 sent two members to parliament) was divided in 1918 into two parliamentary divisions. Banbury and Henley. each returning one member. It also includes the parliamentary borough of Oxiord, returning one member. It is within the diocese of Oxford.

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OXFORD UNIVERSITY. The stories connecting Oxford university with Brute the Trojan, with King Mempeic (1009 B C.) and with the Druids, cannot be traced back beyond the 14th century. Authentic history appears to begin in 1133 with the arrival from Paris of the theologian, Robert Pullen, who lectured there. There is, however, little evidence that Oxford was regarded as a fully equipped university before 1163—allusions to its being a *studium generale* (see Universities) only occur after that date and these by some authorities are held to be inconclusive. Subsequent progress must, however, have been rapid as, about 100 years later. the deputies of Oxford, in an appeal to the king. described the university as *schola* secunda ecclesiae or second to Paris. The coming of the religious communities, the Dominicans. Franciscans and Carmelites in the 13th century and the Benedictines a little later, profoundly affected the advancement of learning. The names of Roger Bacon, John Duns Scotus and John Wycliffe are sufficient to indicate the prominence of Oxford in the middle ages. The earliest colleges to be founded were University college (1249; the mythical foundation by Alfred in 872 is no longer accepted), Balliol (about 1263) and Merton (1264). The latter was established to provide a collegiate discipline for the secular clergy, and its statutes served as a model for subsequent creations, not only at Oxford but at Cambridge.

From the 13th century onward a succession of charters from the crown strengthened the position of the university at the expense of the town. At the Renaissance the new learning found its leading exponents in Erasmus, who lectured there, and in such famous scholars as William Grocyn, John Colet and Sir Thomas More. The old scholasticism received its deathblow from the royal injunctions of 1535. Oxford, as well as Cambridge, suffered from numerous confiscations of land and revenues during the Reformation period. In 1571 the act of Elizabeth incorporated and reorganized the two universities. The statutes of the university were codified in 1636 by the chancellor Archbishop William Laud. With certain modifications, they formed the official code of the university until 1858. During the Civil War the university sided with the king, while the town sympathized with the parliament, but no open breach between the two occurred. Under Oliver Cromwell. who acted as chancellor from 1651 to 1657, an effort was made to restore the standards in work and discipline which had suffered from the civil wars. During the reign of James II, the university acquired popularity by its successful resistance to James's effort to open the university to Catholics, even to the extent of imposing his own Catholic nominee on the fellows of Magdalen. The university, however, soon returned to its Jacobite allegiance, and at the coming of the Georges was definitely anti-Hanoverian, a phase that came to an end after the visit of George III in 1785. In the latter half of the 18th century the influence of the Wesleys on Oxford was far less than on the country at large; on the other hand the Tractarian movement (see Newman. John Henry), at the beginning of the 19th century, had a most profound effect on the Church of England, which remained potent. There was a general rise in the level of studies toward the end of the 18th century as written examinations gradually supplemented the old oral examinations. often merely formal, and henceforth the range of studies themselves extended. By the reform of 1858 the professoriate was increased, reorganized and re-endowed. and dissenters were admitted to entrance to the B.A.—the M.A. being thrown open in 1871.

The reforms of 1877 directed a certain proportion of the college revenues to the use of the university (especially for the encouragement of natural science) and improved the position of professors and lecturers, thus leading to the growth of a regular resident professoriate. Schools and degrees alike multiplied (see UNIVERSITIES) and the history of the university was one of general progress and expansion.

Modern Oxford. — The beginning of the 20th century marked a turning point in university history because of the growth of scientific studies and of specialization in all studies.

In the 19th century the university had grown in size; the number of annual matriculations grew steadily, with a check between 1812 and 1849. from 240 in 1800 to 840 in 1900. Although the quality of teaching improved, the college fellows continued to provide practically the whole of the teaching and administrative strength of the university. This was possible because science made its way slowly. As late as 1900, out of 142 college tutors, only 21 (less than 15%) were scientists. There were in addition an equal number of science teachers paid wholly by the university. By 1940 the number of college tutors in science was 55 (including 4 women) out of 268 (more than 20%), and there were also 78 readers and demonstrators paid wholly by the university. Over the same period the number of science departments grew from 9 to 19. There had also been a considerable shift of interest among the undergraduates. In 1900 the number of candidates taking the final honours science examinations was only 47, or almost exactly 10% of the total number of candidates (469); in 1939 the candidates in science were 21 j out of 1,305, or just over 17%. In the interval important new honours examinations in humane subjects had either developed (English had 4 candidates in 1900 and 120 in 1939) or had been introduced (modern languages had 123 candidates in 1939, and philosophy, politics and economics. 152). This swing from humane studies, which are taught didactically, to science which is taught by demonstration and experiment, mainly caused the growth in the significance of the university. Although five colleges had provided science laboratories, the possibility that science could be studied as a college activity was never really a serious one. Laboratories are common services and must be provided on a huge scale. Between 1900 and 1940 the annual expenditure on the science departments grew from £24,177 to £135,681.

These developments took place without the university's absorbing the colleges Until after World War I the university depended on endowments, which in 1900 yielded £19,000 a year net, and on fees and dues, which brought in £30,488. Major developments were due to private benefactions. After World War I such sources ceased to be adequate, and in accordance with the recommendations of a royal commission, in the face of strong opposition within the university, a government grant was paid. This amounted in 1927–28 to 21% of the total expenditure. In 1938–39 the grants remained 21% (but the total expenditure was about 25% higher); in 1947–48 the grants were 49% and in 1948–49 they were 52%. The subsidizing of individual students out of public funds developed simultaneously, and in 1939 the proportion of students in receipt of some form of financial assistance was 55%.

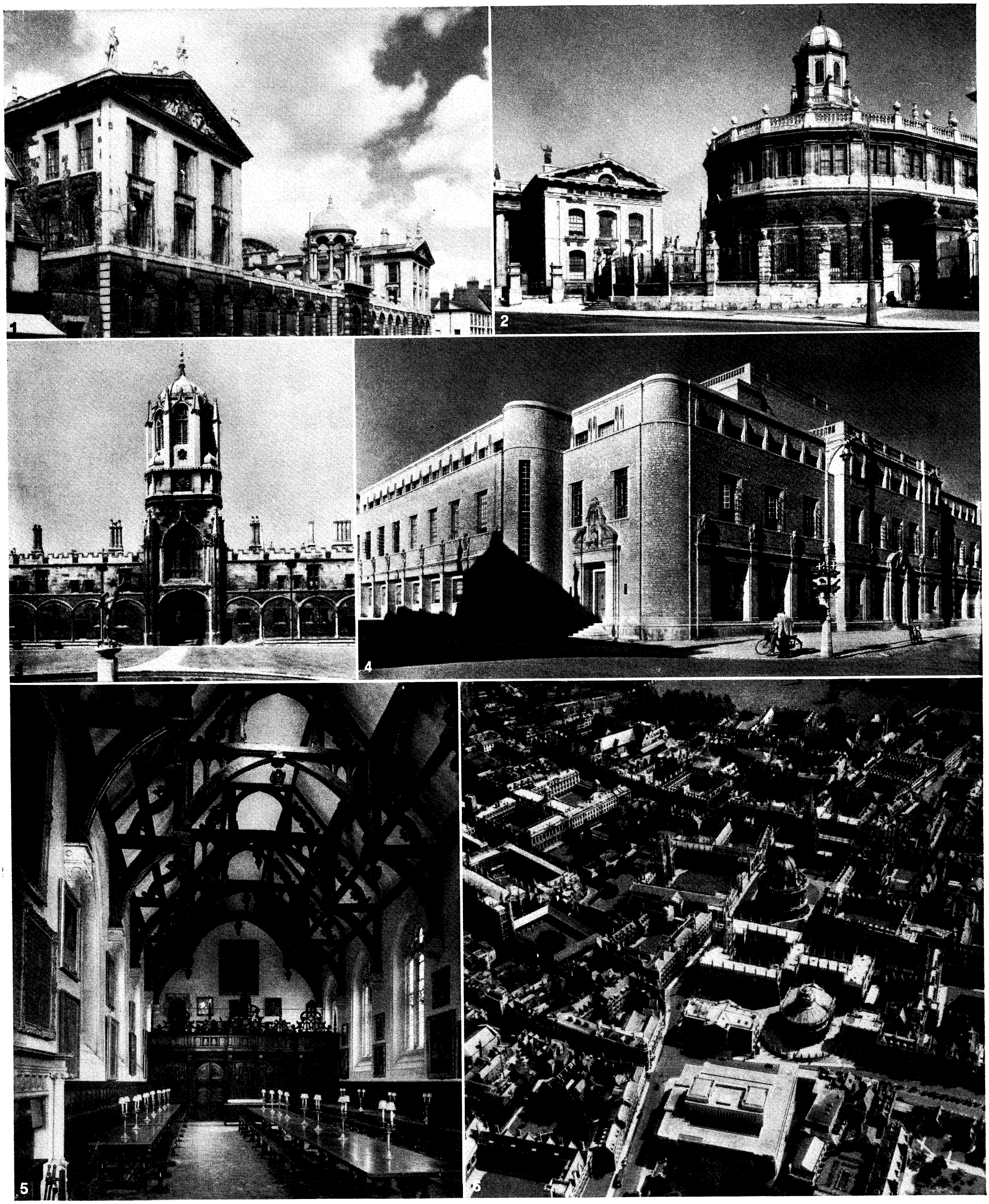
The control of these growing resources, however, never passed into the hands of any body distinct from the colleges. What the framers of the Oxford constitution aimed at was to ensure that the university's business, being for the benefit of scholars, should be controlled by scholars. The effective power was thus vested in the university at large. Naturally it was primarily in the hands of those holding academic positions ("congregation"), but as late as 1919 the nonresident masters of arts were able to defeat a proposal for the abolition of compulsory Greek. In 1926 the nonresident masters were finally relieved of all but revising functions exercised if the university was internally divided; and since the nonresident masters number about 15,000 they could not in any case be an effective body. Power, therefore, rests with congregation (about 1,000 M.A.'s), all members of the separate colleges. The fact that all decisions affecting policy must be passed by congregation, in which it is always easy to stir up opposition, has prevented the university from imposing anything like bureaucratic control upon the colleges. Congregation has, indeed, only a limited power of initiation. its function being to pass judgment on proposals submitted to it by the Hebdomadal council! a body containing j ex officio members (the chancellor, vice-chancellor, the 2 proctors and a pro-vice-chancellor, who is either the outgoing or the incoming vice-chancellor) and 18 M.A.'s elected by congregation. The council is thus a body which exercises a great influence; but it is the influence of a leader in a free community who remains a leader only as long as anyone chooses to follow.

The passing of the powers of convocation (all M.A.'s), though inevitable, was regretted on account of the risk that the university would become a self-complacent community, unresponsive to changing public needs. Partly in order to make this risk less, the Oxford society was founded under the leadership of the then chancellor Viscount Grey of Fallodon in 1932. One of the objects of the society was to provide through its magazine a kind of forum, in which the residents would describe and justify to the nonresidents what they were doing.

Enrolment in World Wars I and 11.—The contrast between the university's experience of World Wars I and II was striking. In World War I the young men were encouraged to enlist indiscriminately, and no attempt was made to use the resources of the university for war purposes, except that some of the buildings were used as hospitals or barracks. The number in residence (about 4,000 in Jan. 1914) by Jan. 1915 had fallen to 1,087. 'In 1917–18 the number fell to 460. In World War II all national resources were mobilized. Young men were ordered to remain at their universities until the services were ready for them. In consequence, the number of men at the university fell only from 4,147 in the Trinity term of 1939 to 2,761 in the Michaelmas term, and to 2,148 by 1940–41. Senior members of the university were also sent or kept where they would be most useful. Thus the university was never entirely denuded of active teachers and research workers.

Benefactions. — The university used to depend for developments upon private benefactors. The Bodleian library, the Sheldonian theatre, the Ashmolean Museum of Art and Archaeology, the Dyson Perrins laboratory, the Serena professorship of Italian, the Stanhope Historical Essay prize and other foundations commemorate the names of some of them. When World War I caused taxation to rise, the days of private benefactions seemed to have passed. Nevertheless, between 1930 and 1943 the university received (apart from Lord Nuffield's gifts to the medical school and Nuffield college, together amounting to £3,800,000; more than £500,000 from a special appeal; and the gifts of the Rockefeller foundation, notably £586,000 for the extension of the Bodleian library) gifts totalling £271,000 and annuities amounting to £2,795 a year: all this was apart from gifts in kind. World War II did not end the generosity of benefactors. In 1948 Antonin Besse gave £1,250,000 for the foundation of a new college. St. Antony's, and £250,000 for the expansion of the existing colleges. In addition a stream of smaller bequests continued to flow either to individual colleges or to the university.

List of Colleges and Halls. — University, Balliol and Merton have been mentioned above. The other colleges in their order of foundation are: Exeter (1314), Oriel (1326), Queen's (1340), New (1379), Lincoln (1427), All Souls (1438), Magdalen (1458), Brasenose (1509), Corpus Christi (1516), Christ Church (begun by Wolsey in 1525, final foundation by Henry VIII, 1546), St. John's (1555), Trinity (1555), Jesus (1571), Wadham (1612, charter received 1610), Pembroke (1624), Worcester (1714), Keble (1870) and Hertford (1874). (For further details see OXFORD.) Of the various academical halls, St. Edmund (reputed foundation, 1226) is the only one that survived. St. Peter's hall,



PHOTOGRAPHS (1-5 A. F. KERSTING, LONDON (6) AEROFILM LTD., LONDON

SOME VIEWS OF OXFORD

1. Queen's college from the High street
2. The Sheldonian theatre (right) and the Clarendon building
3. "Tom tower," Christ Church. The tower was built by Sir Christopher Wren
4. The Bodleian library extension, designed by Sir Giles Gilbert Scott and opened in 1946
5. The Hall of Wadham college
6. General view of Oxford from the air. Reading downward from St. Mary's church (spire) are the Radcliffe Camera (dome), the Bodleian library, the Clarendon building and the Bodleian library extension

founded as a hostel in 1928, became a permanent private hall in 1929, and in 1947 was admitted by decree of convocation to the status of a new foundation (a status differing from that of a college mainly because the head does not become vice-chancellor, and the society does not make statutory contributions to the university: Keble had this status in 1950 though it was then applying to the privy council for incorporation as a college). In 1950 St. Antony's college was established with the status of new foundation. Nuffield college, founded in 1937, is peculiar in being a university institution and not an independent corporation. It is a postgraduate college intended "to encourage research especially but not exclusively in the field of social studies." There are also two private halls. Campion hall (1896) for members of the Society of Jesus and St. Benet's (1897) for Benedictines.

Noncollegiate students were admitted, as members of St. Catherine's society, in 1863. There are five women's colleges: Lady Margaret hall (1878), Somerville (1879), St. Hugh's (1886), St. Hilda's (1893') and St. Anne's (1952). St. Anne's was formerly knon-n as the Oxford Society of Home Students.

Other Academic Buildings of Note.—Oxford possesses fine academic buildings. Some of the principal ones are the group of buildings comprising the Bodleian library, the Convocation house with the Sheldonian theatre and the Old Ashmolean museum, and the Radcliffe Camera not far away. The "university church" of St. Mary lies just to the south of the latter. Another group of buildings is devoted to the Taylor institute and the Ashmolean Museum of Art and Archaeology. Other important buildings are the university science laboratories which are grouped together on a site of about 1; ac.. and the famous Clarendon press. Mention should also be made of the botanical garden by the River Cherwell and the Oxford Cnion society, founded in 1625. *(See* also OXFORD.)

University Constitution.— "The chancellor, masters and scholars of the University of Oxford" form a corporate body, within which the colleges are individual corporations. The highest officer of the university is the chancellor, who is elected by the members of convocation, holds office for life and is generally a distinguished member of the university. 'The vice-chancellor is in practice the head He is nominated annually by the chancellor and must by convention be the senior head of a college who has not yet held this post and who is willing to accept it. Each vice-chancellor is nominated for three years in all. Two proctors (*q.v.*) are appointed annually by two of the collepes in rotation. Until 1950, when the privilege dating from 1604 was abolished, the university returned two members to parliament under a system of proportional representation.

The Hebdomadal council initiates and congregation decides the business of the university: but there is a considerable delegation of executive functions. The administrative work is assigned sparingly so that scholars can do it without affecting their scholarly work. The delegation ranges from such bodies as the curators of the Bodleian library, who spend about £85,000 a year, to such as the committee for ciassical archaeology which spends about £120.

The delegate bodies fall into two groups: (1) those (*e.g.,* faculty boards) dealing with academic questions; which maintain academic standards both by supervising the selection of the teaching and research staffs and their work, and by determining the content and standard of examinations— such bodies are supervised by the general board of the faculties; and (2) those which provide services not regarded as academic. To these, the curators of the university chest bear much the same relation as the general board does to academic delegacies, But the curators are also responsible for advising the Hebdomadal council on financial matters: for managing the real property and other investments of the university and for ensuring tliat accounts are so kept as to form a trustworthy basis for estimating future expenditure and detecting \\-aste.

The colleges consist of a head, whose title varies in different colleges, fellows (who form the governing body) and scholars. To these are to be added the commoners: *i.e.,* those who either receive no emoluments, or hold exhibitions which do not generally entitle them to rank with the scholars. The college officer who is immediately concerned with the disciplinary surveillance of members of the college *in statu pupillari* is the dean (except at Christ Church). Each undergraduate (this term covering all who have not yet proceeded to a degree) is, as regards his studies, under the immediate supervision of one of the fellows as tutor.

Degrees.—Nobody can study for a degree or be a member of the university unless he is a member of a college. The examinations for the B.X. (the title of the first degree, no matter in what subject it is taken) are: (1) responsions—an entrance examination taken before coming into residence (various other examinations of comparable standard are accepted as its equivalent); (2) the first public examination which may be an honours examination in Greek and Latin literature, or in mathematics or science (four subjects), or a pass examination designed as a preliminary to one of the final honour schools; (3) the second public examination which may be either an honours examination in a single subject or in two or three closely related subjects (a final honour school), or a pass examination in three unrelated subjects. In addition there are examinations in theology (for the B.D. degree): law (for the W.C.L.), medicine (for the B.M., and B.Ch.) and music (for the B.Mus.), which are normally taken after the B.A. Degrees of B.Litt., B.Sc. and D.Phil. are awarded for original research undertaken under supervision, and the higher doctorates for published work containing an original contribution to the advancement of learning.

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OXIDATION AND REDUCTION are chemical terms applied to changes in the electrical charge of an element in the course of a chemical reaction. For example, the combination of sodium and chlorine involves the transfer of an electron from a sodium atom to a chlorine atom and the formation of a sodium-chloride molecule in which the sodium is charged positively and the chlorine negatively: (Na^+) (Cl^-). The element which has lost electrons and thus acquired positive charges is said to be oxidized and the process is called oxidation. The element which gained electrons is reduced and the process is one of reduction. Thus, the combination of sodium and chlorine is an oxidation-reduction reaction resulting in the oxidation of the sodium and the reduction of the chlorine. In this reaction the chlorine is the oxidizing agent and the sodium the reducing agent.

Before the introduction of the electron concept, the term oxidation was applied to reactions in which an element gained oxygen as in the burning of carbon, $C + O_2 = CO_2$, or the rusting of iron, $4Fe + 3O_2 = 2Fe_2O_3$; the term reduction designated a reaction by which an element lost oxygen, such as the reduction of copper oxide by hydrogen, $CuO + H_2 = Cu + H_2O$.

In all oxides, the oxygen atom has a charge of -2 (or oxidation number of -2); hence, when free oxygen gas combines with another element to form an oxide, it gains electrons from that element.

In the generalized concept the term oxidation has been extended to include all similar reactions.

Many substances in water solution ionize (that is, dissociate into their charged constituents; *e.g.,* $NiCl_2 = Ni^{++} + 2Cl^-$), and the electrolysis of such solutions results in an oxidation process at the anode and a reduction at the cathode. For the electrolysis of $NiCl_2$ the anode reaction is $2Cl^- = Cl_2 + 2e^-$ and the cathode reaction $Ni^{++} + 2e^- = Ni^{++}$. These reactions involving the electrons are called half reactions or oxidation-reduction couples. Each couple has the reduced state of the element as one half and the oxidized state plus electrons as the other half. In theory, every oxidation-reduction reaction may be broken up into two couples which indicate the mechanism by which electrons are transferred. $Ag + 2HNO_3 = AgNO_3 + NO_2 + H_2O$; couples, $Ag + NO_3^- = AgNO_3 + e^-$ and $e^- +$

$2HNO_3 = NO_2 + NO_3^- + H_2O$. From this mechanism it is evident that oxidation and reduction occur simultaneously and in equivalent amounts; *i.e.*, the number of electrons lost is equal to the number gained. The relative potentials of the two couples determine the direction in which the reaction will proceed (see THERMODYNAMICS).

The most powerful reducing agents are the electropositive metals such as sodium. These readily reduce the compounds of the noble metals and also liberate hydrogen from water: $AgCl + Na = Ag + NaCl$ and $2Na + 2H_2O = 2NaOH + H_2$. The noble metals are poor reducing agents but their compounds are good oxidizing agents. Among the most powerful oxidizing agents are fluorine, ozone and cobaltic ion. These readily liberate oxygen from water, $F_2 + 2H_2O = O_2 + 2HF$. Hydrogen peroxide, potassium permanganate and ceric compounds are examples of powerful oxidizing agents which are used extensively in analytical and industrial chemistry. (W. M. LA.)

OXIDE, in chemistry, a binary compound of oxygen and another element. Oxides are the most plentiful and characteristic components of the earth's hydrosphere and lithosphere: the hydrosphere consists essentially of water, the commoner oxide of hydrogen; and the lithosphere of simple oxides of the general formula A_mO_n and complex oxides of the type $A_xB_yC_z \ldots O_n$. The complex oxides are more abundant, and the study of them forms the greater part of mineralogy, since they include many important rock-forming materials. Work on the structure of crystals has shown that the former inclusion of carbonates, aluminates and aluminosilicates among the complex oxides was not strictly correct (see below), though their empirical formulas are often given as though they consisted of oxides; *e.g.*, beryl, $Be_3Al_2Si_6O_{18}$, which is a silicate, may be written incorrectly as $3BeO.Al_2O_3.6SiO_2$. The ordinary ingredients of soil, subsoil and rocks are partly composed of oxides in either anhydrous or hydrated forms.

Oxygen can be made to combine directly with most elements, although sometimes it will not do so in the entire absence of water vapour; in a few cases in which direct methods are unavailing, as, for example, in the case of noble metals such as gold or platinum which remain unaffected in air even at very high temperatures, indirect methods can be used and oxides can be prepared from the salts of the metals.

Oxides of the inert gases (helium, neon, argon, etc.) do not exist and would not be expected on modern theories of chemical bond formation. Fluorine and later bromine (1930–40) have been oxidized by special methods, but for a long time it was thought that they would not form oxides.

Many elements form a series of several oxides. Thus nitrogen yields six: N_2O, NO, N_2O_3, NO_2 (N_2O_4 at lower temperatures), N_2O_5 and possibly NO_3. In general, the acidic character of the oxide increases with increase in the oxygen content. For purposes of classification it is usual to assign a typical oxide to each element; usually this oxide is the highest having acidic or basic properties and is related to the position of the element in the periodic classification (see PERIODIC LAW) as follows: the typical oxides of Group I are of the form M_2O[I], (roman numeral in brackets indicates periodic group) of Group II those of the form MO[II], of Group III those of the form M_2O_3[III], and so on, Group VI being those of the form MO_3[VI]. The oxides of typical metals (*e.g.*, MgO) are known to be aggregates of oxygen ions (O'') and positive metal ions held together by electrostatic forces in certain geometrical arrangements, while oxides of nonmetals (*e.g.*, CO_2) are usually volatile compounds, the constituent atoms being held together by covalent bonds. Less electropositive metals will form chemical bonds with oxygen which will have considerable covalent nature; *e.g.*, PtO.

Types of Oxide.—Oxides are often classed as (1) acidic oxides; (2) basic oxides; (3) amphoteric oxides; (4) neutral oxides; (5) suboxides; (6) higher oxides including peroxides, superoxides and dioxides or polyoxides; (7) mixed oxides; and (8) complex oxides. An oxide may not fall clearly into any one of these classes but have the characteristics of two.

1. Acidic oxides are those which combine with bases or basic oxides to form salts. Many of the oxides of nonmetals (*e.g.*, carbon, nitrogen, phosphorus and sulfur) are of this type. Some acidic oxides are "mixed" anhydrides: thus nitrogen peroxide reacts with water to give two acids, nitrous and nitric, and with bases to form nitrites and nitrates.

2. Basic oxides similarly react with acids or acidic oxides to form salts, and many of the oxides of metals fall into this class.

3. Amphoteric oxides behave as acidic oxides toward bases and as basic oxides toward acids: thus zinc and aluminum oxides dissolve in acids or bases to give salts of the acid or zincates (aluminates) of the base, respectively.

4. Neutral oxides are those which neither react to form salts nor combine with water to give acids or bases: carbon monoxide and nitrous oxide are examples, for although they result from formic and hyponitrous acids, respectively, by loss of water, they do not combine with water to give these acids and are therefore not acidic anhydrides.

5. Suboxides have less oxygen than the common lowest stable oxide, but the term is often loosely used. Carbon suboxide (C_3O_2) is one of the few true suboxides and is obtained by the dehydration of malonic acid, into which it can be converted again by water. At 200° C. carbon suboxide can be changed into a lower oxide, pentacarbon dioxide, C_5O_2. Some so-called suboxides (*e.g.*, lead suboxide, Pb_2O) are now considered to be mixtures (in this case, of lead and lead monoxide). Certain metals, particularly titanium, will yield solid oxides slightly deficient in oxygen or metal and are therefore nonstoichiometric; *i.e.*, they do not obey the law of constant composition. Such "deficient" oxides often show special electrical conductivity properties.

6. Higher oxides have more oxygen than the typical oxide as determined by the periodic classification and can be divided mainly into three groups: (a) peroxides, (b) superoxides and (c) dioxides.

a. Peroxides contain two oxygen atoms linked together to form the grouping —O—O— and usually occur in solid oxides as O''_2 ions. They are closely related to hydrogen peroxide (a neutral oxide), and the latter is formed when peroxides are treated with water or dilute acid. True peroxides are formed by metals such as sodium and barium (*e.g.*, Na_2O_2 and BaO_2). The peroxide link is also found in certain peracids (*e.g.*, persulfuric acid, $H_2S_2O_8$) and their salts. Many organic compounds can have the oxygen atom replaced by the —O—O— group, and these are known as organic peroxides (*e.g.*, diethyl peroxide, $C_2H_5—O—O—C_2H_5$). They are not very stable and can be used, like other peroxides, as powerful oxidizing agents. The formation of peroxides in the oxidation of gasoline in the internal combustion engine is well known, and diethyl peroxide is a "pro-knocking" agent.

b. The final oxidation products (KO_2) of potassium are known to contain the superoxide ion (—O—O—)–; such compounds, formerly known as tetroxides and written as M_2O_4[I], are called superoxides.

c. Certain other oxides, often termed peroxides, are of an entirely different type from true peroxides and contain the ordinary oxygen ion (O'') linked to the metal ion. Thus lead peroxide is now called lead dioxide since it shows no structural similarity with a true peroxide, but it is, of course, a strong oxidizing agent. Like manganese dioxide it reacts with an acid to give a salt of lower valency, *e.g.*, MnO_2[IV] $+ 4HCl = MnCl_2$[II] $+ Cl_2 + 2H_2O$, but not hydrogen peroxide.

The typical oxides of Group VII elements, Cl_2O_7 and Mn_2O_7, are not peroxides, but S_2O_7 (if it exists) would have more oxygen than the typical oxide of sulfur (SO_3 in Group VI) and might be expected to have some of the properties of a peroxide.

7. Metals that have two valencies can form oxides containing the metal in its two different valencies (*e.g.*, Pb_3O_4 and Fe_3O_4), and these mixed oxides will have some resemblance to complex oxides (see below). Thus Pb_3O_4 has been shown to have a crystal structure consisting of chains of tetravalent lead ions surrounded octahedrally by oxygen ions with divalent lead ions linking the chains together. The action of acids upon such an oxide will yield a mixture of compounds derived from Pb[II] and Pb[IV]: thus $Pb_3O_4 + 2HNO_3 = PbO_2$ [IV] $+ Pb(NO_3)_2$[II].

8. Complex oxides can be divided into two large groups: (a) those which contain oxyions (CO_3'', SiO_3'', etc.) and are more

strictly known as oxysalts rather than oxides; and (*b*) those which consist of aggregates of oxygen ions (O″) and positive metallic ions and are true complex oxides.

The latter will have different geometrical arrangements in their crystal form according to the relative sizes and numerical proportions of the constituents. As the oxygen ion is usually much larger than the metallic ion. there mill be a close packing of the negative oxygen ions with the positive ion or ions occupying the interstices between the oxygen ions.

Metals of the same size will yield complex oxides of similar crystal structure. since it is possible to replace one metal by another of a similar size: thus, in the spinels of general formula MAl_2O_4, the metal M can be Fe, Co, Ni, Mn or Zn, yielding a whole series of spinels. Where the metallic ion approaches the size of the oxygen ion a new geometrical arrangement will be necessary, and there are a number of possible structures; typical of these is the perovskite structure of the so-called titanates. $SrTiO_3$, etc.. in which the large Sr^{2+} or Ba^{2+} ions are closely packed with oxygen ions, and the smaller Ti^{4+} occupies the interstitial positions. The study of such structures is an important aspect of inorganic chemistry (for fuller details see A. F. Wells, *Structural Inorganic Chemistry*, 1951). The production of artificial minerals such as sapphires for use as bearings is an interesting industrial process. Mixtures of metallic oxides and oxides of metals with variable valency such as vanadium are of great importance in modern catalytical chemistry. for example, in the manufacture of sulfuric acid.

Many oxides combine with water to form hydroxides (see HYDROXIDE). and all hydroxides lose water on heating to give the corresponding oxide. The chemical properties of a hydroxide are almost identical with those of the corresponding oxide, but the latter is somewhat more inert, especially if it has been very strongly heated.

For further details *see* OXIDATION AND REDUCTION; *see* also H. B. Weiser, The *Hydrous Oxides,* "International Chemical Series" (1926).

(A. D. M.; F. H. P.)

OXIMES are organic compounds containing the group >C:NOH. They are obtained either by the action of hydroxylamine on an aldehyde or ketone (I). or by the action of nitrous acid or its esters on a compound containing a reactive methyl or methylene group (II). The products of the latter type of reaction are sometimes called isonitroso compounds, but they are all true oximes and the prefix oximino is better than isonitroso.

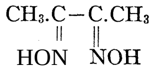
$$>C{:}O + H_2NOH \underset{\mathrm{I}}{\rightarrow} >C{:}NOH + H_2O$$

$$>CH_2 + O{:}NOH \underset{\mathrm{II}}{\rightarrow} >C{:}NOH + H_2O$$

Victor Meyer prepared the first oxime in 1878 and since that date the compounds have been of continued interest to organic chemists because of their value in identification and synthesis and still more so because of the stereoisomerism which occurs in certain classes of oximes (see STEREOCHEMISTRY).

Oximes are usually regarded as derivatives of aldehydes and ketones and thus are divided into aldoximes and ketoximes. Since they are solids which, apart from the simplest members. are insoluble in water and crystallize well. they are used to some extent for isolating and identifying aldehydes and ketones. The rate of oxime formation! however, is often somewhat slow. so that it is frequently more convenient to use derivatives of hydrazine. The oximes behave as weak acids and also as weak bases. They are reduced to primary amines, and this is a useful method for effecting the change $>CO \rightarrow >CHNH_2$. The aldoximes are dehydrated to nitriles by acid chlorides or anhydrides. $-CH{:}NOH \rightarrow -CN + H_2O$, a reaction which was of value in the early study of the structures of the simpler sugars. All oximes can be hydrolyzed by aqueous mineral acids, with varying ease, to the parent aldehyde or ketone and hydroxylamine, but they are stable to aqueous alkalies. The characteristic reaction of ketoximes, the Beckmann transformation! is discussed below.

Certain oximes form stable co-ordination compounds with metals and since there are marked differences in the solubilities of the oxime complexes of closely related metals. these oximes are valuable quantitative reagents in analytical chemistry. Only one example will be given here. Dimethylglyoxime (III). the dioxime of a diketone. forms a series of complexes with metals of which only those with nickel and palladium are insoluble in dilute alkalies and weak acids. It is, therefore, the standard reagent for determining these metals and. in particular, gives a quantitative separation of nickel from cobalt.

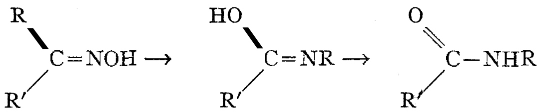


III

Stereochemistry of the **Oximes.**—From the point of view of the development of stereochemistry. the oximes are of great interest. In 1883 Hans Goldschmidt found that the dioxime of benzil (C_6H_5 CO CO C_6H_5) existed in two forms, and a third form was obtained by Victor Meyer in 1889. In the same year Ernst Beckmann found that an aldoxime, that of benzaldehyde. existed in two forms. Geometrical isomerism in unsaturated carbon compounds had already been recognized by J. H. van't Hoff and generally accepted. and in 1890 Arthur Hantzsch and Alfred Werner extended this ronception to compounds containing the group >C:N— and advanced the view that these isomeric oximes were geometrical isomers. This view is now known to be true. but it was not accepted by all at first and the ensuing controversy led to much experimental work which laid a solid foundation for fundamental knowledge in a wide field of stereochemical problems.

The Hantzsch-Werner hypothesis was that the oxime of an unsymmetrical ketone or of an aldehyde can exist in two forms which may be written:

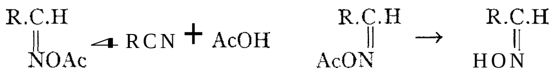
The isomerism mas held to be similar to that of compounds containing the group >C:C<. as nith maleic and fumaric acids The hypothesis implies two postulates: (1) that the hydroxl group is not placed symmetrically with respect to the carbon and nitrogen atoms. but lies to one side of the line joining them; (2) that there is no "free rotation" about the double bond between the carbon and nitrogen atoms, so that the tno forms are not readily interconvertible. There were several weighty reasons for the hypothesis. First. isomeric oximes should, and in fact do. occur only when the groups R and R′ are different: *i e*, in aldoximes and oximes of unsymmetrical ketones. If R and R′ are alike. the tno configurations are identical. Still another argument nas based on the Beckmann transformation of the ketoximes. This occurs when a ketoxime is treated with certain acidic reagents. notably phosphorus pentachloride in dry ether. The product obtained after treatment nith water is a substituted acid amide. 'There must be an exchange of groups, one originally attached to the carbon atom having changed places with that attached to nitrogen (see MOLECULAR REARRANGEMENTS).



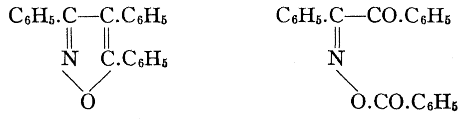
It was pointed out that with two isomeric oximes of formula RR'C SOH, the main product obtained from one isomer is the amide R'CO NHR, whereas the other gives the isomeric amide R CO NHR'. This is strong evidence that the isomeric oximes have the same structure but a different space arrangement

Many more facts later accumulated to support the view of Hantzsch and Werner and show that geometrical isomerism occurs in the oximes. Reference can be made to only a few. The truth of postulate (1), the unsymmetrical position of the hydroxyl group, was established by the ingenious and beautiful experiments of W. H. Mills (1910–31). In this work the aim was to prepare a compound which, if the postulate is correct, has a space configuration not superposable on its mirror image, so that it should exist in optically active forms, whereas, if the postulate is incorrect, resolution into optically active forms is impossible. Several such compounds have been resolved, and in one of them (Mills and B. C. Saunders, 1931) the molecule is such that the optical activity cannot arise from any known cause, probable or improbable, other than the unsymmetrical position of the group attached to nitrogen in >C:N—. A final argument which should be given is that if the isomerism is geometrical, it should occur in compounds containing this group other than the oximes. This is true, since isomeric hydrazones containing the group >C:N.NHR or >C:N.NR_2 are known.

The remaining point of interest is the question of the methods available for allotting configurations to a set of isomeric oximes. Such methods must clearly be based on reactions in which the isomers differ. Hantzsch and Werner pointed out that such reactions are known and applied them to this purpose. With aldoximes the acetyl derivatives of an isomeric pair differ in that one, when treated with aqueous sodium carbonate, is hydrolysed to the oxime, whereas the other eliminates acetic acid and gives a nitrile. If it is assumed that this elimination of acetic acid takes place with the oxime in which the acetpl and hydroxyl groups are on the same side of the double bond, the configurations follow:



Similarly with the ketoximes, they pointed to the two products of the Beckmann transformation mentioned above and allotted configurations on the assumption that groups situated on the same side oi the double bond (often described as in the syn-position) exchange places. Doubts as to the validity of the two assumptions made in these arguments were expressed as early as 1904 (P. Pfeiffcr), but the matter came to a head in 1921 when J. Meisenheimer published results showing that the oxidation with ozone of the compound shown in (IV) gives a derivative of β-benzilmonoxime and the latter must thus have the configuration corresponding to (V). On the assumption of Hantzsch and Werner, however, this is the configuration of the a-monoxime.



IV V

This discovery led to an extended series of investigations both in Germany and England, the aim being to establish the configuration of an oxime by some indisputable method, so that the validity of the original assumptions could he settled All results tended to show that the original assumption was wrong and that groups in the anti-position. and not the syn-, are involved in the Beckmann change. Similarly the configurations of the aldoximes have also been settled, and it has been shown that elimination of acetic acid in an acetyl derivative involves the groups lying across, and not on the same side of, the double bond.
(T. W. J. T.; G. W. WD.)

OXNARD, a city of Ventura county in southern California. U.S., is midway between Santa Barbara and Los Angeles, and about 4 mi. from the Pacific coast. Oxnard is the centre of a rich agricultural area noted for the production of lemons, avocados, strawberries, sugar beets, lima beans, walnuts and other vegetable crops. Industries include sugar processing, fish and vegetable canning, citrus packing, vegetable processing, oil refining and paper making. Harbour facilities have been developed at Port Hueneme, a deep water port 4 mi. S. of Oxnard. Port Hueneme is also the site of a U S. naval station. A naval air missile test centre is located at Point Mugu, 6 mi. S.E. of the city.

In 1898 the Oxnard brothers from Louisiana constructed a large sugar beet factory around which the town developed. Oxnard was incorporated in 1903 and in 1947 adopted a council-manager form of government. For comparative population figures *see* table in CALIFORNIA: *Population.* (R. H. BI.)

OXUS: *see* AMU-DARYA.

OXY-ACETYLENE TORCH: *see* **WELDING.**

OXYGEN is the most abundant of the elements, but its nature eluded the investigation of the early chemists. It was first produced about 1772 by K. W. Scheele, who obtained it by heating certain metal oxides, including mercuric oxide, and described it as "empyreal air." It was discovered independently in 1774 by Joseph Priestley, who also obtained it by heating mercuric oxide, and called it "dephlogisticated air," to denote that it had been separated from "phlogiston." the imaginary substance that was supposed to be the raw material of fire. It was first recognized as a chemical element by A. L. Lavoisier, in his 1775–77 experiments. He named it *oxygine,* later *oxygène,* from the Greek for "acid maker." explaining in his *Elements* of *Chemistry* that "one of the most general properties of this base is to form acids by combining with many different substances."

Lavoisier, however, subscribed to another scientific fiction of the era—"caloric," an intangible and weightless substance that was supposedly the cause of heat. He wrote that the union of oxygen and "caloric" produced "oxygen gas, which is the same with what was formerly called pure or vital air."

Oxygen is taken in from the atmosphere by plants and animals during respiration and given off as carbon dioxide. This process is counterbalanced in nature by the assimilation of carbon dioxide by green foliage and by the evolution of free oxygen (*see* CARBON, OXIDES OF). The atmosphere contains 21% by volume and 23.2% by weight of oxygen. Water contains 88.8% by weight, and there is about 50% of combined oxygen in the earth's crust. The chemical symbol is 0, the atomic number 8 and the atomic weight of the lightest isotope occurring in nature is arbitrarily taken as 15.9994 and serves as the standard with which the physical atomic weights of all other elements are compared. Natural oxygen contains two other isotopes, O^{17} and O^{18}, the relative abundance being $O^{16}:O^{17}:O^{18} = 99.76:0.04:0.20$. Three radioactive isotopes are known, O^{14}, O^{15} and O^{19}, but they are very short lived.

Oxygen is somewhat soluble in water (about 2.8 c.c. per 100 c.c. of water at ;lo° C.) and the solubility in sea water is only a little less. This dissolved oxygen is essentiai to fish.

Ozone (*q.v.*), with the chemical formula O_3, is an allotropic form of oxygen.

Preparation and Properties.—On a laboratory scale oxygen is commonly prepared by heating a mixture of potassium chlorate with about a third of its weight of manganese dioxide at 240° C. The manganese dioxide facilitates the decomposition. Various oxides. peroxides and oxygen-rich compounds such as mercuric oxide, barium peroxide and potassium permanganate also evolve oxygen when heated. The obsolete Brin process for obtaining oxygen from the air was based on converting barium monoxide to peroxide by heating it in compressed air and then raising the temperature and reducing the pressure to bring about the reversion of barium peroxide to the monoxide and oxygen.

The chief commercial source of oxygen is the atmosphere. Air freed from carbon dioxide is liquefied by compressing it and allowing it to expand through a nozzle. In this expansion, work is done, heat is lost and the temperature of the issuing gas falls. By a system of heat exchange the cooled gas, which has been expanded, is made to cool the air still under pressure and the cumulative cooling effect thus obtained leads to liquefaction of the air. The chief components of liquid air, oxygen (boiling point −182° C.), argon (b.p. −185.8° C.) and nitrogen (b.p. −195.8° C.), are separated by rectification of the liquid mixture. The principle is the same as that employed in the fractionating columns used in separating petroleum products. The liquid air is passed down a column fitted with numerous plates so designed as to give intimate contact between the gas ascending the column, and produced by the evaporation of liquid air at the bottom, and the descending liquid. The result is that the more volatile nitrogen and argon are evaporated from the liquid and the less volatile oxygen enriched in it. After a period of operation liquid oxygen is obtained at the bottom of the column and nitrogen at the top. (*See* NEON for an illustration showing fractional distillation of liquid air.) There are many modifications of this general process in commercial practice. They yield both oxygen and nitrogen of purity exceeding 99%. For many purposes oxygen is stored and transported as gas under pressure in steel cylinders, but the storage and transport of the liquid is also common. This is done in double-walled spherical Dewar vessels of spun copper with long narrow necks. The space between the walls is highly evacuated to prevent heat reaching the liquefied gas and may also contain absorptive charcoal, The latter, when cooled by contact with the cold surface, has the property of absorbing residual gas and so maintaining the vacuum. High polish on the metal surfaces also helps to prevent evaporation of the liquid oxygen. A 25-l. container loses by evaporation only about 5% of its full charge per day. A certain amount of oxygen is also obtained as a by-product in the manufacture of hydrogen by electrolysis; *e.g.*, in the electrolysis of aqueous caustic soda.

Oxygen forms a pale blue liquid (b.p. —182" C.). The critical temperature and pressure are —118.8" C. and 49.7 atm., respectively. Solid oxygen melts at —218.4" C. and exists in two crystalline modifications. Oxygen is paramarnetic in all its physical states. It behaves chemically as a bivalent element, forming a large range of compounds in which it is covalently bonded to other elements. These include the oxides of a number of nonmetallic elements (*e.g.*, H_2O, SO_2, SO_3, CO_2). In the lattices of many solid ionic oxides the element is present as the ion O^{2-} (*e.g.*, ZnO). Metallic superoxides and peroxides contain one or other of the ions O_2^- (as in KO_2) or O_2^{2-} (as in BaO_2). Oxygen is also a constituent of the molecules of a large number of chemical compounds of the most varied types. It is an element n-hich combines directly with most others, either at ordinary temperatures or on the application of heat. This process is known as oxidation: when oxidation is accompanied by the evolution of light as well as of heat it is termed combustion. (It should be noted that the chemist also uses the term oxidation in a n-ider sense.) Oxygen is estimated in a gas sample by absorbing it in an alkaline solution of pyrogallol and observing the diminution in volume. Alternative absorbents suitable for the quantitative estimation of oxygen are ammoniacal solutions of cuprous salts, alkaline solutions of sodium hydrosulfite, or yellow phosphorous.

Uses.—The chief industrial use of oxygen is for the fusion welding of metals; *e.g.*, steel, cast iron or aluminum, and for the cutting of steel. Welding is done with an oxyacetylene flame. the two gases being supplied to a special blowpipe in which they are mixed before combustion. The temperature of the inner core of the flame may reach about 4,000° C. and suffices to melt locally the metal surfaces to be joined. The exact procedure and the fluxing materials used depend on the metal to be welded. For cutting metal an oxyacetylene flame is again used but, whereas in welding it is important to minimize oxidation, it now becomes important to oxidize an-ay a certain amount of the metal. To accomplish this the cutting blowpipe is so designed that an auxiliary jet of oxygen is directed onto the heated metal. The oxyacetylene flame is also used in the descaling of steel billets and in the surface hardening of steel components.

Oxygen or oxygen-enriched air is being increasingly used in place of air in blast furnace operation. Liquid oxygen is also finding more and more technical applications. Porous charcoal or other absorptive and readily oxidizable material which has been impregnated with liquid oxygen forms a powerful explosive. The impregnation is done just before use. The explosive has the advantages that it automatically becomes dead through evaporation if it is not fired, and also gives rise to no harmiul gases. Liquid oxygen is used as an oxidizing agent in rockets using liquid fuel. The German V-2 rocket used liquid oxygen in conjunction with alcohol. Gaseous oxypen is often used to enrich the air breathed in the treatment of cases of pneumonia, gas poisoning, etc., and for admixture with nitrous oxide, ether and other anesthetics. It also finds a limited use as an oxidant in the chemical industry. It is also used in the continuous gasification of solid fuel. Oxygen admixed with steam is passed into the fuel bed and maintains a sufficiently high temperature to allow the water-gas reaction to proceed smoothly.
(H. J. Es.)

OXYTETRACYCLINE (Terramycin) is an antibiotic substance isolated from the growth products of the actinomycete bacterium. *Streptomyces rimosis*, when this microorganism is grown on suitable culture mediums. Terramycin. the proprietary brand of oxytetracycline, is useful in either killing or inhibiting the multiplication of a wide range of bacteria. a few rickettsiae, and large viruses and certain protozoan parasites. It is ordinarily administered orally. but map be used intravenously or locally in suitably prepared solutions. Since terramycin destroys the normal balance of intestinal bacteria, its use may result in various gastrointestinal disturbances. This is in addition to those reactions caused by irritation by the drug or sensitivity to it. Terramycin and its antibiotic activity was first described by A. C. Finlay and his associates in Jan. 1950.

See also Antibiotics and Antibiosis.

See monograph in *New and Nonofficial Remedies*, American Medical Association (1932). (Wr. H. B.)

OYAPOCK (Port. Oiapoque). is the river that forms the boundary between the Brazilian territory of Amapá and French Guiana. The river rises in the Guiana highlands and flows northeast for 311 mi. to empty into the Atlantic near Cape Orange. It is navigable only for canoes. The country through which it passes is very thinly populated, and mostly covered by an unbroken tropical rain forrst. (P. E. J.j

OYER AND TERMINER, the Anglo-French name, meaning "to hear and determine," for one of the commissions by which a judge of assize sits (*see* Assize). By the commission of oyer and terminer the commissioners (in practice the judges of assize, though other persons are named with them in the commission) are commanded to make diligent inquiry into all treasons, felonies and misdemeanours whatever committed in the counties specified in the commission. and to hear and determine the same according to law. By the Treason act of 1708 the crown may issue commissions of oyer and terminer in Scotland for the trial of treason and misprision of treason. In the United States oyer and terminer is the name given to courts of criminal jurisdiction in some states; *e.g.*, New Tork, New Jersey. Pennsylvania and Georgia.

OYO, the capital town of the Oyo province of the western region of Nigeria. Africa. lies 33 mi. N. of Ibadan. Pop. (1952) 72.133. Xtiba hall in the Akesan market was opened in 1941 and St. Andrew's college, which is the premier teachers' training college in Nigeria and is run by the Anglican mission, was founded in 1897. The Shango shrine at Koso is a ceremonial place for Shango worshipers and plays a principal part in the installation of a new *alafin* of Oyo. Shango was a mythical early king of the Yoruba (*q.v.*), later deified as the god of thunder and lightning. Oyo is on the main road from Ibadan to Ilorin and the north. Agriculture is the chief occupation of the people but there are local crafts of leatherworking and wood carving.

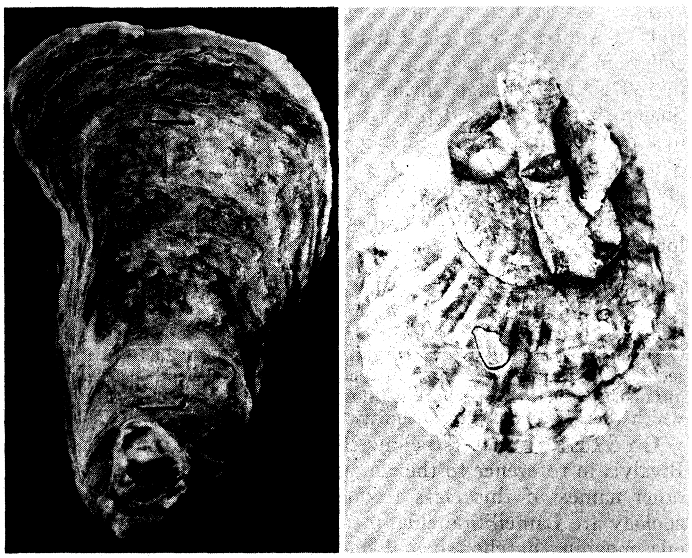
The Oyo kingdom was the most important and authoritative of all the early Yoruba principalities. It broke up at the end of the peaceful reign of Alafin Abiodun in 1839. The site of the former centre. now known as Old Oyo, a-as about 115 mi. N. of the present town. Though Oyo retains some of its traditional pomp, the *alafin* has only nominal secular suzerainty over the Yoruba chiefs, the spiritual head being the ***oni*** of Ife (*q.v.*), from where is taken to Oyo the sword of state through which the *alafin* receives authority at his coronation. (S. A. Y.)

OYSTER. Oysters belong to a large class of mollusks called Bivalvia in reference to their hinged double shells or valves. Two other names of this class frequently found in the textbooks of zoology are Lamellibranchia, meaning platelike gills! and Pelecypoda. meaning hatchet-shaped foot (*see* also Mollusca). In the course of evolution certain bivalves lost their foot and some of them. including all oysters. lost the ability to move. A relatively large foot. used in swimming and crawling, is present in oyster larvae but disappears after the larvae attach to submerged objects (setting). Bivalves without the foot have only one muscle which they use for closing the valves while all others have two muscles. one anterior and one posterior.

The distribution of oysters is limited by the latitudes 64° N. and 44° S. Within this broad belt they occur in shallow inshore waters of all the continents. The adults rest on bottom or are attached by their left valves to rocks or submerged objects.

In the 18th and 19th centuries all oysters were considered belonging to one genus *Ostrea.* On the basis of shell structure. anatomy and their mode of living oysters are now separated into three genera. *Ostrea, Crassostrea* and *Pycnodonte. Ostren* is represented by the circular, flat oysters of the type of European edible oyster, *0. edulis,* and small Olympia oyster of the Pacific coast of the U.S., ***O.*** *lurida.* These species prefer clear, relatively cool water; their eggs and sperm are produced by the same individual (hermaphrodite); and the eggs are incubated inside the brood chambers of the gills (larviparous). The genus *Crassostrea* comprises many species characterized by a deep, left valve and the presence of a promyal chamber. an irregularly-shaped space on the right side of the body. The sexes are separate but may change These oysters are oviparous *i.e* , they discharge unfertilized eggs nhich develop in the sea. The typical representatives of the genus are *Cuassostrea virginica* of the Atlantic coast of North America; *C. angulata,* the Portuguese oyster of the western coast of Europe; *C. gigas,* the large rapid growing oyster of Japan; *C. cucullata* of India; *C. commercialis* of Australia and New Zealand; and C. *chilensis* of the Pacific coast of Central and South America. The genus *Pycnodonte,* native to Australian coasts is an oviparous oyster with large and heavy shells and an internal anatomy that differs from the other genera — their heart surrounds the rectum.

Structure and Functions of **the Oyster.**—The shell completely surrounds the soft body of the oyster. Its hinged narrow part marks the dorsal end; the shells are broad and rounded where they open ventrally. The shell, secreted by the mantle, a soft membrane underlying the valves, consists primarily of calcium carbonate laid between the thin layers of an organic substance known as conchiolin. The two flaps of the mantle are joined together and embrace the body on the anterior and dorsal sides but leave the ventral edges free. Two rows of tentacles along each free border of the mantle guard the body. Mechanical disturbance, change in illumination or presence of irritating substances are sensed by the tentacles; the stimulus is conveyed through the nerves of the mantle to the muscle which closes the shell.



BY COURTESY OF U.S. BUREAU OF COMMERCIAL FISHERIES

LEFT. MOUNTED SHELL OF ATLANTIC COAST OYSTER. CRASSOSTREA VIRGINICA, (22 CM. LONG). PROBABLY OVER 20 YEARS OLD WITH SHELL OF 2 TO 3 YEAR OLD OYSTER ATTACHED TO IT (BOTTOM). RIGHT. SHELL OF 2f YEAR OLD CRASSOSTREA VIRGINICA (ABOUT 6 X 6 CM.) WITH BARNACLES ATTACHED TO IT

The adductor muscle is the most conspicuous organ of the oyster. It occupies a slightly asymmetrical position and its place of attachment to the shell is often dark coloured. This muscle consists of a crescent-shaped, white posterior part and slightly darker, translucent anterior part. The latter is made of fibres which contract more rapidly than the fibres of the opaque portion of the muscle and hold the valves in any position to which they are brought by the contraction of the posterior part. The maintenance of the muscle tonus at any particular level of contraction is attributed to the so-called locking mechanism of the adductor. When the muscle relaxes, the springlike action of the elastic ligament at the narrow end of the shell forces the valves apart. Observations show that in the presence of harmful substances in the water those oysters which remain closed for a longer time have better chance to survive than those which open more frequently. *C. virginica* may remain in good condition for about four months if kept in air at a temperature a few degrees above freezing. Warming, shaking or rough handling causes the adductor to relax; the valves gap, the water retained inside the shell is lost and the oyster soon dies.

The power of the adductor muscle varies with the size and condition of the oyster. Continuous pull equal to 22 lb. applied to the shell proved to fatigue the muscle of an adult American or Japanese oyster in less than an hour, but at least 17 days were needed to attain the same effect with the pulling force of 2.2 lb. A force of from 26 to 33 lb. is required to tear off the muscle of these oysters.

A pair of gills (branchiae) are located under the mantle on the ventral side of the oyster. They are attached by their bases to the body (visceral mass), while their distal edges are free. Each gill consists of two plates (lamellae), I^{T}-shaped in a cross section. Space between the plates is called the interlamellar cavity. In a cross section of the body each gill appears as a W joined by the right and left limbs. Each gill plate is formed by many tubular filaments arranged in a series of folds (plicae) which give the gill a pleated appearance. The filaments are kept together by a series of horizontal shelves which form interfilamentar junctions. The outer and inner lamellae of each plate are joined together by partitions (septae) which divide the interlamellar cavity into a series of water channels opening into a wide passage known as the suprabranchial chamber. The latter leads to the cloaca through which the water is discharged to the outside. In *Crassostrea* the water from the anterior half of the right gill is discharged through a space known as promyal chamber. This asymmetrical chamber is not found in the oysters of other genera. Free spaces between the filaments form oval-shaped openings, ostia, surrounded by powerful cilia ahich beat inward and force the water to enter the gill. Filaments supported by an inside framework of chitinous rods contain blood vessels, muscle fibres, connective tissue and nerves. The surface of the gill is covered with ciliated epithelium and mucous cells. The entire gill can be compared to a folded sieve through which the water is strained. A complex system of currents along the gill surface carries the food particles toward the terminal grooves at the free edge of gill lamellae and in the opposite direction to the base of the gills. In both places they are picked up by the currents which transport them along the length of the gill to the mouth. Water pumped by the gills provides food and oxygen. This vital function is regulated by changing the rate of ciliary motion of gill epithelium and by increasing or reducing the space between the valves through which the water is sucked in.

The rate of pumping of water or ventilation of the gill can be accurately measured and recorded by the methods developed in U.S. laboratories. Large C. *virginica* were reported to pump as much as 37 qt. (35 l.) per hour at temperatures of 71.6°–78.8° F.; the average rate at this temperature is about 15–16 l. With the onset of the cold season the pumping slows down and ceases at about 42.8" F. (hibernation).

Oxygen consumption by *C. virginica* kept at 77° F. is low; in an oyster about 4 in. long (10 cm.), it varies from 2 to 6 ml. of O_2 per hour. The food consists of minute algae and other microorganisms. In feeding, the oyster rejects the particles of unsuitable size or shape and those otherwise undesirable. Sorting begins on the surface of the gills and is finally accomplished on the folded inner surfaces of labial palps which border the mouth.

Gills play an important role in the female spawning of oviparous oysters. Violent shell movements which accompany female spawning force the eggs, discharged from the ovary, to pass through the channels of the gill and ostia and accumulate in the mantle cavity. Ensuing sharp movements of the valves eject and disperse them in the water and also draw in water containing sperm. In this way the chance for fertilization of eggs is greatly enhanced.

The alimentary canal begins with the mouth, which is situated at the dorso-anterior part of the body and surrounded by two pairs of triangular palps. A narrow esophagus opens into the stomach, a large, saclike structure with several pouches or outgrowths protruding from its sides. A finger-shaped posterior outgrowth contains the crystalline style, a gelatinous rod about one-half inch long with a broad head projecting into the stomach. The crystalline style is not a permanent structure; it is always present in the actively feeding oysters but disappears shortly after their removal from water. The style rotates in its sack, mixing and grinding small food particles caught between its head and the gastric shield—a cuticular structure which lines the left side of the inner wall of the stomach. The style contains amylase, the enzyme which digests starch and glycogen, and several oxidases.

A short mid-gut leads from the stomach into the intestine; after making a forward loop. it continues backward into the rectum which opens into the cloaca. Feces discharged through a narrow anus are washed away by the outgoing current running through the cloaca. Time needed for food to pass through the entire alimentary canal of an adult C. virginica varies from 90 to 1jo min. (at 68° F.).

A large brownish mass of digestive gland surrounds the stomach. It consists of numerous blind tubules (diverticula) kept together by connective tissue and lined by irregularly shaped epithelial cells.

Blood cells (phagocytes), always present in the tubules, engulf the food and digest it inside their bodies. Proteolytic enzyme and lipsse have been extracted from digestive organs of oysters, but the question of whether these enzymes are secreted by the gland itself or are liberated from the phagocytes has not been settled.

The circulatory system consists of the heart, arteries, sinuses and veins. The heart has one ventricle and two auricles. The rate of pulsation varies in C. virginica from 15 to 24 beats per minute at 64.4°–68° F. and decreases as the temperature drops. When the oyster closes its shell, the heart beat slows to two or three times per minute regardless of temperature. Through the arteries blood enters the irregular spaces in the tissues (sinuses) from which it flows into veins and back to the heart. An accessory heart, a large vessel at the base of the right and left halves of the mantle, beats independently of the heart and agitates the blood within the mantle.

C. virginica contains no hemocyanin or other blood pigment. The blood cells (amoebocytes and phagocytes) are capable of amoeboid movement and often aggregate on the outer surfaces of gills and mantle (diapedesis) and are discarded.

One pair of visceral ganglia and a smaller pair of cerebral ganglia, with the connecting commissures and branches, constitute the nervous system. A large circumpallial nerve runs along the free edge of the mantle. The structure of commissures and circumpallial nerve resembles that of the ganglia. They consist of numerous nerve cells located mostly along the periphery and of nerve fibres occupying a more central position. Sense organs consist of a series of tentacles which readily respond to various stimuli and of a pallial organ, a small bulge on the side of the adductor muscle inside the cloaca covered by tall ciliated cells. Its function is not known.

The excretory system is formed by a pair of nephridia situated close to the adductor muscle and to the pericardium with which they communicate. They open into the suprabranchial chamber.

The sex organs (gonads) are made of many branching follicles forming a creamy layer around the visceral mass. Each follicle is lined with germinal epithelium from which the sex cells develop. The degree of gonad development varies greatly, depending on the environment. Sexes in the oyster are not stable, and the changes of sex occur in all the species studied. In fiat oysters of *O. edulis* type this change is rapid, the sperm beginning to develop a few days after the egg spawning so that cells of both sexes are present simultaneously (hermaphroditism). In cuplike oysters the change of sex in either direction takes place during the winter resting phase. Observations conducted by P. S. Galtsoff showed that in New England waters about 10% of adult oysters change their sex annually. Young C. virginica are predominantly males, but toward the end of the first year some of them change into females and a 1:1 ratio is established.

Larvae swim freely in water for 2 to 3 weeks (C. virginica, *gigas*). At the end of this period they cement themselves (set) on rocks, piles or on clean surfaces of shells or other material (cultch) spread over oyster grounds by oyster farmers. Those that fail to set perish.

Chemical Composition.—The meat of the oyster consists of proteins (8%–11%), carbohydrates (3.7%–9.6%), glycogen (0.4%–9.5%), fat (1.2%–2.5%j, mineral salts (ash, 0.9%–3.0%) and large quantities of water (76%–89%). Paramyosin, a muscle protein found only in bivalves comprises the bulk of the adductor muscle; actinomyosin, the contracting muscle protein forms only a minor fraction of it. Paramyosin is primarily concerned with the locking mechanism of the muscle. The following inorganic constituents are usually present: sodium, potassium, calcium. magnesium, chlorine. bromine, phosphorus and sulfur.

Many of the heavy metals such as iron, copper, zinc, manganese and iodine are always present in variable quantities, and oysters grown in nater contaminated by industrial nastes may accumulate large amounts of iron and copper and appreciable quantities of arsenic and lead. Excessive accumulation of copper produces a green discoloration and renders them unpalatable. The green colour of the European oyster, however. is cdused by the absorption of a bluish-green pigment of a diatom, *Nitzschia,* which abounds in oyster grounds and is eaten by the oyster.

The chemical composition of the meat changes from season to season and varies somewhat in oysters from different localities. Oysters may be eaten at any season of the year. The so-called "r" rule (that oysters should be eaten only during months in which the letter "r" occurs) probably originated from the observations that during the summer oysters are watery and contain but little glycogen. They can be eaten. however, without any danger to human health. Oyster meat is a low source of energy; an average serving of six raw C. virginica yields only about 60 calories.

Parasites and Commensals.—Oysters harbour many parasites. The most dangerous among them is *Dermocystidium marinum,* a funguslike microorganism which attacks the internal organs and may cause death. Trematode worms, *Bucephalus haimeanus* and B. *cucullus,* infest oysters and destroy their gonads. A parasitic copepod, *Mytilicola* orientalis, sometimes attacks *O. lurida* of the Pacific coast without causing serious injury to the host. The common oyster or pea crab, *Pinnotheres* ostreum, for a long time considered a harmless commensal living on the gills of C. *virginica,* may inflict serious damage to the oyster and even cause its death. Many other invertebrates such as several species of boring sponge (*Cliona*) and boring clam (*Martesia*) damage the oyster shell and are thus injurious. Mud worms, Polydora *websteri* and P. *ligni,* settle on the inner side of the shell, collect mud and cause the formaticn of mud blisters. The slipper shell, *Crepidula* fornzcata, and jingle shell (*Anomia* species) settle sometimes in an incredibly large number on the shells of oysters and become a great nuisance to oyster growers. Many Bryozoa, barnacles, ascidians and other invertebrates grow on oyster shells and occupy all the space that could have been available for the attachment of oyster larvae. *Eliminius* modestus, a barnacle incidentally introduced to British waters from the southern hemisphere, is particularly troublesome in this respect.

Predators.—Among the enemies preying on oysters the most destructive are the various species of snails which bore through the shell by the use of a rasplike radula (*Urosalpinx, Tritonalia,* Thais and other snails commonly known as screw borers, or drills) or break the valves by inserting betneen them a sharp edge of their own shell (nhelks of the genus Busycon). Pyramidellid snails, *Odostomia* (*Menestho*) in America and *Chrysallida* in Europe, settle at the very edge of the shell, wait for the oyster to open, insert their proboscis and suck its blood. In spite of their small size, not exceeding about .2 in. (5 mm.), Chrysallida seriously damages European oysters and *Odostomia bisuturalis* interferes with the growth of young American oysters. Polyclad worms, Stylochus *frontalis, S.* ellipticus and *Pseudostylochus* ostreophagus (on the Pacific coast of the U.S.), destroy large numbers of adult and young oysters. New England oystermen wage continuous warfare against the starfish Asterias forbesi by removing it from the bottom with tangle mops and suction dredges. Skates and drumfish are kept anay from oyster grounds by fences.

Pollution and **Sanitary** Control.—The discharge of industrial wastes into coastal waters often causes the destruction or poor growth of oysters.

The discharge of untreated domestic sewage into natural waters rarely kills the oysters, but it renders them unmarketable. The suitability of grounds for harvesting shellfish for human consumption is determined by a bacteriological examination of water. No shellfish is permitted to be taken from any area which contains more than 70 *Escherichia coli* in each 100-c.c. sample of water. This harmless bacterium flourishes in human intestines and is therefore a reliable indicator of pollution. Oysters from moderately polluted areas may be purified by chlorination, a process used in the U.S. and England. It consists in washing and disinfecting the outside surfaces of the shells with chlorinated sea water, then placing the oysters for self-purification in sterile water containing no residual chlorine. The disposal of radioactive waste from nuclear reactors presents a serious problem because some of the radio-isotopes of metals are readily accumulated by the tissues of mollusks and may render them dangerous for human consumption.

Oyster Farming. — Long before the Christian era, the Chinese were cultivating oysters, and Romans successfully used artificial methods of growing them to satisfy the refined tastes of their epicures.

During the 20th century the progress of biological research and food technology made possible rapid advancement in oyster farming. Many thousands of acres of barren sea bottom were converted into fertile farms under water; the quality of oysters was improved, new harvesting implements were invented, and reliable methods were developed for the preservation of oyster meat by canning, freezing and smoking.

Oyster farming consists of the following operations: (1) selection of suitable bottoms, clearing them of debris and predators and, if necessary, reinforcing them with shells or gravel; (2) planting a sufficient number of adult oysters (spawners) for breeding; (3) scattering clean shells (cultch) or collectors over the bottom or on tidal flats for the attachment of oyster larvae; (4) transplanting young oysters (seed) to growing and maturing grounds; (5) protecting the oysters against predators; and (6) harvesting. Grounds upon which larval oysters set in great abundance may not be suitable for the growth and fattening of market stock and vice versa. These peculiarities of oyster habitat must be studied and determined by field tests.

A crucial problem of oyster farming is the scarcity of seed oysters aggravated by extensive mortalities. Seed oysters are harvested from natural oyster beds or are obtained by scattering clean oyster or clam shells for the attachment of larvae. In the state of Washington the producers of the Pacific oyster depend on the import of large quantities of seed of C. *gigas* from Japan. European oyster growers developed elaborate methods of obtaining seed on tile or brush collectors set on tidal flats. In Japan young oysters are collected on garlands of shells strung on wire and suspended from poles exposed at low water.

Several empirical methods of predicting time of setting have been suggested. For instance, in the Netherlands the breeding of *O. edulis* may be expected to begin when water temperatures reach 59° F. and the release of larvae to occur periodically in June and July, ten days after the full and new moon.

No lunar periodicity in breeding was observed in *C. virginica.* Spawning of this oyster in Long Island sound usually begins between June 1 and 8, and setting may be expected about 18 days later. Deviations from normal air temperatures through Jan.–April along the Pacific coast of the U.S. determine the time of setting of the native oyster, O. *lurida*.

Artificial Raising of Larvae. — Larvae of C. *virginica, gigas* and O. *edulis* have been artificially raised in laboratories. Fertilized eggs of the first two species may be obtained by stimulating spawning in ripe females by adding sperm to the water and increasing the temperature. In a few hours, fertilized eggs develop into minute larvae which hatch out and swim in water. They are given food which consists of various small flagellates and unicellular algae. Cultures of these microorganisms must be prepared in advance. Laboratory methods of artificial raising of larvae were so perfected by 1960 that experimental breeding of oysters became possible.

Introduction of Foreign Species. — The American oyster, *C. virginica,* was planted in northern Europe, and unsuccessful attempts were made to establish this species in the waters of the Pacific coast. The Portuguese oyster, *C. angulata,* was accidentally introduced into the waters of the west coast of France and established itself in the area formerly occupied by O. *edulis*. *O. edulis* raised from fertilized eggs in the laboratory of the Bureau of Commercial Fisheries in Connecticut was planted and established itself in the coastal waters of Maine. Most spectacular was the case of the introduction of the Japanese species, C. *gigas,* into Puget sound and adjacent bays of the American coast where this oyster is successfully cultivated on a large scale. C. *gigas* was planted with fair success in Australia. In several instances the introduction of a foreign oyster was followed by a spread of new predators, which became destructive to local shellfish.

The Japanese snail, *Tritonalia japonica,* brought into Puget sound with the first shipments of seed oysters from Japan, became a serious pest; and the American oyster drill, *Urosalpinx cinerea,* brought into England, became a serious menace to native O. *edulis*. Introduction of any foreign species of oyster must be carefully supervised to avoid such dangers.

Further physiological studies of food and feeding, fattening, respiration and growth are needed to place oyster farming on a sound scientific basis. These problems are studied in numerous oyster laboratories established in western European countries, Japan, Australia, the Philippines, the U.S. and Canada.

Marketing. — Oysters sold in their shells are usually consumed raw (half shell trade). In the U.S. a considerable portion of raw oysters are opened at the oyster houses; the meats are thoroughly washed in water and packed in cardboard containers which may be kept on ice for several days (shucked oysters). Canned oysters are produced by steaming the oysters in large vats, removing the meats, packing and sealing them in metal cans and cooking them under ten pound pressure (240° F.) for 30 or 40 minutes. Some companies specialize in producing smoked oysters packed in oil. Small quantities of oysters are frozen.

Pearls. — Edible oysters have no true pearls. Occasionally, round calcareous concretions may be found in their bodies; they have no lustre and are worthless. True pearl oysters, the genus *Pinctada,* inhabit warm waters of the tropics. They differ from the edible oysters by the presence of a tuft of filaments (byssus) by which they attach themselves to the substratum, and by a number of other characters. The inside of their shell is lined with layers of an iridescent nacreous substance absent in the shells of edible oysters.

See also MOLLUSCA.

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OYSTER BAY, a village of Nassau county, New York, U.S., situated at the foot of Oyster Bay harbour on the north shore of central Long Island. The village of Oyster Bay was first settled in 1653 by a group of English families from Connecticut and Massachusetts. The land was bought from the Matinecock Indians and the only battle between colonists and Indians in the history of Long Island took place within the village area during the first years of settlement.

In the early 19th century Oyster Bay was essentially a rural village, although its harbour was used extensively by the whaling industry which flourished in that section of Long Island during the period. A significant change in the character of the community occurred during the late 19th and early 20th centuries when the land surrounding the village was developed into great estates by industrial and financial leaders. Estates owned by Louis Tiffany, Arthur Weeks, Charles Theirot, William Coe, John

Schiff, George Maxwell, F. W. Woolworth and others gave Oyster Bay a "Gold Coast" reputation In addition, "Sagamore Hill." the three-story home and summer White House of Pres. Theodore Roosevelt, contributed to Oyster Bay's fame.

Later in the 20th century the era of the great estates began to pass, particularly after the depression decade of the 1930s The area continued to be essentially residential and resisted all attempts to increase industrialization or even to extensively settle the village with smaller homes. Shipbuilding, oystering, oil distribution. sand and gravel excavation and plastics were the only industries carried on within the village area.

Places of interest in Oyster Bay include Sagamore Hill, nhich is open to the public; Raynham Hall, the white salt box home of Sally Townsend aho helped save West Point from the British during the American Revolution; the Roosevelt bird sanctuary; and Wisteria house, which was built in 1660. The population is about 5 000. (Wi. M D.)

OYSTER CATCHER, or mussel picker, is a large shore bird, allied to the plovers. These thickset birds composing the family Haematopodidae, are scattered on the seacoasts from Iceland to the Red sea. The common oyster catcher (*Haematopus ostralegus*) is conspicuous in both sexes by its black and white plumage, pinkish legs and long orange-red beak. It feeds largely on marine worms, crustaceans and mollusks and is very wary. The hen lays three clay-coloured eggs blotched with black, usually on a shingle bank near the sea. The young are at first clothed in protectively coloured down and can run at once.

ERIC HOSKING

COMMON OYSTER CATCHER (HAEMATOPUS OSTRALEGUS) OF EUROPE

Usually seen in pairs, oyster catchers sometimes congregate in large flocks. The courtship consists of a dance in which one or both birds run around piping. Sometimes this dance, losing its original significance, is performed as a social function by a number of birds.

The American species (H. *palliatus*) has a longer bill and less white on the back, and its piercing call note differs from the musical trill of the European bird. Various other species occur, some of which are entirely black.

OYSTER PLANT (VEGETABLE OYSTER): *see* SALSIFY.

OZANAM, ANTOINE FRÉDÉRIC (1813–1853), French scholar was born at Milan on April 23, 1813. Antoine studied law at Paris, nhere he joined the Ampère family, Chateaubriand, Lacordaire, Montalembert and other leaders of the neo-Catholic movement. In conjunction with other young men he founded in May 1833 the celebrated charitable society of St. Vincent de Paul, which numbered before his death more than 2,000 members. In 1840 he became assistant professor of foreign literature at the Sorbonne and in 1844 full professor. He died at Marseilles on Sept. 8, 1853. Ozanam was the leading historical and literary critic in the neo-Catholic movement in France during the first half of the 19th century. In contemporary movements he was an earnest advocate of Catholic democracy and socialism, and of the view that the church should adapt itself to the changed political conditions consequent to the Revolution.

His works were published in 11 volumes (1862–65). They include *Deux chanceliers d'Angleterre, Bacon de Verulam et Saint Thomas de Cantorbéry* (1836); *Dante et la philosophie catholique au XIIIème siècle* (1839; 2nd ed., enlarged 1845); *Études germaniques,* 2 vol. (1847–49), translated by A. C. Glyn as *History of Civilization in the Fifth Century* (1868); Documents *inédits pour servir à l'histoire de l'Italie depuis le VIIIème siècle jusqu'au XIIIème* (1850); *Les poètes franciscains en Italie au XIIIème siècle* (1852). His letters were partially translated into English by A. Coates (1886).

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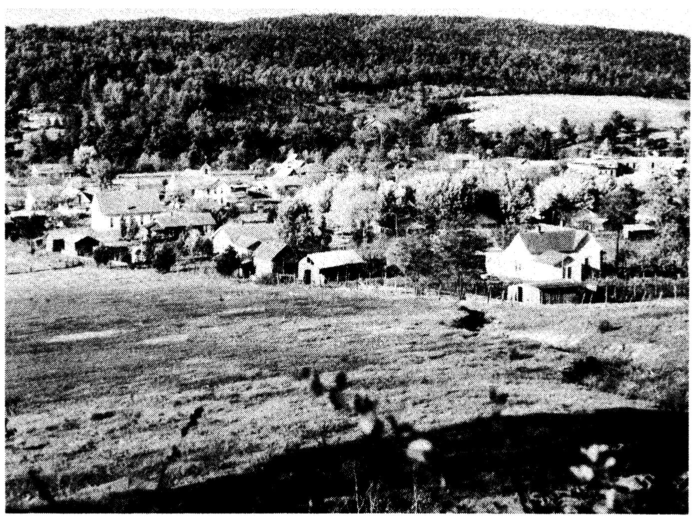
OZARKS. The Ozark highlands are a moderately rugged, heavily forested group of highlands extending southwestward from St. Louis. Mo., to the Arkansas river. Their total area is estimated at 50,000 sq.mi., of which 33,000 sq.mi. are in southern Missouri, 13,000 in northern Arkansas, 3,000 in northeastern Oklahoma and the remainder in southern Illinois and southeastern Kansas. The Ozarks and the adjacent Ouachita mountains (*q.v.*) comprise the only large area of rugged topography between the Appalachians and the Rockies; however, transition from plain to highland is very gradual except on the south and southeast.

The highland is a domal structure composed of an igneous core and gently tilted sediments, primarily limestones. The granites and porphyries of the core are exposed only near the eastern edge, where they form the isolated peaks and knobs of the St. Francois mountains. One knob, Taum Sauk in Iron county, is the highest elevation, 1,772 ft., in Missouri. The domed sediments have been elevated irregularly and have been subjected to varying degrees of weathering, erosion and underground solution. To the west, the Springfield plateau has undergone little erosion; to the east, the plateau surface has been maturely dissected. forming a rough hilly region, the Salem upland. To the south, the Boston mountains, the highest of the Ozarks, have been magnificently sculptured by the White and Arkansas rivers into a bold, mountainous escarpment with many elevations over 2,250 ft.



EWING GALLOWAY

JASPER. ARK. A SMALL VILLAGE IN THE BOSTON MOUNTAINS. SOUTHERN OZARKS

The Ozarks have a smaller population and less wealth than the surrounding lowlands. However, its natural beauty is the basis for a substantial summer tourist trade, and the lead and zinc mines in the tri-state district and southeastern Missouri are leading U.S. producers.

See C. O. Sauer, *The Geography of the Ozark Highland of Missouri* (1920); Wallace W. Atwood, *The Physiographic Provinces of North America*, pp. 235–250 (1940). (A. W. SM.)

OZOCERITE (OZOKERITE), from the Greek meaning "odoriferous wax," is a native wax composed chiefly of solid paraffinic and cycloparaffinic hydrocarbons. Large deposits of ozocerite occur in Galicia, Rumania: Russia and Utah; specimens are found in many other localities. The Galicia and Utah deposits have been mined; peak production of the Galicia mines was about 20,000 tons annually. Production dropped far below this figure after 1940 because of competition from paraffin wax prepared by cooling high-temperature distillation fractions of petroleum.

Ozocerite usually occurs as thin stringers and veins that fill rock fractures in tectonically disturbed areas. It is believed to have separated from paraffin base petroleums which percolated through the rock fissures. In Utah, ozocerite is still being deposited from liquids exuding from fissures exposed in mine drifts. In many respects the paraffin "scale" deposited on borehole walls of oil wells resembles ozocerite. (See also GEOCHEMISTRY: *Bioliths.*)

Native ozocerite is light yellow to dark brown in colour. It ranges in hardness from less than 1 to 2 on Mohs' scale (*q.v.*); specific gravity varies from 0.85 to 0.95 and the melting point from 58° to 100° C. It is soluble in turpentine, toluene, benzene, carbon disulfide. chloroform and ethyl ether.

Mineral impurities are separated by boiling mined ozocerite in water; the wax rises to the surface and is refined by treatment with sulfuric acid and decolorized with charcoal. Ozocerite has a higher melting temperature than typical synthetic petroleum wax, a desirable property in the manufacture of carbon paper, leather polishes, cosmetics, electrical insulators and candles. (S. R. SN.)

OZONE is a bluish gas with a distinctive, penetrating odour. An allotropic form of oxygen, it has the chemical symbol O_3. Ozone is a powerful oxidizer, and is used commercially as an antiseptic and bleaching agent. In the earth's atmosphere, where it occurs naturally in very small amounts, ozone plays a crucial geophysical role because of its intense absorption of solar ultraviolet radiation.

M. van Marum in 1785 noted and reported a peculiar smell in the vicinity of electrical machines. However, it was not until 1840 that C. F. Schonbein recognized clearly that the odour signaled the presence of a new gas to nhich he gave the name ozone. after the Greek *ozein,* meaning "to smell." The chemical composition of this gas was uncertain until the definitive work of B. Brodie in 1872 established it as the triatomic molecule of oxygen.

Ozone finds limited commercial use in a variety of applications As a nater-purification process, ozonization is less prevalent than the cheaper chlorination method; however, its superior ability to eliminate objectionable tastes and odours has led to its adoption in some locations, for example, Philadelphia and Paris. Ozone is used as an oxidant in certain chemical processes: to bleach oils, fats and textiles; to eliminate harmful compounds in industrial wastes; and to control bacteria in cold-storage rooms (as for eggs, fruits and meats). In air-conditioning systems, the use of ozone permits a reduction of the amount of outside air needed for recirculation.

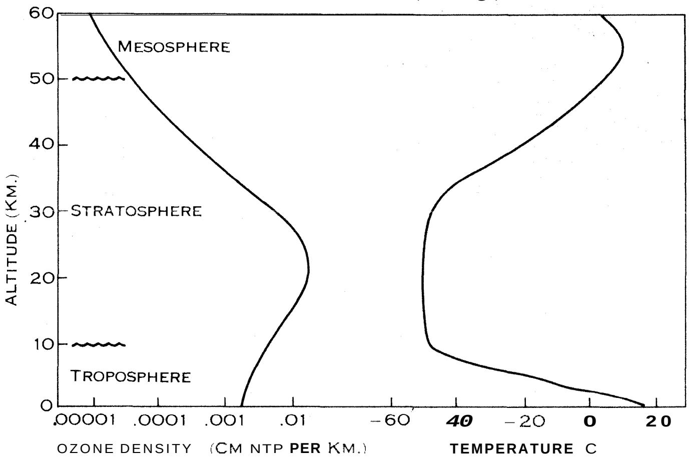
In sufficient concentration, ozone corrodes organic matter, such as rubber and cork. Continued human exposure to concentrations greater than 1 part per 1,000,000 (by volume) is considered hazardous, and irritation to the respiratory tract may follow from smaller dosages. The natural concentration of ozone near the earth's surface, while highly variable, does not reach dangerous levels. However, abnormally high concentrations have been noted in some areas, presumably as a result of combustion products of industry and automobiles. For this reason, the U.S. public health service constantly monitors the ozone concentration in these areas, for example, Los Angeles.

Ozone has a molecular weight of 48.000, a specific gravity (air = 1) of 1.658, and a boiling point of −112° C. It is slightly soluble in water, more so in oil of cinnamon and oil of turpentine. In liquid form, it is dark blue in colour and highly explosive. The usual commercial technique of producing ozone involves a silent electrical discharge through oxygen or dry air; this forms a dilute mixture of ozone and the parent gas. In some commercial applications, oxygen or air is exposed to ultraviolet light, usually from a quartz lamp, to form ozone. Ozone may also be formed by the electrolysis of acidulated water, by some chemical reactions, and by the slow oxidation of many substances.

In the usual method of detecting and measuring ozone, the oxygen-ozone mixture is passed through a neutral solution of potassium iodide. Unlike oxygen, ozone reacts with the potassium iodide to form iodine. The amount of liberated iodine is then measured amperometrically; this gives a measure of the amount of ozone in the sample. Ozone concentration may also be measured photometrically, as a consequence of ozone's intense absorptivity near 2,500 Å (see below); the photometric method is used commercially when small or variable ozone amounts are involved.

Ozone absorbs most strongly in the ultraviolet part of the spectrum, between 2.000 and 3,000 Å, in the so-called Hartley region. The Huggins band, at 3,000–3,500 Å, and the Chappuis band in the visible centred near 6,000 Å, absorb less strongly. In the infrared, ozone has a sharp band at 4.8 μ and a strong band between 9.1 and 10.0 μ, the so-called 9.6-μ band.

Atmospheric Ozone.—Ozone is formed in the earth's upper atmosphere by the photochemical action of solar ultraviolet light. Mixing processes in the atmosphere transport it to lower levels, so that even near the earth's surface a detectable amount exists. The total amount of ozone in a vertical column above the earth's surface, if it were separated from the air with which it is mixed and brought to conditions of normal temperature and pressure, would form a gaseous column only a few millimetres high. (The height in centimetres of such an imaginary column is generally used as the unit to describe amounts of ozone in the atmosphere and is written "cm. NTP".) By contrast the entire atmosphere under the same conditions would reach to 8 km. However. even this minute amount of ozone is sufficient to absorb all the solar energy in the ultraviolet between about 2,100 and 2,900 Å, thus protecting life on the earth from a lethal excess of short-wave radiation. The energy so absorbed serves to heat the upper atmosphere and to produce temperatures near 50 km only slightly lower than those found at the earth's surface (see fig.).



A SCHEMATIC REPRESENTATION OF THE VERTICAL DISTRIBUTION OF OZONE AND TEMPERATURE. BOTH VARY IN DETAIL FROM TIME TO TIME AND PLACE TO PLACE

A few direct and many indirect (but crude) measurements of the distribution of ozone in the vertical have been made. The maximum density of ozone (mass of ozone per unit volume) in the vertical occurs near 22 km., although at times it may be as low as 1 j km. or as high as 30 km. The ozone density at the maximum is also variable. perhaps as low as .008 or as high as .030 cm. NTP per km. The maximum *concentration* (volume of ozone per unit volume of air) is believed to be near 35 km. and to have a value of about 10 parts per 1,000,000, although very few direct measurements have reached so high. The figure shows schematically the vertical distribution of ozone and temperature.

The total amount of ozone (in a vertical column above the earth's surface) has been determined many times by a spectrophotometric technique developed by G. M. B. Dobson. Northern hemisphere observations show a marked latitudinal variation, the minimum amount occurring near the equator. Except near the equator, where there is little annual variation, the maximum amount of ozone occurs in the spring, the minimum amount in the autumn. In addition, except in equatorial regions, there is marked variability from day to day that is correlated with meteorological conditions: ozone excesses usually occur a bit west of the centres of cyclones, deficits a bit west of the centres of anticyclones. A few observations in the southern hemisphere indicate the same over-all pattern of variability.

Ozone is constantly created and destroyed by photochemical processes in the atmosphere. The rates of creation and destruction depend on air density, air temperature, absorbed solar energy and ozone density. For specified values of the first three. one may calculate a value of ozone density for which these rates exactly balance one another. This is called the "photochemical-equilibrium" amount of ozone, which, of course, varies nith altitude, latitude and season. Such calculations agree well with measurements of ozone density above 25–30 km. They predict much less ozone than is observed in the lower stratosphere and troposphere, particularly at high latitudes in spring. Ozone is transported to these lower levels from above by meteorological processes that are as yet poorly understood. Net photochemical destruction then proceeds at such a slow rate that. for practical purposes, the ozone content of an air parcel is unchanging. Detailed observations of ozone density would assist the meteorologist to trace air motions in the lower stratosphere and upper troposphere.

Ozone is also created in relatively small amounts by lightning, and destroyed near ground level by contact with various atmospheric contaminants with which it is chemically active.

See also ATMOSPHERE.

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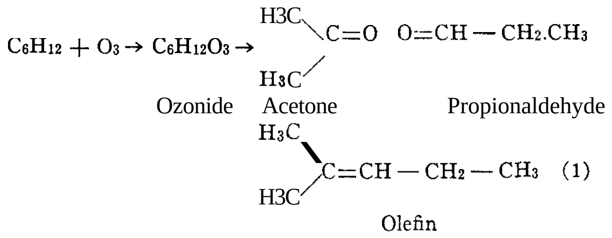
(R. A. CG.)

OZONOLYSIS is a reaction used in organic chemistry to determine the position of a carbon-carbon double bond in unsaturated compounds. It involves the reaction of the compound with ozone leading to the formation of an ozonide and the ozonide yields on hydrogenation or treatment with acid a mixture containing aldehydes, ketones or carboxylic acids. From the determination of the structure of the aldehydes and ketones so produced, it is possible to determine the position of the double bond in the original unsaturated compound. For example, if ozonolysis of an olefin, C_6H_{12}, yielded acetone and propionaldehyde, it could be deduced that the olefin had the structure (1) as indicated in the following scheme:



Ozonolysis has been used very extensively in the determination of the structure of natural products, particularly the terpenes (*q.v.*). It has also been used in the study of the structure of aromatic compounds (see BENZENE) and for the synthesis of rare aldehydes and ketones. Thus oleic acid on ozonolysis yields n-nonanal (pelargonic aldehyde) and azelaic semialdehyde:

$$CH_3(CH_2)_7.CH{=}CH.(CH_2)_7.CO_2H \rightarrow CH_3(CH_2)_7CHO + OCH(CH_2)_7.CO_2H$$

The detailed structure of the ozonides is still under examination and researches (L. Long, Chem. Rev., 27:437; (1940); P. S. Bailey, Chem. Rev. 58:925 (1958)) indicate that a much greater variety of structure than that shown by the pioneering studies of H. Staudinger is possible for the ozonides.

(W. D. Os.)

END OF VOLUME SIXTEEN

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